Taxonomies and ontologies:

Organising knowledge about core components

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Director of the Centre for Behaviour Change

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Session: Defining, Identifying, and Testing Components

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www.ucl.ac.uk/behaviour-change

Taxonomies and ontologies enable us …

Human Behaviour-Change Project

To develop an understanding of human behaviour to answer variants of the ‘big question’

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To develop an understanding of human behaviour
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When it comes to behaviour change interventions:

What works,
compared with what,
for what behaviours,
how well, for how long,
with whom, in what setting,
and why?

What works: behaviour change techniques

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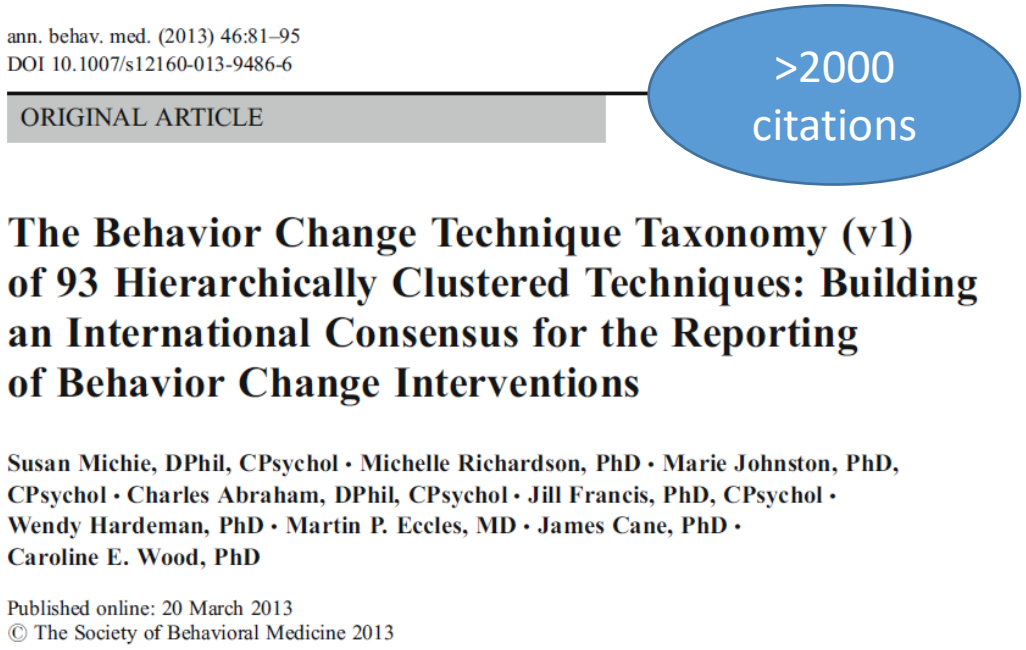
- Aim to be the smallest components that on their own can bring about change
- Have the *potential* to be the 'active ingredients' of an intervention
- Observable and replicable
- Can be used alone or in combination



ann. behav. med. (2013) 46:81–95
DOI 10.1007/s12160-013-9486-6

>2000 citations

ORIGINAL ARTICLE

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

Susan Michie, DPhil, CPsychol · Michelle Richardson, PhD · Marie Johnston, PhD, CPsychol · Charles Abraham, DPhil, CPsychol · Jill Francis, PhD, CPsychol · Wendy Hardeman, PhD · Martin P. Eccles, MD · James Cane, PhD · Caroline E. Wood, PhD

Published online: 20 March 2013
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93 Behaviour Change Techniques: BCTTv1

Online Training:
www.bct-taxonomy.com

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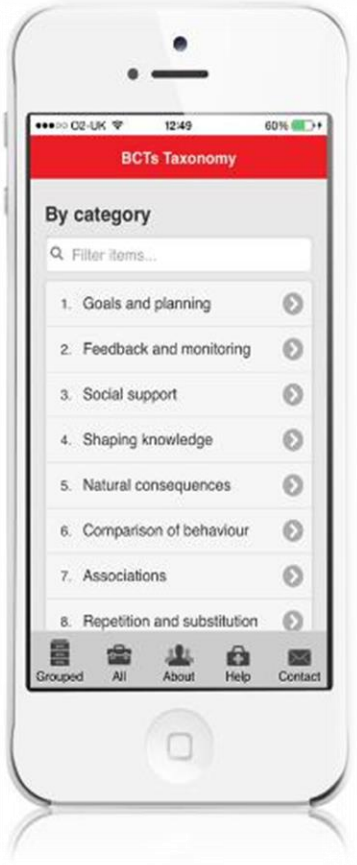
BCTTv1 App:
Search for 'BCT'



93 Behaviour Change Techniques: BCTTv1

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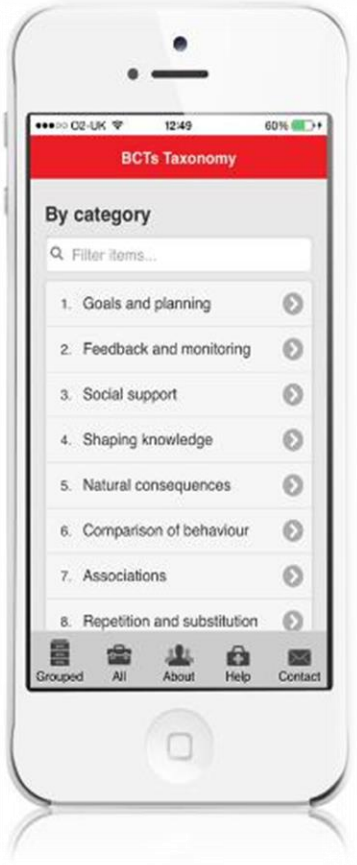

Database of BCTTv1-coded interventions
www.bct-taxonomy.com/interventions

Why a taxonomy?

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- A classification system to organise things using principles that explain similarities and differences
- Classes are uniquely assigned to a higher level class
  - E.g. Goals and planning

Goal-setting

10 sub-routines for smoking e.g. setting clear date

(Lorencatto, 2015)

BCT Taxonomy v1: 93 items in 16 groupings

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BCT Taxonomy v1: 93 items in 16 groupings

Human Behaviour-Change Project

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 1.7. Review outcome goal(s) 1.8. Behavioral contract 1.9. Commitment		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
3	**2. Feedback and monitoring**	**9**	**7. Associations**	**17**	**13. Identity**
	2.1. Monitoring of behavior		7.1. Prompts/cues 7.2. Cue signalling reward 7.3. Reduce prompts/cues 7.4. Remove access to the reward 7.5. Remove aversive stimulus		13.1. Identification of self as role

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		9	**7. Associations**		
			7.1. Prompts/cues		

No.	Label	Definition	Examples
1. Goals and planning			
1.1	***Goal setting (behavior)***	Set or agree on a goal defined in terms of the behavior to be achieved *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, also code **1.4, Action planning***	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

Further components: HBCP identifies …

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1. The intervention
   - *Content (behaviour change techniques)*
   - Delivery (source, schedule, style, mode)
2. Exposure to the intervention (engagement and reach)
3. Mechanisms of action
4. The context
   - Population, setting

Designing interventions: components linked to tools

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- Select BCTs according to ‘behavioural diagnosis’
  - *COM-B model*
  - *Behaviour Change Wheel*
    - www.behaviourchangewheel.com

Designing interventions: components linked to tools

- Select BCTs according to 'behavioural diagnosis'
  - *COM-B model*
  - *Behaviour Change Wheel*
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- Link BCTs to theory
  - *Theory and Techniques Tool*
    - https://theoryandtechniquetool.humanbehaviourchange.org/

Theory and Techniques Tool home screen

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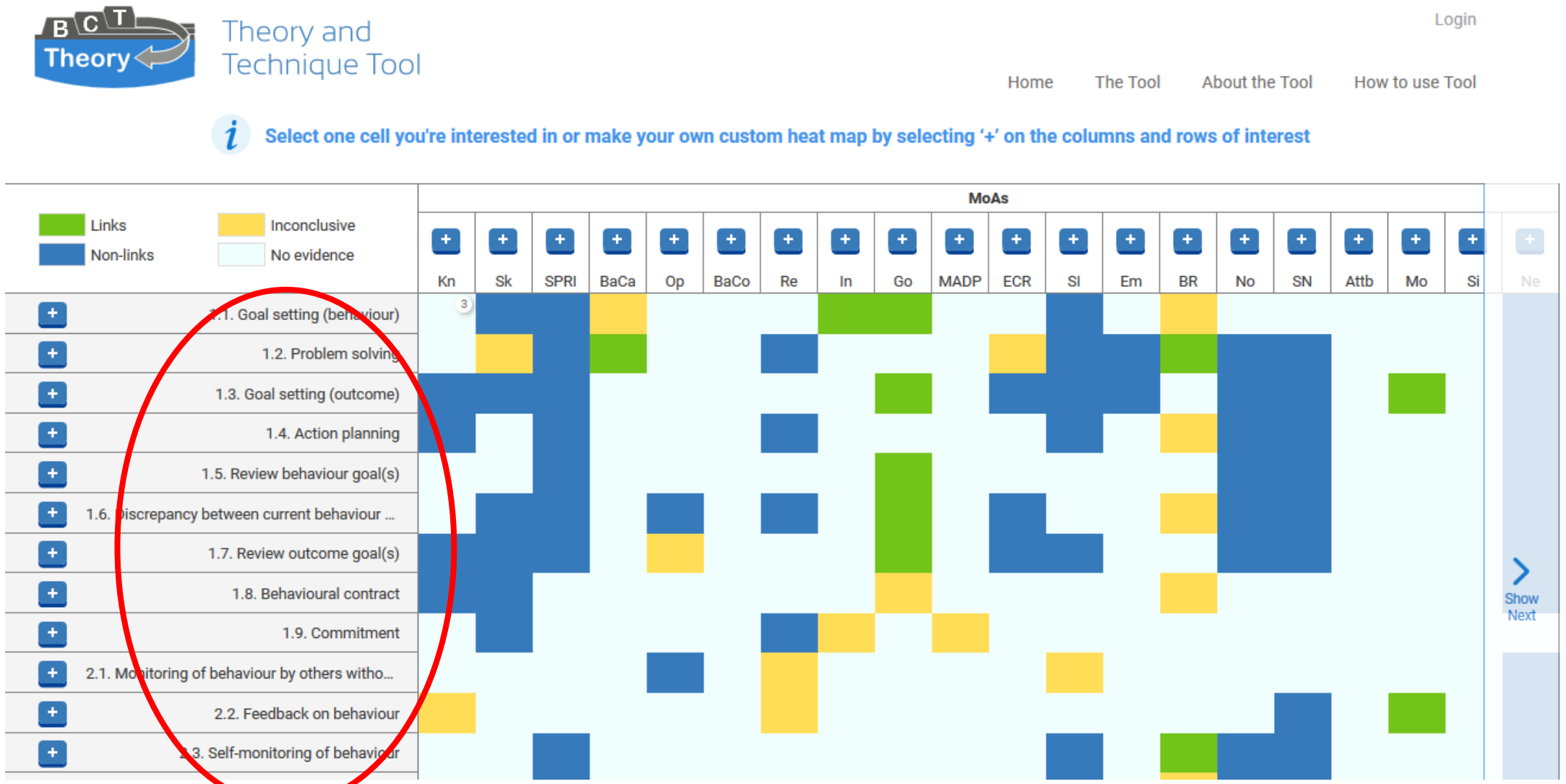
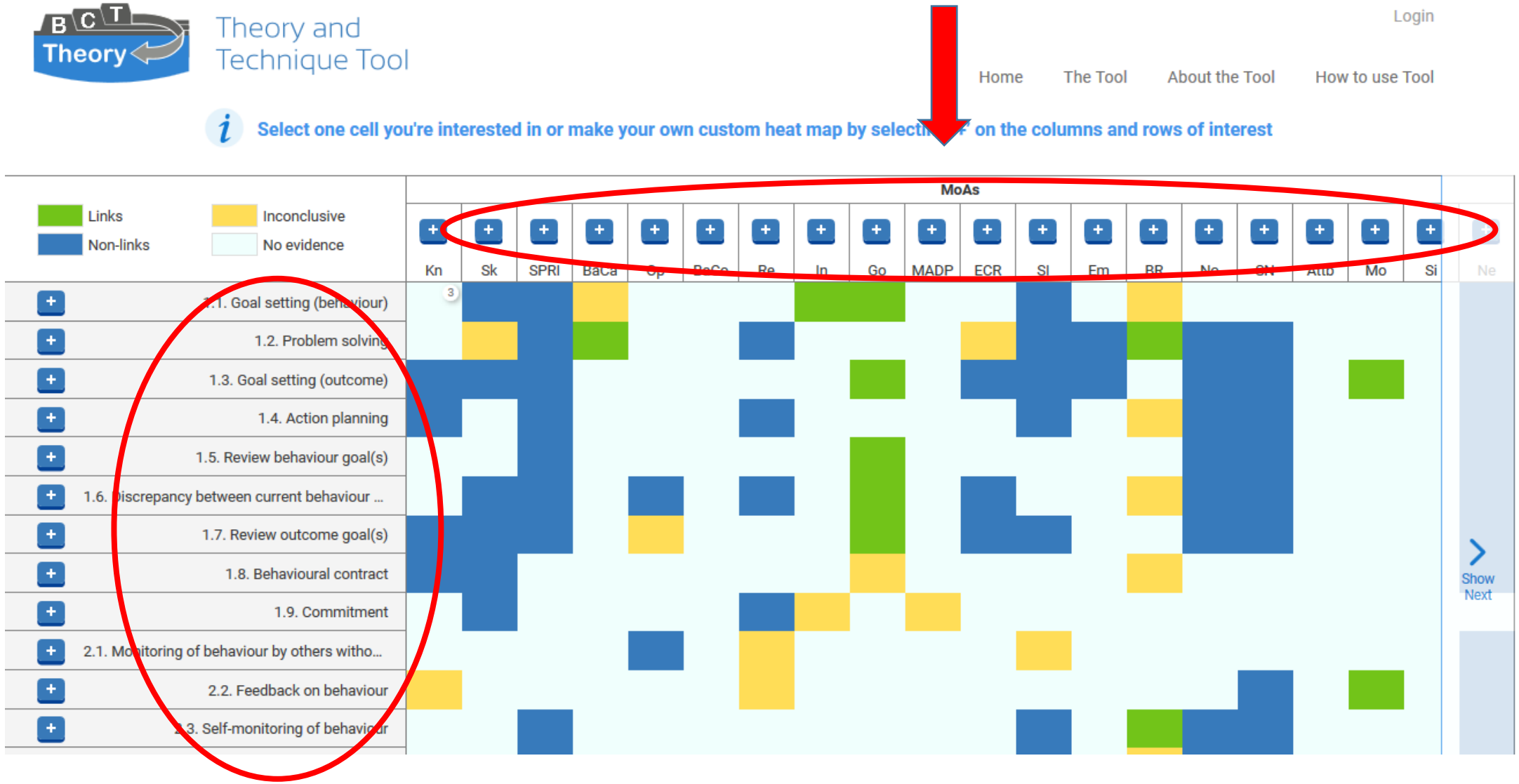


BCTs

Theory and Techniques Tool home screen

Mechanisms of Action

BCTs



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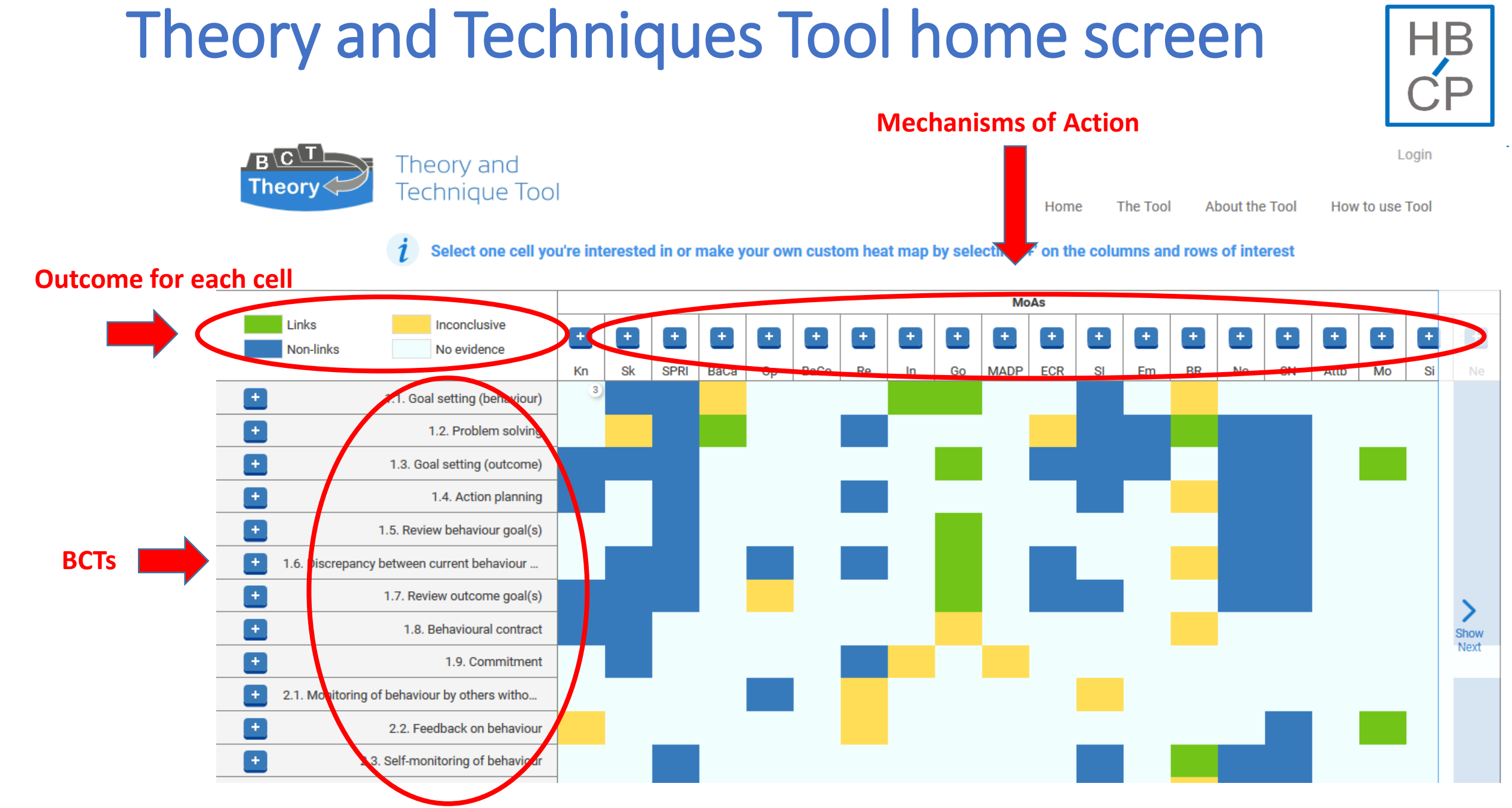

Automating knowledge accumulation

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1. Components allow one to define interventions and their context in a way that is machine readable

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Automating knowledge accumulation

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1. Components allow one to define interventions and their context in a way that is machine readable
2. Enables extraction and synthesis of information from world literature that not possible by hand
3. Computation can generate
   - new evidence and insights based on up-to-date research findings, and
   - inferences from what we know to what we don't

The Human Behaviour-Change Project

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Participating organisations

University of Aberdeen

University of Cambridge

IBM Research

www.humanbehaviourchange.org

@HBCProject

A Collaborative Award funded by the

wellcome trust

osf.io/efp4x/

[1]UCL [2]IBM Research Dublin
[3]Aberdeen University
[4]Cambridge University

Funding: The Wellcome Trust

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Vision of the project

Human Behaviour-Change Project

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The Human Behaviour-Change Project

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Will create and evaluate a Behaviour Change Intervention (BCI) Knowledge System:

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1. An ontology of BCIs and evaluation reports

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The Human Behaviour-Change Project

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5. An interface for computers and human users to interact with the system

The problem

"Messy" evidence, growing faster than humans can keep up with

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The problem

"Messy" evidence, growing faster than humans can keep up with

Messy evidence gets turned into well organised, useful scientific insights

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- Up to date estimates of the effectiveness of behaviour change interventions
- Unpacking reasons for heterogeneity in intervention effectiveness
- Generating new testable hypotheses about behaviour change

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What the HBCP does

Artificial Intelligence
Natural Language Processing
Machine Learning

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HBCP
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The problem

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What the HBCP does

Ontology provides organising structure to guide

Artificial Intelligence
Natural Language Processing
Machine Learning

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What is an ontology?

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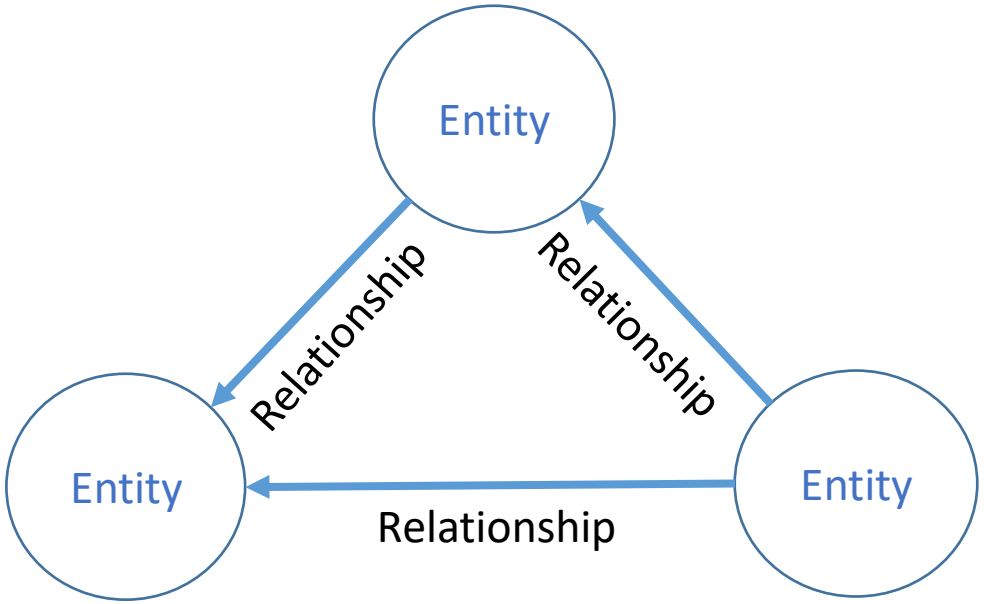
A system for representing knowledge in the form of:

1. A set of unique classes or categories
2. Labels and definitions for these
3. Specification of properties and relationships between them

   e.g. a taxonomy has hierarchical relationships



Arp R, Smith B, & Spear AD (2015). Building ontologies with basic formal ontology. Cambridge: MIT Press

What ontologies can do

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1. Improve clarity of thinking and reporting

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Human Behaviour-Change Project

1. Improve clarity of thinking and reporting
2. Generate new ideas and testable hypotheses
3. Identify information gaps and promotes lateral thinking
4. Facilitate interoperability across domains of knowledge and knowledge representations
5. Provide a powerful and intuitive basis for automated querying and reasoning

Upper-level
Behaviour Change Intervention Ontology

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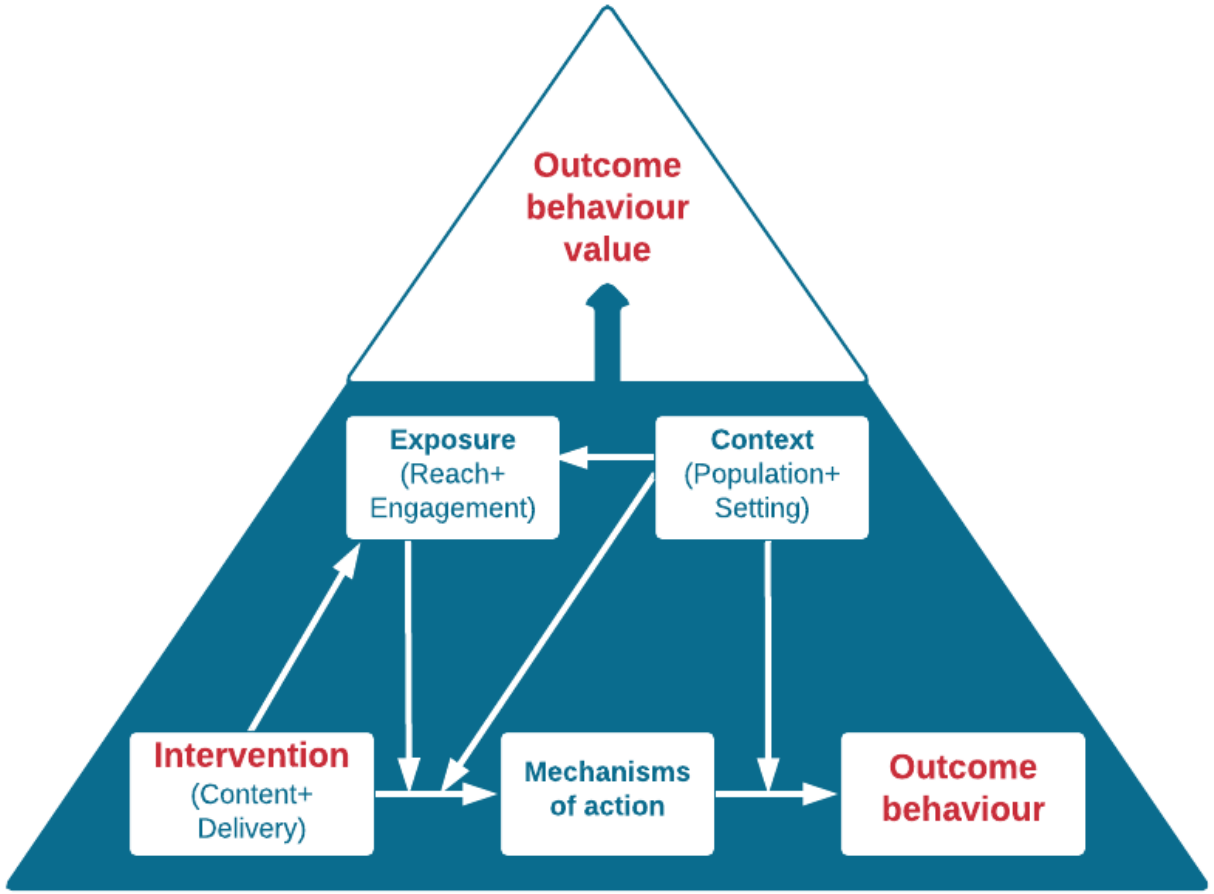

Upper level entities in BCIO

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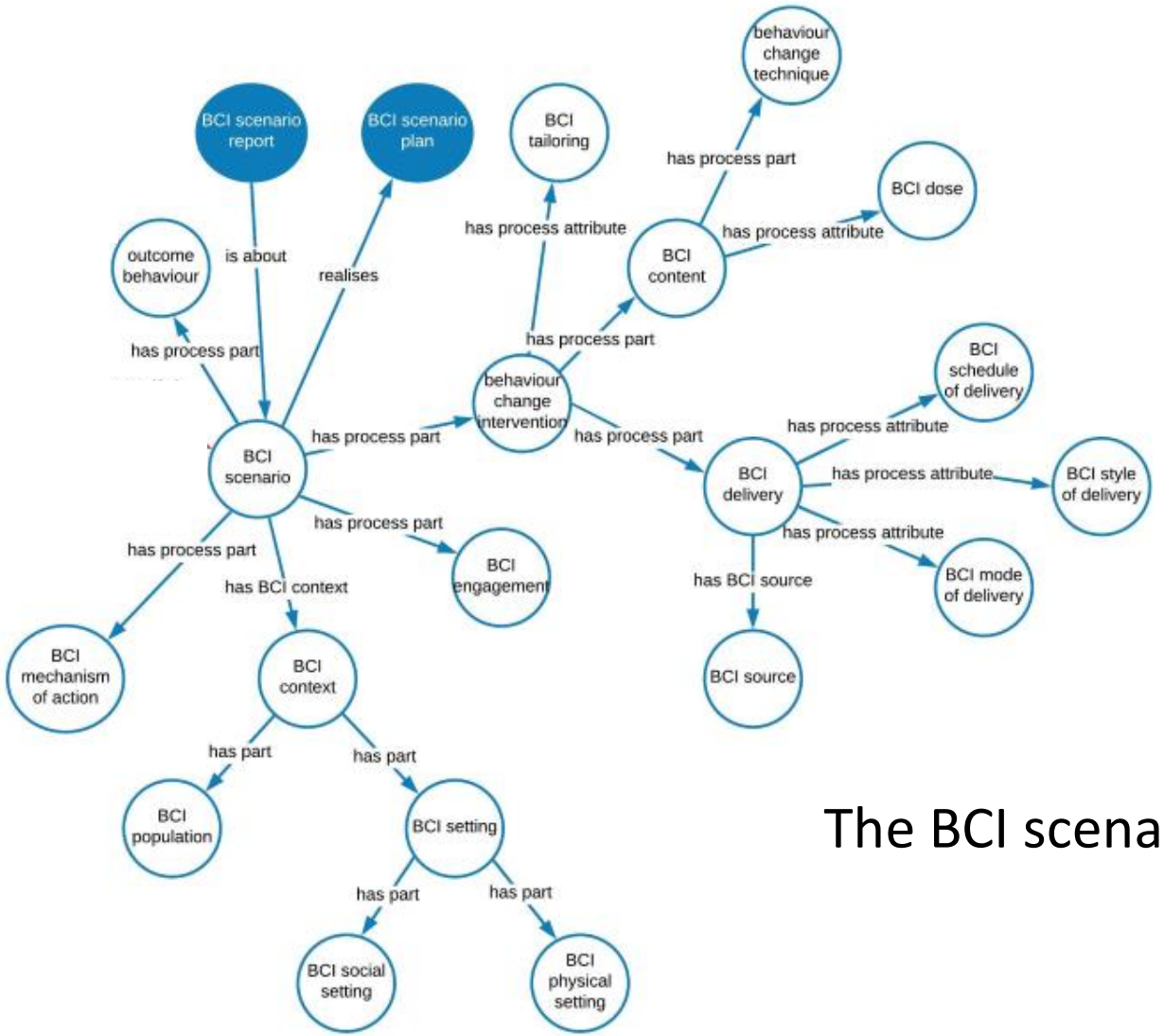

The BCI scenario

Upper level entities in BCIO

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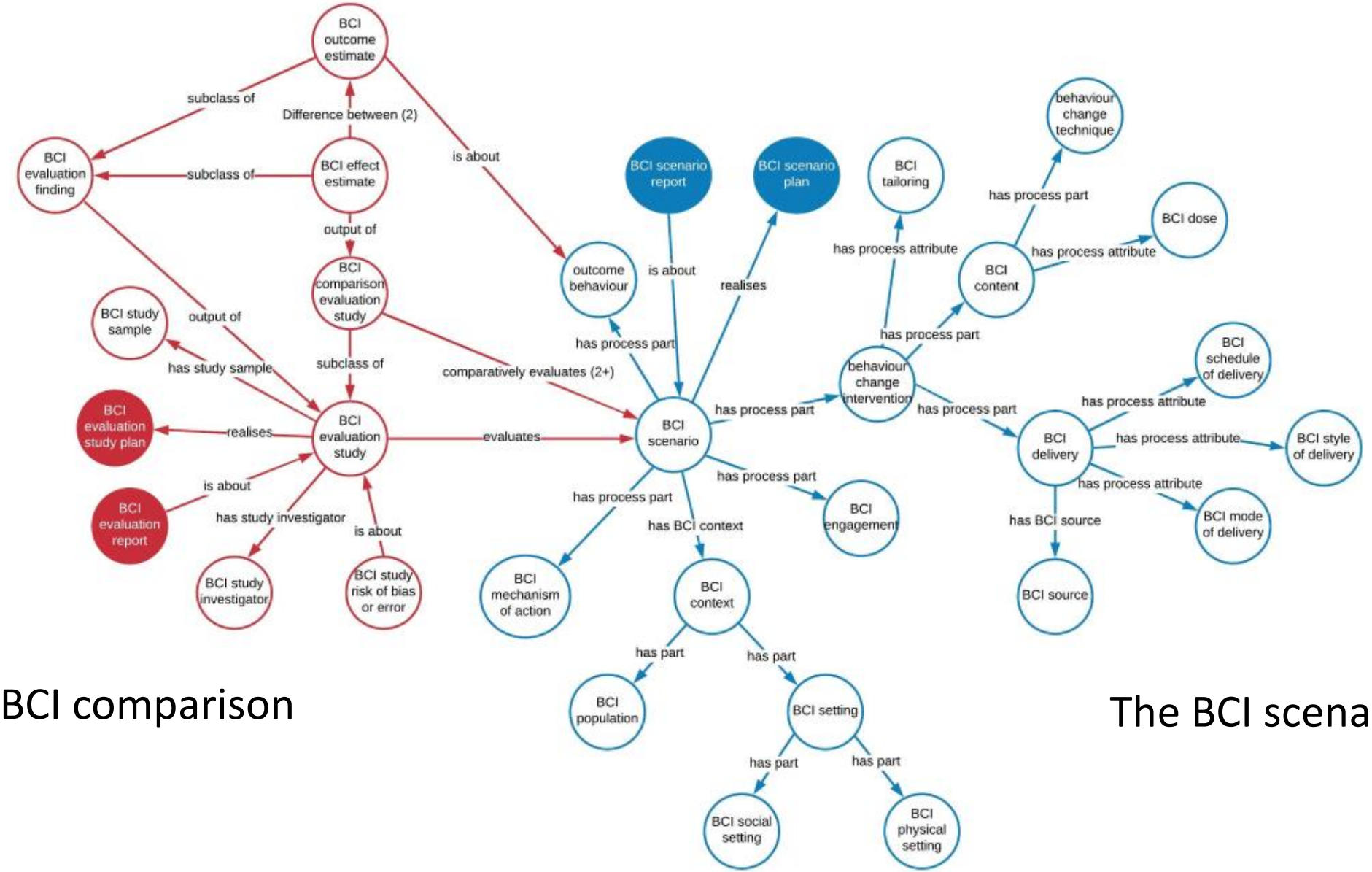

The BCI comparison

The BCI scenario

Publications: Open access

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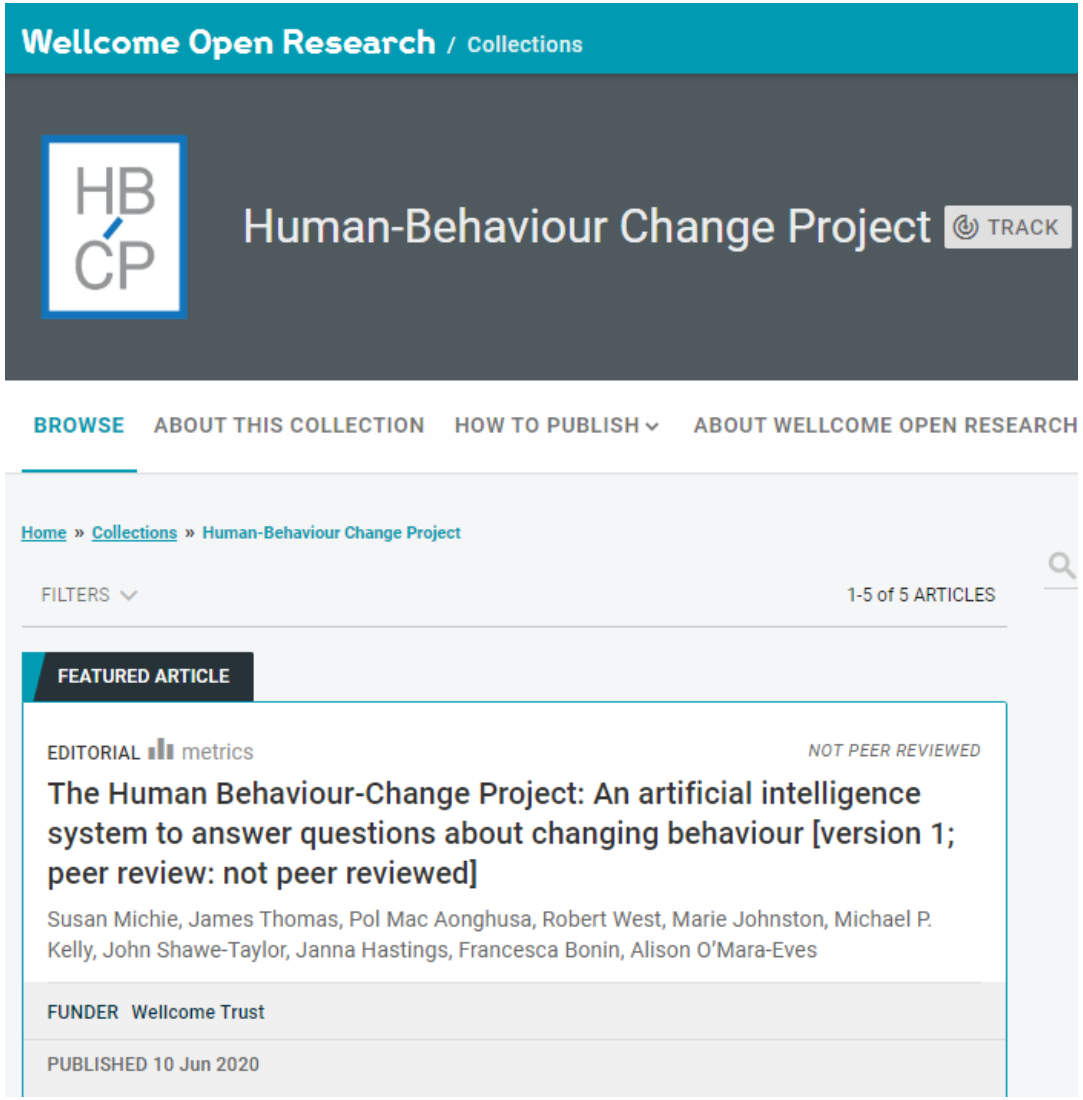
https://wellcomeopenresearch.org/collections/humanbehaviourchange



Michie et al. Implementation Science (2017) 12:121
DOI 10.1186/s13012-017-0641-5
Implementation Science

STUDY PROTOCOL Open Access

CrossMark

The Human Behaviour-Change Project: harnessing the power of artificial intelligence and machine learning for evidence synthesis and interpretation

Susan Michie[1*], James Thomas[2], Marie Johnston[3], Pol Mac Aonghusa[4], John Shawe-Taylor[5], Michael P. Kelly[6], Léa A. Deleris[4], Ailbhe N. Finnerty[1], Marta M. Marques[1], Emma Norris[1], Alison O'Mara-Eves[2] and Robert West[7]

Ontologies making up the BCIO

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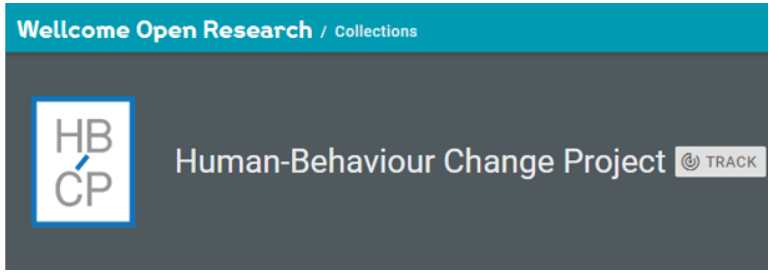
1. **Published**
   1. Behaviour change techniques – *BCTTv1 (Annals Beh Med, 200?)*
   2. Behaviour Change Intervention Ontology Upper Level
   3. Mode of delivery
   4. Intervention setting
   5. Ontology development methods
2. **Under development**
   a. Intervention source, schedule & style of delivery
   b. Exposure of intervention (Reach and Engagement)
   c. Mechanisms of action
   d. Target behaviour
   e. Target population



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Uses of the BCIO

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1. To identify components and their relationships in intervention reports
2. To synthesise evidence across interventions reported using different terms
3. To enable framing of questions about components
4. To facilitate algorithms performing reasoning and inference about data on the effectiveness of interventions

Limitations of ontologies relative to natural language

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- More limited expressive power
- Less economy of expression
- Requires specific expertise
- Could be used to create conceptual hegemony

Evaluating the Knowledge System

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Evaluating the Knowledge System

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- Evaluation criteria include:
  - The adequacy of the new system in comparison with traditional evidence synthesis to provide information that is ..
    - more accurate, extensive, useable and timely
  - The utility of the system as assessed by users

Ontologies are continually developing

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- The BCIO will be published in the Open Biological and Biomedical Ontologies (OBO) Foundry
- This is a group of people dedicated to build and maintain ontologies related to the life sciences
- The OBO Foundry establishes a set of principles for ontology development for creating a suite of interoperable reference ontologies in the biomedical domain
- Thus, ontologies are living things that will be extended, adapted and linked to as they are used

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Questions?

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