

Advancing health psychology through evidence and theory integration

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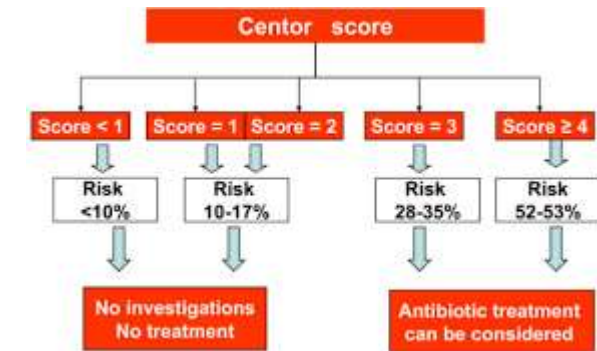
Psychology, Health &
Medicine Conference,
Belfast, 2025

Improving health depends on behaviour



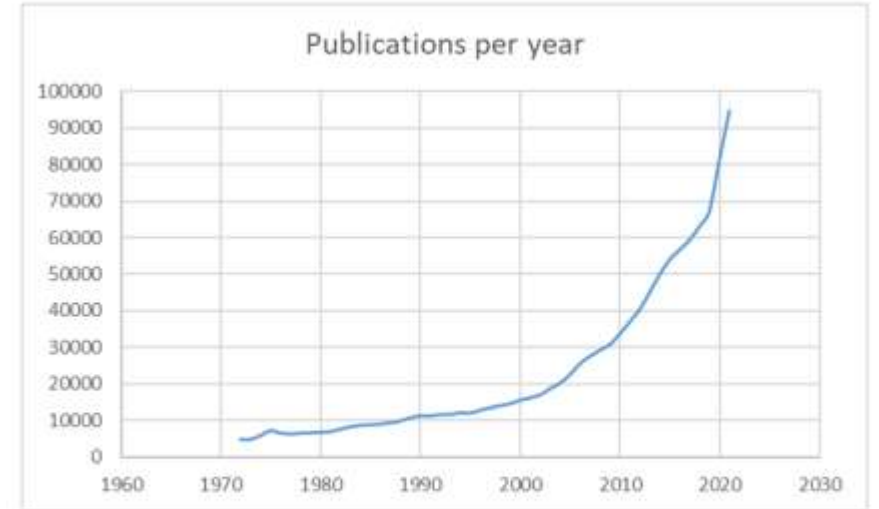
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1. To prevent disease
 - Individuals and populations e.g. pandemics, antimicrobial resistance
2. To manage short-term crises & long-term conditions
3. To deliver high quality, evidence-based healthcare



The potential: we 'know' a lot

- We have a vast and rapidly growing body of evidence of **behavioural interventions** that can improve health and wellbeing
 - >100 evaluations published every week
 - <https://www.geios.com/read/U6VX2Z>



PubMed [TiAb] for mental health OR psychosis OR depression OR anxiety for 1972 to 2021

But we are hampered by problems of ...



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- Finding evidence
 - databases are not linked
- Reporting evidence
 - very variable, often vague or ambiguous & often missing key information
- Integrating evidence
 - Heterogeneous terms, many types of data & different reporting styles



My motivation for developing ontologies ...



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1. Advising Government policy-makers
 - Evidence synthesis process not fit for purpose
 - Too slow, partial evidence, integrated poorly
2. Slow accumulation of knowledge, partly because poorly reporting
 - Descriptions vague or terms not defined
 - Different terms for the same things
 - Undermines replication, communication, advancing knowledge



Part of solution

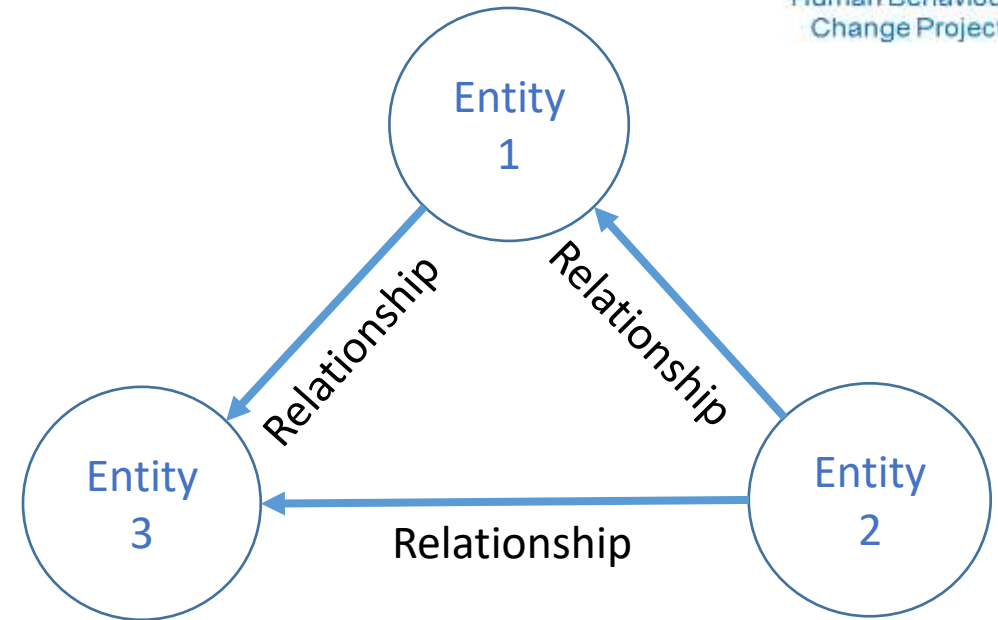
1. Better **reporting** of all aspects of interventions, their mechanisms of action and their contexts
 - Without this, we are limited in our ability to
 - **replicate** findings,
 - **implement, evaluate** and **improve** interventions
2. Improve **organisation** and **synthesis of** large amounts of complex evidence **at scale** and **rapidly**
 - Instead of relatively small knowledge silos, we need large **joined-up** datasets and theories
 - that **cross topics**, disciplines, cultures and countries

Main messages of this talk

1. Advancing knowledge in health psychology can be hugely accelerated by more efficient
 - organisation,
 - sharing and
 - integration of knowledge
2. There are methods for achieving this, used across sciences but only recently in psychology
 - representing knowledge using 'ontologies'
 - common language across disciplines and domains
 - precise enough for computers to read, enabling use of AI for our data

What is an ontology?

- 3 key components: (1) unique **entities** ('classes'), (2) **labels** and definitions, & (3) **relationships** between entities
 - all with unique identifiers, so machine-readable
- Represents knowledge in a **consistent, precise** way, with a **shared** scientific vocabulary
- Enables
 - Searching & integrating knowledge
 - Predicting outcomes of novel scenarios, &
 - Making inferences across contexts



Hastings, J. (2017). Primer on ontologies.
In *The gene ontology handbook* (pp. 3-13).
Humana Press, New York, NY. [open access]

The Human Behaviour-Change Project



Human Behaviour-
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Participating
organisations



www.humanbehaviourchange.org

A Collaborative
Award funded
by the

wellcometrust



osf.io/efp4x/

What we need to know

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

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?



The problem



“Messy”
evidence,
growing
faster than
humans can
keep up with

**Messy evidence gets turned
into well organised, useful
scientific insights**



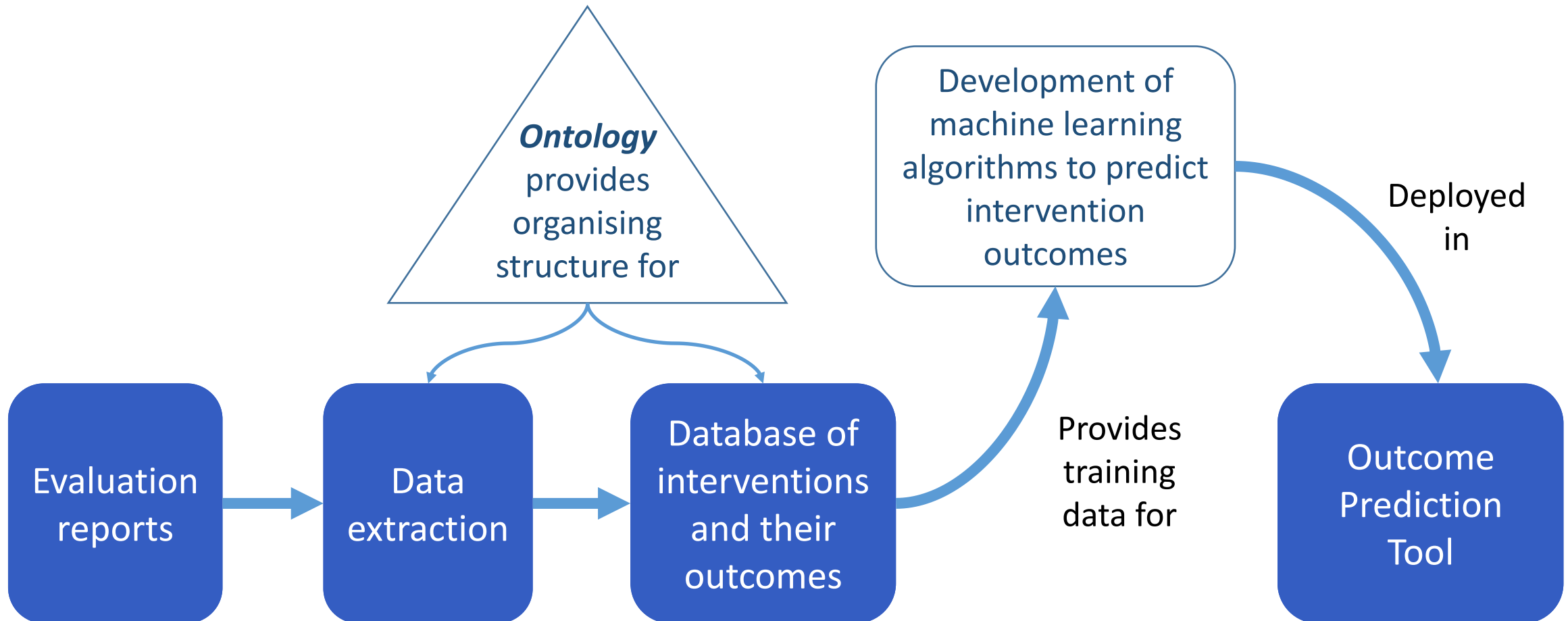
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Up to date
estimates of the
effectiveness of
behaviour change
interventions

Unpacking
reasons for
heterogeneity in
intervention
effectiveness

Generating new
testable
hypotheses about
behaviour change

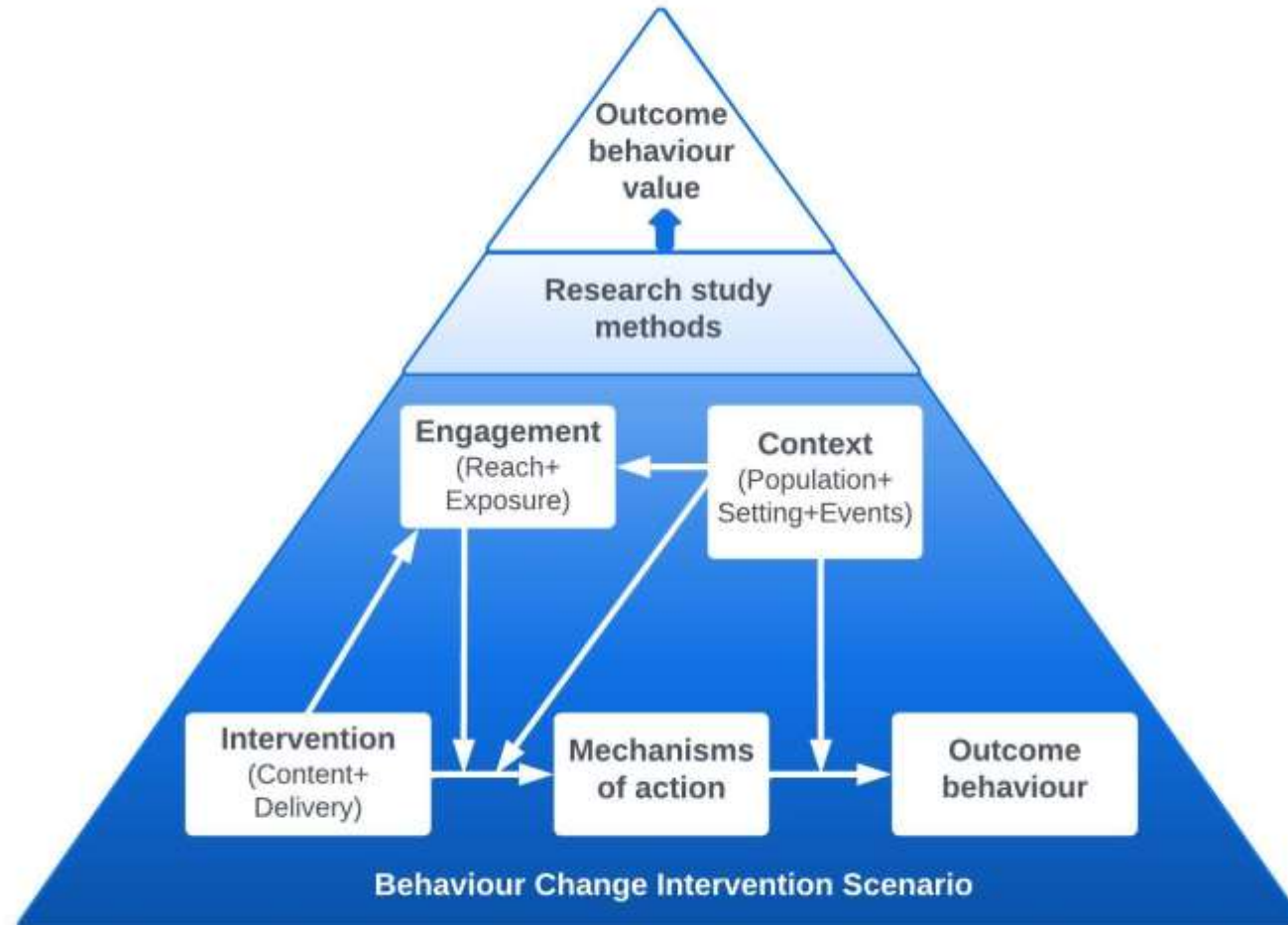
Using ontologies to predict behaviour change intervention outcomes



HBCP has developed the Behaviour Change Intervention Ontology



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www.BCIOntology.org

Ontologies making up the BCIO

Published <https://wellcomeopenresearch.org/collections/humanbehaviourchange>

1. Behaviour Change Intervention Ontology Upper Level
2. Behaviour change techniques
3. Mode of delivery
4. Intervention source
5. Intervention schedule
6. Intervention style of delivery
7. Intervention setting
8. Target population
9. Target behaviour

2451 entities
>2000 relationships

See
<https://wellcomeopenresearch.org/collections/humanbehaviourchange>
(includes a Methods paper)

Nearing completion

- a. Intervention dose
- b. Intervention delivery fidelity
- c. Participant engagement

Behaviour change techniques (BCTs)



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

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

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
© The Society of Behavioral Medicine 2013

BCT Taxonomy v1: 93 items in 16 groupings



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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)		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
		9	7. Associations		
			7.1. 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

Improvement on BCTTv1: developing a BCT Ontology



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RESEARCH ARTICLE

REVISED

The Behaviour Change Technique Ontology: Transforming the Behaviour Change Technique Taxonomy v1

[version 2; peer review: 4 approved]

Marta M. Marques* , Susan Michie , Alison J. Wright* , Robert West , Lisa Zhang , Elizabeth Corker ,
Marie Johnston , Janna Hastings

<https://wellcomeopenresearch.org/articles/8-308>

RESEARCH ARTICLE

REVISED

Behaviour change techniques taxonomy v1: Feedback to inform the development of an ontology [version 2; peer review: 2 approved]

Elizabeth Corker* , Marta Marques* , Marie Johnston , Robert West , Janna Hastings , Susan Michie

<https://wellcomeopenresearch.org/articles/7-211>

Logical (rather than statistical) structure

- Entities - can be added
- Relationships - consensus
- Definitions
 - Unambiguous
 - Computer readable
- Revision
 - Additions
 - Modifications

285 BCTs in 20 high-level classes

BCT Group	No. of BCTs in the group
Goal directed BCT	23
Monitoring BCT	12
Social Support BCT	16
Guide how to perform behaviour BCT	6
Conduct a behaviour experiment BCT	1
Suggest different perspective on behaviour BCT	5
Increase awareness of behaviour BCT	3
Increase awareness of consequences BCT	21
Awareness of other people's thoughts, feelings or actions BCT	7
Associative learning BCT	15

BCT Group	No. of BCTs in group
Advise specific behaviour BCT	9
Manage mental processes BCT	4
Prompt thinking related to mental processes BCT	6
Change the body BCT	1
Promote pharmacological support BCT	3
Advise how to change emotions BCT	20
Restructure the environment BCT	12
Prompt focus on self-identity BCT	5
Behavioural consequence BCT	77
Outcome consequence BCT	35

BCT Ontology

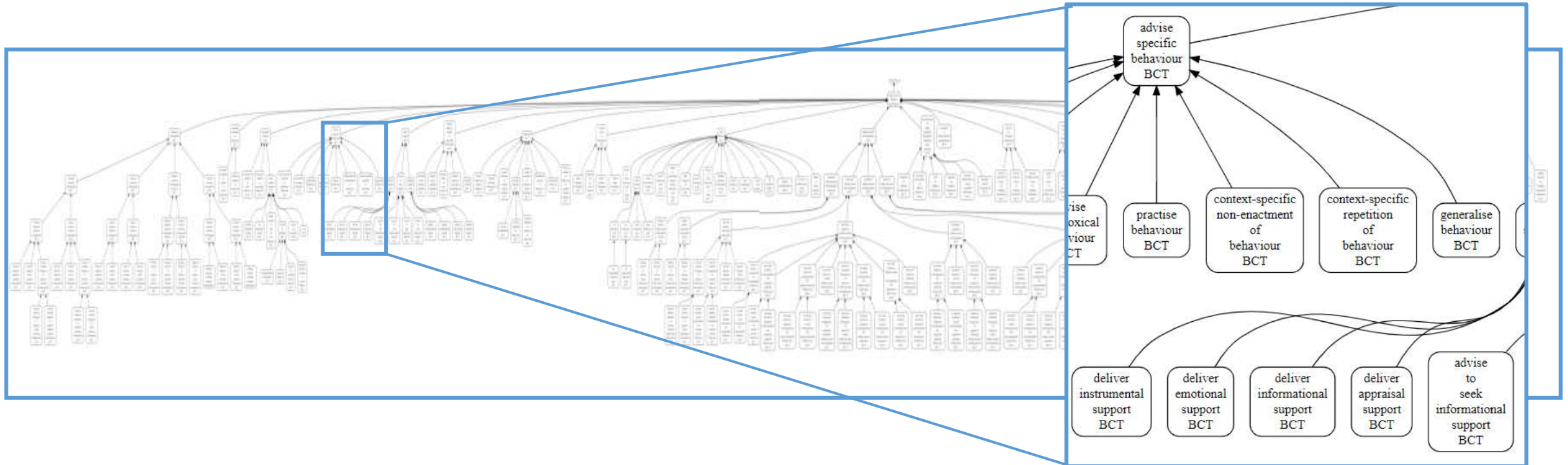
<https://bciovis.hbcptools.org/>



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- 285 BCTs organised into
- 20 high-level classes over ...
- 5 hierarchical levels

NB: these numbers will change as the ontology is revised and updated



BCTO more fine-grained: e.g. *Social Support*



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Definition of Social Support BCT in BCTO

‘A <behaviour change technique> that involves taking steps to secure or deliver the support or aid of another person.’

- Advise to seek support BCT
 - Advise to seek instrumental support BCT
 - Advise to seek emotional support BCT
 - Advise to seek informational support BCT
 - Advise to seek appraisal support BCT
- Arrange support BCT
 - Arrange instrumental support BCT
 - Arrange emotional support BCT
 - Arrange informational support BCT
 - Arrange appraisal support BCT
- Deliver support BCT
 - Deliver instrumental support BCT
 - Deliver emotional support BCT
 - Deliver informational support BCT
 - Deliver appraisal support BCT

Mapping from BCTTv1 to BCTO: <https://osf.io/r7cux>



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No.	BCT label in BCTTv1	BCTTv1 definition	Closest BCT(s) in the BCTO (label and ID)	BCTO class definition(s) Note: Angled brackets (< and >) around some of the text indicate that it is the parent class
3.3	Social support (emotional)	Advise on, arrange, or provide emotional social support (e.g. from friends, relatives, colleagues, 'buddies' or staff) for performance of the behaviour <i>Note: if practical, code 3.2, Social support (practical); if unspecified, code 3.1, Social support (unspecified)</i>	Now three BCTs: Advise to seek emotional support BCT [BCIO:007031] Arrange emotional support BCT [BCIO:007036] Deliver emotional support BCT [BCIO:007041]	Advise to seek emotional support BCT: An <advise to seek support BCT> that suggests the person try to obtain support from another in terms of expressing concern, caring and empathy. Arrange emotional support BCT: An <arrange support BCT> that organises support from another in terms of expressing concern, caring and empathy. Deliver emotional support BCT: A <deliver support BCT> that provides expressions of concern, caring and empathy.



Good news, there is a BCIO User Group



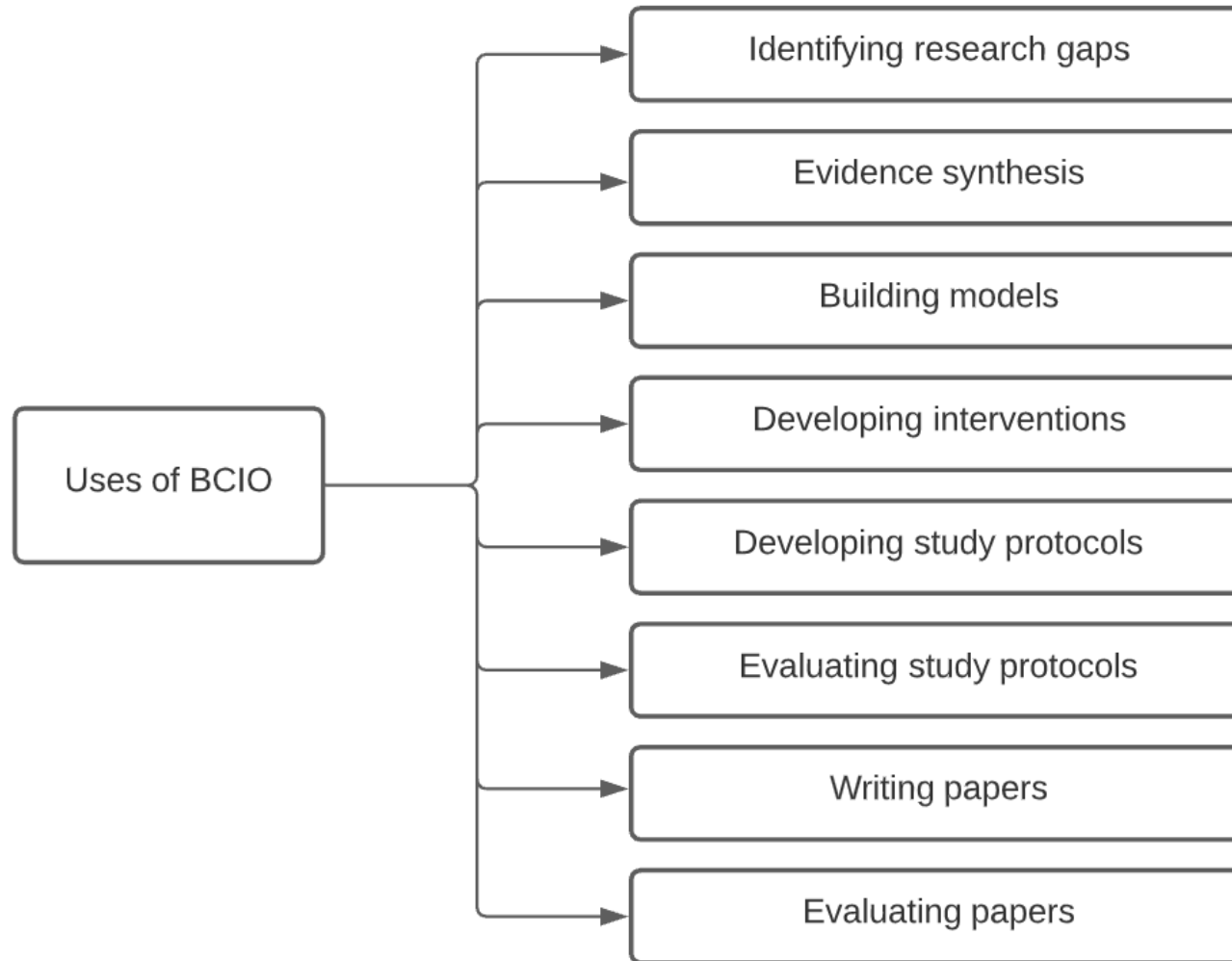
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What are ontologies useful for?



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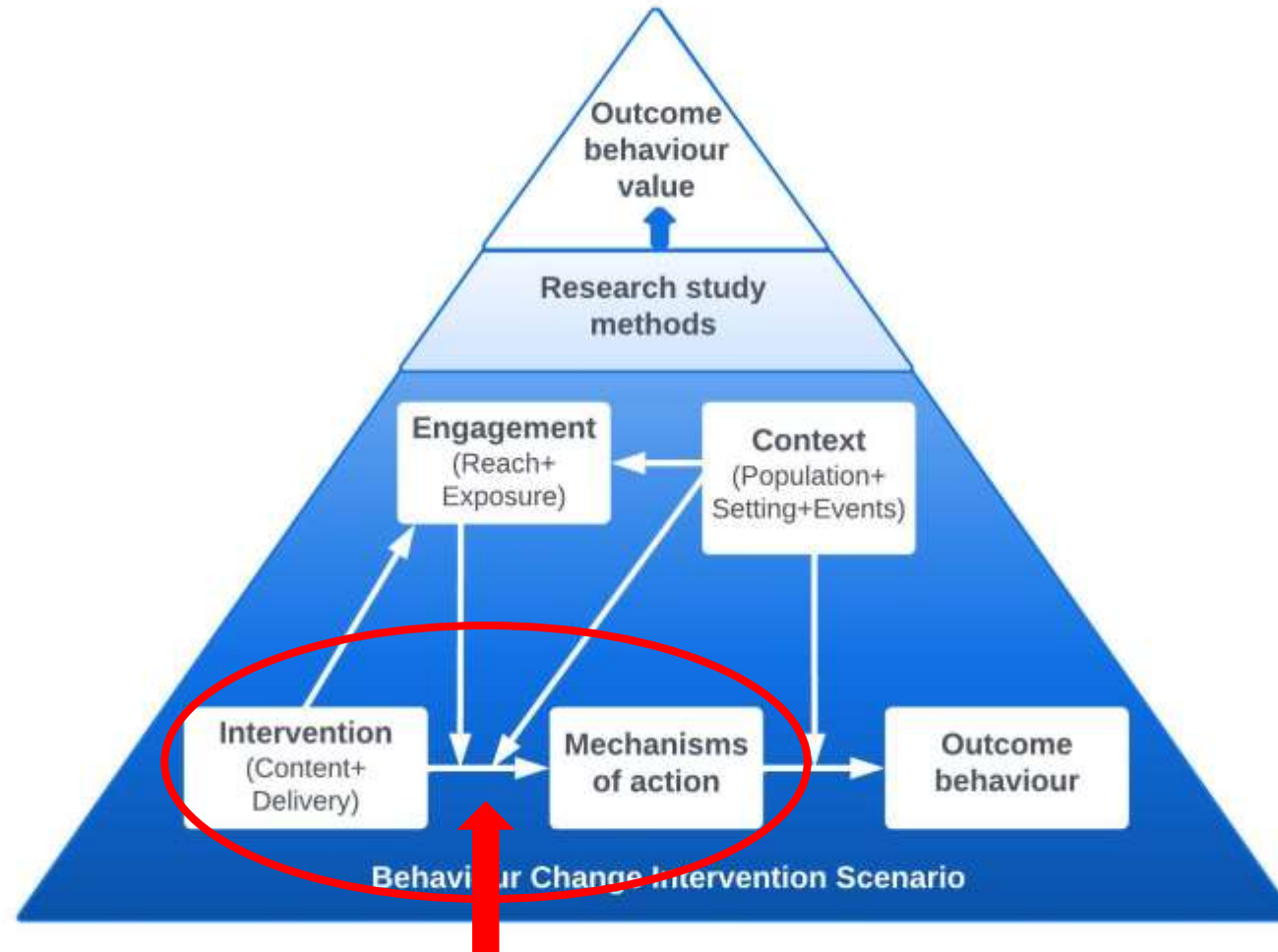
Thinking about theory

- Theories are helpful ways of
 - summarising what we know and
 - accumulating knowledge about a topic
- They explain
 - processes of change (mechanisms of action)
 - variation across e.g. populations, settings, types of behaviour

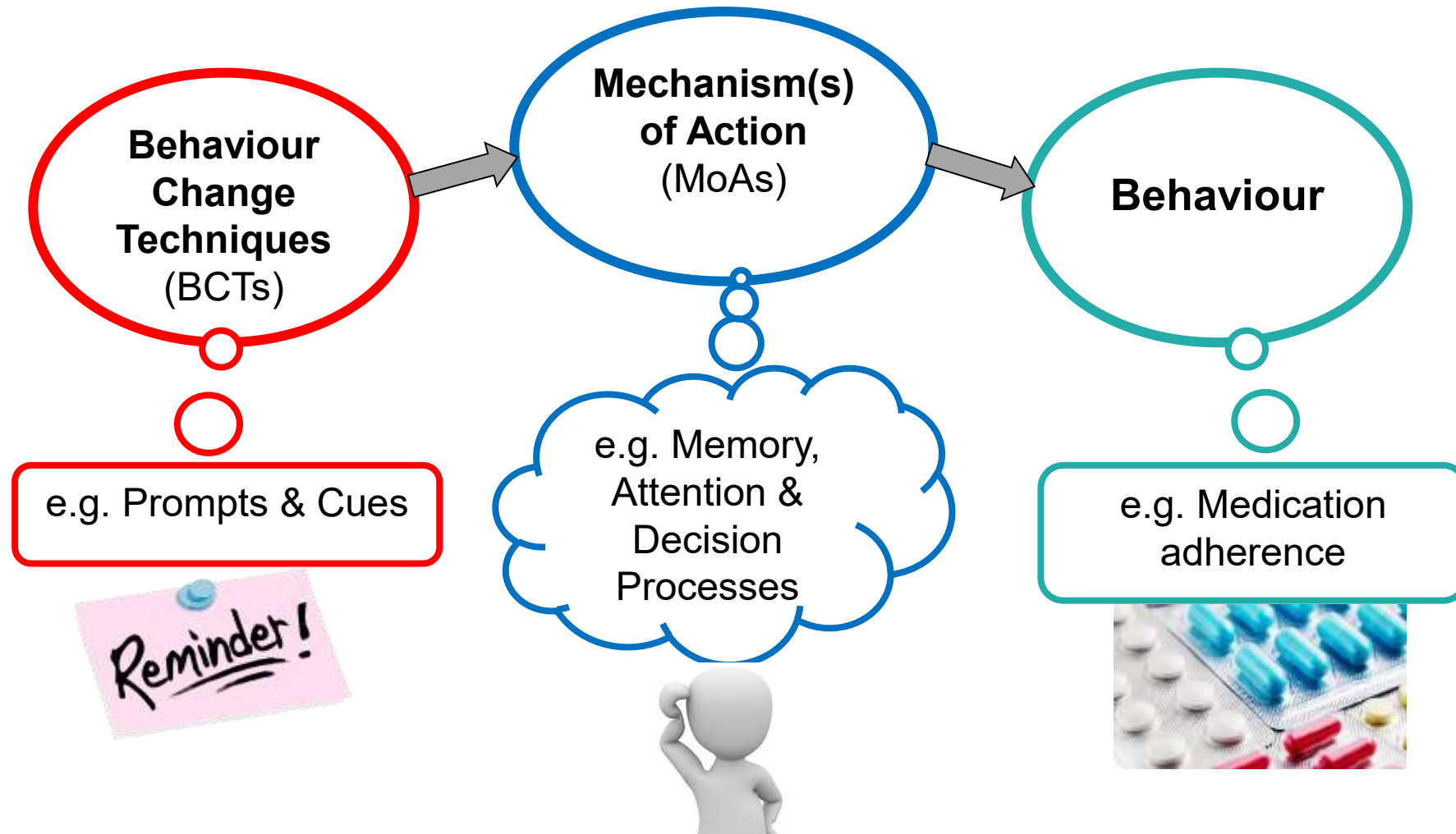
Theory in relation to interventions

1. If this intervention is effective, **why**?
 - What are the processes of change through which the intervention had its effect?
2. If we want to draw on theory to design an intervention, **how** do we do this?

Linking BCTs to Mechanisms of Action



Example



Linking BCTs and Mechanisms of Action

- Theory and Techniques Tool: A free, online platform
- Developed by analysing
 - Published literature (how authors think about links between BCTs), and
 - Expert consensus (agreement about both links and about ‘non-links’)
- Can be found at
<https://theoryandtechniquetool.humanbehaviourchange.org/>
 - Part of the Human Behaviour-Change Project/APRICOT Project



Theory and Techniques Tool home screen



Login



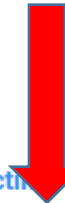
Theory and
Technique Tool

[Home](#) [The Tool](#) [About the Tool](#) [How to use Tool](#)

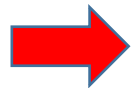


Select one cell you're interested in or make your own custom heat map by selecting [+/-](#) on the columns and rows of interest

26 Mechanisms of Action



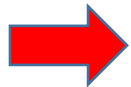
Outcome for each cell



Links
 Non-links
 Inconclusive
 No evidence

		MoAs																											
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3																													

60
BCTs



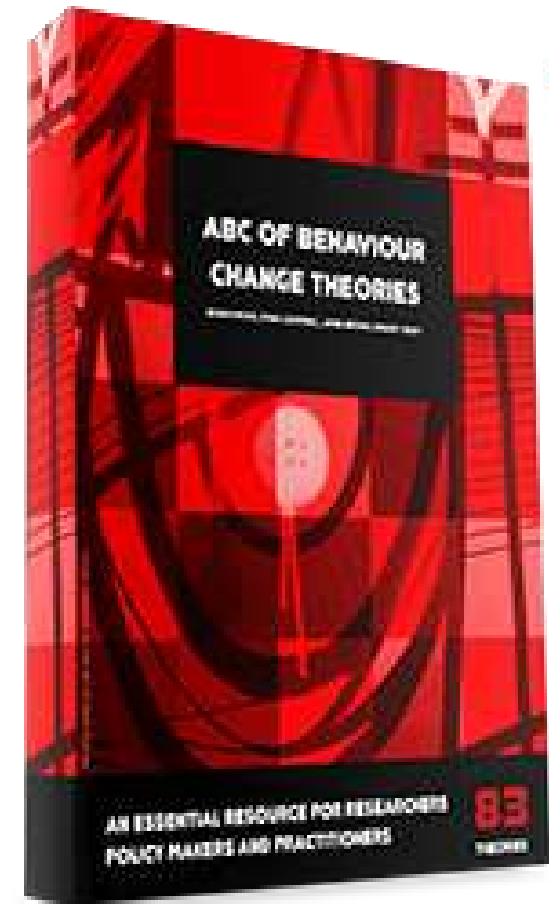
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We have too many theories!

- A systematic review of theories of behaviour and behaviour change identified 83 theories
 - Ave number constructs/theory = 20
- Most are partial and many overlap
- Constructs and relationships are rarely specified clearly
- Different terms are often used interchangeably, with the same words describing different things and vice versa

Davis, Campbell, Hilsdon, Hobbs & Michie (2015), *Health Psychol Rev.*

Michie, West, Campbell, Brown, & Gainforth (2014) *ABC of behaviour change theories*



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Ontologies can be used to integrate them



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Wellcome Open Research

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RESEARCH ARTICLE

An ontology-based modelling system (OBMS) for representing behaviour change theories applied to 76 theories

[version 1; peer review: 2 approved]

Joanna Hale , Robert West , Susan Michie , Janna Hastings, Carmen E. Lefevre, Artur Direito , Lauren Connell Bohlen ,
Cristina Godinho, Niall Anderson , Silje Zink, Hilary Groarke

First phase of the project

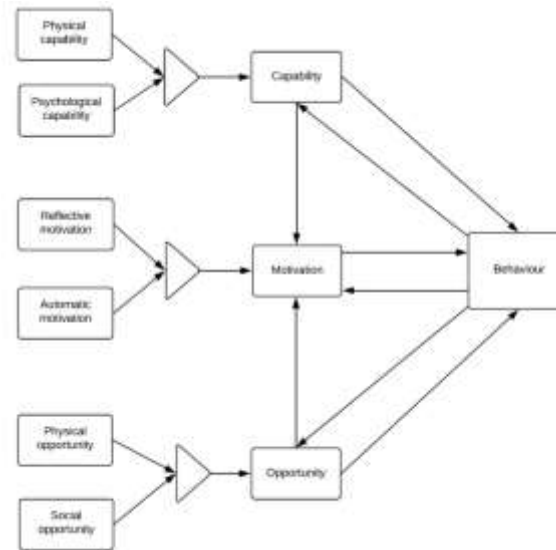


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Screen 83 theories



Represent 76 theories in OBMS diagram form



Generate searchable database: by theory or construct

Search

To search for a theory by name, enter a search string:

To search for a construct within a theory, enter a search string:

To search for a triple by relation type, enter a search string:

Browse theories

To view the content of a theory, you can select a theory from the list:

- 1: Action Theory Model of Consumption
- 2: Affective Events Theory
- 3: AIDS Risk Reduction Model
- 4: Behavioural Ecological Model of AIDS Prevention
- 5: CEOS Theory
- 6: Change Theory
- 8: COM-B
- 9: Consumption as social practices
- 10: Containment Theory
- 11: Control Theory
- 12: Differential Association Theory
- 13: Diffusion of Innovations
- 14: Ecological Model for Preventing Type 2 Diabetes

Michie, West, Campbell, Brown, & Gainforth
(2014), *ABC of behaviour change theories*.

<https://theory-database.hbcptools.org/>

All data and code available at: osf.io/q25nw

Second phase: Mapping

- 1379 theory constructs from 76 theories were mapped to
 - 495 classes from the Behaviour Change Intervention Ontology (BCIO; www.BCIOntology.org) or other ontologies in <https://www.bssofoundry.org/>
 - 83 outstanding constructs still to map

Early findings: Most common ontology classes across theories



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Ontological class	Frequency of occurrence
Environmental system, social environmental system	37, 36
Individual human behaviour	33
Behavioural intention	28
Self-efficacy belief for a behaviour	25
Behavioural opportunity, Social behavioural opportunity	18, 13
Behavioural motivation	17
Behavioural capability	17
Belief about consequences of a behaviour	16
Social influence behaviour	13
Goal	13

Final reflections ontologies

1. Sharpens thinking especially representing complexity
2. Helps enquiry to be coherent and comprehensive
3. Links evidence and theory across subject domains & scientific fields
4. Enables *cumulative* science by representing new knowledge and understanding as they develop
5. Machine readable so can harness machine learning, natural language processing and AI
 - Step change in evidence synthesis, interpretation and generation of new knowledge

... But also challenges

1. Unfamiliarity of language and way of thinking
 - Formal and informal definitions
2. May reduce economy of exposition and subtlety of expression
3. Needs ontological and domain-specific expertise
4. Ensure include
 1. Inter-rater reliability assessment,
 2. stakeholder feedback, &
 3. broad consensus



APRICOT
Ontology Tools

APRICOT PROJECT OFFICIAL LAUNCH

*Advancing Behaviour Change Science through
Ontologies!*



17 JUNE, 2025



3:30 PM - 5 PM (UK TIME)



ONLINE EVENT

<https://tinyurl.com/HBCP-APRICOT>

3:30 PM - 3:40 PM

Welcome and introduction to
APRICOT

> Susan Michie

3:40 PM - 3:45 PM

Advancing the behavioural
and social sciences through
ontologies.

> Bruce Chorpita

3:45 PM - 3:50 PM

Perspectives on ontologies
from an applied behavioural
scientist

> Rick Moser

3:50 PM - 3:55 PM

Using ontologies to
understand and predict
behaviour

> Janna Hastings

**Q&A
(3:55 PM - 4:15 PM)**

4:15 PM - 4:20 PM

Tools and resources for
research and intervention
development

> Robert West

4:20 PM - 4:25 PM

Linking datasets and
knowledge across silos

> Bill Hogan

4:25 PM - 4:30 PM

Co-production and building a
community of practice

> Marta Marques

**Q&A
(4:30 PM - 4:50 PM)**

4:50 PM - 5:00 PM

Summary and next steps





> Susan Michie

Resources








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Information about ontologies and BCIO

Resource	URL
 Human Behaviour-Change Project Website	www.humanbehaviourchange.org/
 Behaviour Change Intervention Ontology Website and Training Programme	www.bciontology.org/ https://www.bciontology.org/training
 Collection of HBCP publications	https://wellcomeopenresearch.org/collections/humanbehaviourchange
 HBCP Webinar Series	https://www.youtube.com/@humanbehaviourchangeproject

Tools for accessing and using BCIO



Resource	URL
 BCIOSearch: Find BCIO classes	https://www.bciosearch.org/
 BCIOVisualise: Visualise BCIO classes	https://bciovis.hbcptools.org/
 Ontology Lookup Service: Browse the BCIO	https://www.ebi.ac.uk/ols/ontologies/bcio
 GitHub: Download the BCIO	https://github.com/HumanBehaviourChangeProject
 Open Science Framework	https://osf.io/efp4x/

Funding of the theory work over 10 years!



- ***For preparation work***

Human Behaviour-Change Project

- ***For future tools and resources work***

The APRICOT Project

www.humanbehaviourchange.org

- ***For integration work***

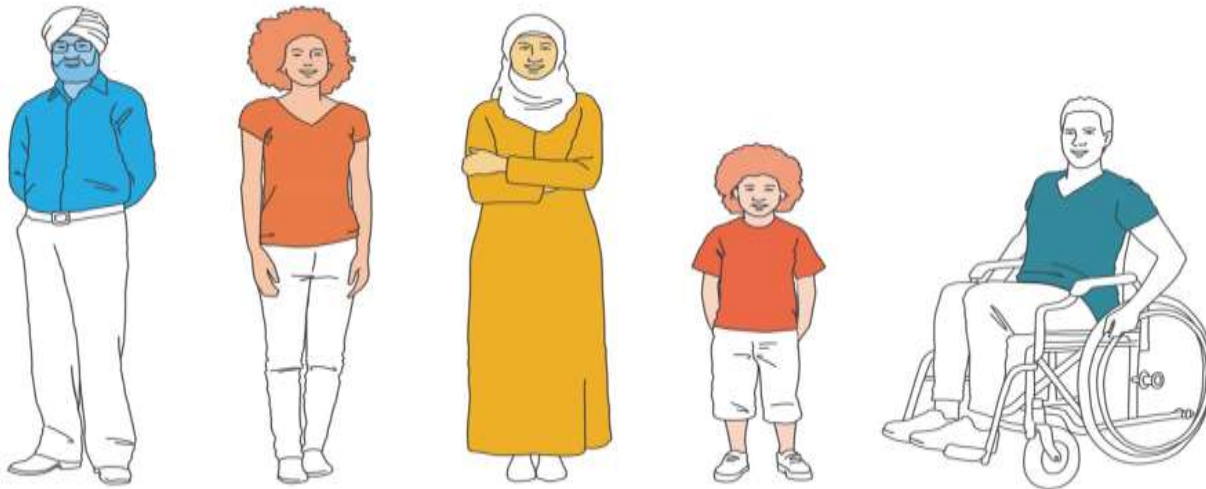
Behavioural Research-UK



Vision of Behavioural Research UK

To achieve a step-change in innovative and impactful behavioural research by achieving:

- Integration & co-ordination
- Inclusiveness & collaboration
- Embeddedness across the UK



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<https://osf.io/8qwyn/>



Behavioural
Research UK

BR-UK is supported by the
Economic and Social
Research Council
[grant number
ES/Y00104

Thank you for listening

Further details

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Centre for Behaviour Change:	<u>www.ucl.ac.uk/behaviour-change</u>
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