From theory-inspired to theory-based interventions: Linking behaviour change techniques to their mechanisms of action

Susan Michie

The team: Marie Johnston, Alex Rothman, Mike Kelly & Marijn de Bruin, Rachel Carey & Lauren Connell

@SusanMichie @UCLTaxonomy
Theories and Techniques of Behaviour Change Project
International Advisory Board

42 members from 10 countries
Background

- Recent advances in behavioural science methods
  - e.g. Improved methods for standardising reporting of interventions
    - TIDieR framework for intervention reporting (Hoffman et al, *BMJ*, 2014)
    - Behaviour change techniques (Michie et al, *HTA*, 2015)
- Some promising interventions to change behaviour
  - but effects tend to be modest and variable
- Systematic accumulation of evidence slow
How can we improve?

- Increasing recognition of the need for systematic application of theory to the development and evaluation of behavioural interventions e.g.
  - MRC guidance for complex interventions (Craig et al, 2008)
MRC Guidance for developing and evaluating complex interventions

Craig et al, 2009 BMJ

Development
Identifying the evidence base
Identifying or developing theory
Modelling process and outcomes

Feasibility and piloting
Testing procedures
Estimating recruitment and retention
Determining sample size

Evaluation
Assessing effectiveness
Understanding change process
Assessing cost effectiveness

Implementation
Dissemination
Surveillance and monitoring
Long term follow-up
Current state of theory use
Example from systematic review:

Does Theory Influence the Effectiveness of Health Behavior Interventions?
Meta-Analysis

Andrew Prestwich
Institute of Psychological Sciences, University of Leeds

Craig Whittington
University College London

Lizzie Rogers
Institute of Psychological Sciences, University of Leeds

Falko F. Sniehotta
Institute of Health and Society, Newcastle University

Stephan U. Dombrowski
Institute of Health and Society, Newcastle University

Susan Michie
University College London

• 190 studies; interventions analysed by
  – Theory Coding Scheme (Michie & Prestwich, Health Psy, 2010)
  – Behaviour Change Techniques (Michie et al, HTA 2015)
Current state of theory use
Findings from systematic review (Prestwich et al, 2013)

• 107 (56%) used theory, i.e. almost half did not
• Where theory used, partially & inconsistently
  - 90% studies: BCTs not linked to theoretical constructs
  - 91% studies: constructs not targeted by BCTs
Findings from our literature synthesis
(Study 1)

Methods
- 974 intervention papers screened for hypothesised links between BCTs & mechanisms of action (MoAs)

Findings
- 697 (72%): No explicit link reported
- Of those hypothesising a link (n=277),
  - 14% did not mention any theoretical basis for the intervention
  - a further 13% mentioned theory but without specifying how theory was applied to intervention development and/or evaluation
Why link BCTs to their theoretical mechanisms of action?

1. To design interventions based on theory

2. For effective interventions …
   … to understand their possible mechanisms of action
‘Theory and Techniques’ project

Aim:
• To identify *hypothesised* links between intervention content (i.e. BCTs) and
  – (i) mechanisms of action (MoAs) and
  – (ii) theories

Two data sources:
  1. Published reports of interventions
  2. Expert consensus
**Key Concepts & Definitions for our studies**

**Behaviour Change Techniques (BCTs)**
- Potentially active ingredients within an intervention designed to change behaviour

**Mechanism(s) of Action (MoAs)**
- Process(es) through which a BCT affects behaviour

**Behaviour**
- Anything a person does in response to internal or external events
Summary of four studies

Study 1: Published Explicit Links
Identified BCT-MoA links from published interventions

Study 2: Expert-Agreed Explicit Links
Identified BCT-MoA links through consensus methods

Study 3: Integrated Matrix of Explicit Links
Developing matrix of BCT-MoA links using data from S1 & S2

Study 4: Published Implicit Links
Identified links between groups of BCTs and behavioural theories
From Theory-Inspired to Theory-Based Interventions: A Protocol for Developing and Testing a Methodology for Linking Behaviour Change Techniques to Theoretical Mechanisms of Action

Susan Michie, PhD¹ · Rachel N. Carey, PhD¹ · Marie Johnston, PhD² · Alexander J. Rothman, PhD³ · Marijn de Bruin, PhD² · Michael P. Kelly, PhD⁴ · Lauren E. Connell, PhD¹
Study 1: Aim & Methods

Aim: To identify links between BCTs & MoAs, as hypothesised in behaviour change interventions

Methods:
- 974 published interventions collated
- 277 included (explicitly hypothesised a link)
- BCTs coded using BCTTv1¹
- MoAs 14 TDF domains + 14 most frequent other constructs in 83 theories of behaviour change
- For each BCT & MoA link, information extracted on
  - explicitness, precision, empirical evaluation

¹Michie et al, Health Technology Assessment, 2015
Study 1 Literature: Findings

• 2639 hypothesised BCT-MoA links identified
  – Approx. 10 links per paper ($SD = 13.80$)
  – 33% required some inference to code
  – Majority (88%) were linked as *groups* of BCTs or MoAs
  – Minority (9%) had been empirically tested

• Series of binomial tests conducted on the data
  – 84 significant links, covering 51 BCTs and 23 MoAs
### Study 1 Literature: Findings

#### Examples of significant links

<table>
<thead>
<tr>
<th>Behaviour Change Technique</th>
<th>Mechanism of Action</th>
<th># Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feedback on Behaviour</td>
<td>Subjective Norms**</td>
<td>19</td>
</tr>
<tr>
<td>Self-Monitoring of Behaviour</td>
<td>Behavioural Regulation**</td>
<td>18</td>
</tr>
<tr>
<td>Social Support (Unspecified)</td>
<td>Social Influences**</td>
<td>34</td>
</tr>
<tr>
<td>Information about Health Consequences</td>
<td>Knowledge**</td>
<td>18</td>
</tr>
<tr>
<td>Pros and Cons</td>
<td>Attitude towards the Behaviour**</td>
<td>9</td>
</tr>
<tr>
<td>Behavioural Practice/Rehearsal</td>
<td>Skills**</td>
<td>24</td>
</tr>
<tr>
<td>Graded Tasks</td>
<td>Beliefs about Capabilities**</td>
<td>28</td>
</tr>
</tbody>
</table>

**$p < .001$**
Study 2: Aim & Methods

Aim: To use consensus methodology to identify links between BCTs & MoAs, as hypothesised by behaviour change experts

Methods

• 101 experts (of 105; 96%) answered the following question:
  – When [BCT X] is effective in changing behaviour, does it do so by changing [MoA Y]?

<table>
<thead>
<tr>
<th>Definitely Yes</th>
<th>Possibly</th>
<th>Uncertain/Don’t Know</th>
<th>Definitely No</th>
</tr>
</thead>
</table>
Study 2 Consensus: Findings

- Of 1,586 BCT-MoA links (61 BCTs x 26 MoAs) considered by experts:
  - 90 BCT → MoA links agreed (≥80% of experts rated ‘definitely yes’)
  - 464 BCT → MoA ‘non-links’ agreed (≥80% of experts rated ‘definitely no’)

### Study 2 Consensus: Findings

100% of experts agreed on the following 10 BCT-MoA links:

<table>
<thead>
<tr>
<th>Behaviour Change Technique</th>
<th>Mechanism of Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem Solving</td>
<td>→ Behavioural Regulation</td>
</tr>
<tr>
<td>Goal Setting (Outcome)</td>
<td>→ Goals</td>
</tr>
<tr>
<td>Discrepancy between Current Behaviour and Goal</td>
<td>→ Feedback Processes</td>
</tr>
<tr>
<td>Social Comparison</td>
<td>→ Social Influences</td>
</tr>
<tr>
<td>Prompts &amp; Cues</td>
<td>→ Behavioural Cueing</td>
</tr>
<tr>
<td>Comparative Imagining of Future Outcomes</td>
<td>→ Beliefs about Consequences</td>
</tr>
<tr>
<td>Social Reward</td>
<td>→ Reinforcement</td>
</tr>
<tr>
<td>Incentive (Outcome)</td>
<td>→ Motivation</td>
</tr>
<tr>
<td>Conserving Mental Resources</td>
<td>→ Memory, Attention and Decision Processes</td>
</tr>
<tr>
<td>Verbal Persuasion about Capability</td>
<td>→ Beliefs about Capabilities</td>
</tr>
</tbody>
</table>

**Notes:**
- BCT: Behaviour Change Technique
- MoA: Mechanism of Action

**Explanation:**
- Problem Solving leads to Behavioural Regulation
- Goal Setting (Outcome) leads to Goals
- Discrepancy between Current Behaviour and Goal leads to Feedback Processes
- Social Comparison leads to Social Influences
- Prompts & Cues lead to Behavioural Cueing
- Comparative Imagining of Future Outcomes leads to Beliefs about Consequences
- Social Reward leads to Reinforcement
- Incentive (Outcome) leads to Motivation
- Conserving Mental Resources leads to Memory, Attention and Decision Processes
- Verbal Persuasion about Capability leads to Beliefs about Capabilities
Study 3: Aim

- To evaluate the agreement between published interventions and expert consensus and produce an integrated matrix of hypothesised BCT–MoA links

Findings compared & integrated

![Diagram showing Triangulation between Literature synthesis, Expert consensus, and integrated findings.]

- Literature synthesis
- Triangulation
- Expert consensus
Study 3 Integration: Methods

- BCT-MoA links from Studies 1 & 2 were compared and categorised into:

<table>
<thead>
<tr>
<th>Categorisation</th>
<th># links</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evidence of link in both studies</td>
<td>36</td>
<td>Information about Health Consequences → Perceived Susceptibility</td>
</tr>
<tr>
<td>No evidence of link in Study 1, evidence of ‘no link’ in Study 2</td>
<td>461</td>
<td>Problem Solving → Reinforcement</td>
</tr>
<tr>
<td>No evidence in Study 1, no strong evidence (either way) in Study 2</td>
<td>904</td>
<td>Goal Setting (Outcome) → Beliefs about Consequences</td>
</tr>
<tr>
<td>Inconsistencies and marginal evidence</td>
<td>185</td>
<td>Social Reward → Motivation</td>
</tr>
</tbody>
</table>

- Experts (n=16) rated these 185 links
## Study 3 Integration: Findings

- **92** BCT-MoA links identified
  - covering **51** of **93** BCTs & **20** of **26** MoAs

### Examples of agreed links:

<table>
<thead>
<tr>
<th>Type of Inconsistency from Studies 1 &amp; 2</th>
<th>Example of data from Study 3</th>
<th>% experts (n=16)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evidence of link in Study 1, disagreement about link in Study 2</td>
<td>Self-Monitoring of Behaviour → Behavioural Regulation</td>
<td>94% rated ‘definitely yes’</td>
</tr>
<tr>
<td>Evidence of link in Study 1 and ‘definitely no’ link in Study 2</td>
<td>Avoidance/Reducing Exposure to Cues → Needs</td>
<td>100% rated ‘definitely no’</td>
</tr>
</tbody>
</table>
Data are represented in heat maps to indicate the frequency with which each BCT is hypothesised to link to each MoA.
Next steps

- Create **interactive online tool**
  - Click on cell to find
    - data on strength of link (Spring 2017)
    - Information on empirical evidence (all)
    - Information on who is investigating the link (all)

- Development of an Ontology of Behaviour Change Interventions

Further information from s.michie@ucl.ac.uk

www.humanbehaviourchange.org
Additional Slides
Study 2 Methods: Identifying a Set of MoAs

MoAs from Theoretical Domains Framework¹
1. Knowledge
2. Skills
3. Social/Professional Role & Identity
4. Beliefs about Capabilities
5. Optimism
6. Beliefs about Consequences
7. Reinforcement
8. Intentions
9. Goals
10. Memory, Attention & Decision Processes
11. Environmental Context & Resources
12. Social Influences
13. Emotion
14. Behavioural Regulation

Additional MoAs from 83 theories of behaviour change²
15. (Societal) Norms
16. Subjective Norms
17. Attitude towards the Behaviour
18. Motivation
19. Self-image
20. Needs
21. Values
22. Feedback Processes
23. Social Learning/Imitation
24. Behavioural Cueing
25. General Attitudes/Beliefs
26. Perceived Susceptibility

¹Cane et al., 2012; ²Michie et al., 2014
BCTTv1 Developments

Online Training: www.bct-taxonomy.com

Feedback on BCTTv1: www.ucl.ac.uk/behaviour-change-techniques/BCTTv1Feedback

BCTTv1 App: Search for ‘BCT Taxonomy’

Database of BCTTv1-coded interventions
www.bct-taxonomy.com/interventions
# Categorisation of Mechanisms of Action (MoA)

## Example

<table>
<thead>
<tr>
<th>Author’s Label</th>
<th>Author’s Definition</th>
<th>Categorisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-efficacy</td>
<td>Belief in ability to increase level of physical activity</td>
<td>Beliefs about Capabilities</td>
</tr>
<tr>
<td>Attitude</td>
<td>Attitude towards taking an HIV test</td>
<td>Attitude towards the Behaviour</td>
</tr>
<tr>
<td>Alcohol expectancies</td>
<td>Beliefs about the positive and negative effects of alcohol use</td>
<td>Beliefs about Consequences</td>
</tr>
<tr>
<td>Misperceptions</td>
<td>Perceptions of others’ drinking behaviour</td>
<td>Subjective Norms</td>
</tr>
</tbody>
</table>
Study 4: Aim & Methods

Aim: To identify whether groups of co-occurring BCTs can be linked to specific behavioural theories

Methods

• 5 groups of BCTs identified from Study 1 literature using factor analysis

• 25 experts answered the following question:
  – An intervention was developed that includes the BCTs listed above; how confident are you that this group of BCTs is linked to [Theory X]?

Confident that they are linked
Uncertain/Don’t Know
Confident that they are not linked
Study 4: Findings

- >80% agreement was reached for 5 links, covering 3 of 5 BCT groups and 5 of 83 theories.
  - E.g. 93% of experts were ‘confident’ about the link between:
    - Self-Efficacy Theory (Bandura) and
    - 3 BCTs:
      - Behavioural Practice/Rehearsal
      - Demonstration of the Behaviour
      - Instruction on How to Perform the Behaviour.