Revolutionising evidence synthesis and use: the Human Behaviour-Change Project

Human Behaviour-Change Project

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German Network for Evidence-based Medicine, 2018

Acknowledgments

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- Funders including

- The Human Behaviour Change Project

- The Health Psychology Research Team

- The Centre for Behaviour Change

This talk

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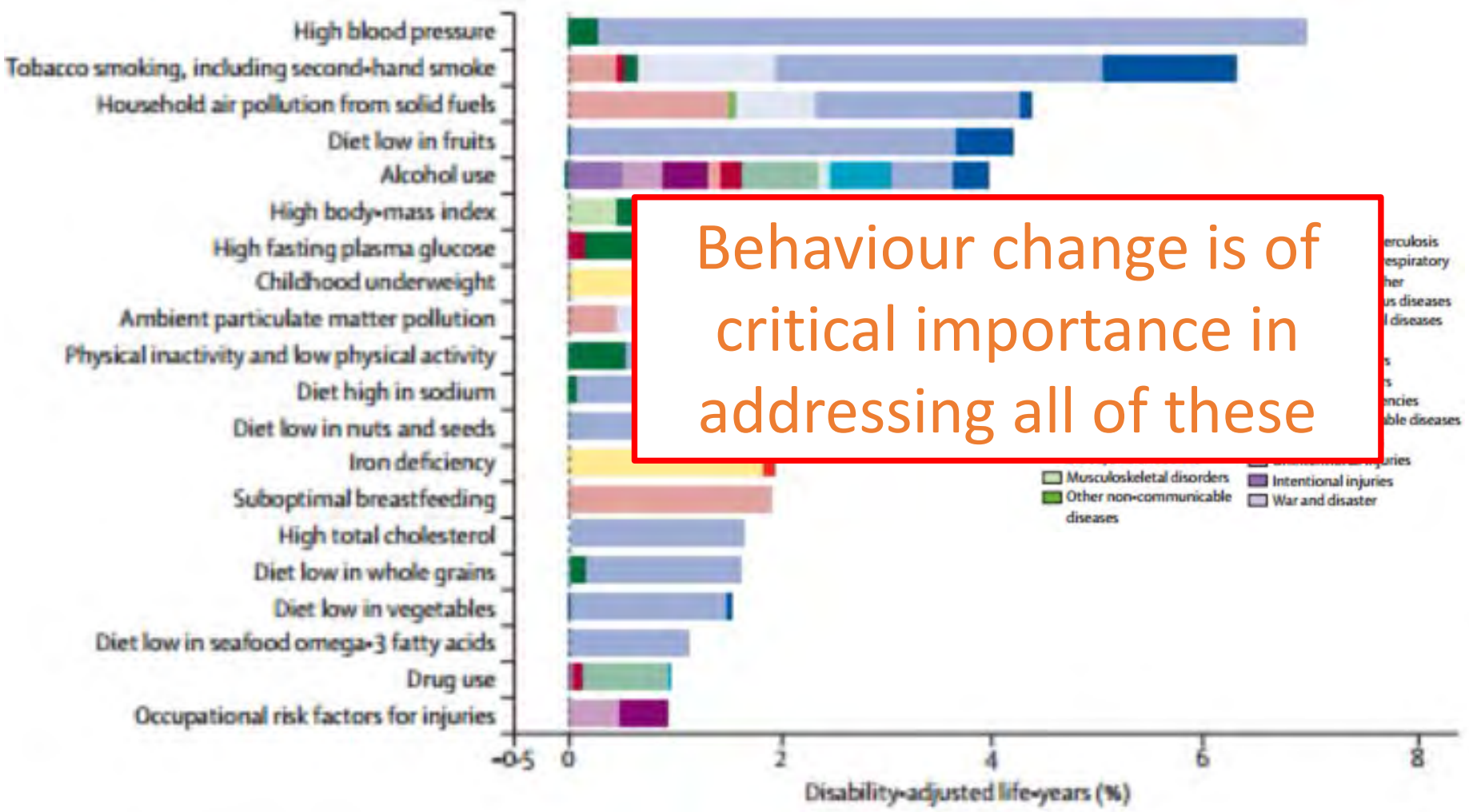
1. Challenges to increasing the effectiveness of behavioural interventions
   - Reporting interventions
   - Synthesising evidence to generate new insights about behaviour change

2. The Human Behaviour-Change Project

Major causes of disability and premature death globally



Behaviour change is of critical importance in addressing all of these

Lim et al *Lancet* 2012

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Interventions to change behaviour

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- We have a rich sou… …thods for intervention desig…
- Considerable in… …med at individuals, com… …s
  - Trials: estimated 1… …interventions per day
- Most have mod…st and variable effects
  - *e.g. Cochrane database, National Institute for Health & Care Excellence (NICE)*

How can we improve this situation?

Interventions to change behaviour

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- If we are to improve interventions, need to
  1. understand reasons for their variation
  2. reduce waste in research (*Lancet* series, 2014)
- This requires
  1. Better reporting of all aspects of interventions and their contexts
  2. The ability to
     1. organise and synthesise large amounts of complex evidence at scale and rapidly
     2. Make inferences from that evidence to generate new understanding

THE LANCET

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Research: increasing value, reducing waste 5

Reducing waste from incomplete or unusable reports of biomedical research

Paul Glasziou, Douglas G Altman, Patrick Bossuyt, Isabelle Boutron, Mike Clarke, Steven Julious, Susan Michie, David Moher, Elizabeth Wager

- 40–89% interventions non-replicable
- Recommendations include
  - High quality and complete reporting demanded by journals, authors and peer reviewers
    - use reporting guidelines

Glasziou et al, *Lancet*, 2014

Reporting behavioural interventions

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- vague, partial and/or use terminology inconsistently

Title of journal article	Description of "behavioural counseling"
The impact of ***behavioral counseling*** on stage of change fat intake, physical activity & cigarette smoking in adults at increased risk of coronary heart disease	"***educating*** patients about the benefits of lifestyle change, encouraging them, and suggesting what changes could be made" (Steptoe et al. *AJPH* 2001)
Effects of internet ***behavioral counseling*** on weight loss in adults at risk for Type 2 diabetes	"***feedback*** on ***self-monitoring*** record, ***reinforcement***, recommendations for change, answers to questions, and general support" (Tate et al. *JAMA* 2003)

The problem of poor descriptions

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- Vague and lacking detail; use of inconsistent and varying terminology
- We need language that is understood by all, with the same terms used for the same things
- Without this, we are limited in our ability to
  - replicate,
  - implement effective interventions,
  - evaluate or
  - improve interventions

Reporting guidelines/ tools helpful

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Better reporting of interventions: template for intervention description and replication (TIDieR) checklist and guide

Tammy C Hoffmann *associate professor of clinical epidemiology*[1], Paul P Glasziou *director and*

Behaviour change techniques: the
evaluation of a taxonomic metho
and describing behaviour change interventions
(a suite of five studies involving consensus methods, randomised controlled trials and analysis of qualitative data)

Susan Michie, Caroline E Wood, Marie Johnston, Charles Abraham, Jill J Francis and Wendy Hardeman

PICO

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Reporting intervention content: behaviour change techniques (BCTs)

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- "Active ingredients" within an intervention designed to change behaviour
- They are
  - discrete, low-level components of an intervention that on their own have potential to change behaviour
  - observable and replicable

Michie S, Johnston M, Carey R. (2016). Behavior change techniques. In Turner, JR. (Ed.) *Encyclopedia of Behavioral Medicine*. Springer New York.

BCT Taxonomy v1

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- 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

Michie et al (2013). *Ann Behav Med.* 46.

BCT Taxonomy v1: 93 items in 16 groupings

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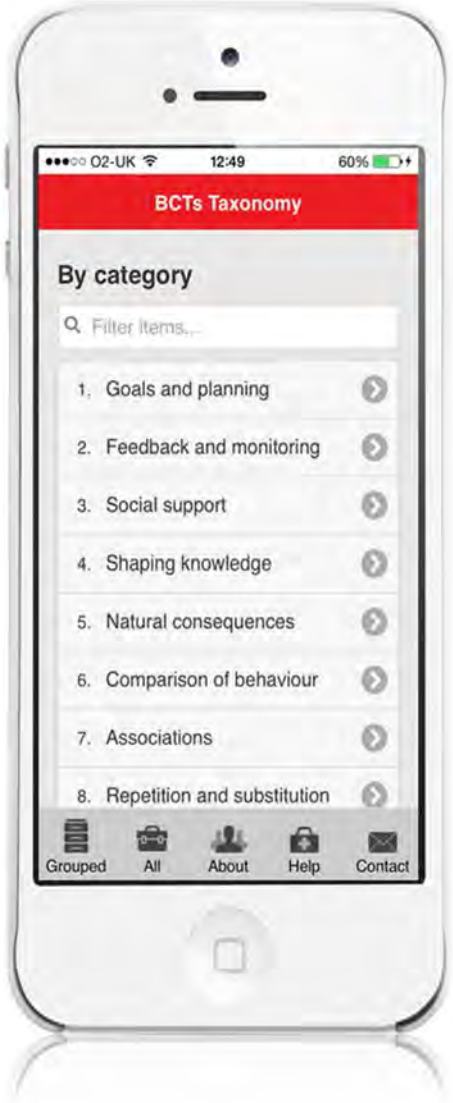
Page	Grouping and BCTs	Page	Grouping and BCTs	Page	Grouping and BCTs
1	**1. Goals and planning**	**8**	**6. Comparison of behaviour**	**16**	**12. Antecedents**
	1.1. Goal setting (behavior) 1.2. Problem solving 1.3. Goal setting (outcome) 1.4. Action planning 1.5. Review behavior goal(s) 1.6. Discrepancy between current behavior and goal 1.7. Review outcome goal(s) 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
		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	***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

The BCT smartphone app



- Search by BCT label, BCT category or alphabetically

or

Find by search term: BCTs

Guidelines and taxonomies

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- Improve reporting and reduce waste in research

BUT

- on their own do not create new knowledge

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Participating organisations

UCL

UNIVERSITY OF ABERDEEN

UNIVERSITY OF CAMBRIDGE

IBM Research

www.humanbehaviourchange.org

@HBCProject

A Collaborative Award funded by the

wellcome trust

The collaboration

Human Behaviour-Change Project

	Behavioural science	Computer science	System architecture
Grant-holders	Susan Michie[1] Marie Johnston[3] Robert West[1] Mike Kelly[4]	John Shawe-Taylor[1] Pol MacAonghusa[2]	James Thomas[1]
Researchers	Alison Wright[1] Ailbhe Finnerty[1] Marta Marques[1] Emma Norris[1]	Debasis Ganguly[2] Lea Deleris[2]	Alison O'Mara-Eves[1] Gillian Stokes[1] Patrick O'Driscoll[1]

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

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

Implementation Science

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STUDY PROTOCOL Open Access

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]

The primary goal of Behavioural Science

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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?

Challenges and solutions in evidence synthesis

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Challenge	Solution
Research conduct: Diversity of research methods and topics; inconsistency and incompleteness in reporting	Ontology of behaviour change interventions

Challenges and solutions in evidence synthesis

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Research conduct: Diversity of research methods and topics; inconsistency and incompleteness in reporting	Ontology of behaviour change interventions to organise evidence
Resource limitations: Insufficient human resources given the increasing volume of research and need for timely knowledge	Use of automated literature searching and study feature extraction

Challenges and solutions in evidence synthesis

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Challenge	Solution
Research conduct: Diversity of research methods and topics; inconsistency and incompleteness in reporting	Ontology of behaviour change interventions to organise evidence
Resource limitations: Insufficient human resources given the increasing volume of research and need for timely knowledge	Use of automated literature searching and study feature extraction
Research findings: Equivocal or contradictory findings; sparseness of findings relative to the variety of behaviours, interventions, contexts; complexity of interactions between intervention components, contexts and behaviours	Use of machine learning and reasoning algorithms for evidence synthesis and interpretation to build a Knowledge System

The Human Behaviour-Change Project

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Brings together behavioural science, computer science and information science to create and evaluate a Behaviour Change Intervention (BCI) Knowledge System:

1. An ontology of BCI interventions and evaluation reports
2. A largely automated feature extraction system to read BCI evaluation reports, using Natural Language Processing
3. A BCI database containing information from evaluation reports structured according to the ontology
4. Reasoning and machine learning algorithms to synthesise this information in response to user queries
5. An interface for computers and human users to interact with the system

The Behaviour Change Intervention (BCI) Knowledge System

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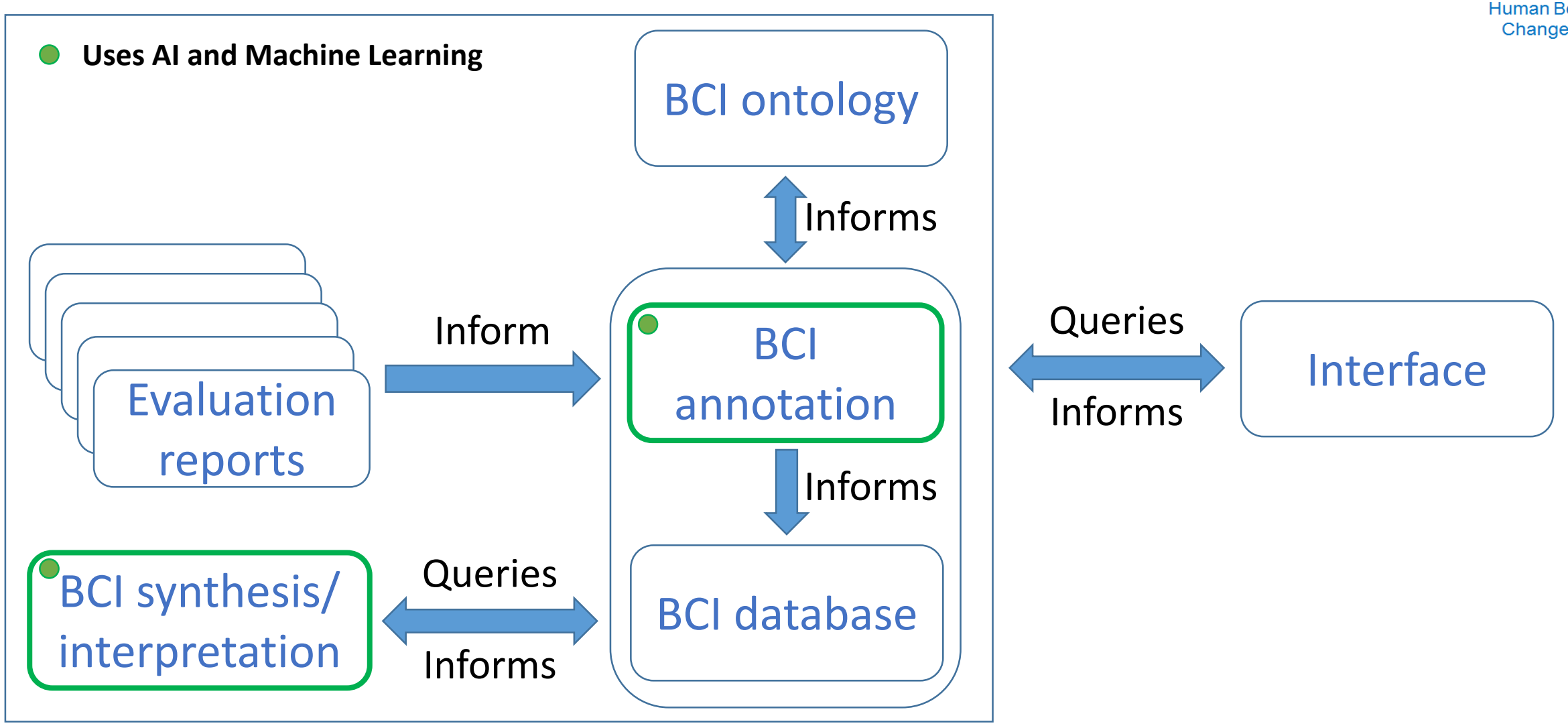

Examples of Human Users

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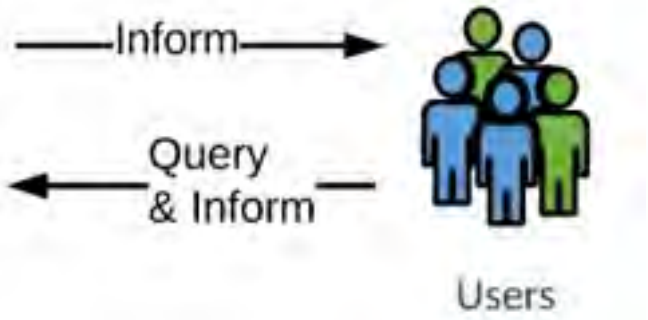

Behavioural scientist

E.g. what mechanisms of action are likely to account for the effect of x on y?

Public health policy-maker

E.g. what do I need to do to bring about this change in this population?

Detects patterns, makes inferences

The Knowledge System

Ontology

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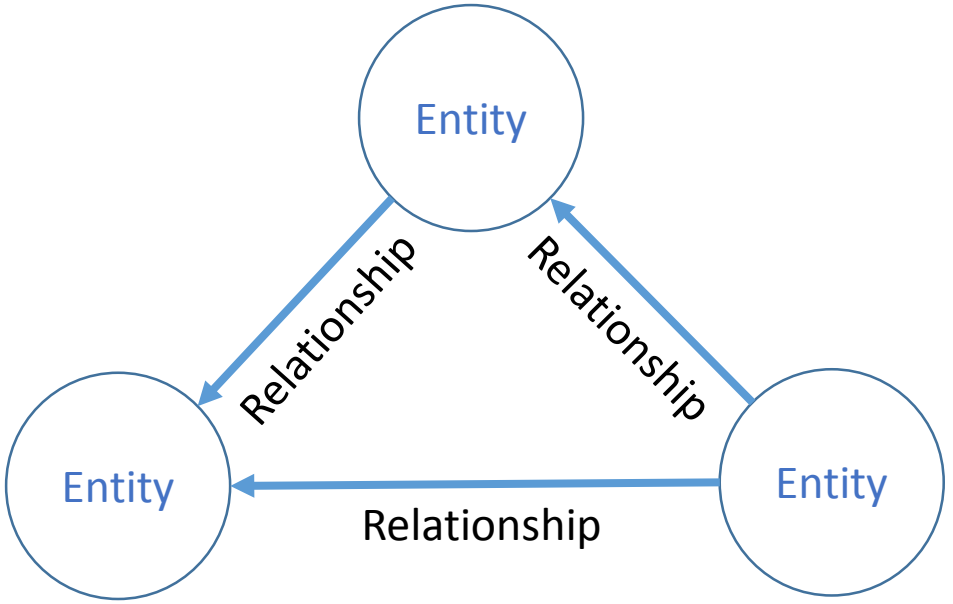
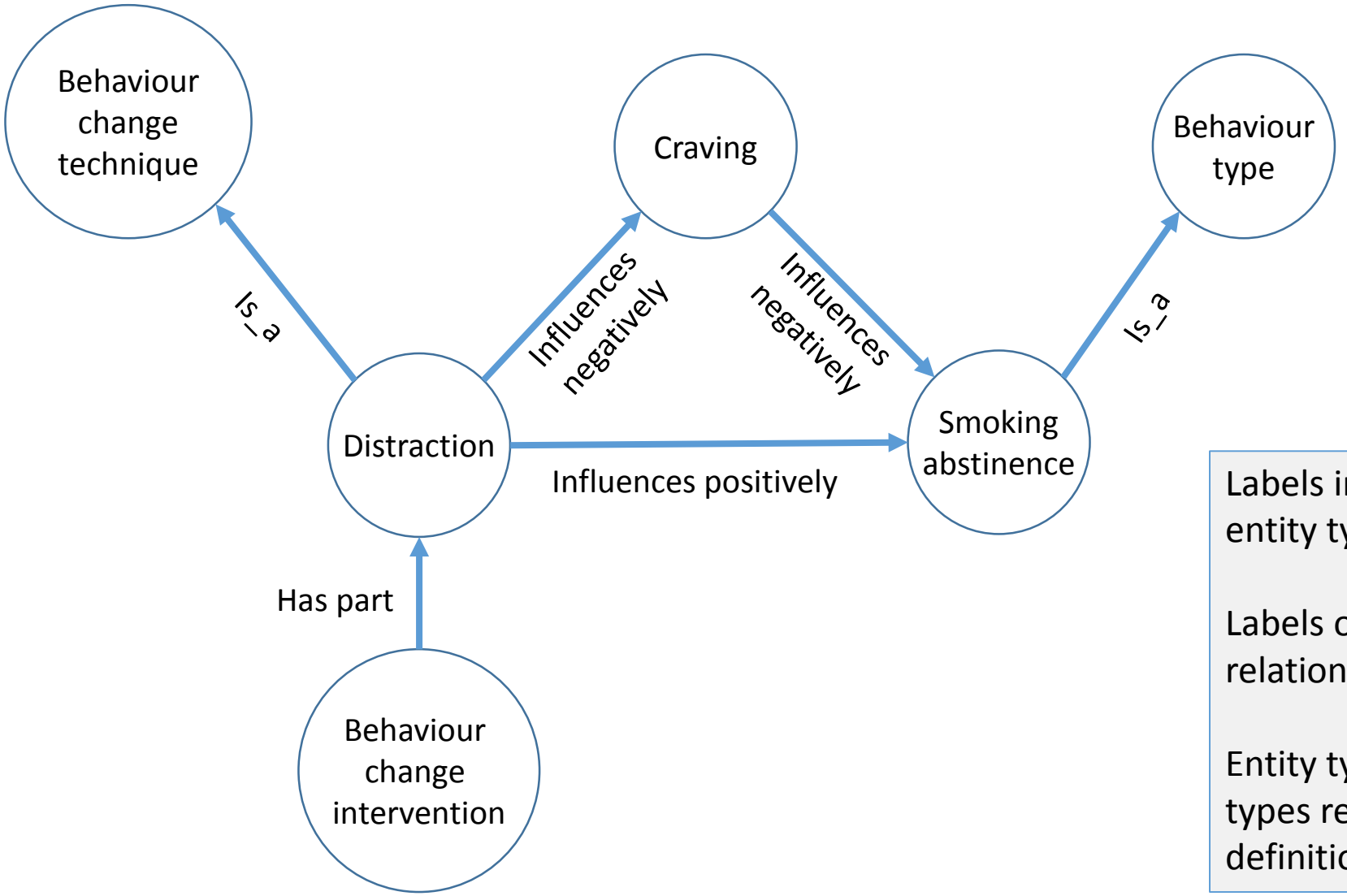
In information science, a system for representing knowledge in the form of:

1. A set of unique identifiers of ‘entities’
2. Labels and definitions for these
3. Specification of relationships between them (‘is a’, ‘part of’, ‘positively influences’ …)



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

A mini-ontology



Labels in circles identify entity types

Labels on arrows identify relationship types

Entity types and relationship types require formal definitions

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What ontologies can do

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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

Top-level BCI Ontology (BCIO): scenario entities and causal connections

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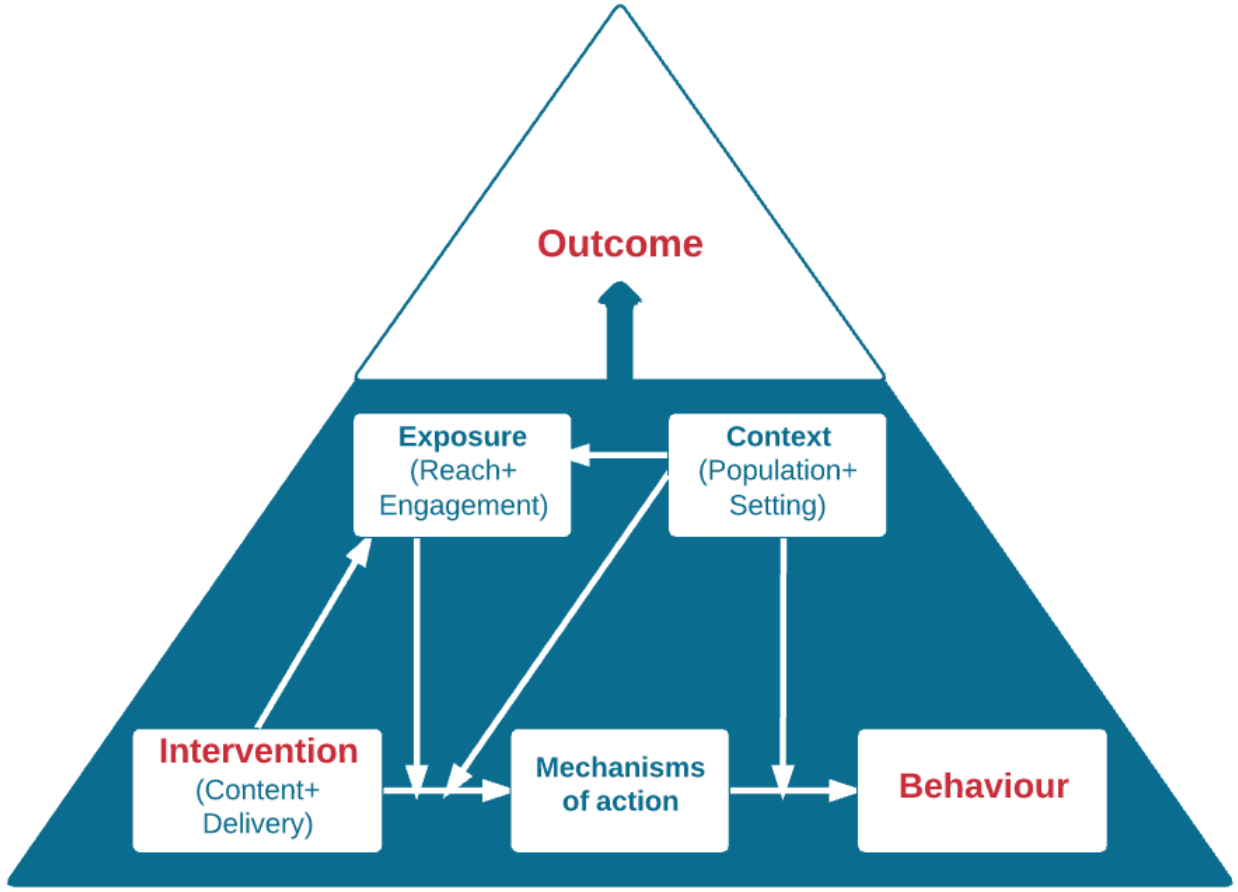
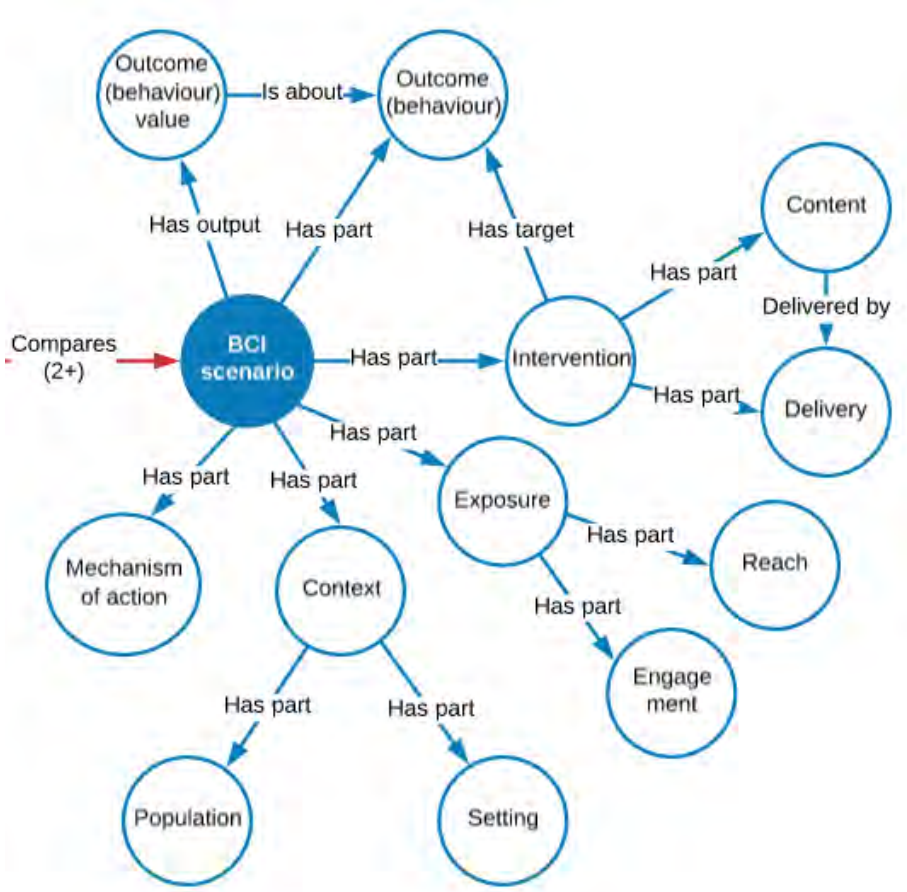


Top level entities in BCIO



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Specific ontologies being developed for…

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1. Behaviour change techniques – BCTTv1
2. Mode of delivery
3. Exposure of intervention
   - Reach and engagement
4. Target behaviour
5. Target population
6. Intervention setting
7. Mechanisms of action
   - Processes by which change occurs

Desirable qualities

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- Clear definitions for all terms i.e. non-overlapping terms without redundancy
- Well-organised, hierarchical structure
- Comprehensive coverage of the area
- Granularity
  - appropriate to how information represented in evaluation reports and to types of question likely to be asked of the Knowledge System

Domain and scope

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- Domain
  - Evaluations of behaviour change interventions
- Scope
  - Initially reports of RCTs of smoking cessation interventions
    - In Cochrane meta-analyses
  - Expanding to RCTs of interventions to change other behaviour types
    - Physical activity, alcohol consumption, dietary behaviours
  - Eventually extend across behaviours and study designs and quality

Building the Knowledge System

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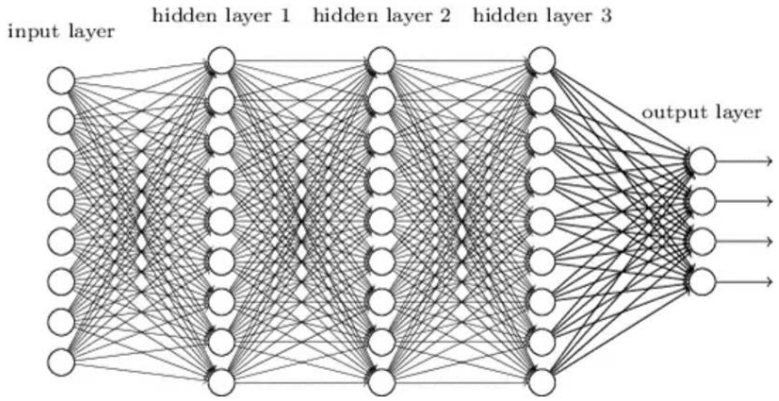
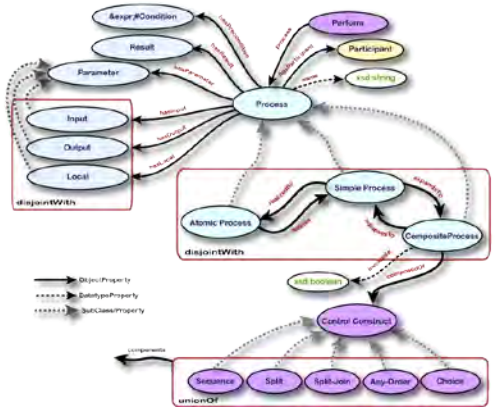


Machine Learning

Find optimal connections and weights to classify outputs from input data



Reasoning Algorithms

Using entity relationships and axioms to infer new entity relationships

Machine Learning and Reasoning Algorithms

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- The algorithms will
  - be trained, tested and updated using the BCI database and BCI ontology
  - query the BCI database for features specified by the user
  - predict effect sizes for BCI Ontology entities that are queried, along with a confidence estimate i.e. a machine generated judgement of the probability that the prediction is correct
  - allow explanation of how they arrived at their conclusions and state important caveats
  - generate new insights about behaviour change from patterns of associations

Interactive Interface

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- Develop and evaluate an online, open-access, interactive interface to enable widespread use of the knowledge generated
  - provide an easy method for searching the literature using purpose-built syntax for fixed and open parameters, level of abstraction etc.
  - bring user feedback from a wide perspective of views into the database, and into the BCI Ontology
  - use by other computer programs

Key resource: addressing problem upstream

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- Template for reporting BCIs and BCI evaluations using the BCIO
- To enable
  - clear, full reporting
  - data synthesis
  - interoperability i.e. link to other, related ontologies thus extending knowledge

Feature in BCIO	Value
Sample_mean_age_yrs	35.4
Sample_female_%	52.1
Intervention_brand	ACT
Intervention_content_BCTs	1,3,12,34,45,60
Comparator_content_BCTs	1,3,12
Behavioural_target_type	Smoking cessation
Outcome_type	Sustained_abstinence
Setting_clinical_type	GP practice
Etc.	Etc.

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Read Supplementary Files!

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Questions and discussion

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