Evaluating behavior change interventions in terms of their component techniques

Susan Michie
Professor of Health Psychology
Director, Centre for Behaviour Change
University College London, UK

ISBNPA conference, May 2014, San Diego
Acknowledgements

• Key collaborators in this work
  – Prof Robert West, UCL
  – Prof Marie Johnston, Aberdeen
  – Health Psychology Research Group

• Key funders

![MRC Medical Research Council](MRC.png)
![National Institute for Health Research](NHS.png)
![Cancer Research UK](Cancer.PNG)
This talk

- Behaviour change interventions are complex
- Effective evaluation requires
  1. Good description
  2. Identifying effective component techniques
     - evidence synthesis
     - primary research
  3. Understanding mechanisms of action
     - applying theoretical frameworks
  4. Assessing fidelity of delivery
Interventions are complex

- Several, potentially interacting, techniques
- Vary in
  - content or elements of the intervention
  - delivery of the intervention
    - the mode of delivery (e.g., face-to-face)
    - the intensity (e.g., contact time)
    - the duration (e.g., number of sessions over a given period)
    - characteristics of those delivering the intervention
    - characteristics of the recipients,
    - characteristics of the setting (e.g., worksite)
  - adherence to delivery protocols

Content different than modes of delivery: how content is delivered

• Face-to-face
  – Individual
  – Group

• Distance
  – Population-level
    • Mass-media: internet, TV, radio, billboard, print media, leaflet
  – Individually-tailored
    • Phone: helpline, text, app.
    • Individually accessed computer programme
Interventions to change behaviour

• Have had variable effects
  – *Cochrane database*

• If we are to improve interventions, need to
  – Unpack the black box of interventions
    • What is in the black box?
    • How do components have their effect?
    • How to use this information to design more effective interventions?
What is in the black box?

• Poor descriptions of interventions
  – Vague and lacking detail
  – Inconsistent and varying terminology

• We need good, clear descriptions
  – Using language that is understood by all
    • Same term used for same component

• Without this, we are limited in our ability to
  – replicate,
  – implement effective interventions,
  – evaluate or
  – improve interventions
Example of the problem: Descriptions of “behavioural counselling” in two interventions

<table>
<thead>
<tr>
<th>Title of journal article</th>
<th>Description of “behavioural counselling”</th>
</tr>
</thead>
<tbody>
<tr>
<td>The impact of <em>behavioral counseling</em> on stage of change fat intake, physical activity, and cigarette smoking in adults at increased risk of coronary heart disease</td>
<td>“educating patients about the benefits of lifestyle change, encouraging them, and suggesting what changes could be made” (Steptoe et al. AJPH 2001)</td>
</tr>
<tr>
<td>Effects of internet <em>behavioral counseling</em> on weight loss in adults at risk for Type 2 diabetes</td>
<td>“feedback on self-monitoring record, reinforcement, recommendations for change, answers to questions, and general support” (Tate et al. JAMA 2003)</td>
</tr>
</tbody>
</table>
Biomedicine vs behavioural science … example of smoking cessation effectiveness

Varenicline *JAMA, 2006*

- **Intervention content**
  - [Chemical structure image]

- **Mechanism of action**
  - Activity at a subtype of the nicotinic receptor where its binding produces agonistic activity, while simultaneously preventing binding to a4b2 receptors

Behavoural counselling *Cochrane, 2005*

- **Intervention content**
  - Review smoking history & motivation to quit
  - Help identify high risk situations
  - Generate problem-solving strategies
  - Non-specific support & encouragement

- **Mechanism of action**
  - *None mentioned*
New methodology: describe content in terms of behaviour change techniques (BCTs)

• “Active ingredients” within the intervention designed to change behaviour
• They are
  – observable,
  – replicable and
  – discrete, low-level components of an intervention that on their own have potential to change behaviour
• Can be used alone or in combination with other BCTs
“Taxonomies” of BCTs

- Physical activity/healthy eating/mixed: 26 BCTs
  Abraham & Michie, 2008
- Physical activity & healthy eating: 40 BCTs
  Michie et al, Psychology & Health, 2011
- Smoking cessation: 53 BCTs
  Michie et al, Annals of Behavioural Medicine, 2010
- Reducing excessive alcohol use: 42 BCTs
  Michie et al, Addiction, 2012
- Condom use: 47 BCTs
  Abraham et al, 2012
- General behaviour change: 137 BCTs
- Competence framework: 89 BCTs
  Dixon & Johnston, 2011
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

www.ucl.ac.uk/health-psychology/BCTTaxonomy
BCT Taxonomy v1

- Applies to an extensive range of behaviour change interventions
- Agreed by an international consensus to be potential active components of interventions
- 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
Development of BCT Taxonomy v1

- Improvement of labels and definitions
  - Consensus methods, starting with published taxonomies
    - Delphi procedure
    - Iterative process of revisions and consultation with international experts (n=30)
  - Feedback from training workshops (n>300)
- Hierarchical structure
  - Open sort task and cluster analysis (18 experts)
    - Cane et al, BJHP, 2014
- Reliability and validity assessment
  - 48 trained coders, 40 intervention descriptions
- Participants
  - 400 participants from 12 countries
BCT Taxonomy v1: 93 items in 16 groupings

<table>
<thead>
<tr>
<th>Page</th>
<th>Grouping and BCTs</th>
<th>Page</th>
<th>Grouping and BCTs</th>
<th>Page</th>
<th>Grouping and BCTs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1. Goals and planning</td>
<td>8</td>
<td>6. Comparison of behaviour</td>
<td>16</td>
<td>12. Antecedents</td>
</tr>
<tr>
<td></td>
<td>1.1. Goal setting (behavior)</td>
<td></td>
<td>6.1. Demonstration of the behavior</td>
<td></td>
<td>12.1. Restructuring the physical environment</td>
</tr>
<tr>
<td></td>
<td>1.2. Problem solving</td>
<td></td>
<td>6.2. Social comparison</td>
<td></td>
<td>12.2. Restructuring the social environment</td>
</tr>
<tr>
<td></td>
<td>1.3. Goal setting (outcome)</td>
<td></td>
<td>6.3. Information about others’ approval</td>
<td></td>
<td>12.3. Avoidance/reducing exposure to cues for the behavior</td>
</tr>
<tr>
<td></td>
<td>1.4. Action planning</td>
<td></td>
<td></td>
<td></td>
<td>12.4. Distraction</td>
</tr>
<tr>
<td></td>
<td>1.5. Review behavior goal(s)</td>
<td></td>
<td></td>
<td></td>
<td>12.5. Adding objects to the</td>
</tr>
<tr>
<td></td>
<td>1.6. Discrepancy between current behavior and goal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.7. Review outcome goal(s)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>7. Associations</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>7.1. Prompts/cues</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 1. Goals and planning

<table>
<thead>
<tr>
<th>No.</th>
<th>Label</th>
<th>Definition</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td><strong>Goal setting (behavior)</strong></td>
<td>Set or agree on a goal defined in terms of the behavior to be achieved</td>
<td>Agree on a daily walking goal (e.g. 3 miles) with the person and reach agreement about the goal</td>
</tr>
</tbody>
</table>

*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**.*
BCT Taxonomy v1: Evaluation

• Reliability
  – Inter-coder: Good for 80 of the 93 BCTs, maintained over one month (Kappa>0.70)
  – Test-retest reliability: Good

• Validity
  – agreement with expert consensus good for 14 of the 15 frequently occurring BCTs identified in the descriptions assessed

• Training
  – Workshops improved inter-coder reliability,
    • not agreement with expert consensus
  – Distance tutorials improved agreement with expert consensus,
    • not inter-coder reliability
Now live at: www.bct-taxonomy.com
This talk

• Behaviour change interventions are complex

• Evaluation requires
  1. Good description
  2. Identifying effective component techniques
     • primary research
     • evidence synthesis
  3. Understanding mechanisms of action
     • applying theoretical frameworks
  4. Assessing fidelity of delivery
Identifying active ingredients in interventions

• Usual meta-analysis
  – overall effect of heterogeneous interventions
  – cannot identify active ingredients

• Technique-based meta-regression
  – classify interventions into component BCTs
  – meta-regression to investigate effects of
    • individual BCTs across interventions
    • theoretically-based combinations of BCTs

• An example …
What BCTs are effective in interventions to increase physical activity and healthy eating?

- **Inclusion criteria**
  - Interventions using behavioural &/or cognitive techniques
  - in adults
  - designs experimental or quasi-experimental
  - outcome measures objective or validated self-report

- 6 electronic databases, 1990-2007

- **Intervention content analysed using**
  - a reliable taxonomy of 26 BCTs (Michie & Abraham, 2009)
  - a theoretically-derived combination of BCTs

- Random effects meta-analysis and meta-regression
The interventions

• 84 interventions (n=28,838)

• Interventions ave. 6 techniques (range 1-14)
  – Many different combinations

• Effect d=0.37, 95% CI 0.29-0.54

• Very heterogeneous effects ($I^2=79\%$)
  – not explained by 10 moderators examined e.g.
  • Setting, population, intervention characteristics, target behaviour
Results

• Only one technique, self-monitoring, had a significant effect for both behaviours across interventions
  – $d=0.57$, $14.6\%$ variance

• Next step
  – Use psychological theory to predict combinations of techniques that might be more effective
  – Control Theory suggests how feedback may interact with other BCTs to change behaviour

*Carver & Scheier, 1982*
A Self-regulation (control) Theory: Carver & Scheier, 82

**GOAL**

1. **Compare behaviour with standard**
   - **No discrepancy – goal reached**
   - **Discrepancy noted**
     - **Disengage from goal – give up**

2. **Act to reduce discrepancy**

**SELF-MONITORING**

**GOAL-SETTING**

**ACTION-PLANNING**

Environmental influences
Theoretical combination of self-regulatory BCTs

• **Self-monitoring** PLUS
• One or more of:
  – feedback on performance
  – setting goals
  – reviewing goals
  – specifying action plans
Findings

• Interventions comprising self-monitoring with at least one other “self-regulatory” BCT (n=28)
  – compared with the other interventions (n=56)

• were twice as effective

• $d=0.60$ vs $d=0.26$
  – Michie et al, 2009, *Health Psychology*

• Replicated by
Alternative statistical analysis: Classification and Regression Trees (CART)

• To examine synergistic effects of BCTs
• Re-analysis of data Michie et al. 2009
  – 101 studies; 122 study effect sizes
  – Partitioning of interventions in homogeneous subsets
• Identified effective combination of BCTs
  – provide information on consequences
  – provide information on behaviour-health link
  – use follow-up prompts

Dusseldorp et al (2014) Health Psychology
Other applications of BCT methodology in evidence synthesis

- Identify content of standard care of control groups e.g. De Bruin et al, 2009
- Investigate internet-based interventions e.g. Webb et al, 2010
- Re-analyse Cochrane review of evidence e.g. of alcohol interventions, Michie et al, 2012
- Investigate links between intervention content and theoretical basis, Prestwich et al, 2013, Health Psychology
- See www.ucl.ac.uk/health-psychology/bcntaxonomy – [or Google ‘BCT Taxonomy’]
Primary studies to identify effective BCTs

- Link with large datasets
  - e.g. West et al, 2011, *Nicotine & Tobacco Research*

- New experimental designs
  - e.g. MOST (Multiphase Optimisation Strategy)
    - Collins et al, 2013, *Translational Behavioral Medicine*
  - Theory guided fractionated factorial designs allow one to unpack the
This talk

- Behaviour change interventions are complex
- Evaluation requires
  1. Good description
  2. Identifying effective component techniques
     - primary research
     - evidence synthesis
  3. Understanding mechanisms of action
     - applying theoretical frameworks
  4. Assessing fidelity of delivery
Theory: What it is and why use it?

• How variables relate to each other
  – behaviours, thoughts, emotions, environmental and social variables

• How interventions “work”
  – mechanisms of action
    • ‘mediators’
  – why they vary across population, setting, type of target
    • ‘moderators’ or ‘modifying variables’
Applying theory to intervention design and evaluation

• Apply formal theory
  – 83 theories of behaviour change identified in cross-disciplinary review
    • www.behaviourchangetheories.com
  – Theory Coding Scheme,
    Michie & Prestwich, Health Psychology, 2010

OR

• Use an integrative theoretical framework
  – Behaviour Change Wheel, Michie et al, 2011
    • www.behaviourchangewheel.com
The Behaviour Change Wheel

- Synthesis of 19 behaviour change frameworks identified in a cross-disciplinary review
- Identified 9 intervention functions and 7 policy categories
- Linked to a model of behaviour – COM-B
  - Forms the hub of the ‘wheel’

Michie et al (2011) *Implementation Science*
The COM-B model: Behaviour occurs as an interaction between three necessary conditions

- **Capability**: Psychological or physical ability to enact the behaviour
- **Motivation**: Reflective and automatic mechanisms that activate or inhibit behaviour
- **Opportunity**: Physical and social environment that enables the behaviour

Michie et al. (2011) *Implementation Science*
Behaviour at the hub .... COM-B
Interventions: activities designed to change behaviours
Intervention functions
Policies: decisions made by authorities concerning interventions

Use the Behaviour Change Wheel to …

1. **Design** interventions and policies
   - COM-B links to intervention functions link to BCTs
2. “Retrofit” – **identify** what is in current interventions and policies
3. Provide a framework for **evaluation**
   - How are interventions working?
4. **Structure** systematic reviews
This talk

• Behaviour change interventions are complex

• Evaluation requires
  1. Good description
  2. Identifying effective component techniques
      • primary research
      • evidence synthesis
  3. Understanding mechanisms of action
      • applying theoretical frameworks
  4. Assessing **fidelity** of delivery
      • identify BCTs delivered *and* theoretical mechanisms
Fidelity of delivery

If we don’t know what was delivered, we cannot know what was effective

- A seemingly ineffective intervention may have been effective if delivered adequately, and vice versa
- BCTs allow fidelity to be investigated
Intervention to increase physical activity of those at risk of Type 2 diabetes

- “ProActive”: 14 BCTs
- Delivered by trained professionals in 5 sessions over 12 months
- Specified in detailed protocols/manuals
- An RCT of 365 people, family history & sedentary
  - Increased activity by equivalent of 20 minutes per day
  - No difference between intervention and “control” groups

Kinmonth et al, Lancet, 2008
BCTs

1. Give information
2. Elicit questions
3. Summarise message
4. Set goals
5. Self-monitor
6. Build motivation
7. Action plans
8. Use prompts
9. Use rewards
10. Build support
11. Review goals
12. Build habits
13. Relapse prevention
14. Generalise skills

Theories

1. Theory of Planned Behaviour
2. Relapse Prevention Theory
3. Self-regulation Theory
4. Operant Learning Theory
The implementation process

Theories of behaviour change

Techniques in manual

Delivery of techniques by professional

Participant response to intervention

Physical activity
Question: How did the intervention work?

- 27 participants selected to study in depth
- Audio-recorded and transcribed sessions
- All discussion in sessions relevant to behaviour change was reliably coded into BCTs and theories
  - Both of providers and of participants

% BCTs in protocol delivered by providers: 45%
How were techniques distributed over the theories? (a) in protocol (b) delivered
Process linking theory and behaviour change

Theories of behaviour change
  Techniques in manual
  Delivery of techniques by professional
    Participant response to intervention
      Physical activity
How was (a) provider (b) participant talk about behaviour distributed over the theories?
Which theories best accounted for change?

Although *Self-regulation theory* is the basis of the most commonly delivered intervention techniques, *Operant learning theory* may be a better explanation for behaviour change among participants.
Conclusion

• Behavioural interventions are complex
  – By specifying the content in terms of BCTs
    • The \[\text{can be opened}\]

• BCTs specify content more precisely
  – Helps replication, implementation, evidence synthesis, design and evaluation

• BCTs can link to theory to elucidate how interventions have their effect
  – Allows the development of more effective interventions
  – This is part of my current programme of research
For more information

• Susan Michie
  – s.michie@ucl.ac.uk

• Books
  – www.behaviourchangewheel.com
  – www.behaviourchangetheories.com

• UCL Centre for Behaviour Change
  – Summer School 4-8 August 2014
  – www.ucl.ac.uk/behaviour-change