

Can tech change our
behaviour or can clever
behaviour models get the
tech used?

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“Develop world-leading evidence based innovative research in the area of digital health”

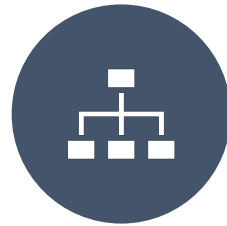


All research participants for their time, commitment and valuable input ProACT is funded by the European Union’s Horizon 2020 research and innovation programme under grant agreement no. 689996. This presentation reflects the views of only the authors, and the European Union cannot be held responsible for any use of the information contained therein.





Understanding the role of behavioural change in the design and development of digital behavioural change interventions (DBCIs)



Taxonomy and Framework to aid design and development



ProACT:
Incorporating a behavioural change/science approach to the deliver a complex digital intervention into a complex healthcare ecosystem

Behavioural Change (BC) can be defined as the use of techniques such as motivating approaches, improving education, constructing a problem definition, serious gaming, continuing support and evaluation (Peyrot and Rubin 2007) to help individuals maximise their ability to act on personal and professional feedback to improve their health and wellbeing.





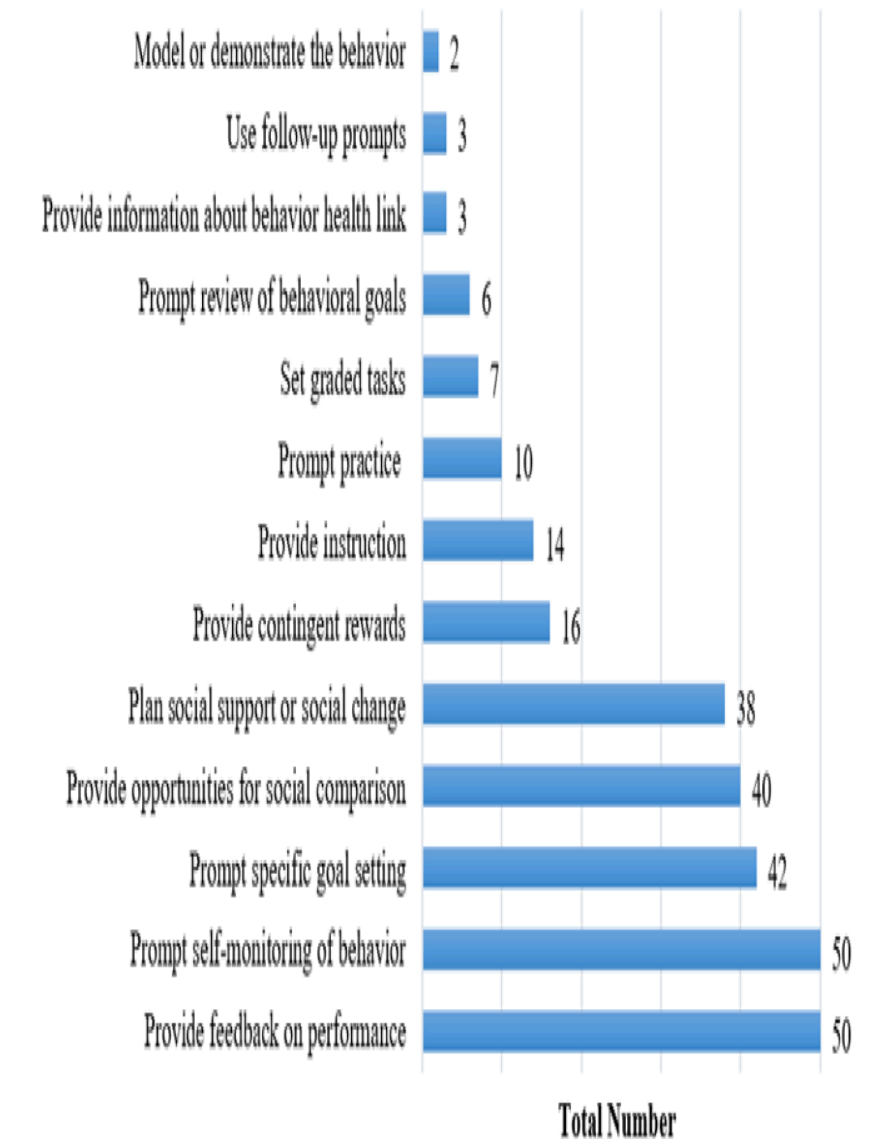
Digital behavior change interventions

(DBCIs): are interventions that employ digital tech to encourage and support behavior change that will promote and maintain health, through primary or secondary prevention and management of health problems

- Behavioural change is poorly understood and implemented in digital health
- Design and development of many digital health interventions lack a solid theoretical basis for behavioural change
- Most have modest/variable effects

Using BCTs in Apps – Physical Activity

- Systematically assess the features, content, and quality of the most popular apps
- 51 apps included, none specified the age of the target group and only one mentioned the involvement of health professionals.
- n=18 followed the guidelines for physical activity
- On average, 5.5 BCTs were identified per app; the most frequently used techniques were “provide feedback on performance” and “prompt self-monitoring of behavior” (n=50)
- The overall quality score was 3.88/5 (SD 0.34)



Challenge with Incorporating BC Theory

- Large amount **theories** and **methods** for intervention design and evaluation (83 identified) (Michie et al., 2014 & Prestwich et a., 2014)
- Majority **generally poor specification**, both in construct definitions and in the relationships between them.
- Most behavioral theories **emphasized group-level** and largely static generalization (predict average changes in outcomes in groups).

Ideally, a good theory will provide both group-level and individual-level generalizations.

Opportunity for DCBIs

- Individuals that use digital tech have a wide range of data gathered about them. These “**digital traces**” are aggregated, connected, and organized and can be used for a variety of purposes such as **highly targeted recommendations** or inferring psychological characteristics, such as personality & personal preferences.
- Advances in **Artificial Intelligence** can enable more “**context-sensitive**” understanding of (teachable) moments to deliver interventions and behaviour change techniques



Improving Patient Engagement

To adopt new lifestyle changes by using online services to empower home based care and ownership of their health.



BCT Taxonomy v1

- Developed by 400 experts from 12 countries
- Clearly labelled, well defined, distinct, precise; can be used with confidence by a range of disciplines and countries
- Hierarchically organised to improve ease of use
- Applies to an extensive range of behaviour change interventions

The Behavior Change Technique Taxonomy (v1) of 93 Hierarchically Clustered Techniques: Building an International Consensus for the Reporting of Behavior Change Interventions

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Abstract

Background CONSORT guidelines call for precise reporting of behavior change interventions: we need rigorous methods of characterizing active content of interventions with precision and specificity.

Objectives The objective of this study is to develop an extensive, consensually agreed hierarchically structured taxonomy of techniques [behavior change techniques (BCTs)] used in behavior change interventions.

Methods In a Delphi-type exercise, 14 experts rated labels and definitions of 124 BCTs from six published classification systems. Another 18 experts grouped BCTs

according to similarity of active ingredients in an open-sort task. Inter-rater agreement amongst six researchers coding 85 intervention descriptions by BCTs was assessed.

Results This resulted in 93 BCTs clustered into 16 groups. Of the 26 BCTs occurring at least five times, 23 had adjusted kappas of 0.60 or above.

Conclusions "BCT taxonomy v1," an extensive taxonomy of 93 consensually agreed, distinct BCTs, offers a step change as a method for specifying interventions, but we anticipate further development and evaluation based on international, interdisciplinary consensus.

Electronic supplementary material The online version of this article (doi:10.1007/s12160-013-9486-6) contains supplementary material, which is available to authorized users.

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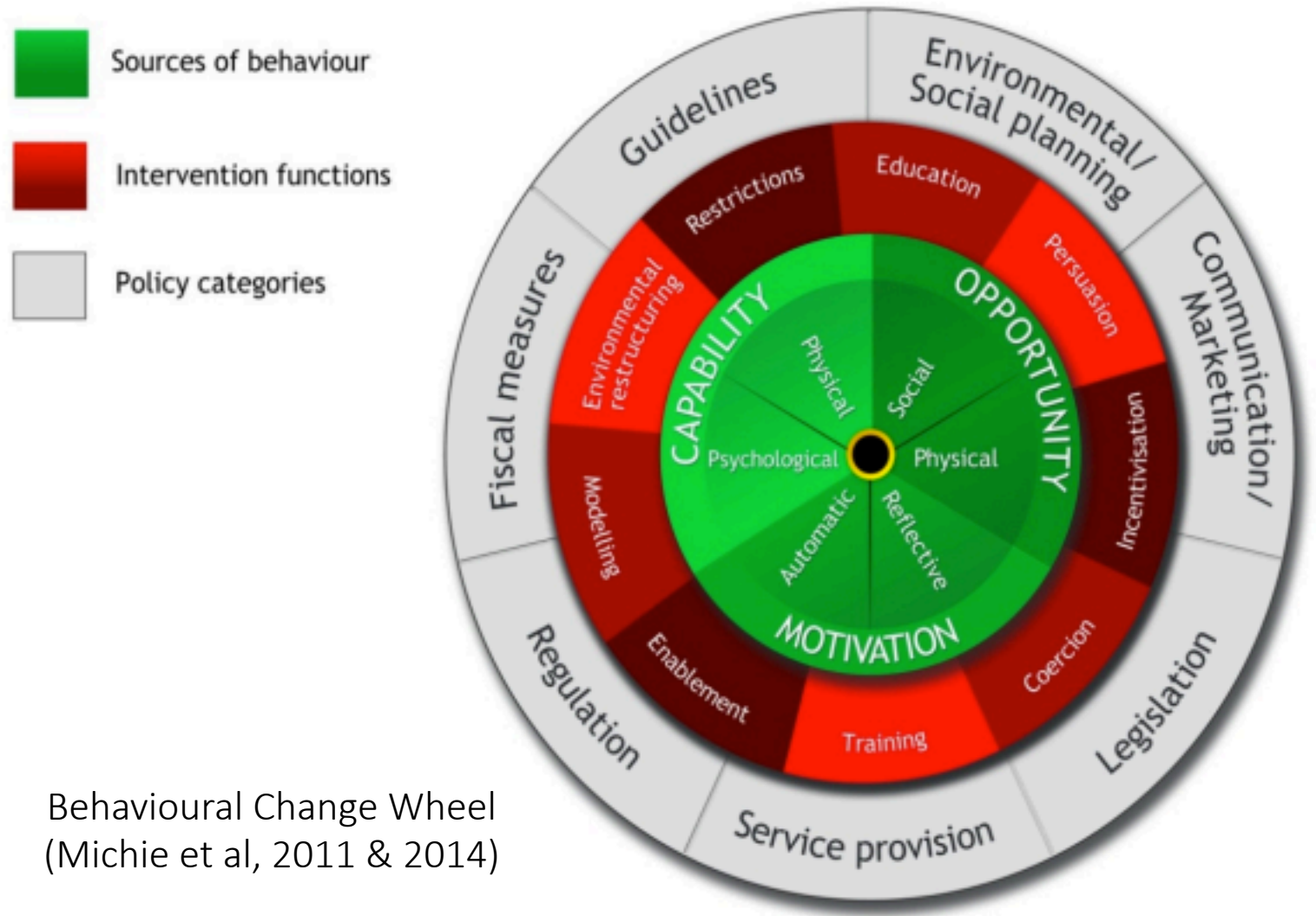
BCT Taxonomy v1: 93 items in 16 groupings

Page	Grouping and BCTs	Page	Grouping and BCTs	Page	Grouping and BCTs
1	1. Goals and planning	8	6. Comparison of behaviour	16	12. Antecedents
	1.1. Goal setting (behavior) 1.2. Problem solving 1.3. Goal setting (outcome) 1.4. Action planning 1.5. Review behavior goal(s) 1.6. Discrepancy between current behavior and goal		6.1. Demonstration of the behavior 6.2. Social comparison 6.3. Information about others' approval		12.1. Restructuring the physical environment 12.2. Restructuring the social environment 12.3. Avoidance/reducing exposure to cues for the behavior 12.4. Distraction 12.5. Adding objects to the environment 12.6. Body changes
	1.7. Review outcome goal(s) 1.8. Behavioral contract 1.9. Commitment	9	7. Associations		
			7.1. Prompts/cues 7.2. Cue signalling reward 7.3. Reduce prompts/cues		

No.	Label	Definition	Examples
1. Goals and planning			
1.1	<i>Goal setting (behavior)</i>	Set or agree on a goal defined in terms of the behavior to be achieved <i>Note: only code goal-setting if there is sufficient evidence that goal set as part of intervention; if goal unspecified or a behavioral outcome, code 1.3, Goal setting (outcome); if the goal defines a specific context, frequency, duration or intensity for the behavior, <u>also</u> code 1.4, Action planning</i>	Agree on a daily walking goal (e.g. 3 miles) with the person and reach agreement about the goal Set the goal of eating 5 pieces of fruit per day as specified in public health guidelines

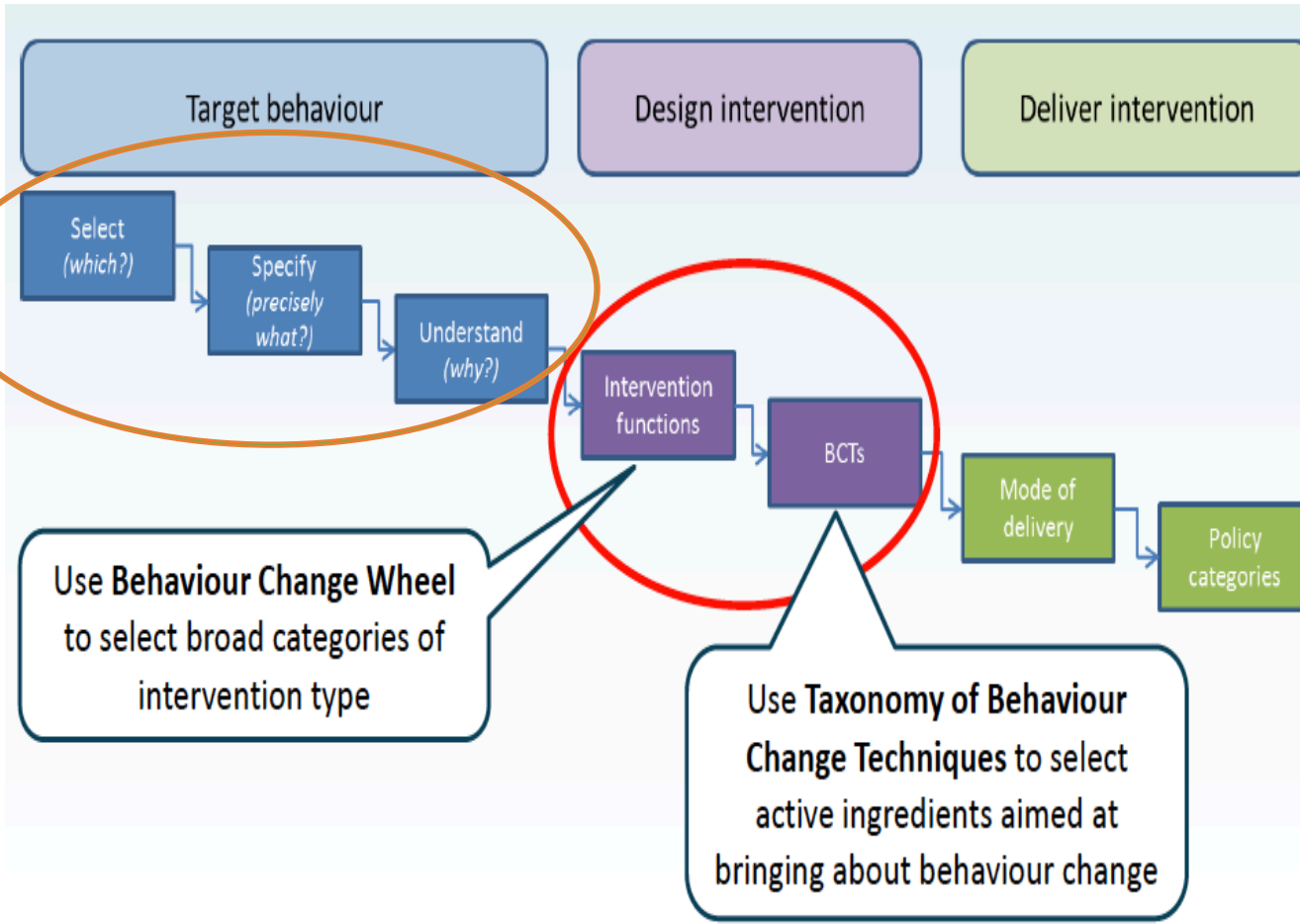
Implementing BCTs in Design and Development

- Synthesis of 19 frameworks to classify interventions (health, environment, culture change and social marketing)
- **Centre:** COM-B model
- **Inner ring:** Nine intervention functions (what purpose(s) we the intervention serves)
- **Outer ring:** Seven policy categories

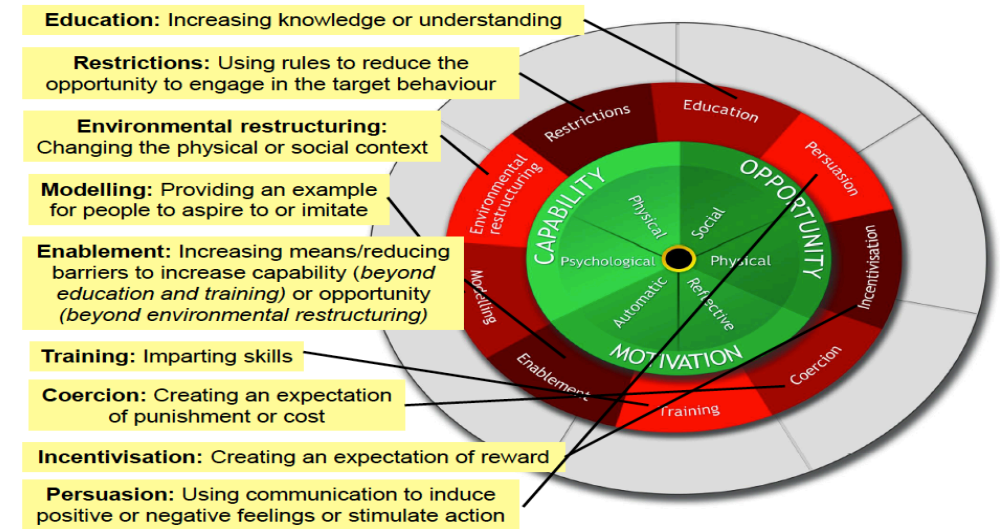
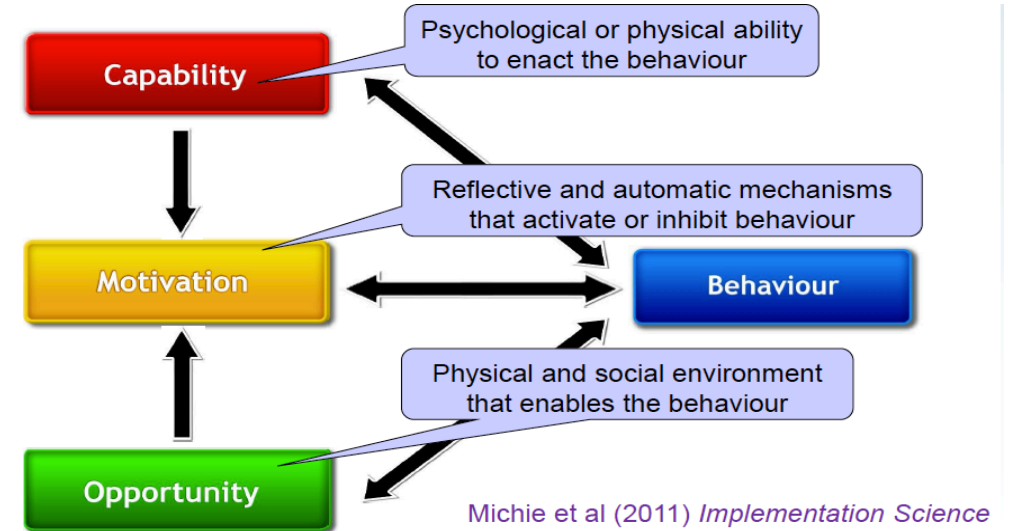


Behavioural Change Wheel
(Michie et al, 2011 & 2014)

BCW: Framework for Implementing the Taxonomy



Behavioural Change Wheel
(Michie et al, 2011 & 2014)

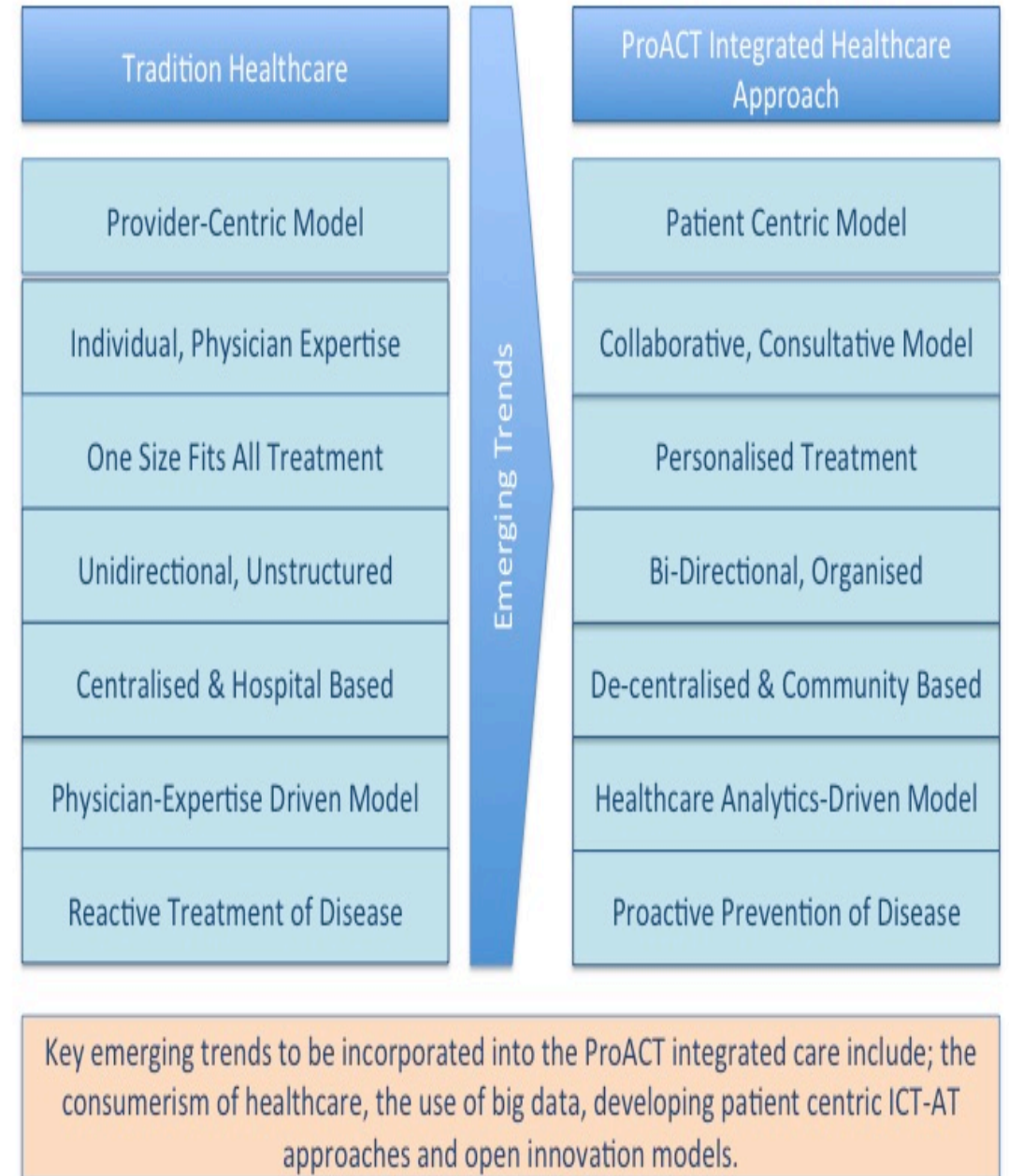


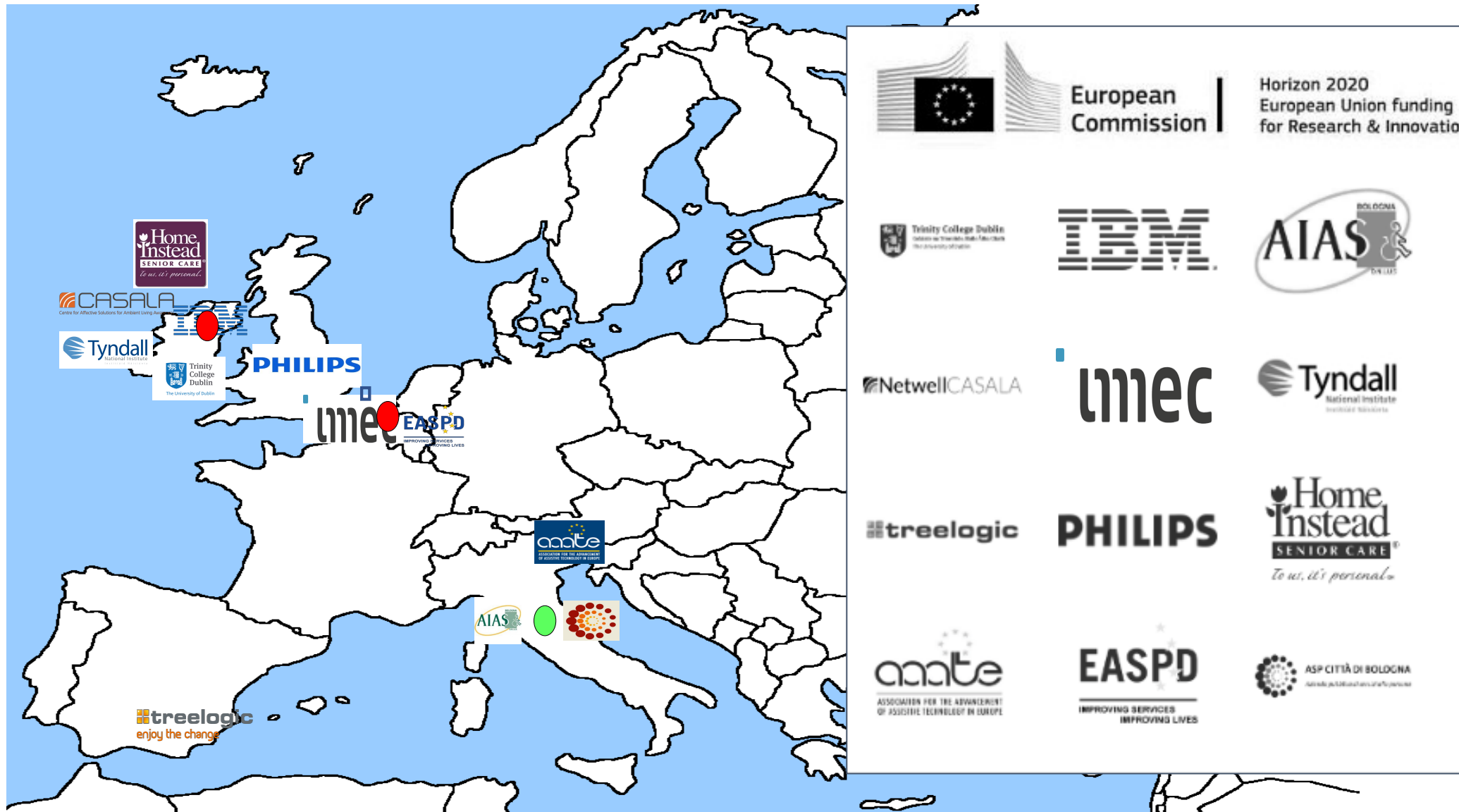


AIMS:

1- Challenge the EU focus on supporting a single disease framework of care to create a patient centric integrated care (IC) ecosystem to understand and manage multimorbidity.

2 - ProACT aims to develop and evaluate a cloud based open API to integrate a variety of new and existing technologies to advance 'home based' integrated care (IC) for multimorbidity self-management.





European Commission

Horizon 2020
European Union funding
for Research & Innovation

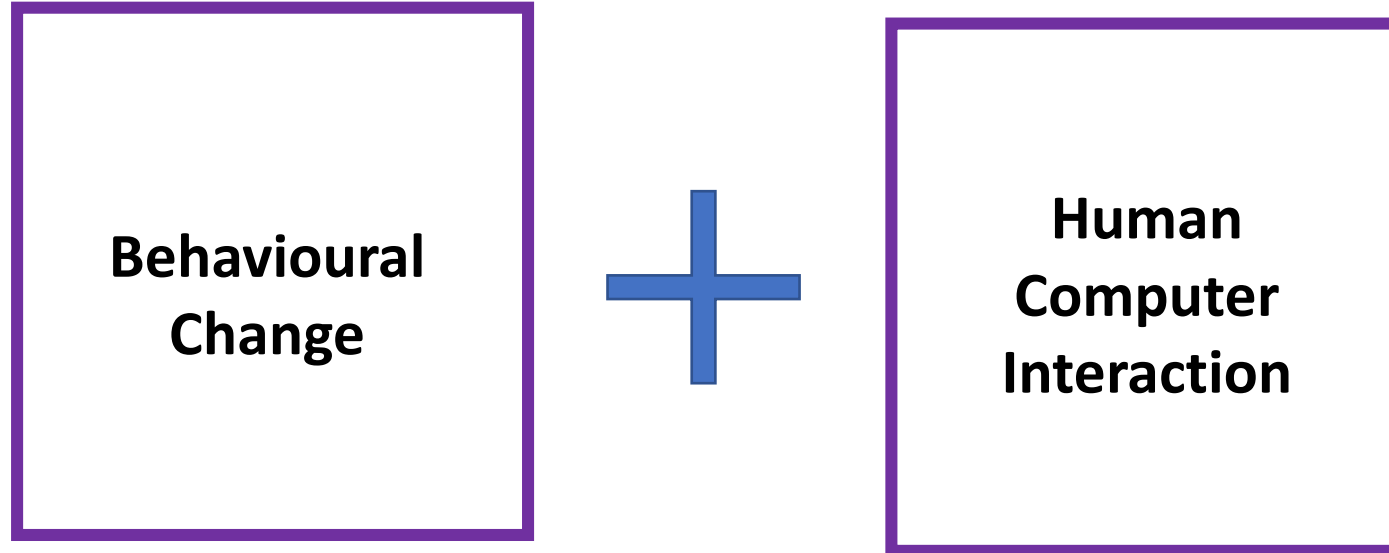


Focus – Self-Management

- **Self-management is a core activity**
- Self-management of multimorbidity is **challenging**, requiring engagement in **multiple tasks** such as symptom monitoring, recognition of exacerbation, medication adherence and inter-stakeholder communication.
- A **digital, integrated care approach** is a critical part of the solution.
- The main objective of our work is to design a **technology ecosystem to facilitate older adults to self-manage multimorbidity, with support from their care network.**



Designing ProACT as a BC intervention



Project Outline (2016-2019)

- Phase 1: User Needs Research and Scoping (**M1-9 complete**)
- Phase 2: System Design, Development and Testing (**M9 – M40**)



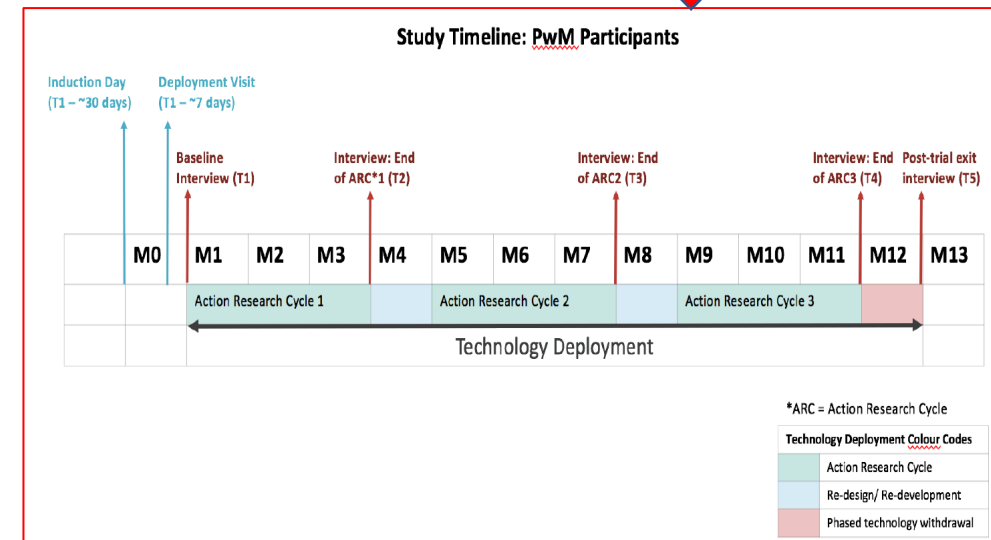
- Phase 3: Pilot Trials and further co-design and development (**M14 to M26**)

- Phase 4: Main Proof of Concept Trial (**2018: M26/27 to M37/38**)

- Ireland: 60 PwM and support actors
- Belgium: 60 PwM and support actors
- Conditions: **Diabetes, COPD, CHF/CHD**
- **Longitudinal Action Research Design (12 months)**

- Phase 5: Transfer Feasibility Study (**2018: M30 to M36**)

- Italy: 15 PwM and support actors



ProACT ICT-AT Platform

Person with Multimorbidity

Devices
(e.g. Motiva,
Withings,
SmartThings
etc.)



CareApps



CABIE

CareAnalytics



InterACT

support networks

powered by:     

built by:          

Meet Sarah



Sarah is 85

Conditions: Diabetes and Heart Failure

Everyday for the last 5 years she has measured her:

- Weight
- Blood Pressure
- Blood sugar

She writes readings in notebooks and brings them with her to her GP and specialist clinics that she attends for her conditions.

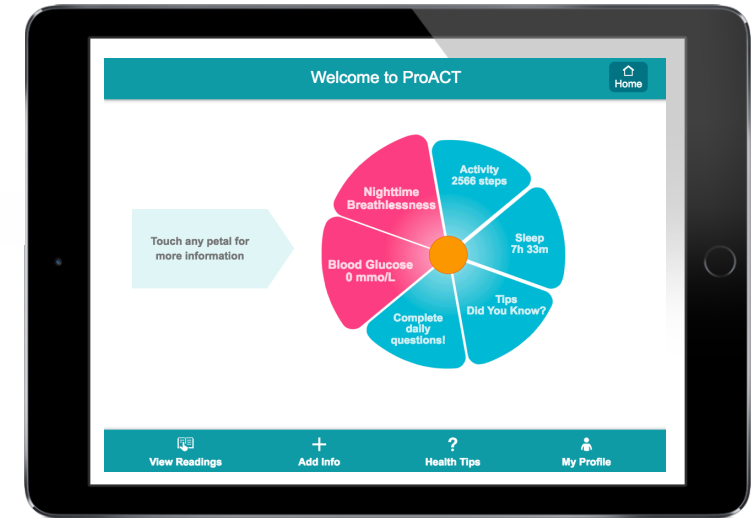
Day Date	Breakfast			Lunch			Dinner			Bedtime		Night
	before Blood Sugar	insulin	after Blood Sugar	before Blood Sugar	insulin	after Blood Sugar	before Blood Sugar	insulin	after Blood Sugar	insulin	Blood Sugar	
Mon 11-15	82	10F	128	109	12M		172	15H	198	209	221	
Tue 16	92	10		160	13		170	15		206	21	161
Wed 17	122	10		198	19		165	15		181	222	
Thu 18	89	10		94	12		189	15		72	226	
Fri 19	118	11		95	12		212	16		188	222	69
Sat 20	139	16		148	13		184	15		280	224	311
Sun 21	102	10		96	12		210	16		220	224	311

Sarah is finding it hard to remember when to take measurements and to write down the different readings into separate notebooks every day.

How Can ProACT Help Sarah

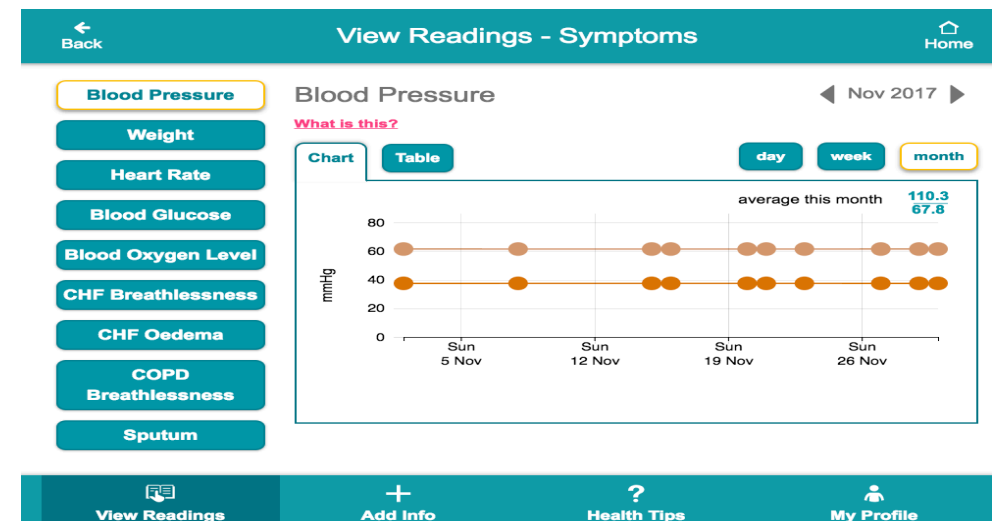
Monitoring Symptoms

- Sarah's GP recommended that she try a new technology to help her monitor her symptoms automatically
- ProACT also help Sarah to keep track of other important parameters such as sleep, activity, mood and breathlessness.



Viewing Symptoms

- Her new devices now send her readings automatically to a tablet where she can view her symptoms over the last day, week or month

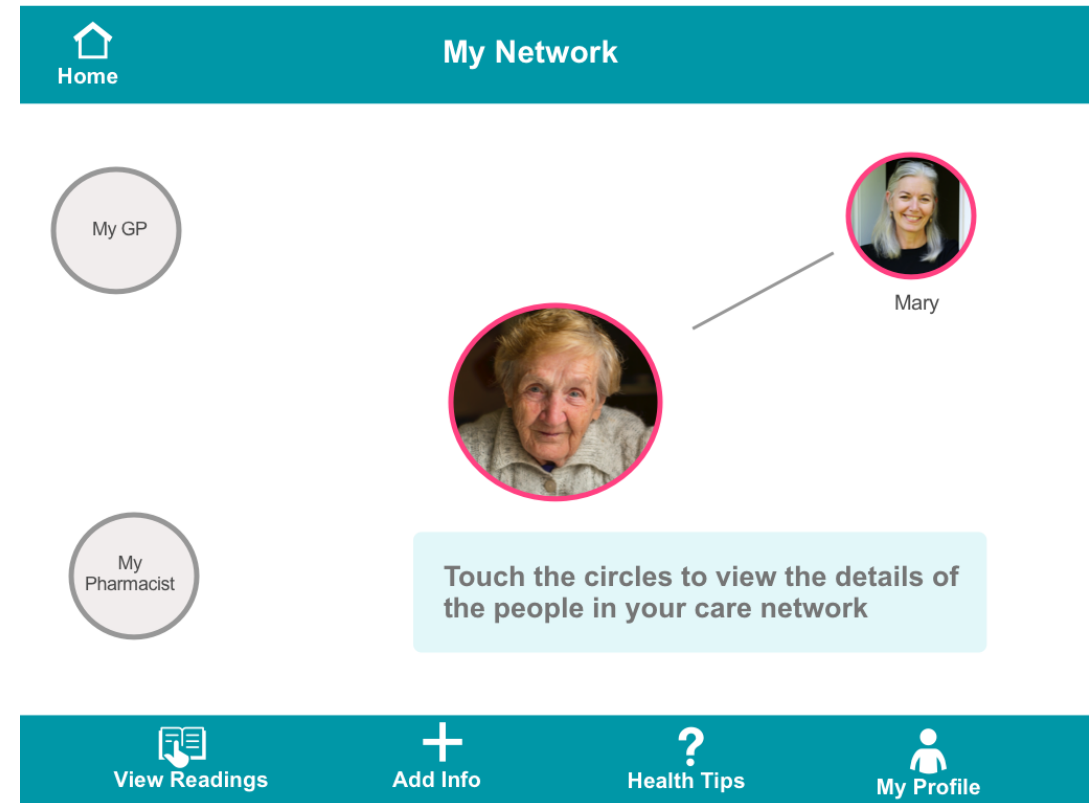


Knowledge and Education:

- The system also provides Sarah with tips that might be useful for her to manage her conditions and stay as healthy as possible.
- ProACT gives Sarah trustworthy and clear information on managing diabetes and heart failure but also on general topics such as exercise and how to get off the floor safely after a fall.

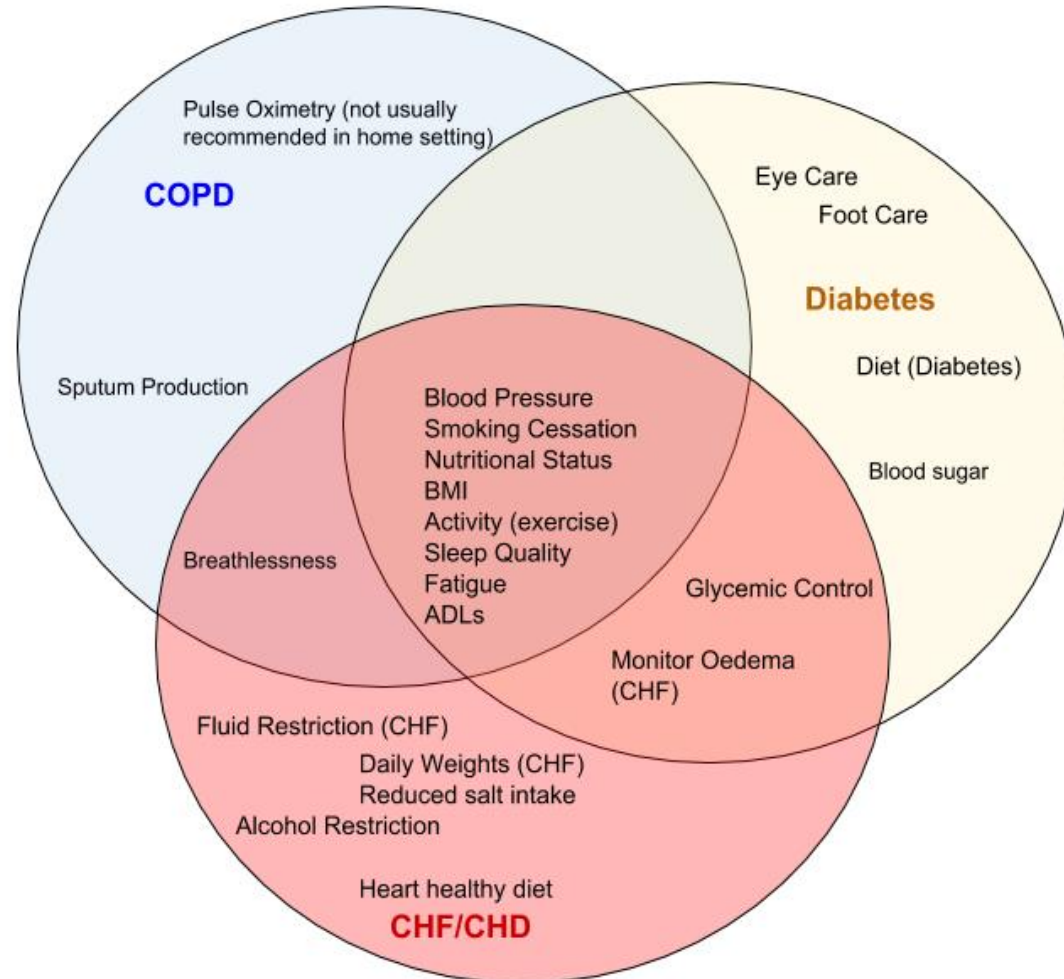
Health and Care Network:

- Person driven modular ability to personalise care network
- Sarah's daughter Mary can view the health readings that she chooses to share with her from her phone.

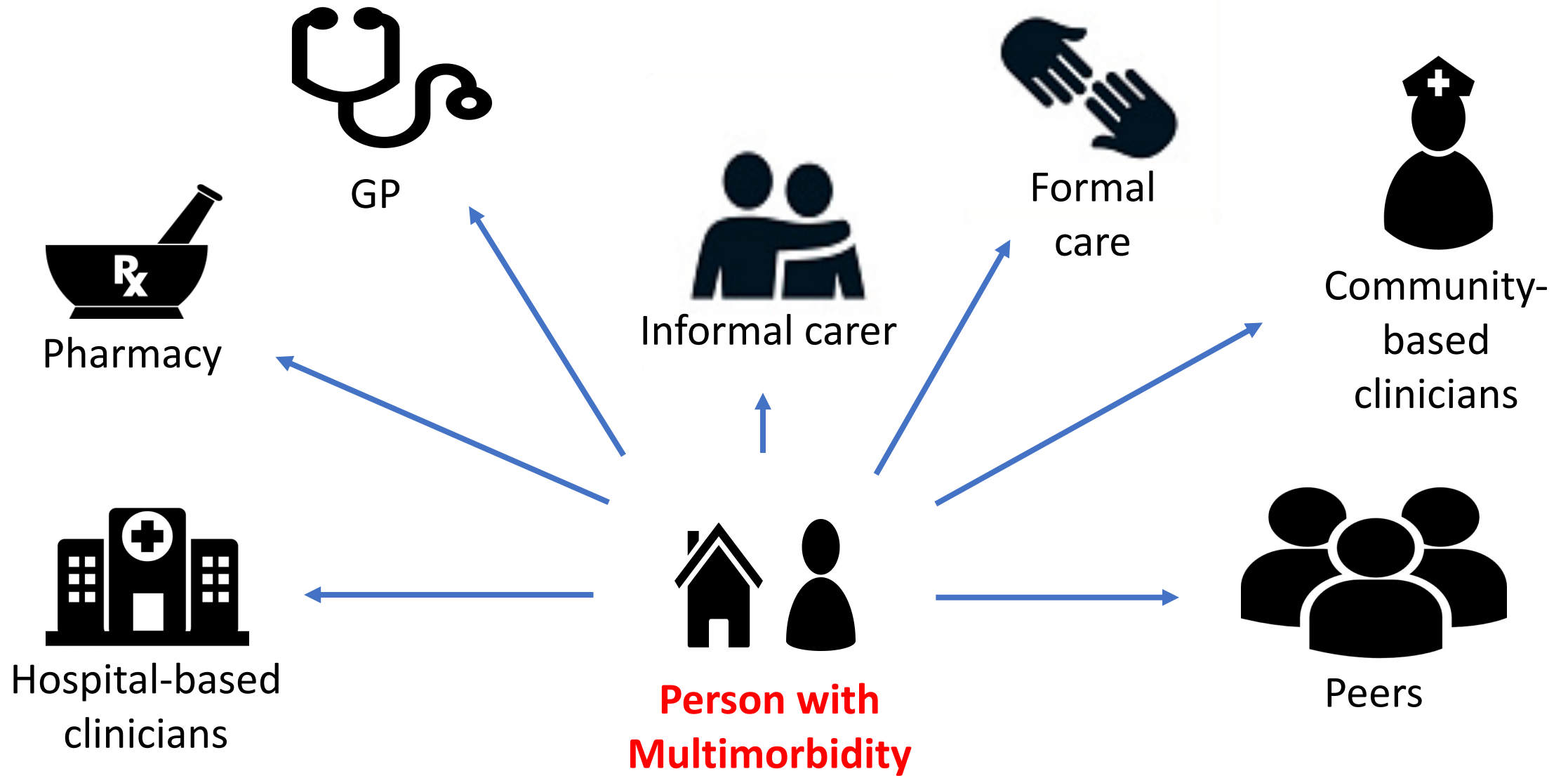


User Requirements: Scoping

ProACT Core Self Management Variables



Significant desk research;
Literature and policy reviews on
disease management,
treatment and care pathways
within national contexts



User Requirements

- Qualitative study
- Interviews and focus groups – semi-structured; 45-120 minutes
- Demographic questionnaires (PwM and informal carer)
- 124 participants across Ireland and Belgium
- Thematic analysis
- Diabetes + CHF/CHD most prevalent
- 57% women
- 21% MCI

	Ireland	Belgium
Person with Multimorbidity	19	19
Informal carer	7	10
Formal carer	11	10
GP	6	5
Community based healthcare Public health nurse; care coordinator	3	1
Hospital based clinician Geriatrician; Clinical Nurse Specialists; Physio; Occupational Therapist; Dietician; Speech and Language Therapist; Cardiologist; Endocrinologist	12	6
Formal care provider	5	2
Pharmacist	4	4
Total	124	

Key Outcomes - PwM

- **Hugely impacts on;** Lifestyle, relationships, psychological well-being
 - **Lack of awareness of** strategies for self-management
 - **Complexities of interactions** between conditions aren't understood
 - **Maintaining independence** - remaining at home - **key motivator!**
 - **Barriers to self-management;** Lack of physical mobility; Limitations of conditions
 - **Polypharmacy:** difficult keeping track of many medications; Paper-based lists managed by PwM
- “If there was one thing I believe that would help people that end up going back into hospital, or end up being at home safer, is a much better pathway in minding their medications”**
- (Healthcare Professional interviewed in Ireland)

Key Outcomes – Support Actors

- Lack of info on **how to navigate the healthcare system** & absence of one unified care plan.
- **Most information** received verbally/ info leaflets
- Essential role played by **informal carers**
- Additional training needs among **formal carers**
- **Pharmacist** reliable/trusted source of info/support
- **GP** – essential coordinating role
- **Communication difficulties** between healthcare professionals

“It’s so disjointed, and people are running blind – families, carers, you name it - everyone”

(Formal care worker interviewed in Ireland)

“It’s definitely a case of detective work linking into the community, the family, and any of the MDTs that the patient is linked with.

God, it’s hard.” (Healthcare Professional interviewed in Ireland)

We employed traditional user-centred HCI techniques to help to translate this qualitative data into meaningful requirements for design supported by the BCW:

47 key requirements across a number of categories:

1. Reducing impact of multimorbidity (3)
2. Self-management of multimorbidity (14)
3. Medication management (7)
4. Information, knowledge and education (7)
5. Sources of support (3)
6. Communication (2)
7. Technology use (11)

Whitepaper on the needs and requirements of older people with multiple chronic conditions to self-manage their health

ProACT

Authors

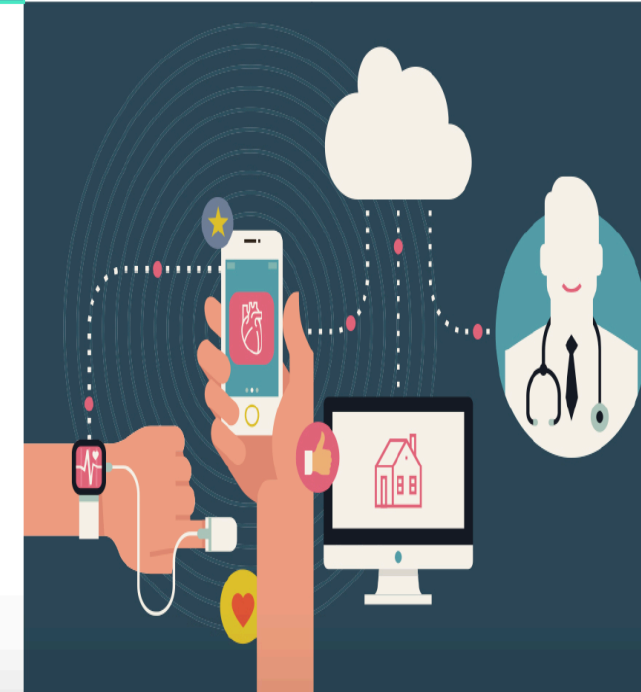
Julie Doyle, Evert-Jan Hoogerwerf, Janneke Kuiper, Lorenzo Desideri, Valentina Fiordelmondo, Caoimhe Hannigan, An Jacobs, Lorenza Maluccelli, Emma Murphy, Suzanne Smith

Editors

Emma Murphy, Caoimhe Hannigan, John Dinsmore

Published

October 2016



Systematically Incorporating BC into Design

- **What is the aim of the system?**

To improve self management skills and support for PwMs using a digital rather than paper based system

- **What is the behaviour that needs to change to do this?**

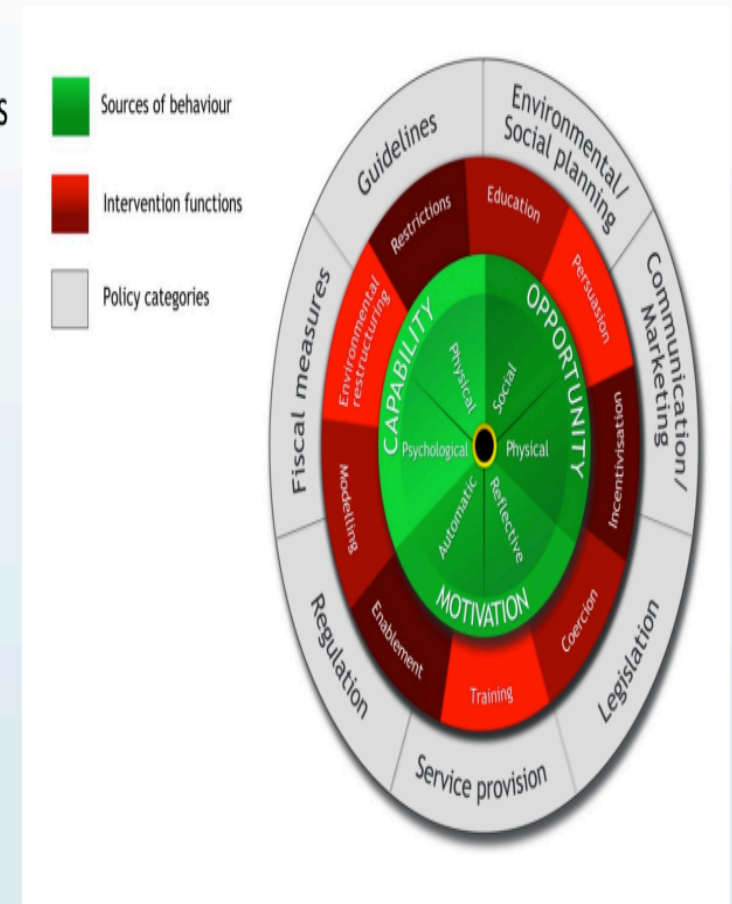
PwM - needs to change their behaviour from managing their conditions using memory and paper based strategies to a digital self management tool

- **Systematic approach to address this?**

The Behavioural Change Wheel approach involves an 8-stage process for developing behavioural change diagnoses and targeted interventional strategies.

- Synthesis of 19 frameworks to classify interventions (health, environment, culture change and social marketing)

- **Centre:** COM-B model
- **Inner ring:** Nine intervention functions (what purpose(s) the intervention serves)
- **Outer ring:** Seven policy categories

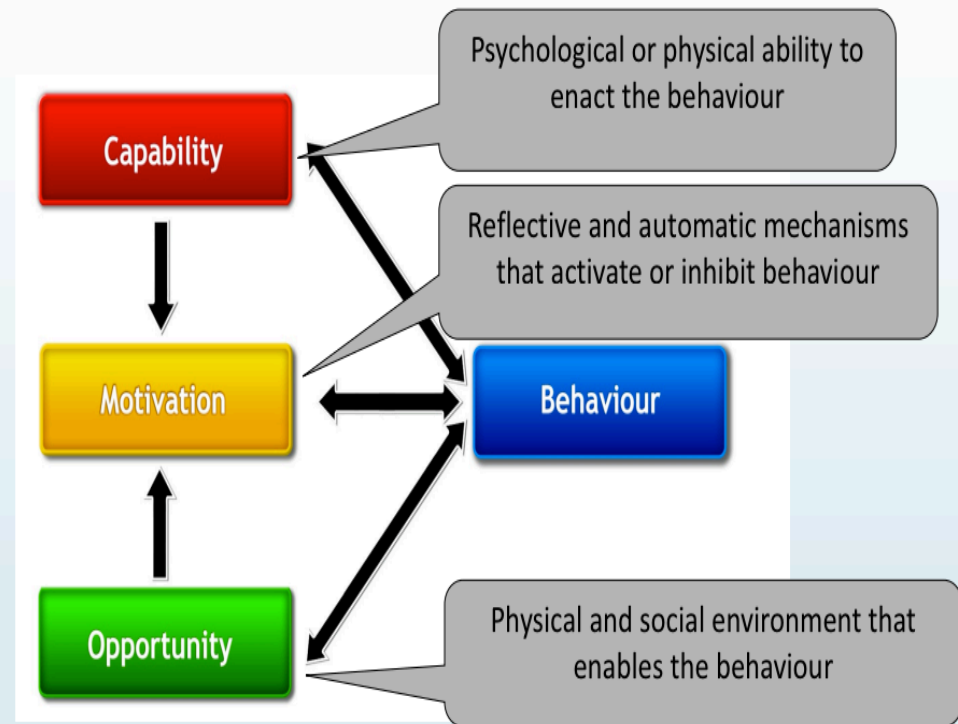


(Michie, Atkins and West, 2014)

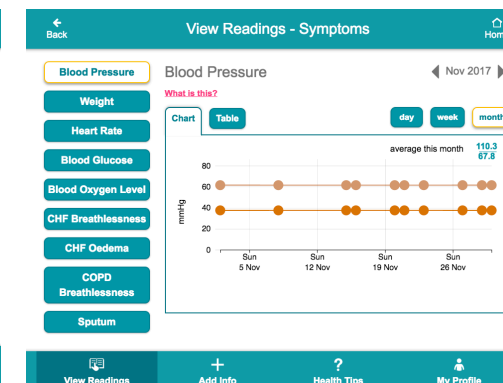
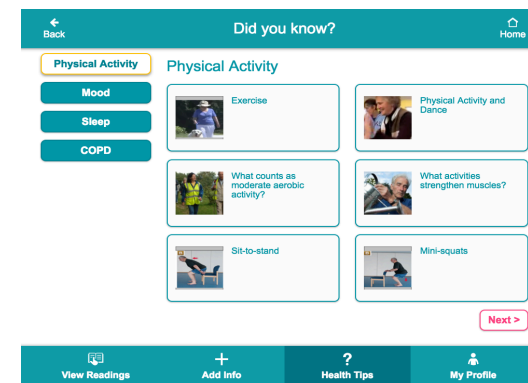
Why apply the BCW model?

- Enabled us to design ProACT technology as a behaviour change intervention
- Understanding target behaviours within the framework of COM-B provides the first steps in **selecting appropriate intervention strategies** to bring about the desired change.
- UI Through the process of creating intervention strategies for each of the targets, we have translated intervention functions into additional application features.
- Behaviour change interventions may fail because the **wrong assumptions** have been made about what needs to change (Michie, Atkins and West, 2014).

COM-B: A simple model to understand behaviour...



(Michie, Atkins and West, 2014)

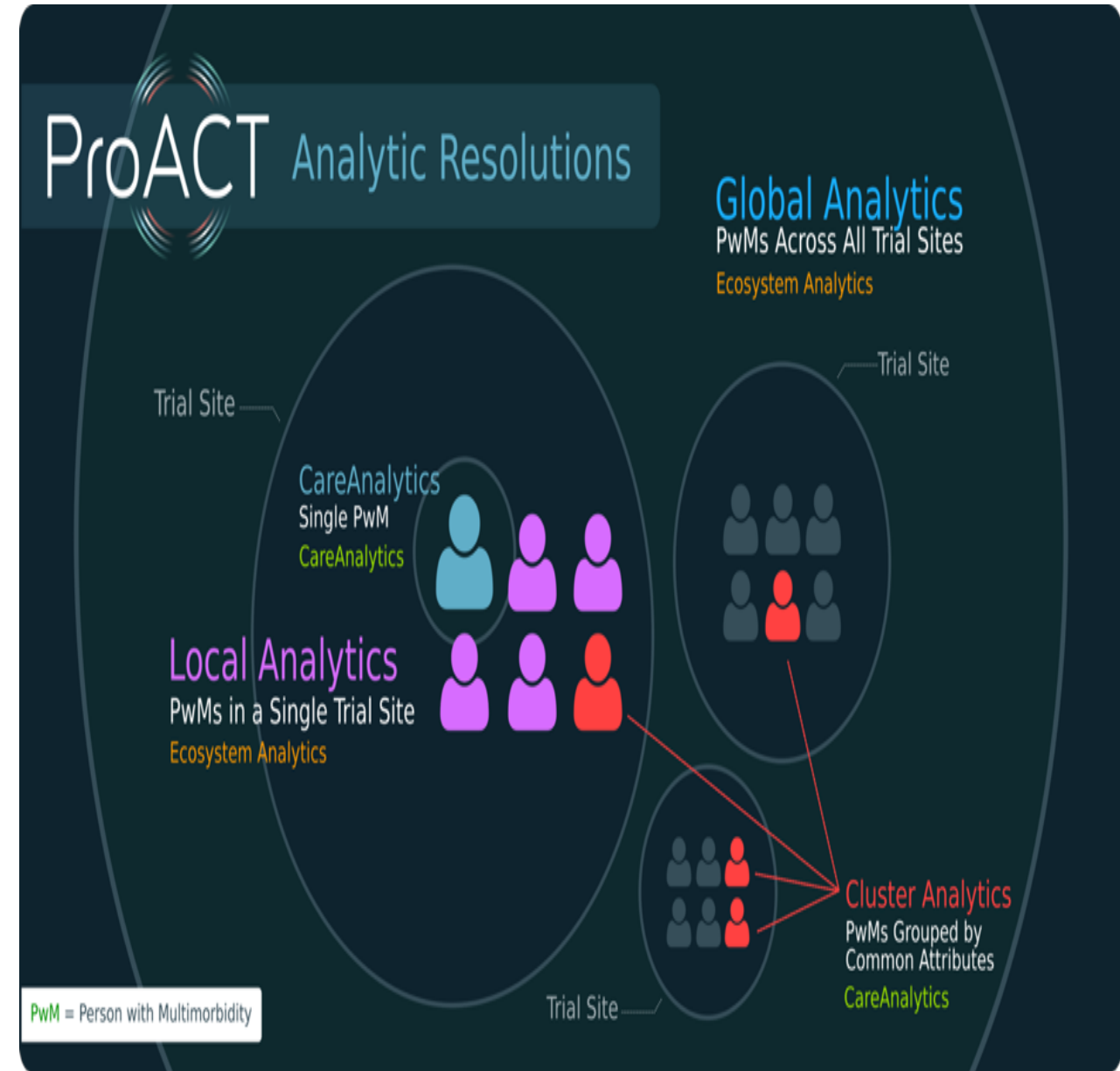


Target 1: Measure and view key symptom readings on ProACT (Person with Multimorbidity)

Intervention functions	COM-B components served by intervention functions	BCTs to deliver intervention functions
Education	Psychological capability Reflective motivation	5.1 Information about health consequences 1.2 Feedback on behaviour 2.7 Feedback on outcome(s) of the behaviour 7.1 Prompts/cues
Training	Psychological capability Automatic Motivation	4.1 Instruction on how to perform a behaviour. 6.1 Demonstration of the behaviour 8.3 Habit Formation.
Environmental Restructuring	Physical opportunity	12.5 Adding objects to the environment 12.1 Restructuring the physical environment.
Persuasion	Reflective motivation	9.1 Credible source
Enablement	Social opportunity	3.1 Social support
Incentivisation	Reflective motivation	10.4 Social reward

BCW: Implications for Analytics

- BCW has highlighted the importance of *User Engagement metrics and analytics* to help us to evaluate ProACT as a BC intervention
- The BCW has highlighted the need for the *personalisation* of behaviour change techniques and interventions which we have considered in the design of our CareAnalytics (PROACT Artificial Intelligence - IBM)

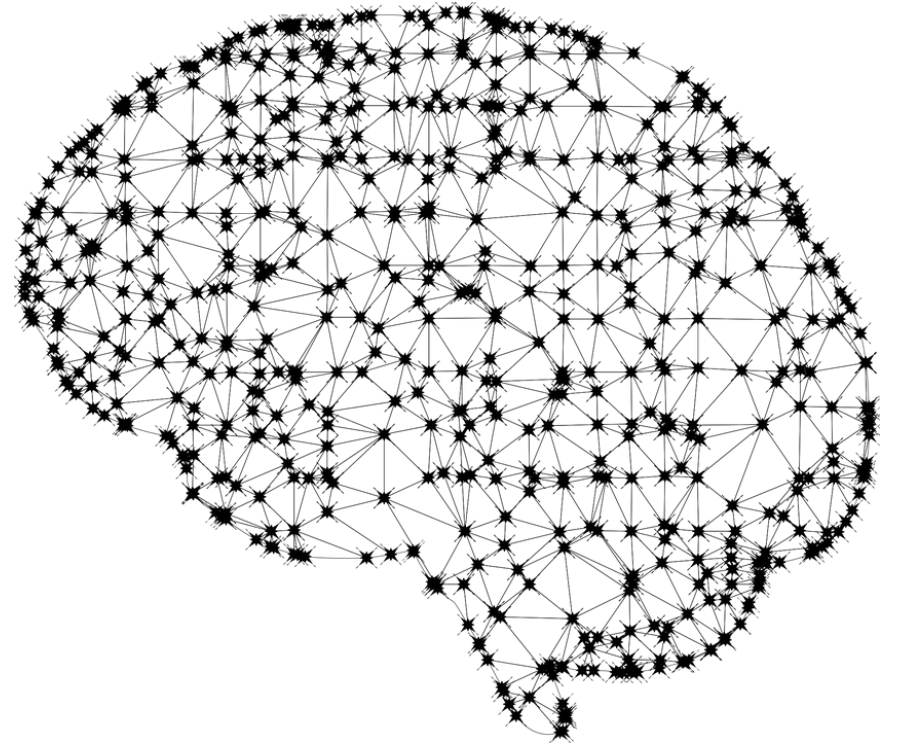


GOAL SETTING

- **Presents particular challenges and complexities** for multimorbidity. Due to link with age additional conditions impact on ability to achieve goals.
- **S.M.A.R.T goals (Doran, 1981) were not common practice** for PwM or care network. Goals were general and not measurable.
- **Issue:** Lack of awareness around types of realistic goals to set, lack of support from care network (time, not wanting to overload PwM, sense PwM should self direct, care network insufficient data to inform goals). Peer rather than clinical support a key motivator.



1. Present PwM Goal Suggestions **taking into account their complete profile** and health and well-being status
2. Education to understanding **how to set realistic goals themselves** based on data feedback
3. System to support **true collaborative goal settings**, initiated by PwM
4. System can **support single disease if necessary** when acute difficulty with one condition is identified.
5. **Flexibility of goal revision** - to account for bad and good health days



Evaluating ProACT as a BC Intervention

Each of the BC targets will be evaluated by:

- **Analysing system usage statistics** – how participants engage with specific features of the system i.e. measuring symptoms, recognising change, view education content
- **Quantitative trial assessment data (assessment measures)**
- **Qualitative interview data** – Thematic Analysis - Understand experiences

23 key metrics including: Session length, dashboard time, reflection screen time, view readings time, view reading screen responses health tips time, my info time, button presses on each screen, daily app opens etc.

19 Assessments including: Usability (T2;T3;T4), Burden (T2;T3;T4), technology proficiency (T1;T4), social connectedness (T1, T4), QoL (T1-T4), self efficacy (T1-T4), illness perceptions (T1-4), self-management (T1-T4), Demo (T1), med lists (T1;T4)

Interview schedules, reflect key assessment areas above.

Conclusion

- **DBCI**s require theories and models of behavior change that capture and take into account **individual variation and changes over time** and in context.
- There should be increased movement toward **theories and models that are as precise, quantitative, and testable** as possible for describing the complexity of behavior change
- Digital interventions should **systematically adopt behavioural change** approaches
- The inherent complexity of behavior change implies that no one research group is likely to, alone fully understand its application in DBCI's. **Need for more transdisciplinary research consortia.**