Human Behaviour Change Project

Developing the Behaviour Change Intervention Ontology

Evaluations of interventions to change behaviour

- >100 published a week
  - more than we can keep up with
  - research reported in highly heterogenous ways
  - terminology imprecisely defined and used differently by different groups, and
  - key information is often omitted.
- This hinders the accumulation of knowledge.

What is needed

- A method for representing knowledge in a shared structure and language to bring together evidence across studies, academic disciplines and topic domains

- An ontology is a model of what is already known about a domain, and the relationships between entities in a domain. This enables computers to analyse large bodies of content for patterns and gaps

- We have developed the Behaviour Change Intervention Ontology (BCIO) that represents all the entities involved in behaviour change interventions, and their contexts, mechanisms of action and evaluation

Why do we need the BCIO?

Same words are used to describe different things and different words are used to describe the same thing

The BCIO provides **consistent terminology** & unique ID number to share evidence unambiguously

Key bits of information are often missing (e.g., **how often** was an intervention delivered, was an intervention **delivered as planned**?)

The BCIO provides **prompts** to encourage researchers to consider all aspects of intervention evaluation

The quantity of outputs makes it difficult to synthesise evidence effectively

Unique ID number attached to each entity can help **AI to organise and synthesise** evidence at speed

What we need

- Automation to find the evidence and extract information
  - to generate useful and useable knowledge for planners, policy-makers, practitioners and researchers
- Need an ontology to organise this evidence
 - to enable AI to use it in making predictions about intervention outcomes in novel scenarios

The questions people want answered …

To develop an understanding of human behaviour
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?
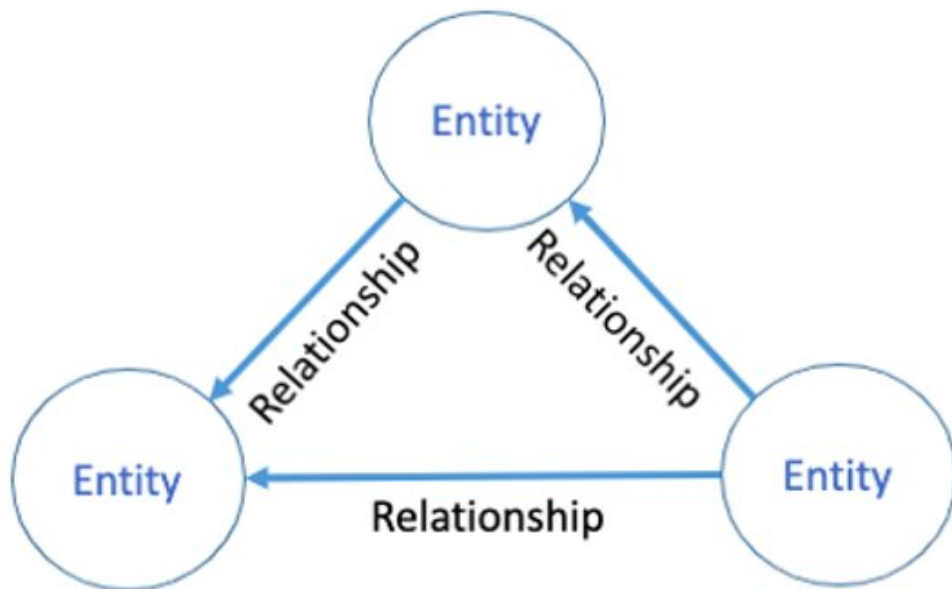
The Behaviour Change Intervention Ontology is an ontology for all aspects of human behaviour change interventions and their evaluations.

It provides a **clear and controlled vocabulary** to describe what happened in a behaviour change intervention
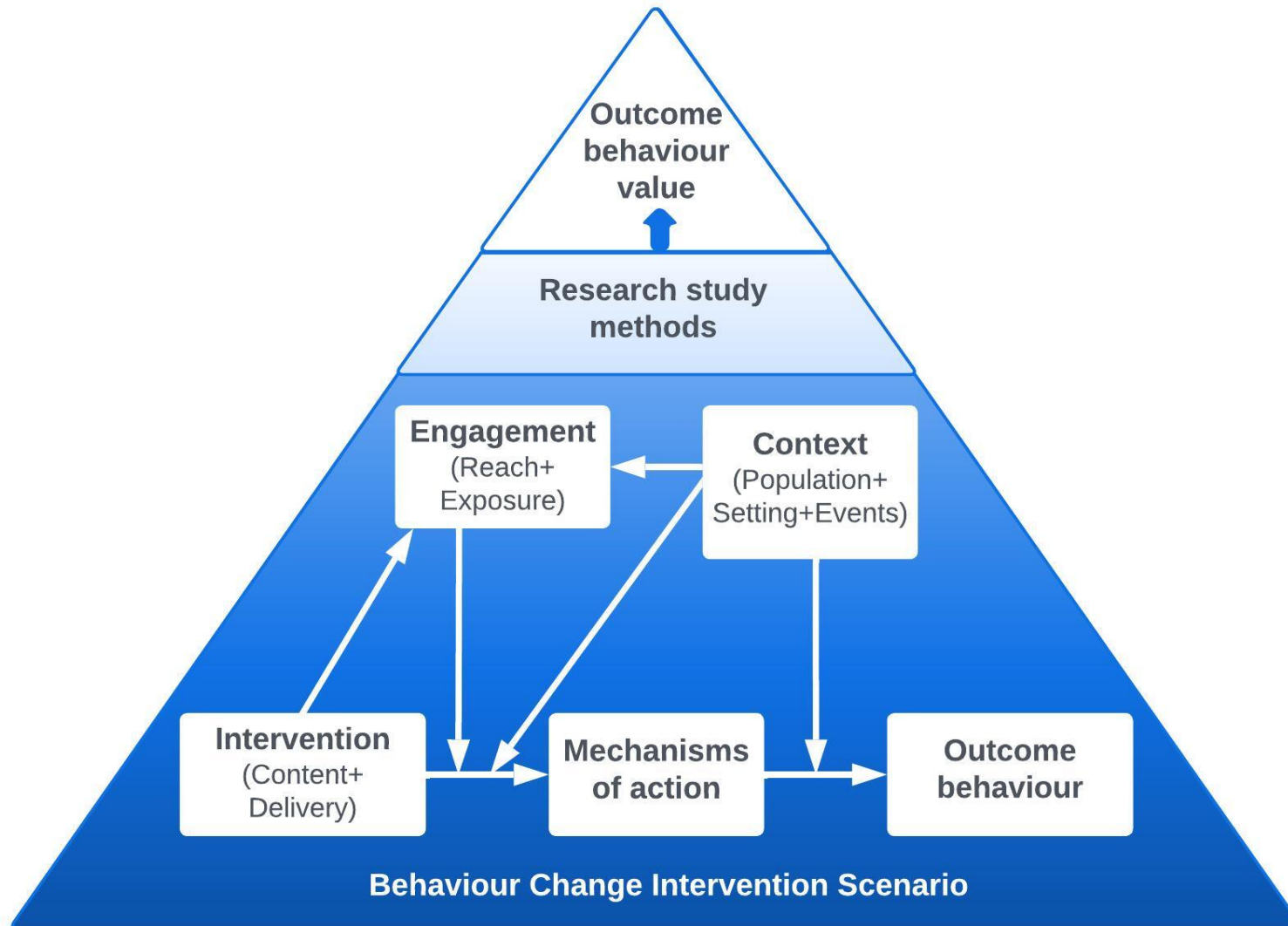
Methods for developing the BCIO

Wright et al. (2020), *https://wellcomeopenresearch.org/articles/5-126*
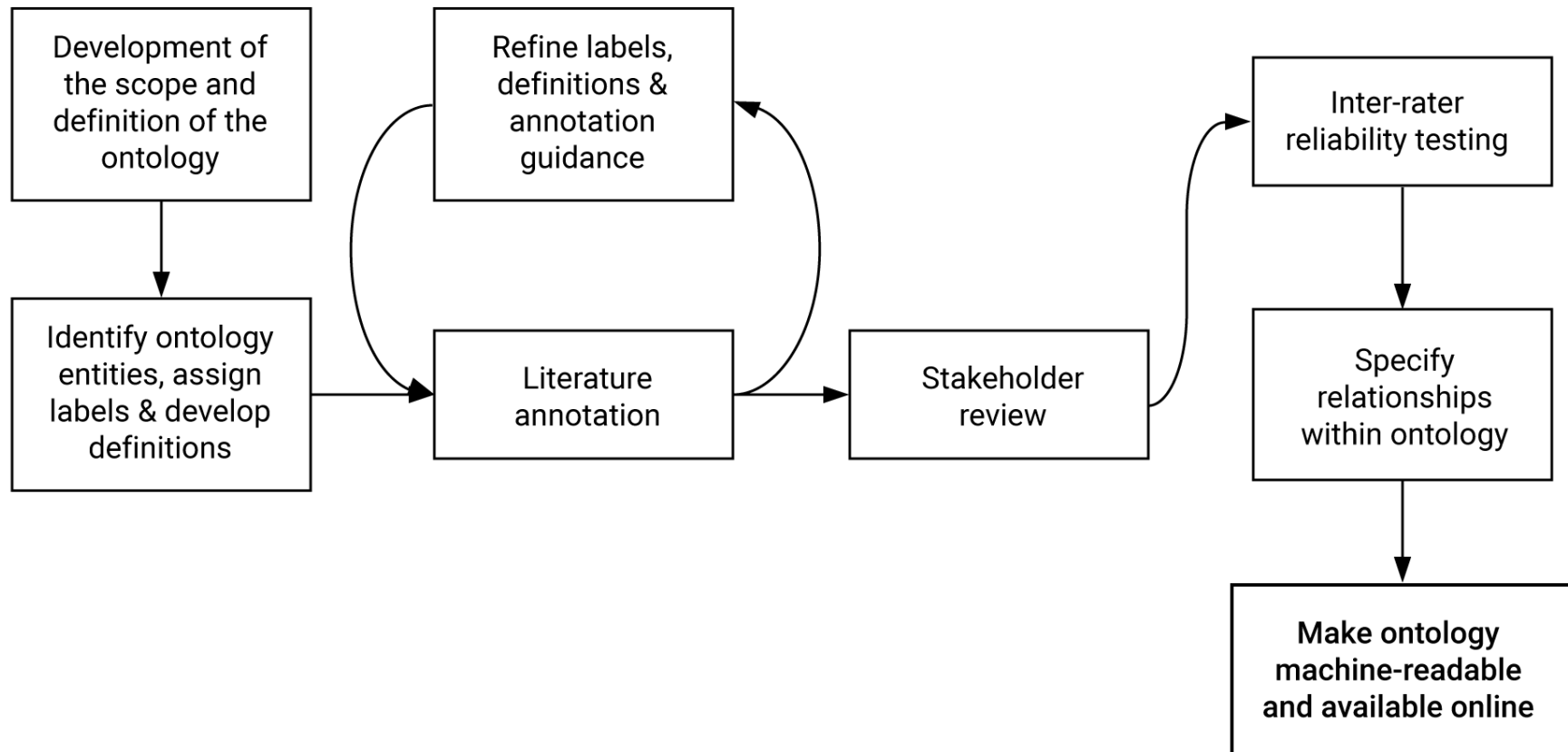
Method details: Identifying key entities to include

- Bottom-up development

  - Extracted relevant terms from published intervention reports

- Top-down development – searching for extracted terms

  - Reuse of existing ontologies and/or controlled vocabularies (e.g. MeSH) where relevant

  - Build on existing classification structures - preference for international applicability

  - Create new entities if no appropriate entity in an existing ontology

Expert Review

- International panel of behavioural science, public health and ontology experts

- Complete an online questionnaire
  - Presented with classes from the ontology and asked to suggest any changes to labels and definitions
  - Asked to suggest additional classes that should be included

- Revised entities and definitions based on this feedback

Method details: Inter-rater reliability testing

Pairs of coders use the ontology to code published RCTs of behaviour change interventions

Inter-rater agreement assessed using Krippendorff's alpha

If inter-rater agreement is low, examine where disagreements arose
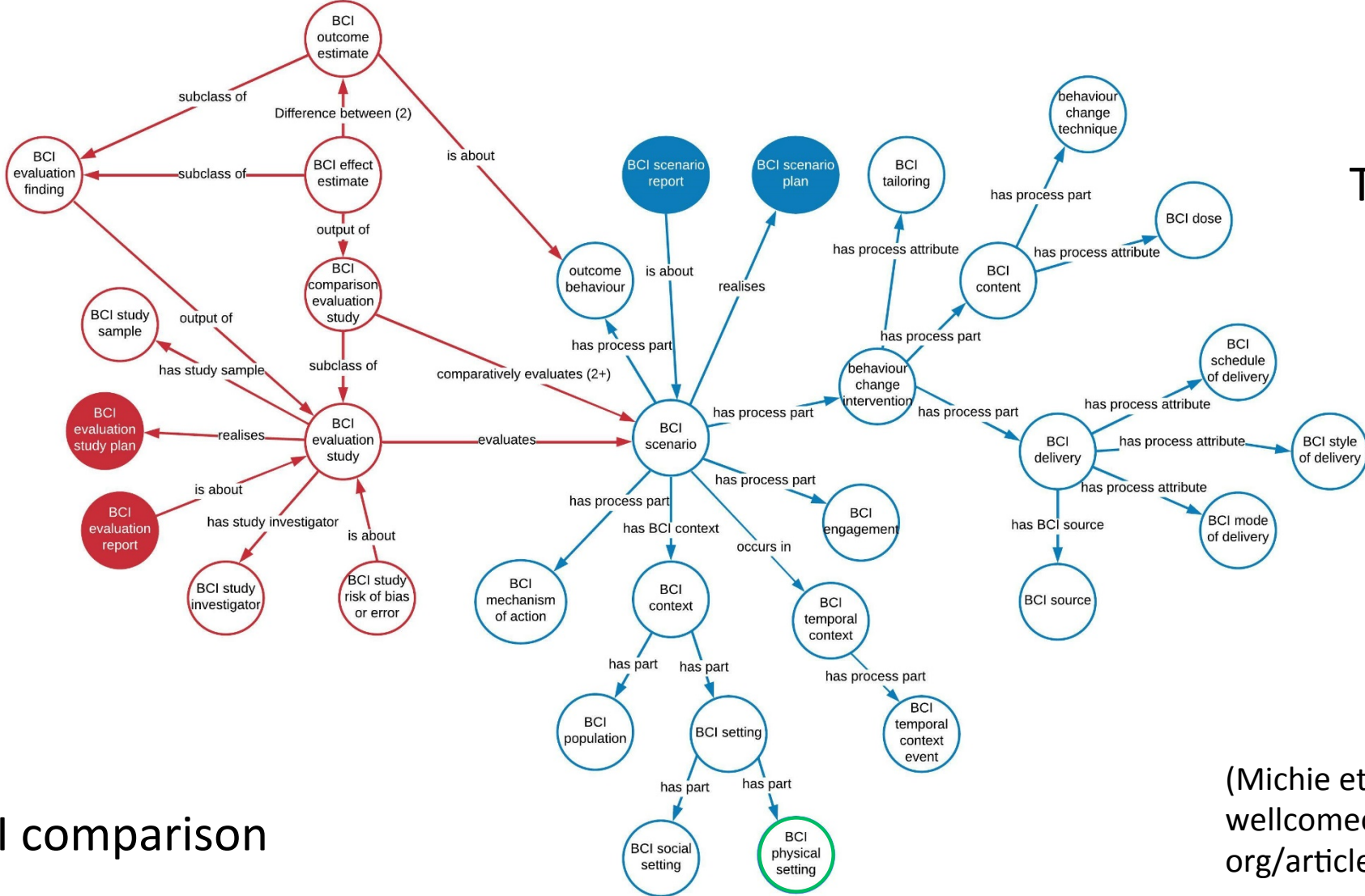
Revise the ontology as required

Repeat IRR testing with a second pair of coders

Qualities of a "good" ontology

Quality	Definition	How tackled in BCIO development methods
Completeness	How well it covers the domain of interest	• Scoping terms to include from intervention reports and other classification systems • Literature annotation • Expert review
Accuracy	How well it accords with experts' knowledge	• Expert review • Development team with considerable experience in behaviour change interventions
Clarity	Does it communicate the intended meaning of the defined classes?	• Literature annotation • Inter-rater reliability testing
Inter-operability	Ability to interconnect with other ontologies	• Using "Basic Formal Ontology" as the backbone of the ontology

Adapted from Vrandečić (2009).   See Wright et al (2020) for how the BCIO accords with OBO Foundry principles

Results: Higher level entities in the BCIO

The BCI scenario

The BCI comparison

(Michie et al, 2020 https://wellcomeopenresearch.org/articles/5-123)

allenge	Lessons learnt

of ontological
ertise e.g. writing
nitions
	Include ontological expertise; provide training
	
	Keep cumulative log of decisions and best practice
	
	Create resources e.g.
	    Michie, West, Hastings: Creating ontological definitions for use in science. _Q_
	    Writing a book for social and behavioural scientists
	    Online training and webinars

sion between ological purity and prehensible uage	Good communication; use of dictionaries; user feedback
erences between members in how to organise entities xpress terms	Time and patience

Key success factor

- The team - a dedicated group with complementary skills
- Effective leadership, combining task-focused with people-focused
- For next time, get more efficient workflow from beginning

Accessing the BCIO

- Browsable via the Ontology Lookup Service:
https://www.ebi.ac.uk/ols/ontologies/bcio

- Available for download from GitHub:
https://github.com/HumanBehaviourChangeProject/ontologies

- The BCIO will be submitted to the Open Biological and Biomedical Ontology (OBO) Foundry (https://obofoundry.org/) and the Behavioural and Social Sciences Ontology (BSSO) Foundry (https://www.bssofoundry.org/) once complete

Online tools for using the BCIO

- BCIOVocab, which is used to:

  - Browse the content in the whole BCIO

  - Find a specific entity by its label or associated text (e.g. synonyms, definitions)

  - Connect from one entity to another by relationships

https://www.bciovocab.o

- BCIOVisual, which is used to:

  - Visualise the BCIO

  - See a diagrammatic representation of entities from the ontology

http://vis.tools.bssofoundry.or

The living nature of ontologies

- Ontologies are always open to refinements to better meet the needs of the scientific community

- The BCIO will be maintained, revised and updated based on feedback from users and new evidence about entities and relationships

- Users can give feedback and report issues about the ontologies here: https://github.com/HumanBehaviourChangeProject/ontologies/issues