



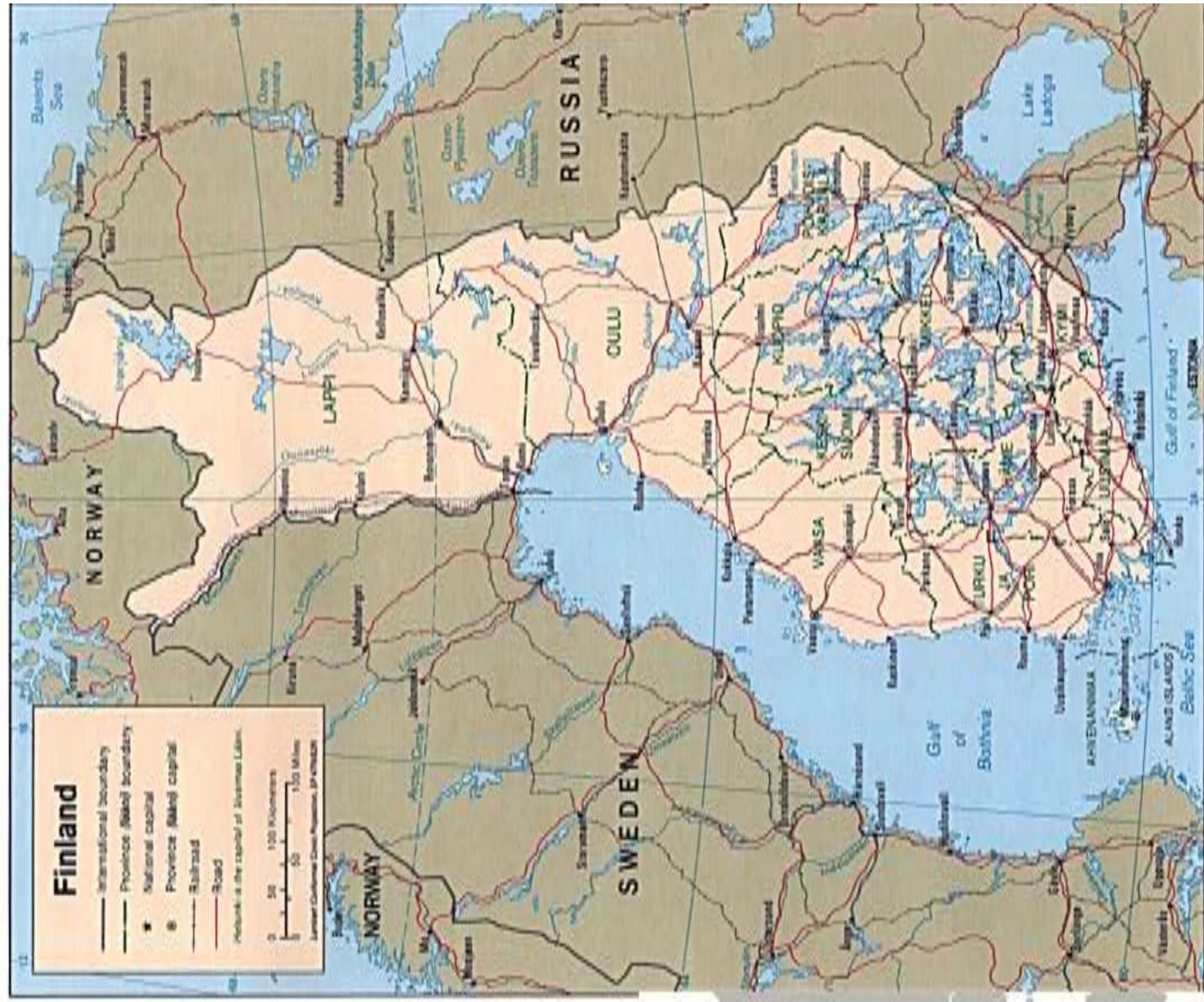
BEHAVIOURAL INFORMATICS

Supporting healthy lifestyles

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Where Do I Come From?



Digital Health @ VTT

Citizen-centric services using digital tools

<http://www.vttresearch.com/services/health-and-wellbeing/digital-health>



Health monitoring

- Mobile health and wellness applications
- Tools for self-management and behaviour change
- EHR, PHR, interoperability and standards.



<https://headsted.fi/>

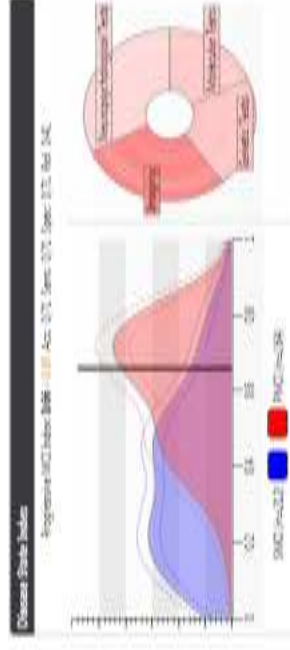


<http://euro.pulseon.com/>



Human data analysis

- Biosignal and medical image analysis
- Mining and fusion of heterogeneous multi-variate data
- Clinical decision support tools



<http://www.combinostics.com/>

Health



The ability to adapt and self manage in the face of social, physical, and emotional challenges.

BMJ 2011;343:d4817



“Non-Communicable Diseases are diseases that will break the bank”

Margaret Chan, Director General, WHO 2011



World Health Organization

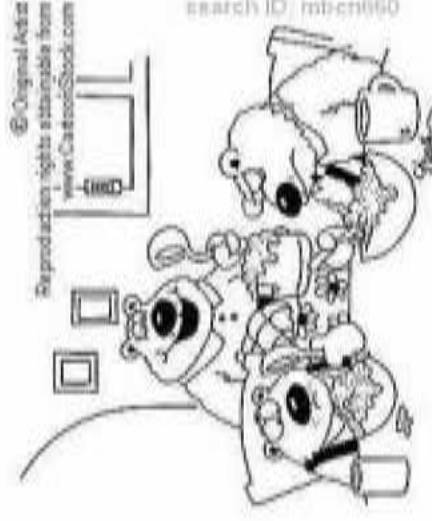
Globally, deaths due to chronic diseases exceed 35 million annually. Nearly 2/3 of deaths are due to chronic diseases.

In USA 75% of health expenditure is caused by non-communicable (chronic) diseases.



Disease prevention through behavior change

- Each day, people make numerous choices that affect their health
- Many chronic diseases stem from lifestyle-related reasons such as
 - Prolonged stress
 - Lack of sleep
 - Insufficient exercise
 - Excessive use of alcohol
- Behavior is influenced by
 - Personal abilities and interests
 - What is available in terms of healthy and unhealthy choices
 - Social support and pressure





PREVE: ICT research directions in disease prevention FP7, 2010, CSA

1. It's about individuals deciding on their own free will that a lifestyle change is needed
2. It's about providing from the outside support to make the change and to maintain the course
3. It's about creating a supportive environment for healthy behaviours
4. It's about orchestrating the interactions of individuals with their environment
5. It's about setting the rules of the game for the **Health Outreach ecosystem**.

Home

- Ambient sensing**
- Sleep (bed sensor)
 - Sedentarism (TV, sofa)
 - Eating (fridge)
 - Weight (floor sensors)
 - Environment (lighting, temperature)
 - Lab tests
 - Measurements: blood pressure, blood glucose

- Interventions**
- TV
 - Game console
 - PC

Profile-based offers

Shopping assistant:
which product is good for me?

Exercise facilities

Personal trainer

ment, shops, dining



***International Workshop on New Computationally-Enabled Theoretical Models to Support Health Behavior Change and Maintenance
Brussels, October 2012***

Experts from the European Union (15) and the United States (15): e-, tele- and mHealth (mental health, metabolic health, substance use), web marketing, persuasive technologies, policy, physics, systems science, economics, clinical, health & behavioral psychology, gaming, informatics and communications technology, artificial intelligence, human computer interactions, health informatics, computer science, biomedical engineering, health disparities, medicine (chronic disease, endocrinology, primary care), public health and public health law, art and design.



How can ICT be used for lifestyle management and behaviour change?

- Behavioural Informatics =
- The science and technologies of ICT supported lifestyle management and behaviour change =

Moving Behavioural Sciences into the 21st Century

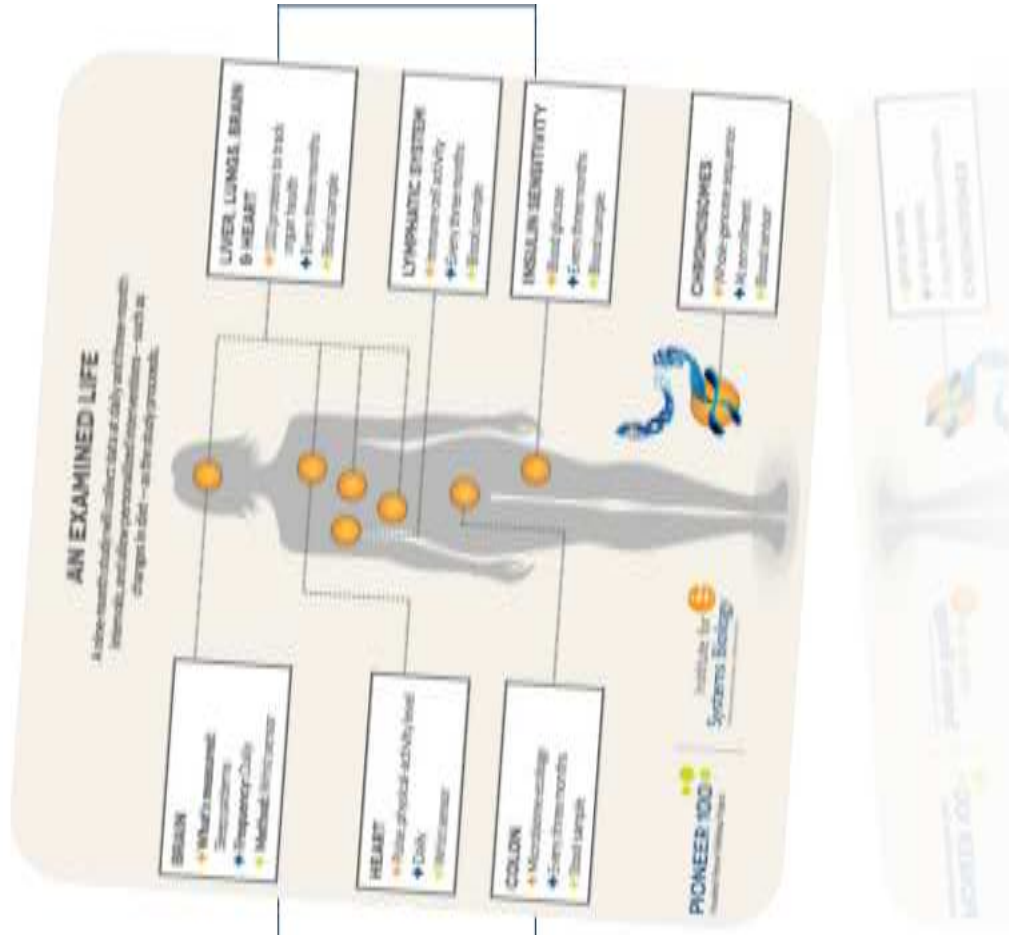


Presentation outline

- NCDs
- Lifestyle → 24/7
- People are different
- Theories of behaviour change
- Role of ICT
- Ethics and Privacy
- Concluding



HEALTH BEHAVIOURS AND NON COMMUNICABLE DISEASES ARE LINKED

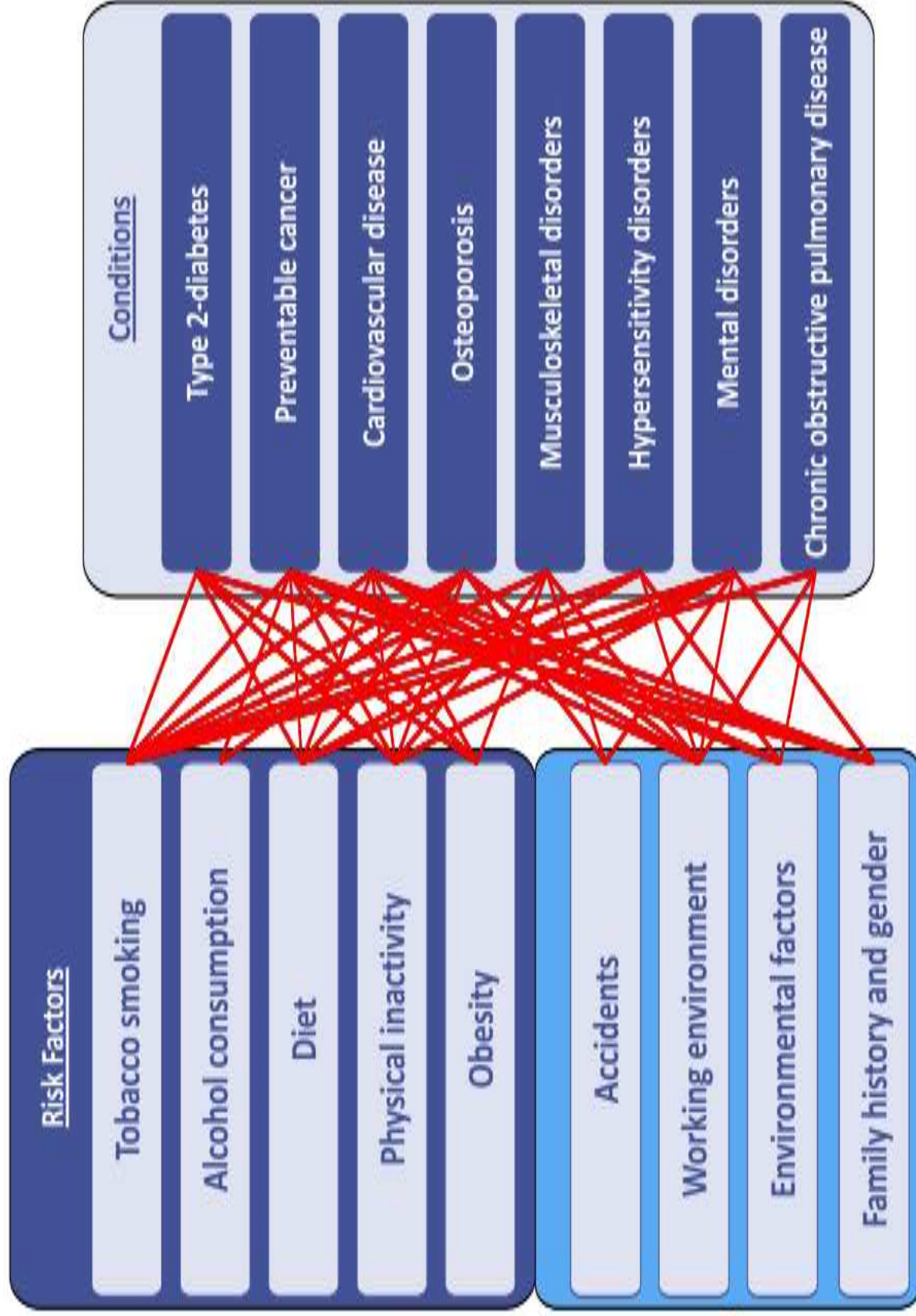




**Modifiable
by Citizens**

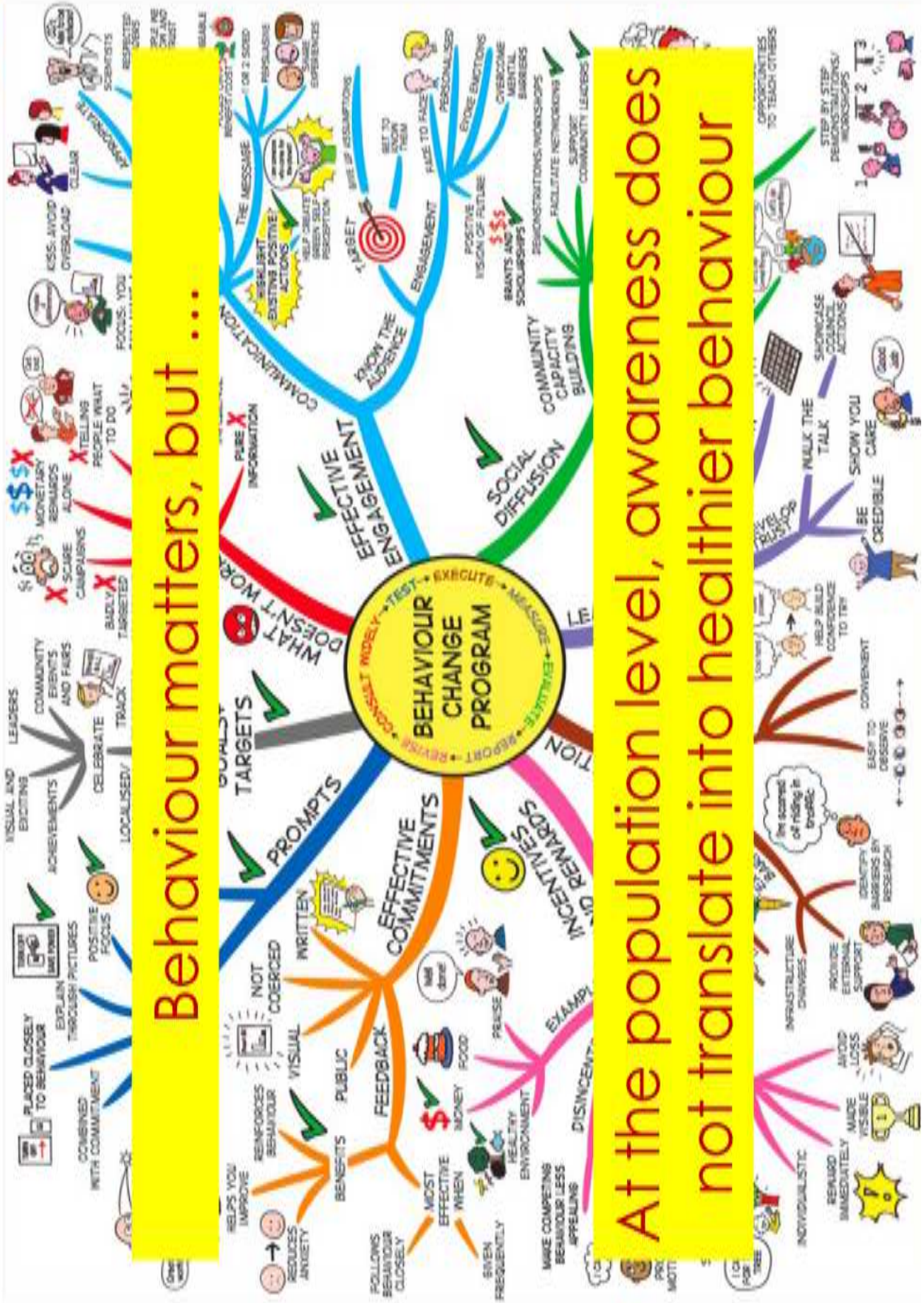
**Non-Modifiable
by Citizens**

Evidence Based Associations between Risk Factors and Conditions



Behaviour matters, but ...

At the population level, awareness does not translate into healthier behaviour



WHAT IS LIFESTYLE?





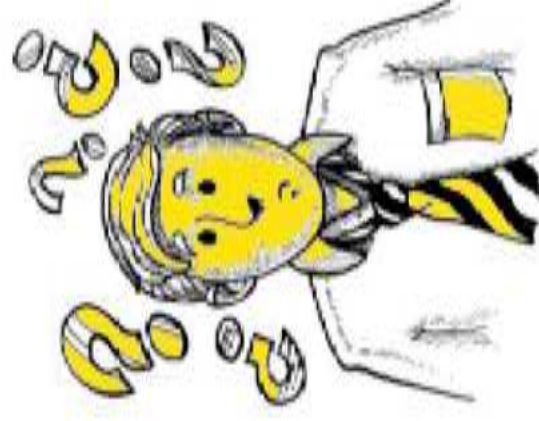
PREVE

Lifestyle: what does it really mean?

He needs to **remember**
what to do, and when
for drug intake, physiological
parameters monitoring,...
at work, at home,
at school, on the move

He needs to **comply**
with medical advices...
while shopping,
cooking, eating,
exercising

He needs
to **get educated &
timely updated**
on topics of his/her
own interest





Lifestyle: what does it really mean?

Pharma Industry

Hospital

Physical Activity

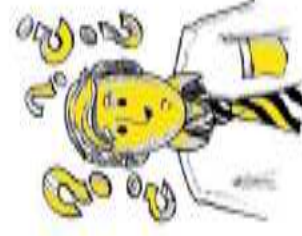
Supermarket

Home

Food Industry

Media Industry

Pharmacy



Medical Doctor

Workplace

Mobility

School

Lifestyle: what does it really mean?

Health and Well-Being is a **CROSS-MARKET** service!

Pharma Industry

Hospital

Physical Activity

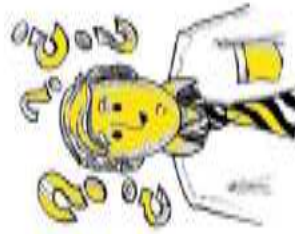
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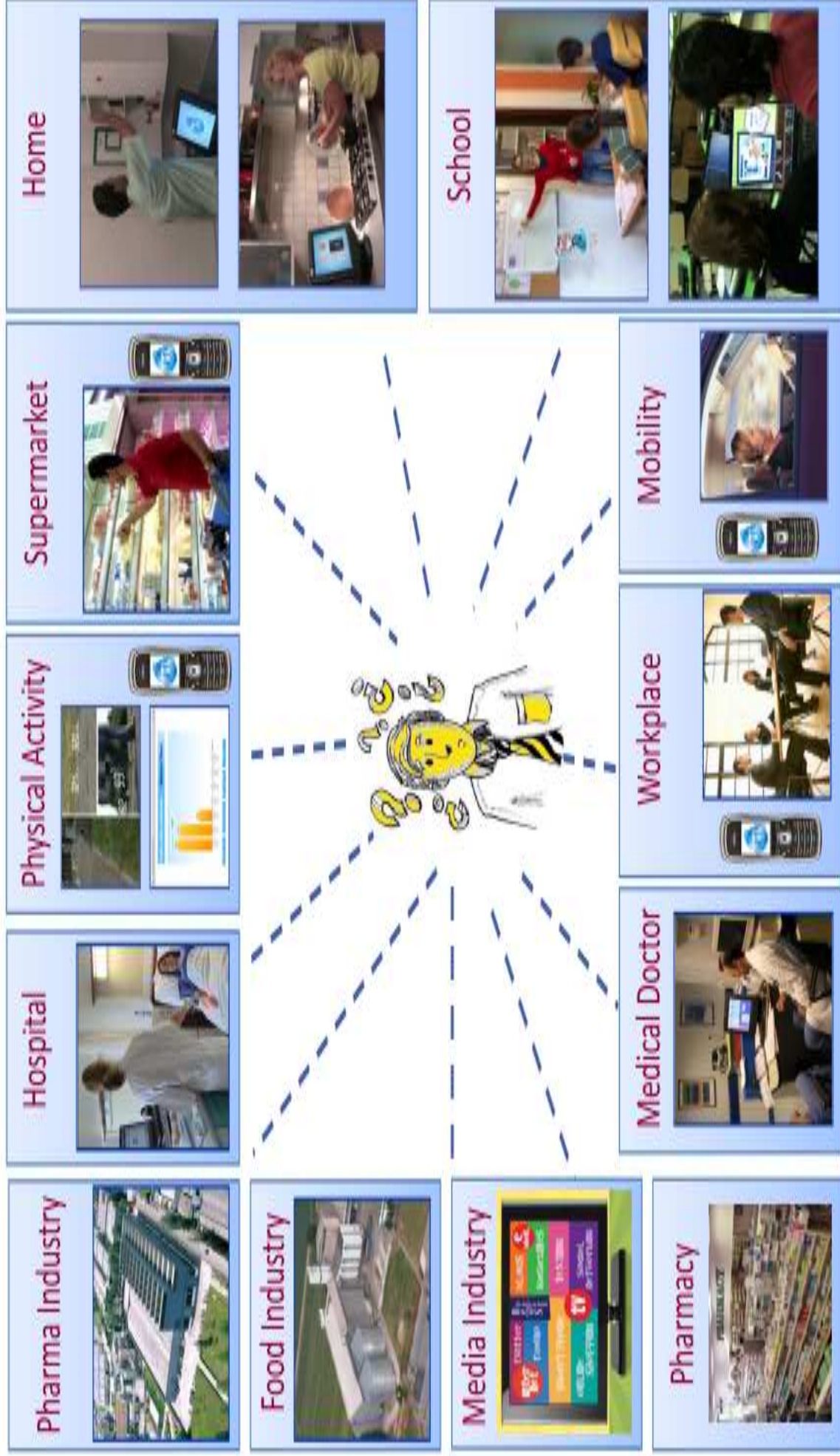
Medical Doctor

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Mobility

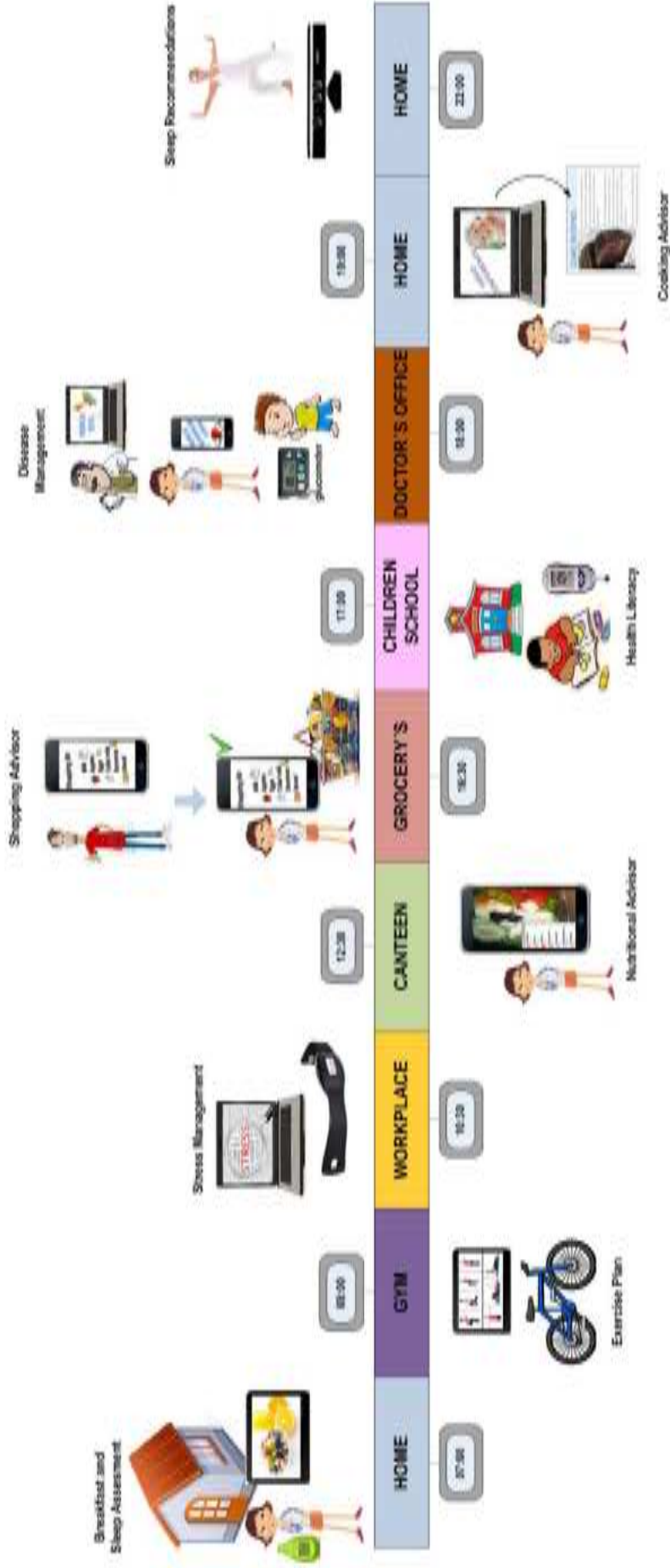
School

Personalized e-Services for Life and Health ... to educate, motivate & assist in making informed choices in daily life





Health (behaviour) is co-created



Behavior is generated through on-going dynamic, shifting interactions between the **individual** and the **social** and the **physical environment** over time.

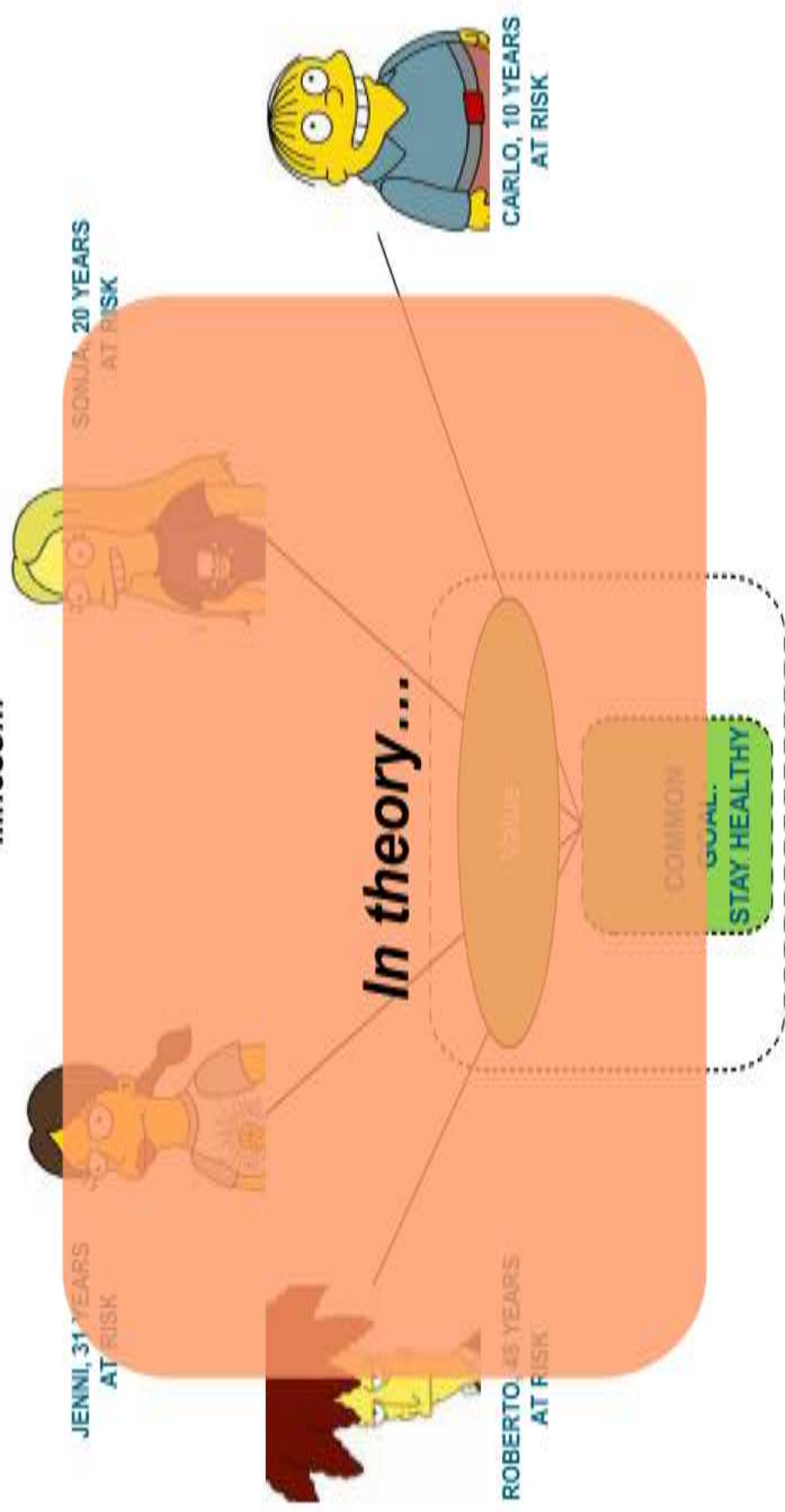


PEOPLE ARE DIFFERENT



VALUE PROPOSITION

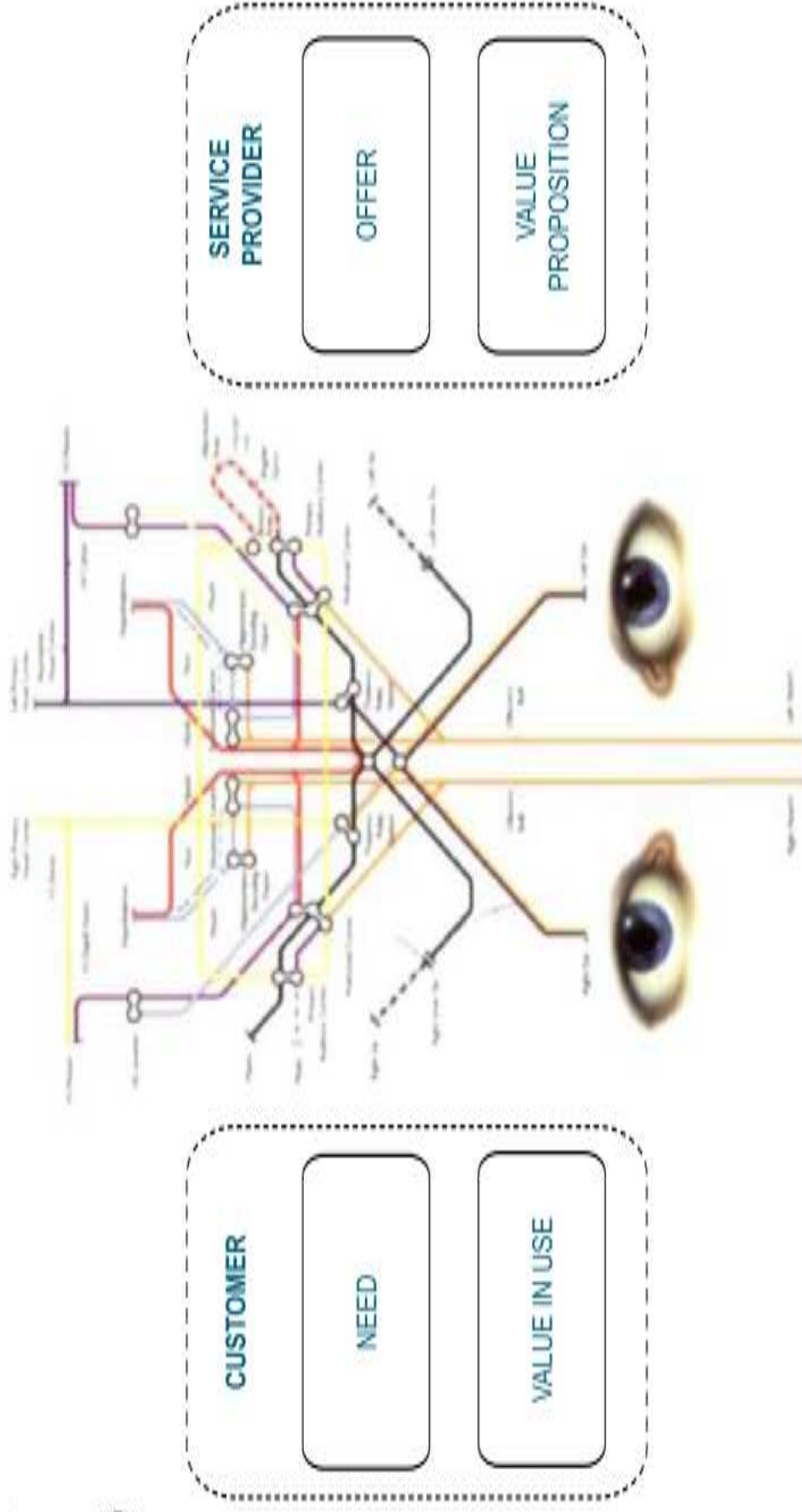
All persons *healthy* or *at risk of developing an illness*...





VALUE PROPOSITION

“Everybody has their own mental model.”



What does this mean?



VALUE PROPOSITION revisited



JENNI, 31 YEARS
AT RISK



SONJA, 20 YEARS
AT RISK



ROBERTO, 48 YEARS
AT RISK



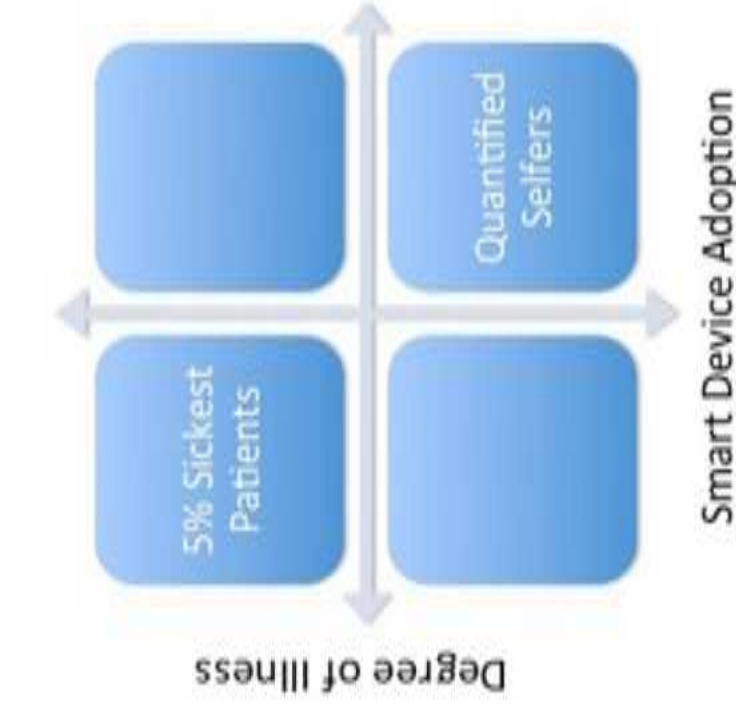
CARLO, 10 YEARS
AT RISK

In practice...

We are all different & motivated by different things in our life situations

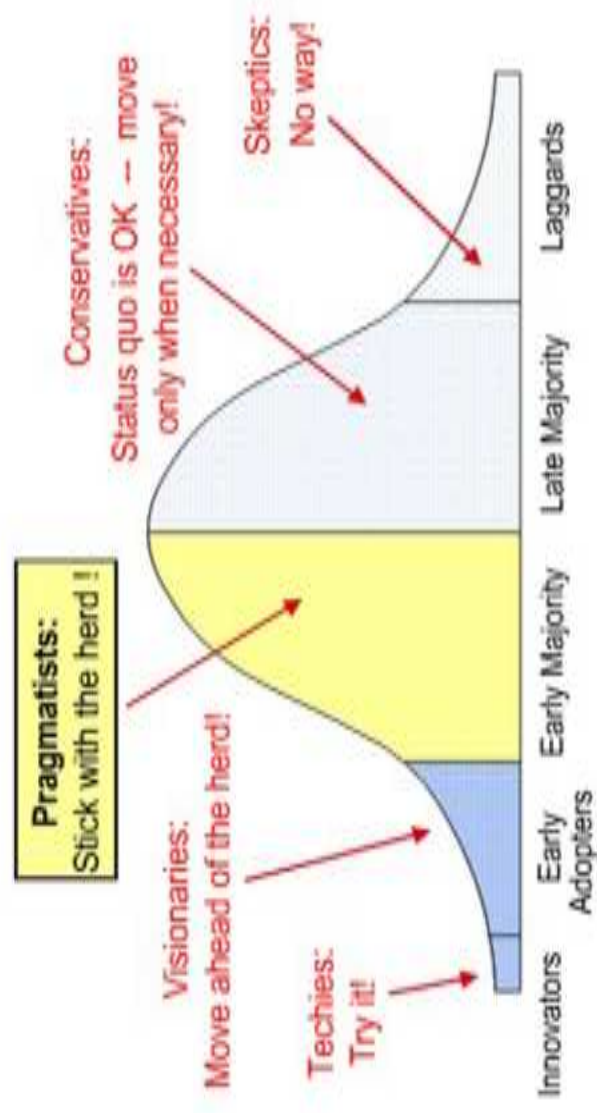
1) LONG TERM
BEHIND OTHER

We need to reach the "95%"



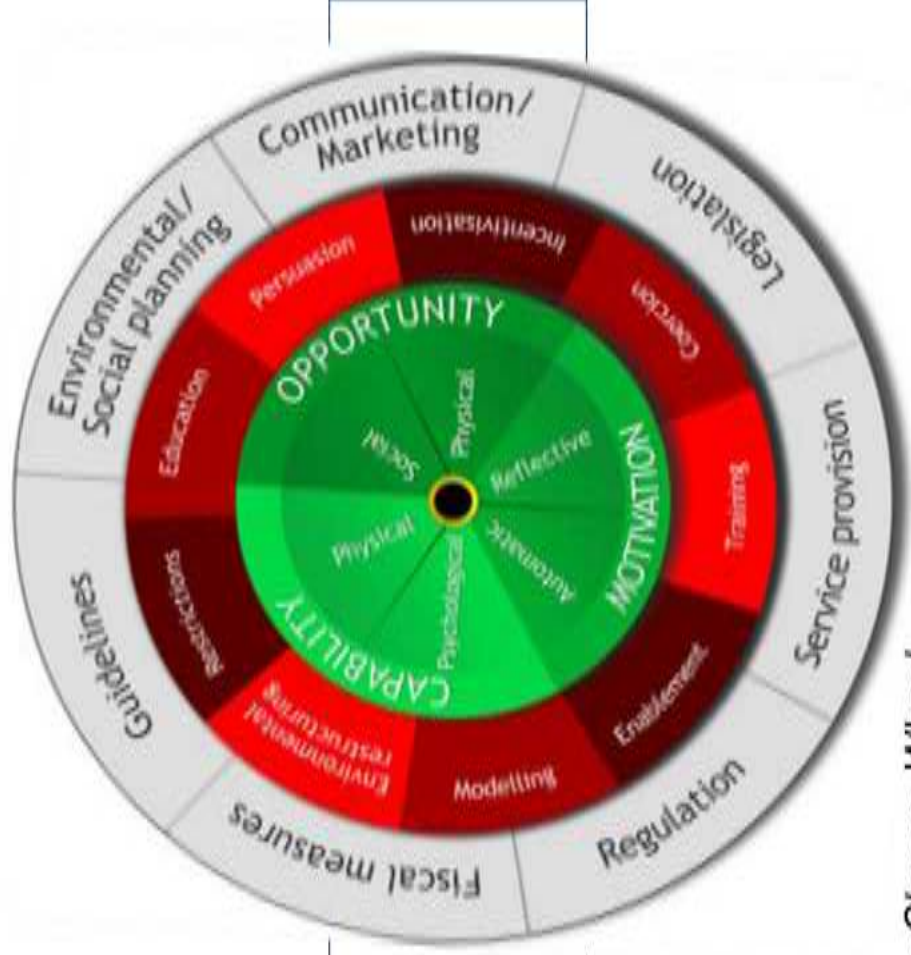
High-Tech Markets develop in a relatively predictable pattern ...
 ... based on the changing behavior of customers

Quadrant



Pragmatists are crucial to the adoption of new technologies -- they cast the deciding vote.

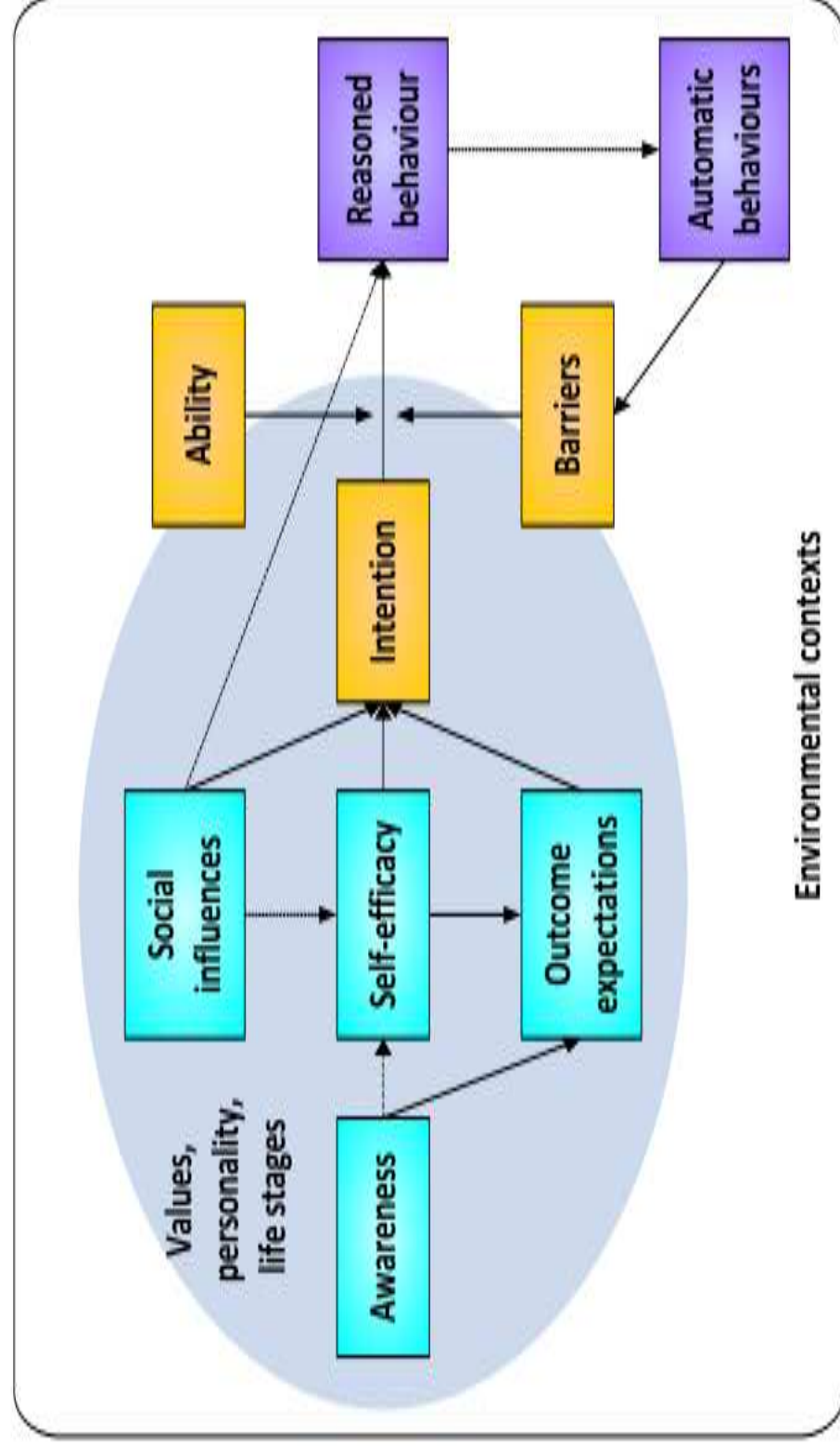
THEORIES AND INTERVENTIONS ON BEHAVIOUR AND BEHAVIOUR CHANGE



Behaviour Change Wheel
(S. Michie)



Determinants of health behavior



Environmental contexts

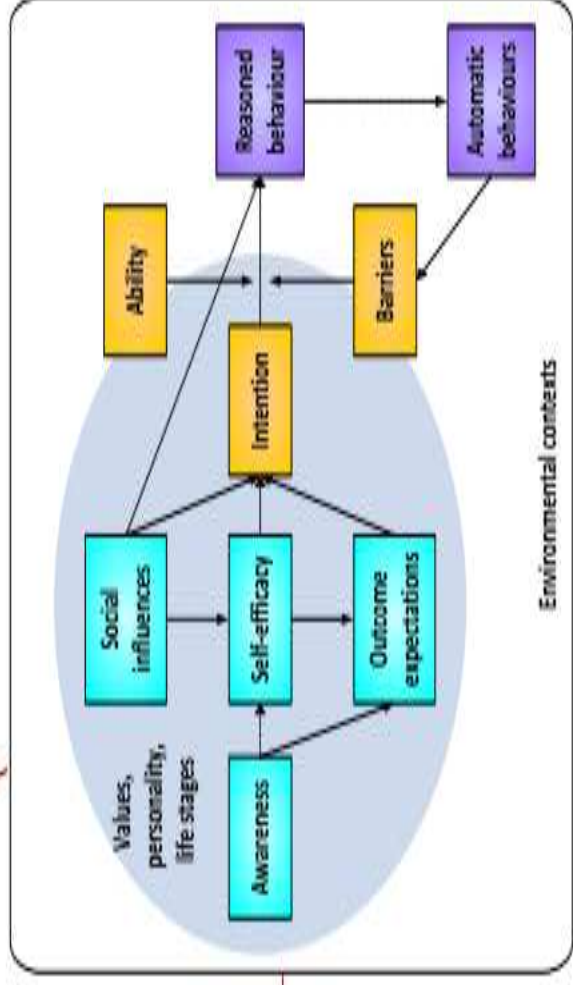
Dynamic user model (personal profile)

Risk stratification

- Health risks & behaviours
- Genetic risks



Personal preferences



Kahneman's "fast and slow"

- System 1 is automatic, makes judgments subject to biases and heuristics
- System 2 is slow, effortful, conscious and rule-based
- Dual process theories found in social, personality, cognitive, and clinical psychology are based on similar principles.



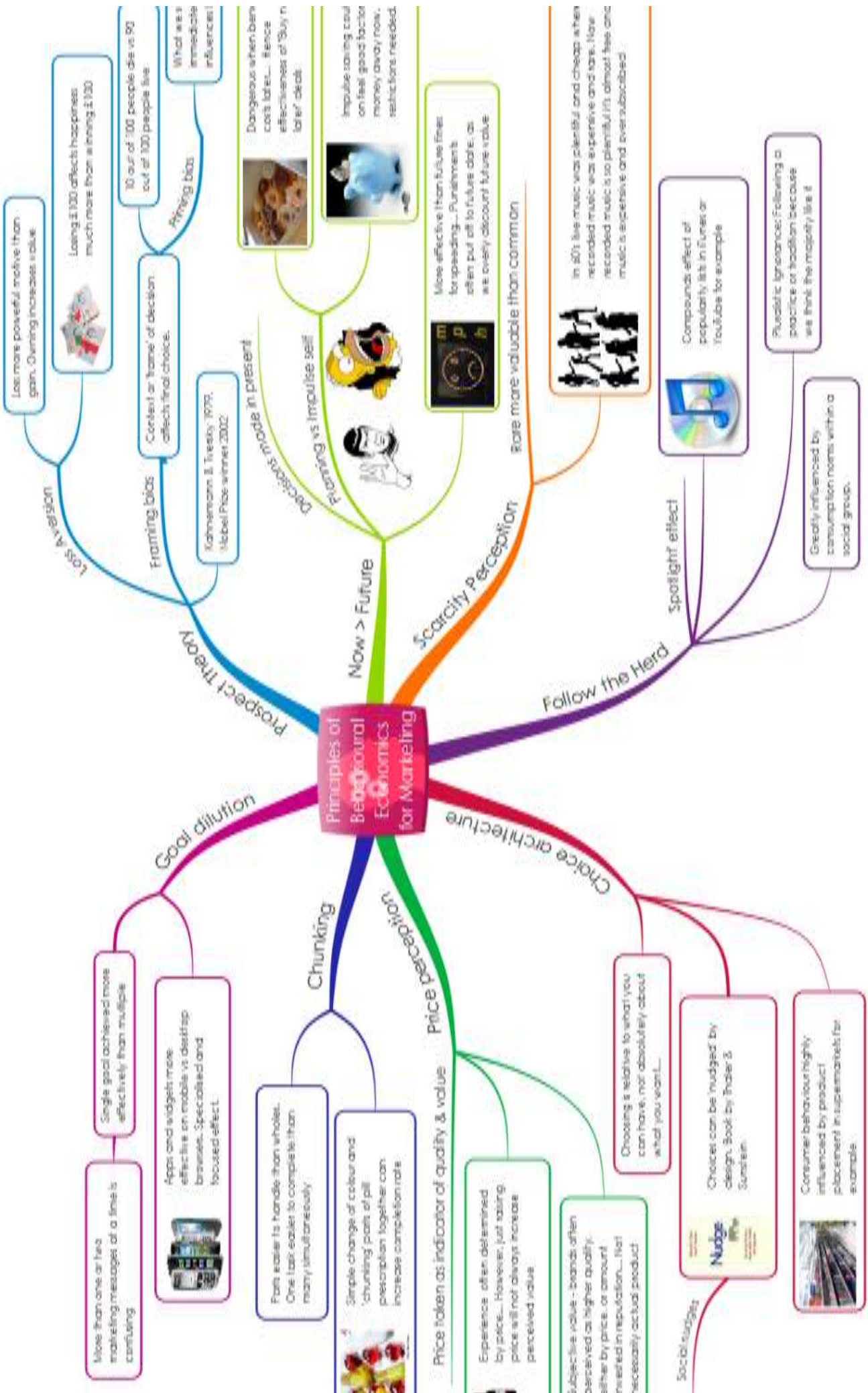
”ABC of Behaviour Change Theories”

83 theories

S. Michie et al,
www.behaviourchange theories.com
<http://www.bct-taxonomy.com>

1. Action Theory Model of Consumption
2. Affective Events Theory
3. Adult Risk Reduction Model
4. Behavioural Ecological Model of Adolescent
Adult Prevention
5. CEOS Theory
6. Change Theory
7. Classical Conditioning
8. COM-B System
9. Consumption as Social Practices
10. Constraint Theory
11. Control Theory
12. Differential Association Theory
13. Diffusion of Innovations
14. Ecological Model for Preventing Type 2 Diabetes
in Minority Youth
15. Embedded Information Processing Model
16. Embedded Parallel Processing Model
17. Feedback Intervention Theory
18. Focus Theory of Normative Conduct
19. General Theory of Crime
20. General Theory of Deviant Behaviour
21. Goal Directed Theory
22. Goal-Framing Theory
23. Goal Setting Theory
24. Health Action Process Approach
25. Health Behaviour Goal Model
26. Health Behaviour Intervention Model
27. Health Belief Model
28. Health Promotion Model
29. I-Change Model
30. Information-Motivation-Behavioural Skills Model
31. Information-Motivation-Behavioural Skills Model of Adherence
32. Integrated Theoretical Model for Alcohol and Other Drug Abuse
Prevention
33. Integrated Theory of Doping Behaviour
34. Integrated Theory of Health Behaviour Change
35. Integrative Model of Behavioural Prediction
36. Integrative Model of Factors Influencing Smoking Behaviour
37. Integrative Model of Health Attitude and Behaviour Change
38. Integrative Model of Factors Influencing Smoking And Attitude
And Health Behaviour Change
39. Model of Pro-Environmental Behaviour
40. Motivation-Opportunities-Abilities Model
41. Needs-Opportunities-Abilities Model
42. Norm Activation Theory
43. Openair Learning Theory
44. Protection Adoption Process Model
45. Pressure System Model
46. PRAIE Theory
47. Problem Behaviour Theory
48. Prospect Theory
49. Protection Motivation Theory
50. Prototype Willingness Model
51. Rational Addiction Model
52. Reflective Impulsive Model
53. Regulatory Fit Theory
54. Relapse Prevention Model
55. Risk as Feelings Theory
56. Self-Determination Theory
57. Self-Efficacy Theory
58. Self-Regulation Theory
59. Six Staged Model of Communication Effects
60. Social Action Theory (1)
61. Social Action Theory (2)
62. Social Change Theory
63. Social Cognitive Theory
64. Social Consensus Model of Health Education
65. Social Development Model
66. Social Ecological Model of Behaviour Change
67. Social Ecological Model of Walking
68. Social Identity Theory
69. Social Influence Model of Consumer Perceptions
70. Social Learning Theory
71. Social Norms Theory
72. Systems Model of Health Behaviour Change
73. Technology Acceptance Model 1, 2 & 3
74. Temporal Self-Regulation Theory
75. Terror Management Theory
76. Terror Management Health Model
77. Theory of Interpersonal Behaviour
78. Theory of Normative Social Behaviour
79. Theory of Planned Behaviour
80. Theory of Triadic Influence
81. Transcendental Model of Motivation
82. Translational Model of Behaviour Change
83. Value Belief Norm Theory

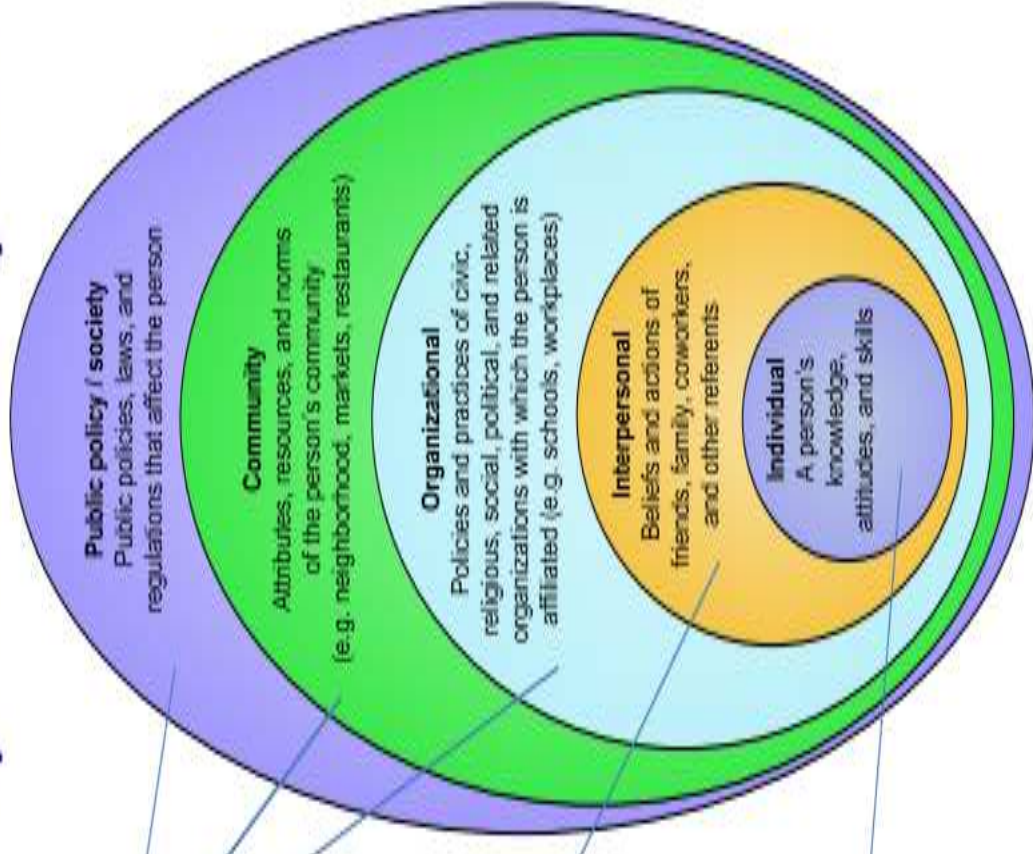
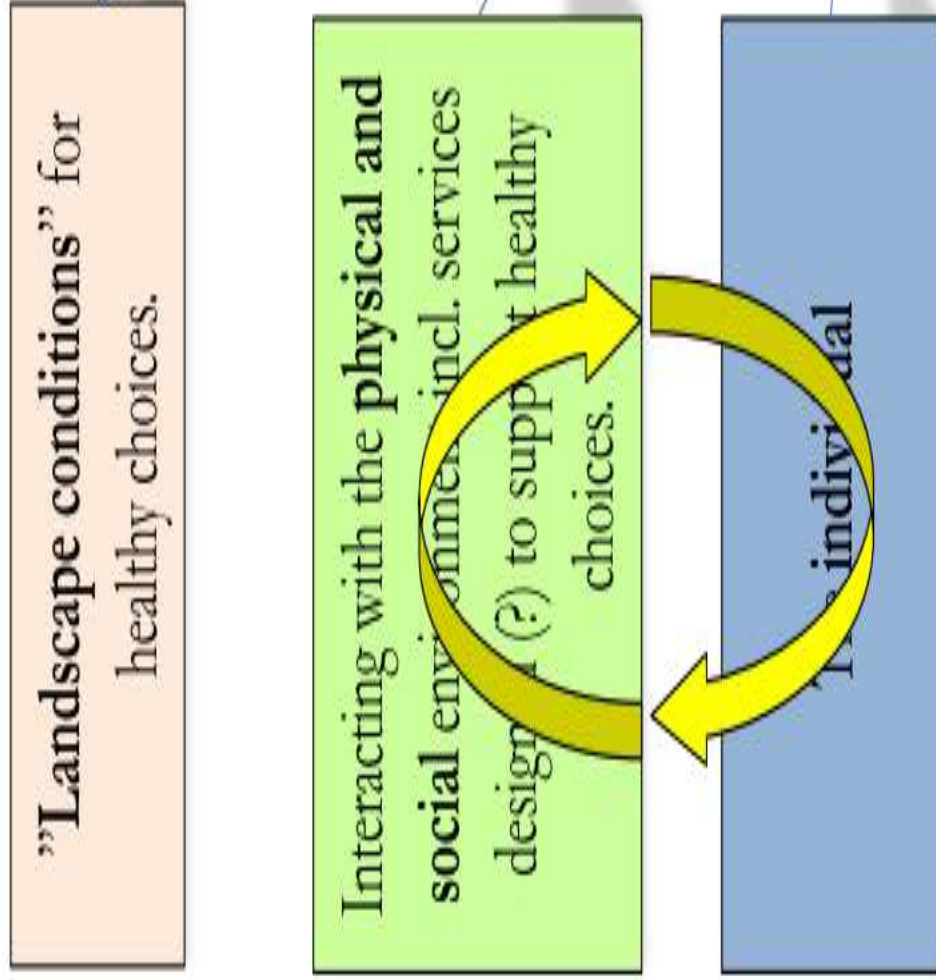
Principles of Behavioural Economics for Marketing





Health co-creation

Three interacting time-dependent layers





NO SHORTAGE OF APPS SENSORS, (SOON) OPEN PLATFORMS



Thousands of sensors and apps for mobile phones, e.g.

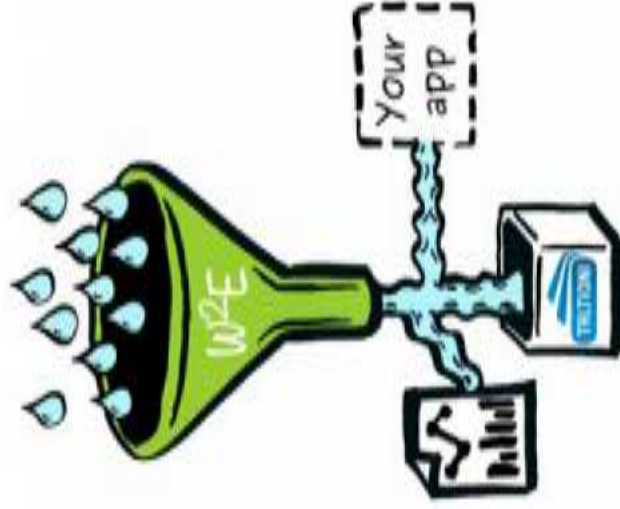




Platforms (open and proprietary) and tools for visualizing are emerging, e.g.

W2E

Wellness Warehouse
Engine
w2e.fi/#/



24/03/2015

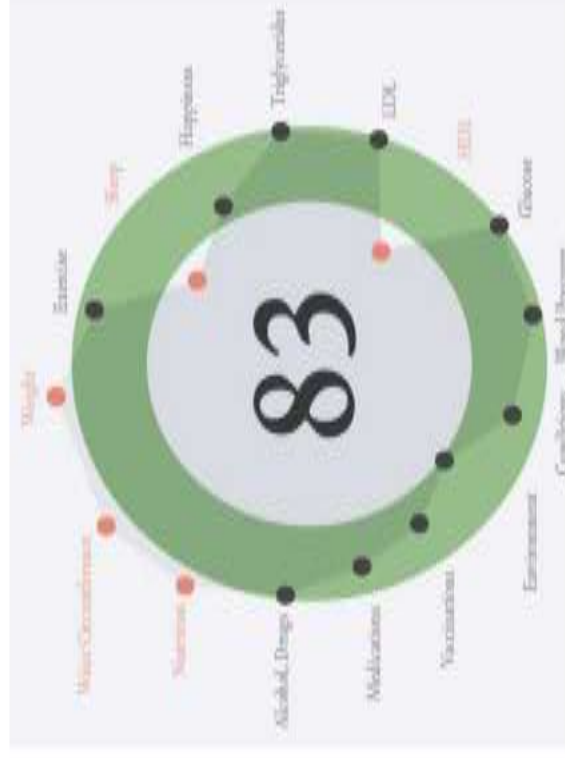
Apple

ResearchKit
www.apple.com/researchkit/



hGraph

Open source system for
visualizing personal
health metrics
hgraph.org/

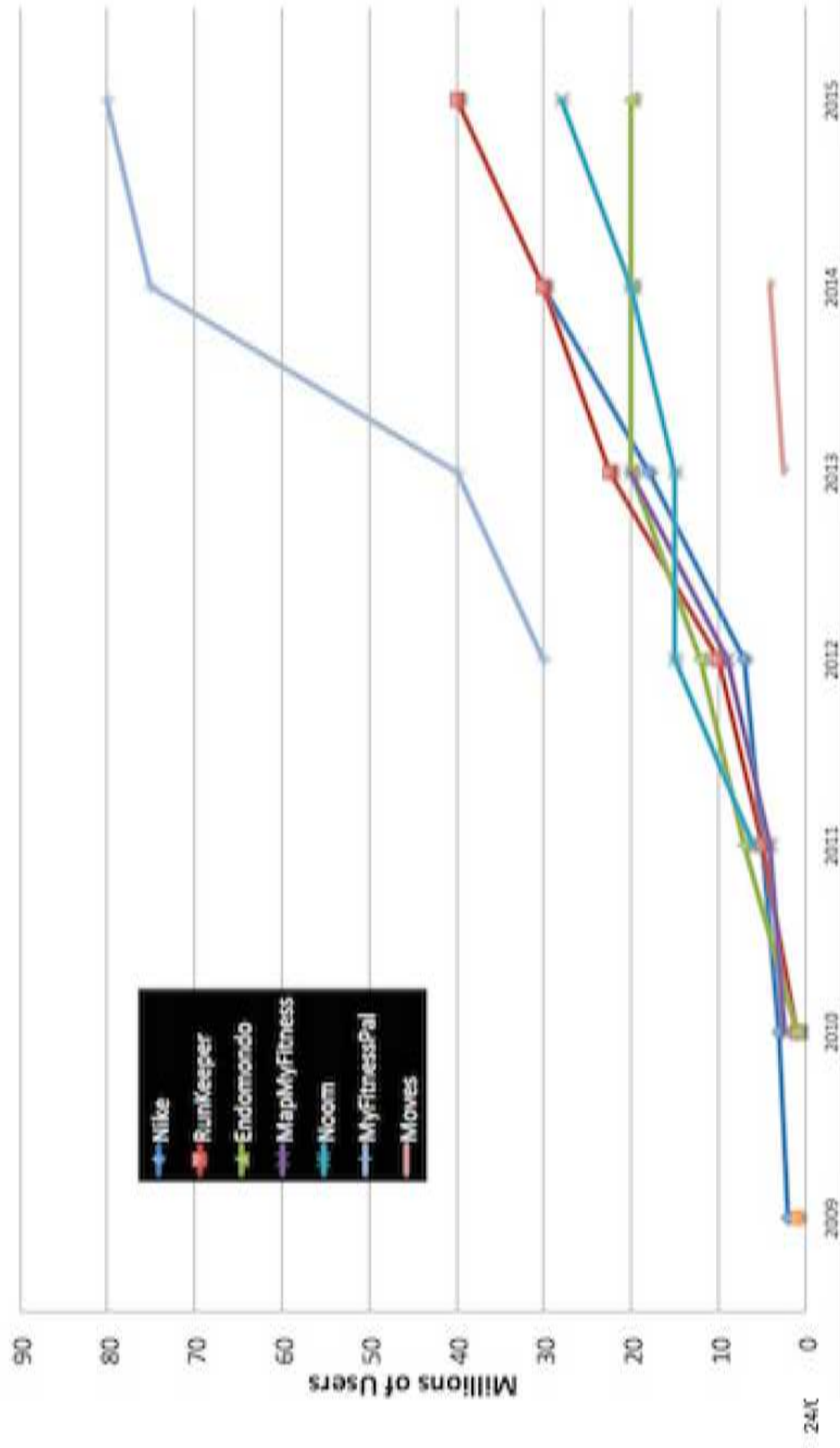


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“A Brief History of Fitness Tracking Apps”

MobiHealthNews | Feb 6, 2015





But these will not be enough

- We need solutions that “close the loop”
 - It needs to be personalized
 - It needs to be engaging
 - It needs to work in the everyday life context

Wearable Devices as Facilitators, Not Drivers, of Health Behavior Change

VIEWPOINT

Mitlesh S. Patel,
MD, MBA, MS
Philadelphia VA
Medical Center,
University of
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David A. Asch,
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University of
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Kevin G. Volpp,
MD, PhD
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Medical Center,
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Philadelphia

Several large technology companies including Apple, Google, and Samsung are entering the expanding market of population health with the introduction of wearable devices. This technology, worn in clothing or accessories, is part of a larger movement often referred to as the “quantified self.” The notion is that by recording and reporting information about behaviors such as physical activity or sleep patterns, these devices can educate and motivate individuals toward better habits and better health. The gap between recording information and changing behavior is substantial, however, and while these devices are increasing in popularity, little evidence suggests that they are bridging that gap.

Only 1% to 2% of individuals in the United States have used a wearable device, but annual sales are projected to increase to more than \$50 billion by 2018.¹ Some of these devices aim at individuals already motivated to change their health behaviors. Others are being considered by health care organizations, employers, insurers, and clinicians who see promise in using these devices to better engage less motivated individuals. Some of these devices

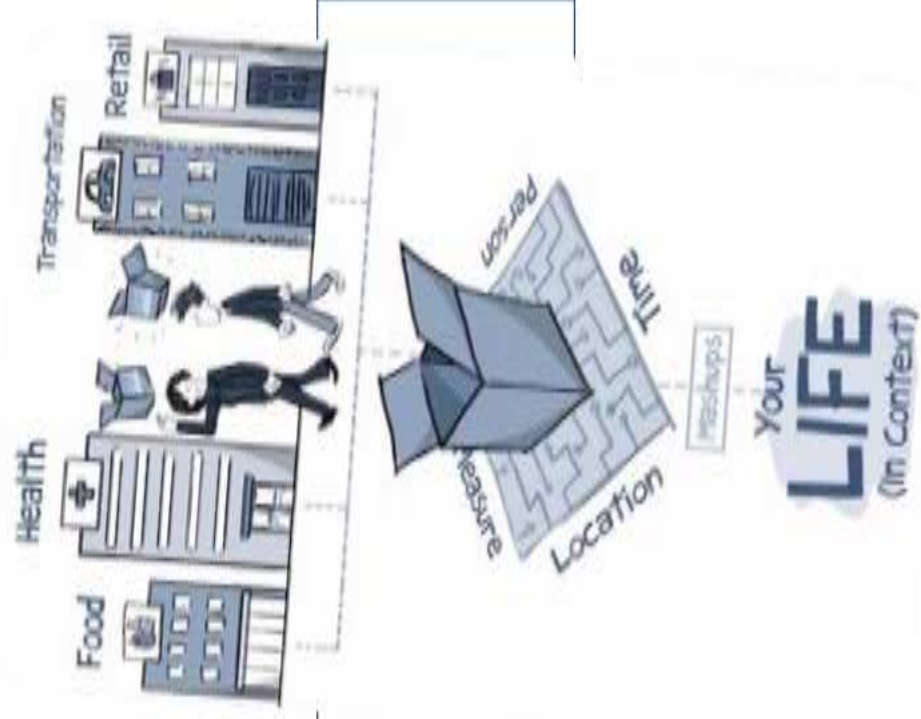
Identifying and Addressing the Gaps

Using wearable devices to effectively promote health behavior change is a complex, multistep process. First, a person must be motivated enough to want a device and be able to afford it; this is a challenge, because some devices can cost hundreds of dollars. Perhaps for these reasons, wearable devices seem to appeal to groups that might need them least. In a survey of wearable device users, 75% described themselves as “early adopters of technology,” 48% were younger than 35 years, and 29% reportedly earn more than \$100,000 annually.⁴ The individuals who might have the most to gain from these devices are likely to be older and less affluent. To better engage these individuals, wearable devices must be more affordable, or new funding mechanisms are needed. For example, employers and insurers might pay for a device that helps individuals better adhere to their medications, potentially yielding significant downstream health care savings. Or, devices that demonstrate effectiveness could be financed in a manner similar to that for prescription drugs.

Published Online: January 8, 2015. doi:10.1001/jama.2014.14781.

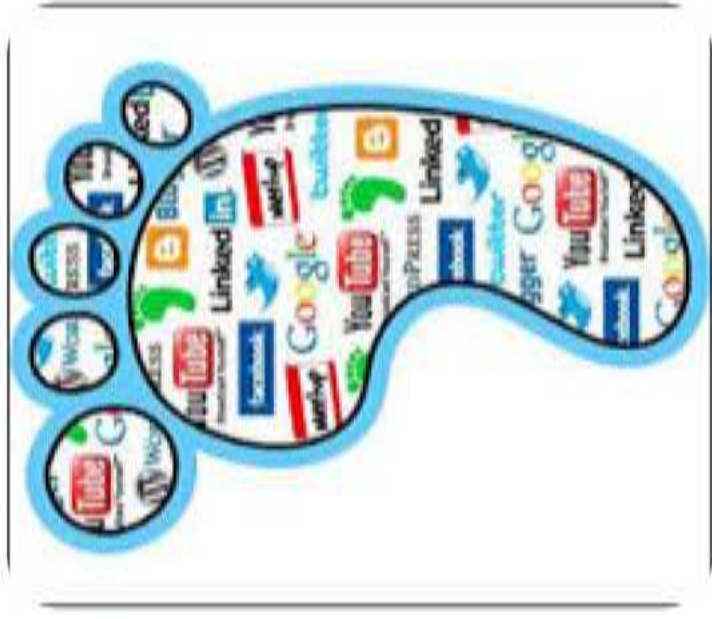
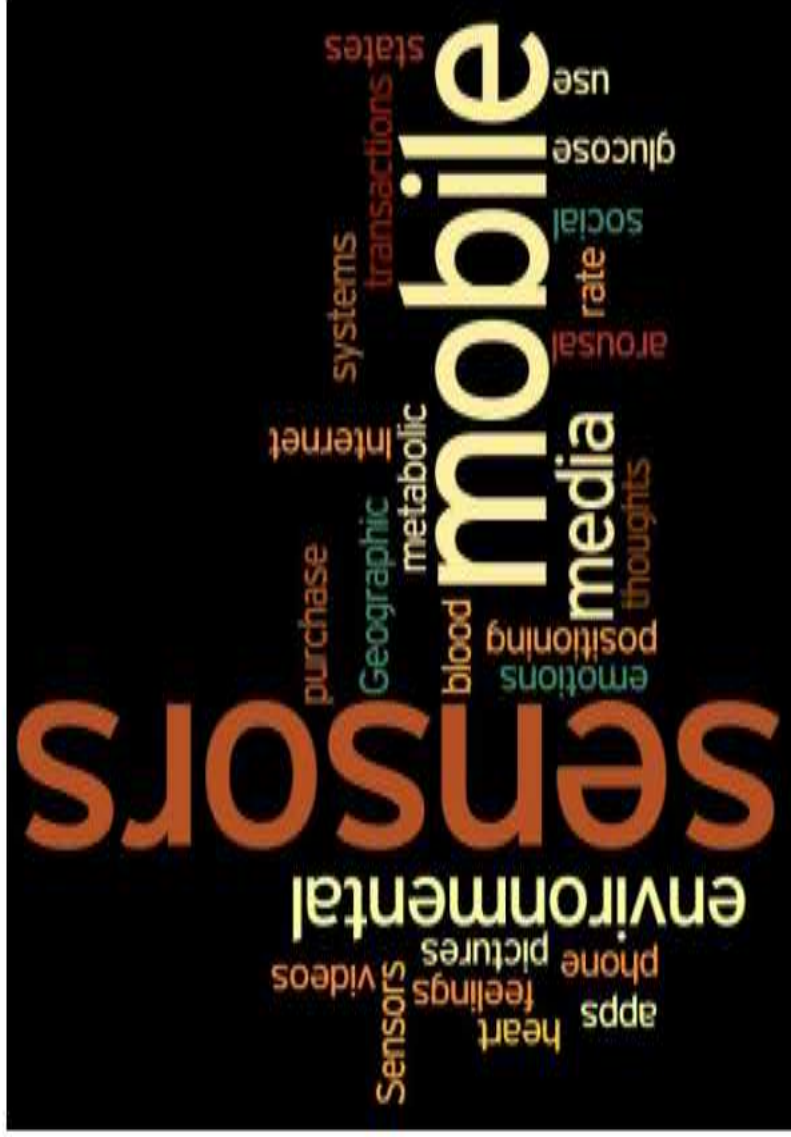


WE WILL NEED TO MOVE BEHAVIOURAL SCIENCES INTO 21ST CENTURY



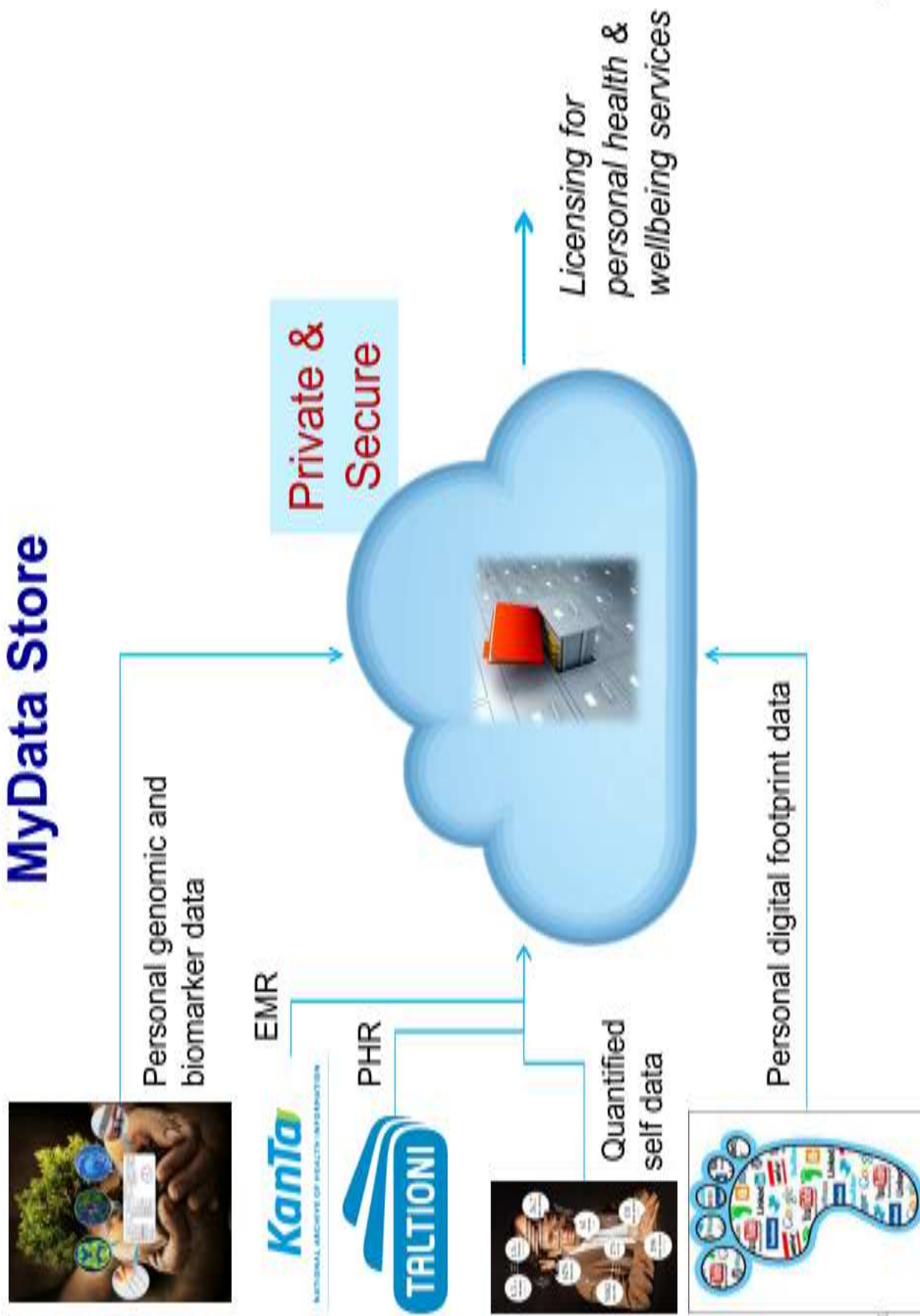
www.youtube.com/watch?v=y1txYjoSQQc





Our digital 'footprints' record our behavior in context and real time.

MyData Store



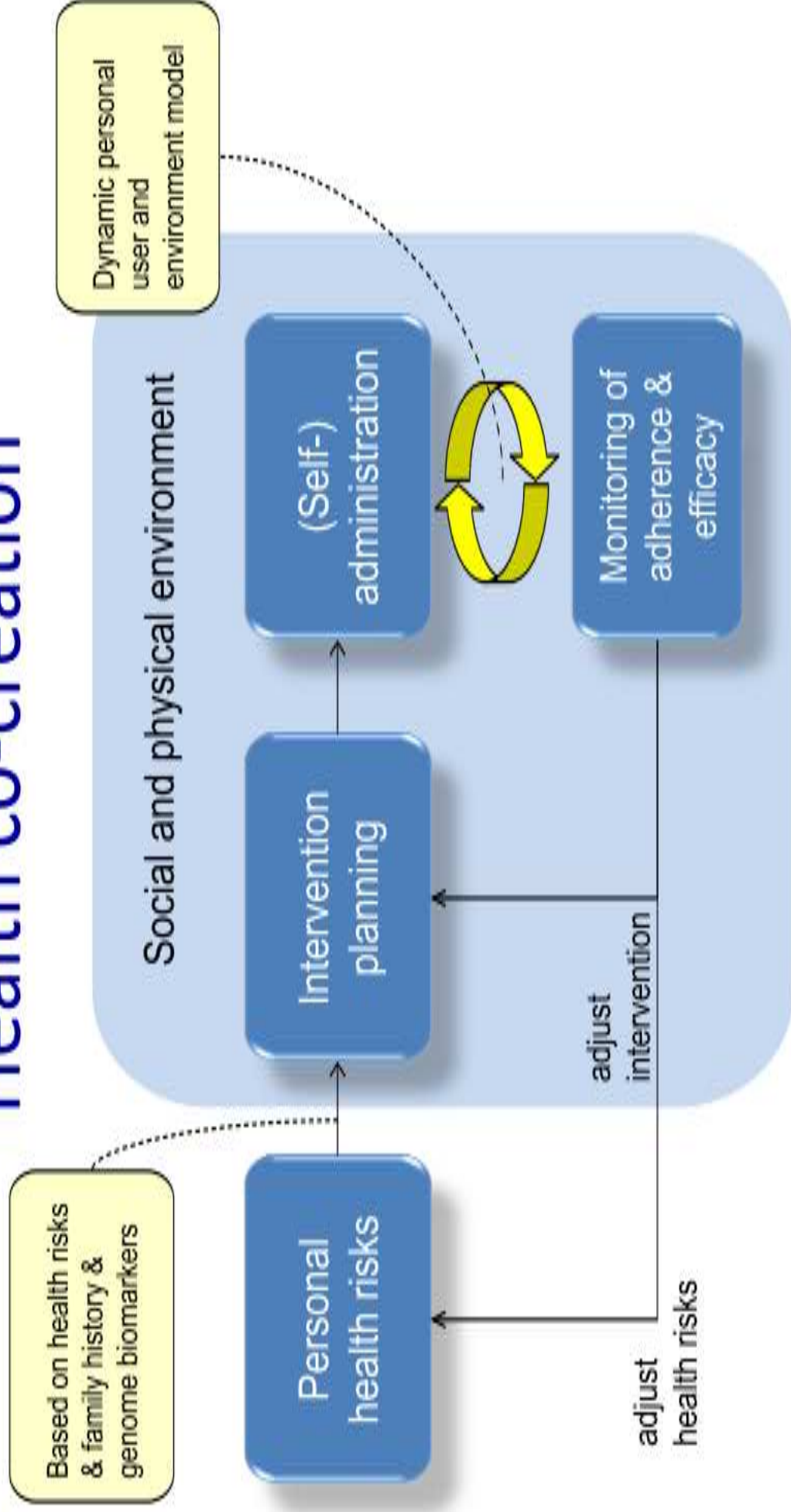
MyData – ethics , privacy, security, see e.g.

- Open knowledge, <https://okfn.org/>
- EU Commission
 - **Ilves report**
<http://www.president.ee/images/stories/pdf/ehtf-report2012.pdf>
- World Economic Forum
 - **Rethinking Personal Data**
<http://www.weforum.org/projects/rethinking-personal-data>
- Midata lab
<http://www.midatalab.org.uk/>
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Health co-creation

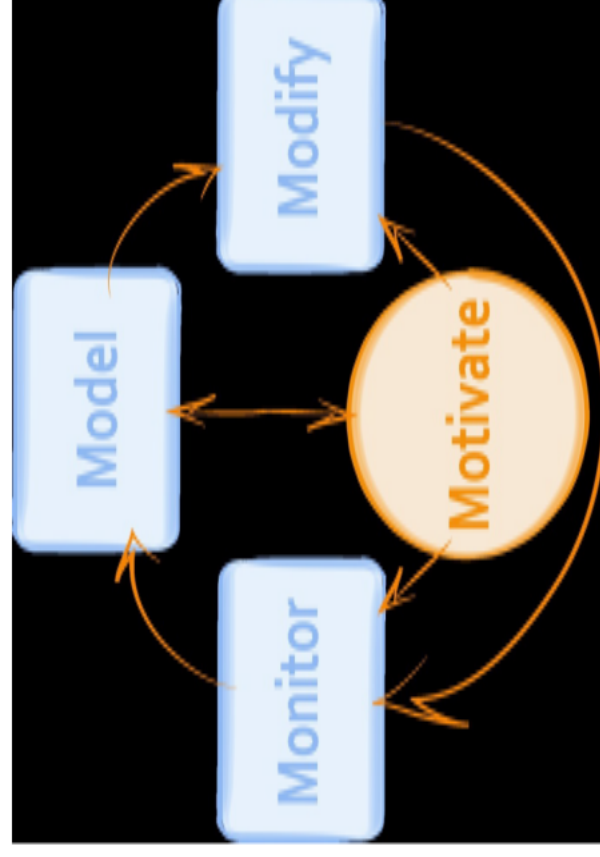


Vigilance of adverse affects

THE JOB TO BE DONE*

While maintaining the required level of personal privacy and security

- Collect comprehensive datasets on personal behaviour in context incl. the digital footprint
- Build predictive models of personal behaviour using data mining and systems modeling
- Deploy the models combined with knowledge from systems medicine and behaviour science to motivate and engage them to managing their (health) behaviours.
- Modify if / when needed





CONCLUDING

Prevention and management of NCDs: Awareness, health literacy; regulatory policies (laws, taxation, urban planning) ...

Risk assessment: Personal health history, 'omics data, personal profile ...

Access to personal data: Self-measurements; environmental data; personal digital footprint ("24/7 life" – open data); contextual data ...

Technologies for data access: Sensors; mobile phones; smart environments; IoT, digital services, ...

Predicting health behaviours: Data mining; systems modelling ...

Engaging: Psychological theories and interventions for behavior change; ICT tools (decision support, HCI, social networks, persuasive technologies, affective and empathic computing, gamification ...)

Embedding into society: co-production of health; ecosystems (governance, value in use, business models)

Ethics and Trust (privacy, security, data licensing)

Challenges

- Society
 - Ethics of intervening in people's lives
 - Legislation of "MyData" – Privacy & Security
- Creating the theoretical base
 - Modelling for predicting behaviours
 - Dynamic complex systems & multi-modal and –scale data
 - Engagement strategies
- Technological
 - Accessing personal data, incl. Digital Footprint
 - Sensors, mHealth apps and platforms
- Does it work?
 - Business – sustainable business models
 - "Reaching the 95 %"



TECHNOLOGY FOR BUSINESS

