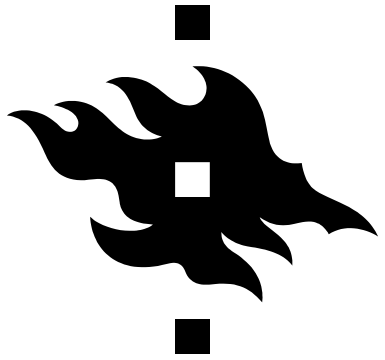




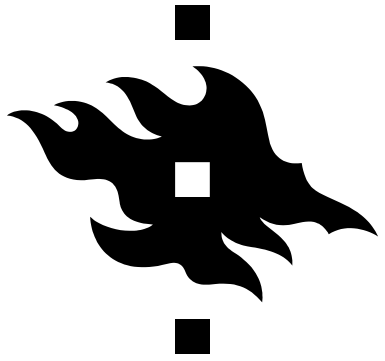
WHY IS IT USEFUL TO CONSIDER COMPLEXITY SCIENCE INSIGHTS TO BEHAVIOUR CHANGE RESEARCH?

Nelli Hankonen @NHankonen

October 8, 2020



- **What are behaviour change interventions and how do we currently design and study them?**
- **What is complexity?**
- **Why use complexity lens for intervention development?**
- **Why use complexity lens for evaluation?**
- **Note: Various systems:** The complex system we are looking at can be the individual, the group, the intervention, the community, etc...

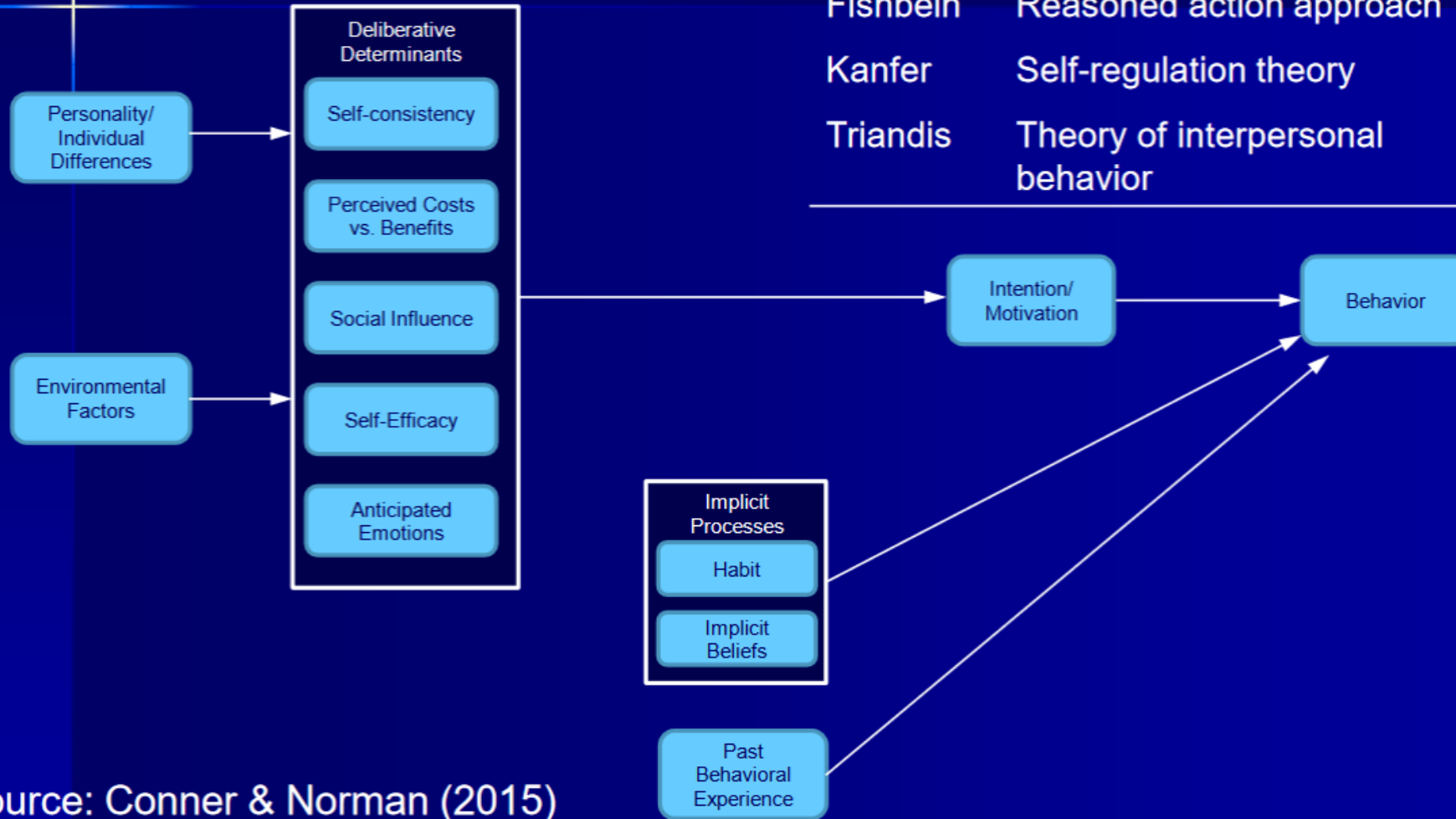


Behaviour change interventions

- Aims to change the behaviour of a population or group, by targeting particular behaviour(s), in order to solve a problem (e.g., prevention of illness, environmental protection)
- Examples:
 - One-on-one counseling
 - Programs at school, workplace, health care, etc.
 - Educational / persuasive media campaigns
 - Environmental/social planning (e.g. design of parks/buildings)
 - Regulation (e.g. fines)
 - Fiscal measures (e.g. taxation)



The 'Major Theorists' Model

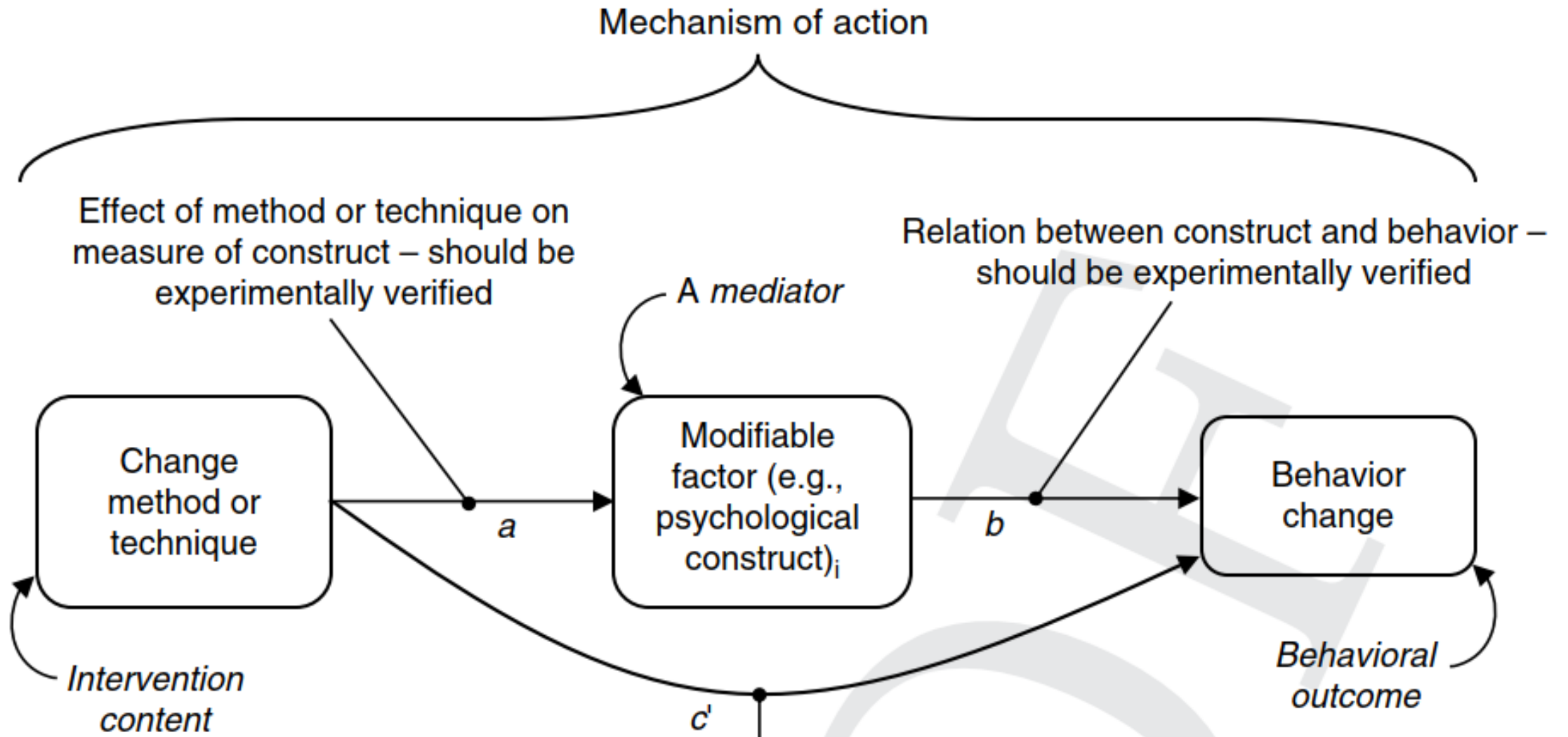


Source: Conner & Norman (2015)

Theorist	Theory
Bandura	Social cognitive theory
Becker	Health belief model
Fishbein	Reasoned action approach
Kanfer	Self-regulation theory
Triandis	Theory of interpersonal behavior

Prof. Martin Hagger: Why and how do interventions work?
Evaluating mechanisms of impact

<https://vimeo.com/user39826906/the-1st-besp-symposium/video/336456005>



Behaviour Change Technique Taxonomy

- Shared language to describe intervention content
Abraham & Michie 2008 *Health Psychology*
Michie et al 2013 *Annals of Behavioral Medicine*

ann. behav. med.

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

© The Society of Behavioral Medicine 2013

Abstract

Background CONSORT guidelines call for precise reporting of behavior change interventions: we need rigorous methods of characterizing active content of interventions with precision and specificity.

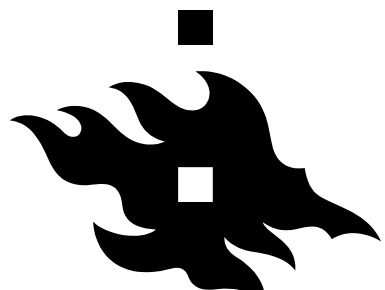
according to similarity of active ingredients in an open-sort task. Inter-rater agreement amongst six researchers coding 85 intervention descriptions by BCTs was assessed.

Results This resulted in 93 BCTs clustered into 16 groups.

BCT Taxonomy v1 (Michie et al., 2013)

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)		6.1. Demonstration of the behavior		12.1. Restructuring the physical environment
	1.2. Problem solving		6.2. Social comparison		12.2. Restructuring the social environment
	1.3. Goal setting (outcome)		6.3. Information about others' approval		12.3. Avoidance/reducing exposure to cues for the behavior
	1.4. Action planning				12.4. Distraction
	1.5. Review behavior goal(s)				12.5. Adding objects to the
	1.6. Discrepancy between current behavior and goal	9	7. Associations		
	1.7. Review outcome goal(s)		7.1. Prompts/cues		

No.	Label	Definition	Examples
1. Goals and planning			
1.1	<i>Goal setting (behavior)</i>	<p>Set or agree on a goal defined in terms of the behavior to be achieved</p> <p><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></p>	<p>Agree on a daily walking goal (e.g. 3 miles) with the person and reach agreement about the goal</p> <p>Set the goal of eating 5 pieces of fruit per day as specified in public health guidelines</p>



We are interested in identifying the best techniques to CHANGE motivation & behaviour

Journal

Health Psychology Review >

Volume 12, 2018 - Issue 3

2,830 23

Views

CrossRef citations to date

500

Altmetric

Systematic Review and Meta-Analyses

How can interventions increase motivation for physical activity? A systematic review and meta-analysis

Keegan Knittle  , Johanna Nurmi, Rik Crutzen , Nelli Hankonen , Marguerite Beattie &

Stephan U Dombrowski

Interventions delivered face-to-face or in gym settings, or which included the BCTs 'behavioural goal setting', 'self-monitoring (behaviour)' or 'behavioural practice/rehearsal', or which combined self-monitoring (behaviour) with any other BCT derived from control theory, were all associated with beneficial changes in multiple motivational constructs (effect sizes ranged from $d = 0.12$ to $d = 0.46$)."

3CTs and
at least
 $d = 0.74$).

3,532

Views

34


CrossRef citations
to date

570

Altmetric

Conceptual Review

A meta-analysis of techniques to promote motivation for health behaviour change from a self-determination theory perspective

Fiona B. Gillison , Peter Rouse, Martyn Standage, Simon J. Sebire & Richard M. Ryan

using items from the Cochrane risk of bias tool. 2496 articles were identified of which 74 met inclusion criteria; 80% were RCTs or cluster RCTs. Techniques to promote need supportive environments were coded according to two established taxonomies (BCTv1 and MIT), and 21 SDT-specific techniques, and grouped into 18 SDT based strategies. Weighted mean effect sizes were computed using a random effects model; perceived autonomy support $g=0.84$, autonomy $g=0.81$, competence $g=0.63$, relatedness $g=0.28$, and motivation $g=0.41$. One-to-one interventions resulted in greater competence satisfaction than group-based ($g=0.96$ vs. 0.28), and competence satisfaction was greater for adults ($g=0.95$) than children ($g=0.11$). Meta-regression analysis showed that individual strategies had limited independent impact on outcomes, endorsing the suggestion that a need supportive environment requires the combination of multiple co-acting techniques.

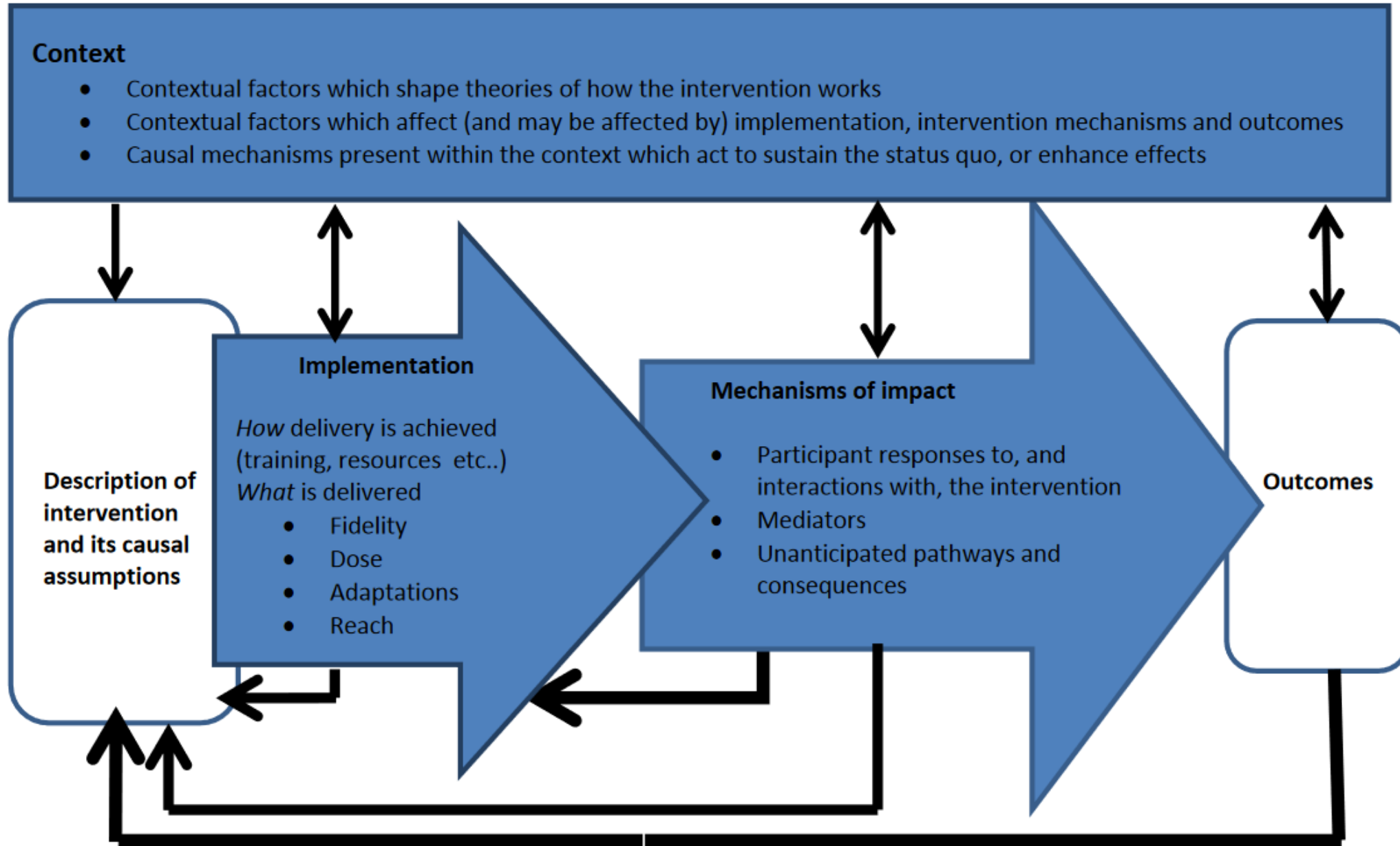
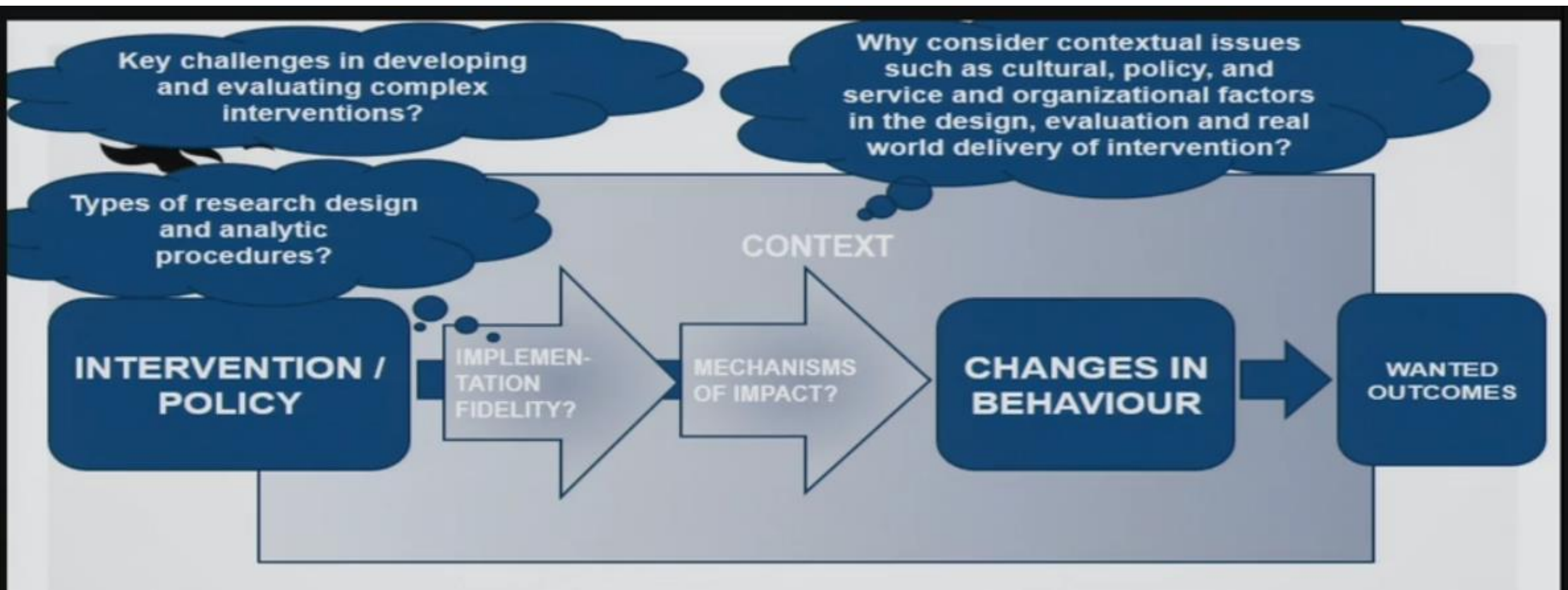


Figure 1. Key functions of process evaluation and relationships amongst them. Blue boxes represent components of process evaluation, which are informed by the causal assumptions of the intervention, and inform the interpretation of outcomes.



Various evaluation aspects:

<https://vimeopro.com/user39826906/the-1st-besp-symposium/page/1>

Debate

Open Access

A chaotic view of behavior change: a quantum leap for health promotion

Ken Resnicow*¹ and Roger Vaughan²

Why after years of false starts and failed attempts, a person succeeds at increasing their physical activity, eating healthier or losing weight? Or, why after years of success a person relapses?

“health behavior change - - is conceptualized as a **linear, deterministic process** where individuals weigh pros and cons, and at the point at which the benefits outweigh the cost change occurs. Consistent with this paradigm, the associated statistical models have almost exclusively **assumed a linear relationship between psychosocial predictors and behavior**. Such a perspective however, **fails to account for non-linear, quantum influences on human thought and action.**”

Embracing chaos and complexity: a quantum change for public health

Kenneth Resnicow¹, Scott E Page

Affiliations + expand

PMID: 18556599 PMCID: [PMC2446457](#) DOI: [10.2105/AJPH.2007.129460](#)

[Free PMC article](#)

Abstract

Public health research and practice have been guided by a cognitive, rational paradigm where inputs produce linear, predictable changes in outputs. However, the conceptual and statistical assumptions underlying this paradigm may be flawed. In particular, this perspective does not adequately account for nonlinear and quantum influences on human behavior. We propose that health behavior change is better understood through the lens of chaos theory and complex adaptive systems. Key relevant principles include that behavior change (1) is often a quantum event; (2) can resemble a chaotic process that is sensitive to initial conditions, highly variable, and difficult to predict; and (3) occurs within a complex adaptive system with multiple components, where results are often greater than the sum of their parts.

We have been studying complex interventions,.... Haven't we...?

MRC

Medical
Research
Council

Developing and evaluating complex interventions:

(2006)

But: "Intervention characteristics are only one aspect of complexity"

Box 2 What makes an intervention complex?

Some dimensions of complexity

- Number of and interactions between components within the experimental and control interventions
- Number and difficulty of behaviours required by those delivering or receiving the intervention
- Number of groups or organisational levels targeted by the intervention
- Number and variability of outcomes
- Degree of flexibility or tailoring of the intervention permitted



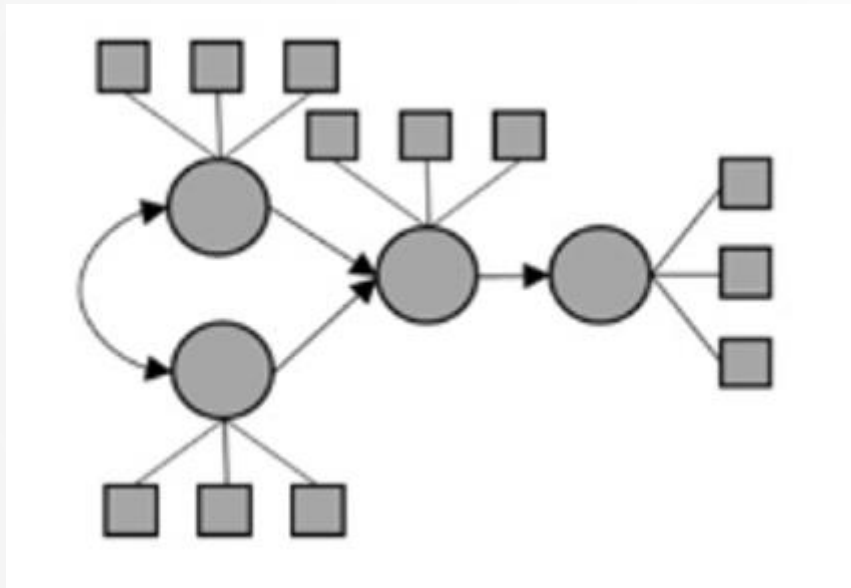
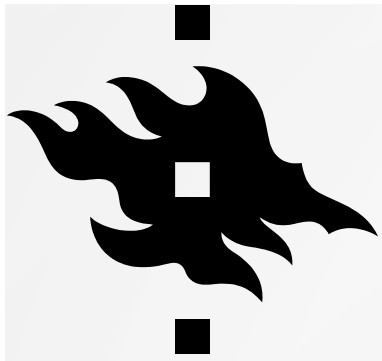
What is complexity?

Table 1. Simple, Complicated and Complex Problems (Glouberman and Zimmerman, 2002)

<i>Simple:</i> <i>Following a recipe</i>	<i>Complicated:</i> <i>Sending a rocket to the moon</i>	<i>Complex:</i> <i>Raising a child</i>
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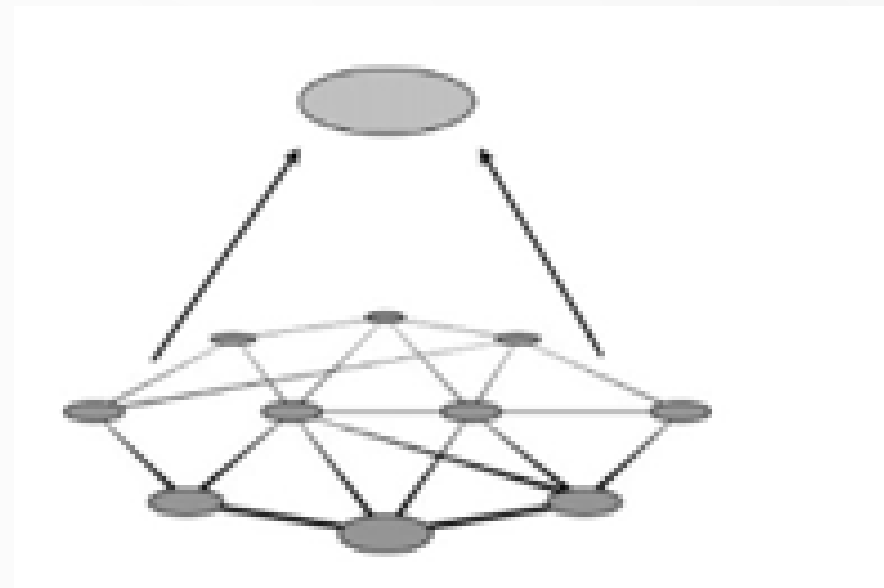
Table 1. Simple, Complicated and Complex Problems (Glouberman and Zimmerman, 2002)

<i>Simple:</i> <i>Following a recipe</i>	<i>Complicated:</i> <i>Sending a rocket to the moon</i>	<i>Complex:</i> <i>Raising a child</i>
The recipe is essential	Formulae are critical and necessary	Formulae have a limited application
Recipes are tested to assure easy replication	<div>Sending one rocket to the moon increases assurance that the next will be OK</div>	<div>Raising one child provides experience but no assurance of success with the next</div>
No particular expertise is required but cooking expertise increases success rate	High levels of expertise in a variety of fields are necessary for success	Expertise can contribute but is neither necessary nor sufficient to assure success
Recipes produce standardized products	<div>Rockets are similar in critical ways</div>	<div>Every child is unique and must be understood as an individual</div>
The best recipes give good results every time	<div>There is a high degree of certainty of outcome</div>	<div>Uncertainty of outcome</div>
Optimistic approach to problem-solving		
<div>Which of these do behaviour change interventions remind more?</div>		

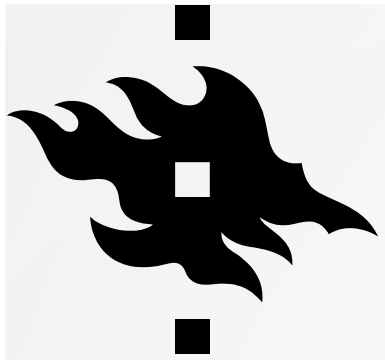


Component dominant system

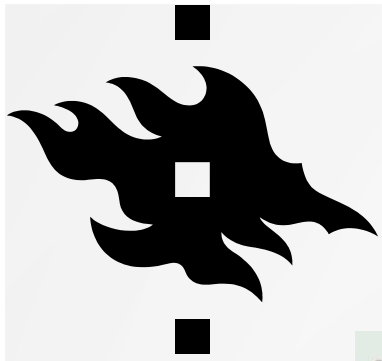
vs.



an interaction dominant system



Why use complexity lens for intervention development?



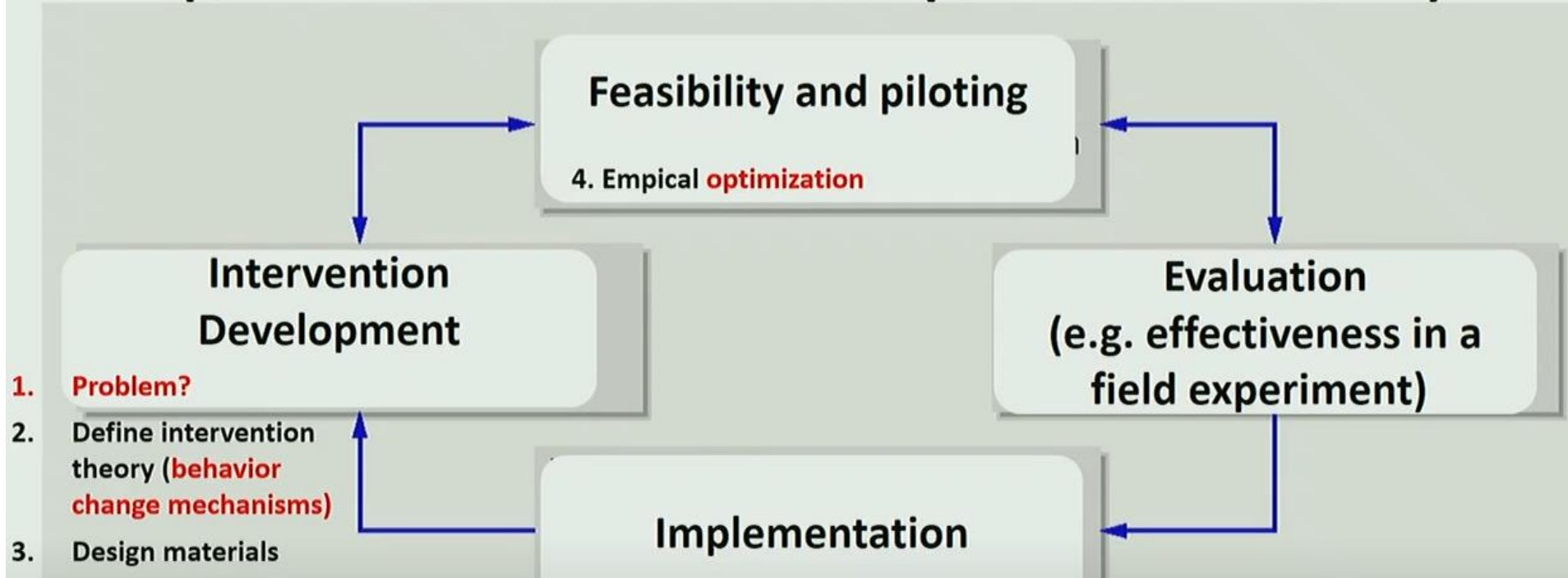
INTERVENTION DEVELOPMENT FRAMEWORKS

Key Tasks in Intervention Development

- **Task 1. What is the problem to be addressed?**
 - Analyze the problem in behavioral terms
 - Develop a preliminary logic model or program theory
 - Assess needs and resources
 - Consider systems of behaviors and ecological system
 - Define the target behavior(s)
- **Task 2: What are the hypothesized mechanisms of effect and intervention components?**
 - Understand the target behavior(s) informed by theory and evidence
 - Select key modifiable determinants to be targeted
 - Define and develop intervention content and delivery modes
 - **Bringing it all together: A well-defined logic model or program theory**
- **Task 3. Development of intervention materials and technology**
- **Task 4. Empirical optimization of the intervention**

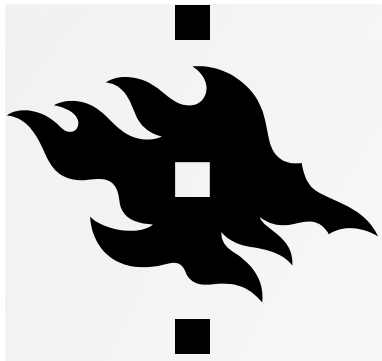
Make use of appropriate formal theories!

Phases in intervention research (UK MRC Guidance on complex interventions)



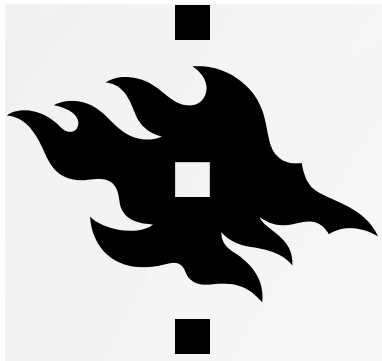
Nelli Hankonen (2nd BeSP): Common tasks and principles in behaviour change intervention development frameworks: Integrative review

<https://www.helsinki.fi/en/unitube/video/6aeb94e0-24a0-4b8b-989d-caef709b2a58>



RECENT CALLS...

- Currently, **program theories typically assume causal pathways with separate components, usually hypothesized to be linearly associated**
 - But: Individuals, organizations and behavior, which are the targets of interventions, AND the interventions themselves are complex, adaptive and dynamic systems (see e.g. Gomersall 2018, Resnicow & Page, 2008)
 - There are limitations of approaches to interventions which use reductionistic 'engineering' (e.g. Hawe, 2015)
- consider interventions (and behavior change) as complex systems!
-→ focus on the **relationships and interconnections between different parts or components**, rather than on **individual parts separately**



COMPLICATED VS. COMPLEX INTERVENTIONS

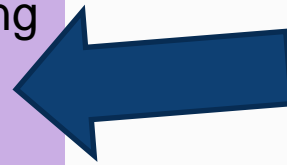
- **Complicated** interventions may involve numerous interacting components, but still can be divided into discrete sets of actions with predictable, stable and linear consequences

Thus, **intervention program theories** & ensuing **evaluations** should take such aspects into account (Rogers, 2008)

E.g.

- recursive causality (with reinforcing loops)
- disproportionate, non-linear relationships ('tipping points')
- emergent outcomes

- **Complex interventions:** emergent, unpredictable, and non-linear nature of associations between actions and outcomes.
 - Many behavior change interventions!!
 - Humans are active agents, whose behavior continuously adapts in response to feedback from one another, and individual's behaviors are part of broader small group and community systems (Moore et al. 2019)



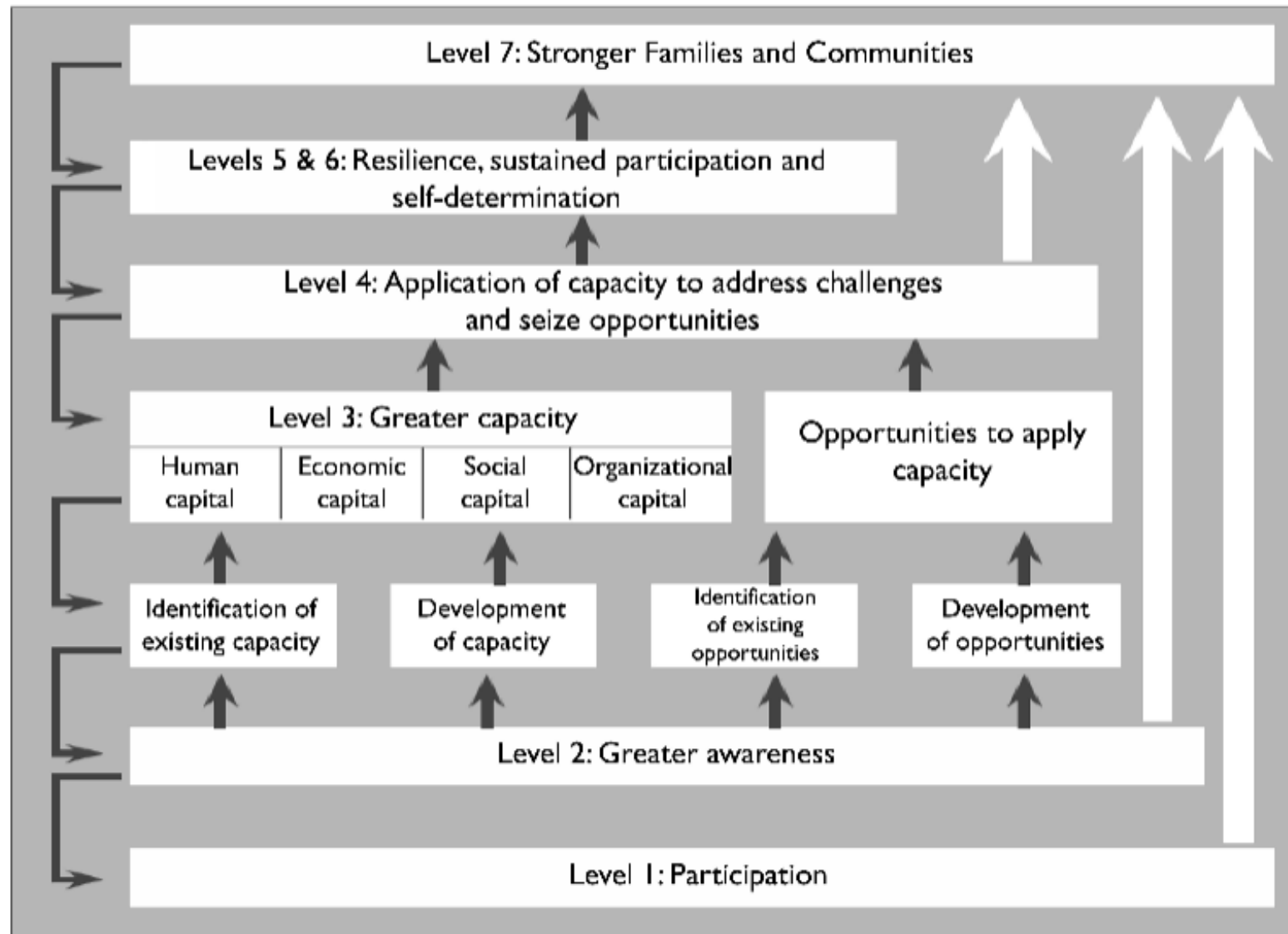
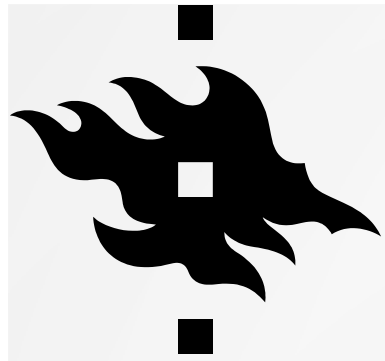


Figure 5. Logic Model for a Complex, Complicated Intervention: Community Capacity-Building Programme (CIRCLE, 2006)



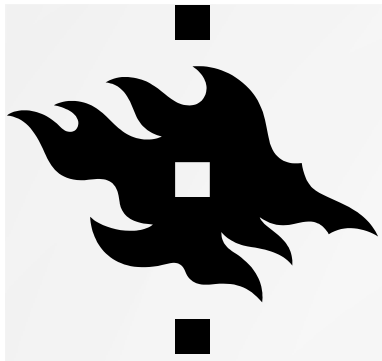
- Behaviour change is COMPLICATED vs. COMPLEX?

Table 4. Two Aspects of Complication

<i>Aspect of complexity</i>	<i>Simple intervention</i>	<i>Complex intervention</i>
1. Recursive causality and disproportionate effect	Linear, constant dose–response relationship	Recursive, with feedback loops, including reinforcing loops; disproportionate effects at critical limits
2. Emergent outcomes	Pre-identified outcomes	Emergent outcomes

- Of course, partially we are “prisoners” of current theories

Patricia Rogers (2008). Using Programme Theory to Evaluate Complicated and Complex Aspects of Interventions



- **Prof. Susan Michie:** Applying behavioural science to policy and interventions: a tool for collaboration <https://unitube.it.helsinki.fi/unitube/embed.html?id=0fbd8f6d-ff4a-401b-bc39-033d5d7711b5>



Example of indoor air pollution system in Nairobi

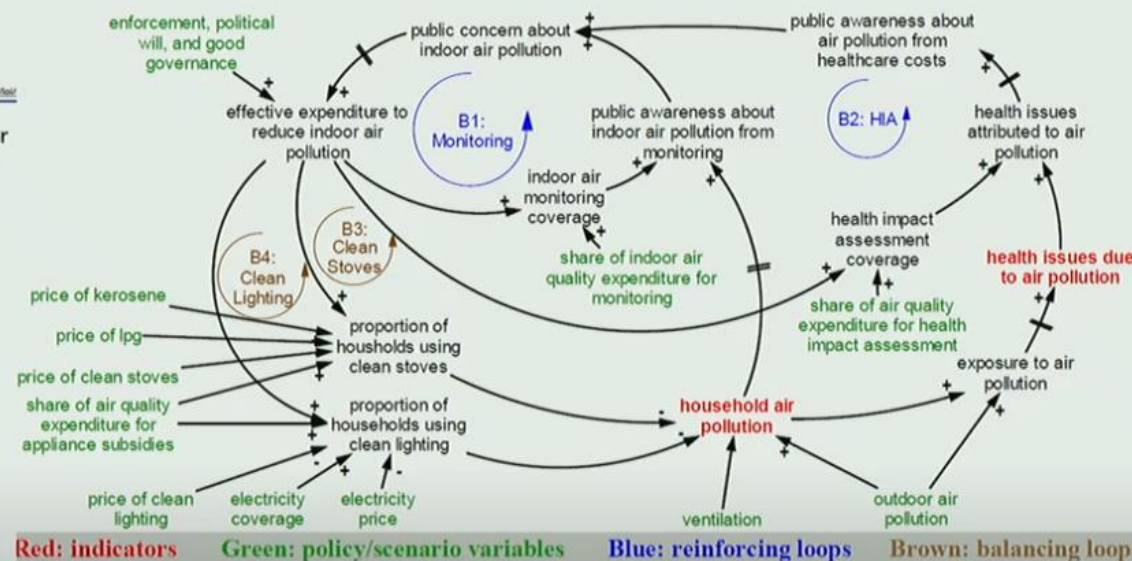


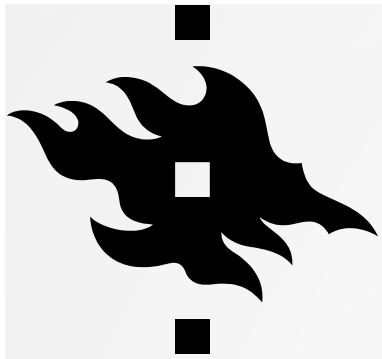
Building Research & Information

ISSN: 0961-3218 (Print) 1466-4321 (Online) journal homepage: <http://www.tandfonline.com/loi/brin>

Participatory system dynamics modelling for housing, energy and wellbeing interactions

Sibel Eker, Nici Zimmermann, Shane Carnohan & Mike Davies





DO COMPLEXITY FEATURES IMPROVE EFFICACY?

If the intervention acknowledge the dynamic, adaptive nature of human behavior and contexts – evolving and co-evolving nature of systems – does it improve effectiveness?

Leykum et al 2007 studied four CS characteristics:

- **Learning: People are active agents** who process information and react to changes therein
- **Interconnections** in the system, e.g. new connections between agents in the system
- **Self-organization** (e.g., order is created in a system without explicit hierarchical direction)
- **Co-evolution** (the system and the environment influence each other's development).

Research article

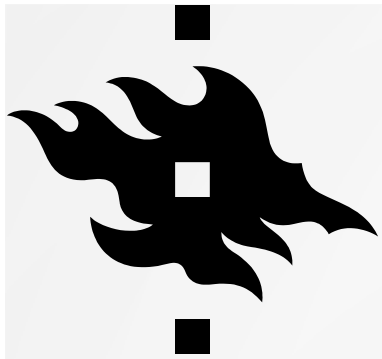
Open Access

Organizational interventions employing principles of complexity science have improved outcomes for patients with Type II diabetes

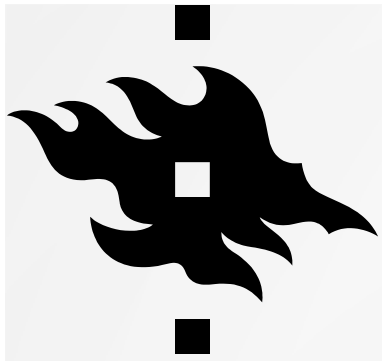
Luci K Leykum*¹, Jacqueline Pugh¹, Valerie Lawrence¹, Michael Parchman², Polly H Noël¹, John Cornell¹ and Reuben R McDaniel Jr³

Table 2: Examples of interventions utilizing characteristics of complex adaptive systems

Intervention	Characteristics Present	Score Given
I-page reminder of BP goals put on the front of the charts of all diabetics	None	0
Educational materials (articles, videotapes) sent to physicians at defined intervals	Learning	1
Decision – support system generated treatment recommendations based on current treatment and level of control. Patients seen monthly until controlled.	Interconnections Co-evolution	2
Pharmaco-evaluation and med review conducted at set intervals over 1 year. Emphasis on education, but tailored to progress of individual patients	Learning Interconnections Co-evolution	3
Usual visits replaced with group visits led by a physician and diabetes nurse educator, who were allowed to tailor the meeting frequency and content to the needs of the group. The goal of these visits was to improve compliance through education.	Learning Interconnections Self-Organization Co-evolution	4

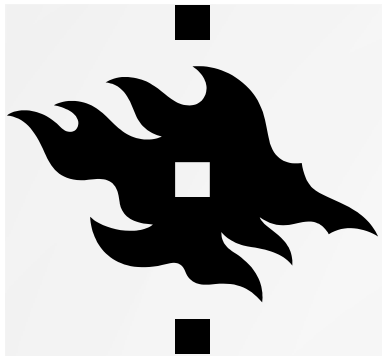


- Although many interventions and policies have included CS principles, many intervention development *frameworks* have not explicitly drawn on these
- CS views could be more explicitly integrated and adopted in intervention development frameworks and behavior change theories
 - I.e., not just as one of the formal theories used as a basis
- **How to best harness, address, model, and plan for characteristics of dynamic complex systems in intervention development?**
- Note: Not only conceptualizing the “outer” system, but also individuals, dyads, and groups etc. as complex systems



NOTE: MANY OF CURRENT INTERVENTIONS DO TAKE THIS INTO ACCOUNT!

- More and more intervention developers model behaviours in context and as parts of systems of competing/facilitating behaviours
- Developers and researchers DO acknowledge interventions are more complex than their linear logic models → often drawn in a simplified fashion for clarity & communication for stakeholders etc.
- Complex systems features are often included in the interventions, but not necessarily explicitly named as such / stemming from an explicit CS base
 - E.g., our Let's Move It intervention design was in line with several complexity features
 - [Matti Heino's talk: https://www.youtube.com/watch?v=faZABqka-5Q&t=7025](https://www.youtube.com/watch?v=faZABqka-5Q&t=7025)
- **However, lots of missed opportunities...**

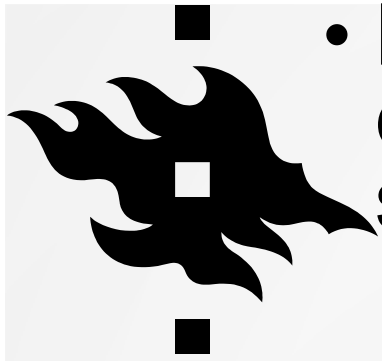


MISSED OPPORTUNITIES OF CS FOR INTERVENTION DEVELOPMENT

- Behaviour change is **COMPLICATED** vs. **COMPLEX**?
- Possible problems & choices in intervention development:
 - Expecting determinant-BC relationships to be **linear**?
 - Deconstructing psych./BC processes to its **component parts ("determinants"/influences)** – **not modeling/making use of synergistic effects**
 - Focusing on **components** and **not their interconnections, not forging** & strengthening interconnections more intentionally
 - Enough **room for self-organization and emergence**?
 - **Pre-specified paths** vs. **co-evolution**
- → Embrace complexity aspects in intervention program theories (Rogers, 2008)
- But we also need to renew our *formal theories* to account for the complexity



Why use complexity lens for evaluation?



- Limited utility of using randomised controlled designs to evaluate effects of complex interventions in complex systems
- Recommended talk from 1st BeSP: Dr. Michael Sanders: Practical Science - how we bring rigour into the evaluation of policy
<https://vimeopro.com/user39826906/the-1st-besp-symposium/video/336145420>

Complexity

- The What Works Network has generally failed at embracing complexity
- Where we've run trials looking at complicated things, they've very often failed
- This means that the tail ends up wagging the dog – we only evaluate that which is easy to evaluate





Complex Systems Research in Educational Psychology: Aligning Theory and Method

Jonathan C. Hilpert¹ and Gwen C. Marchand²

working or useful research model (Sloane & Wilkins, 2017). Although theoretical postulations in educational psychology often describe interaction dominant phenomena, they are regularly reduced to complicated theoretical models with component dominant characteristics that lend themselves to linear empirical testing. And ergodicity, or the assumption that the structure and strength of the rela-

Studying behaviour change mechanisms under complexity

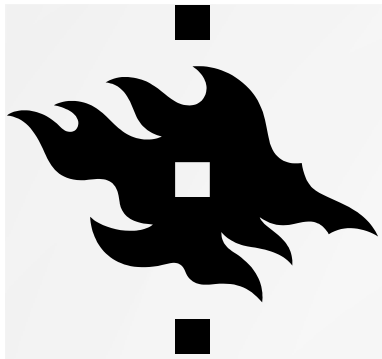
AUTHORS

Matti Heino, Keegan Knittle, Chris Noone, Fred Hasselman, Nelli Hankonen

“Many psychological and behaviour change theories seem to at least implicitly assume the presence of reciprocal causation and intertwined processes (e.g. Bandura, 1986, p. 6), but empirical testing of such processes has to date been limited.”

<https://psyarxiv.com/fxgw4>

This has only been possible for a short while...



(Video explanation:
https://youtu.be/T_IN5y2HcVU)

Two types of mathematical formalism:

Random events / processes
Linear
Efficient causes

component dominant dynamics

The Law of Large Numbers (Bernoulli, 1713) +
The Central Limit Theorem (de Moivre, 1733) +
The Gauss-Markov Theorem (Gauss, 1809) +
Statistics by Intercomparison (Galton, 1875) =
Social Physics (Quetelet, 1840)

Collectively known as:
The Classical Ergodic Theorems

Molenaar, P.C.M. (2008). On the implications of the classical ergodic theorems:
Analysis of developmental processes has to focus on intra
individual variation. *Developmental Psychobiology*, 50, 60-69

Random events / processes
Deterministic events / processes
Linear / Nonlinear
Efficient causes / Circular causality

interaction dominant dynamics

Deterministic chaos (Lorenz, 1972)
(complexity, nonlinear dynamics, predictability)

Takens' Theorem (1981)
(phase space reconstruction)

Systems far from thermodynamic equilibrium
(Prigogine, & Stengers, 1984)

$\text{SOC} / \frac{1}{f^\alpha}$ noise (Bak, 1987)
(self-organized criticality, interdependent measurements)

Fractal geometry (Mandelbrot, 1988)
(self-similarity, scale free behaviour, infinite variance)

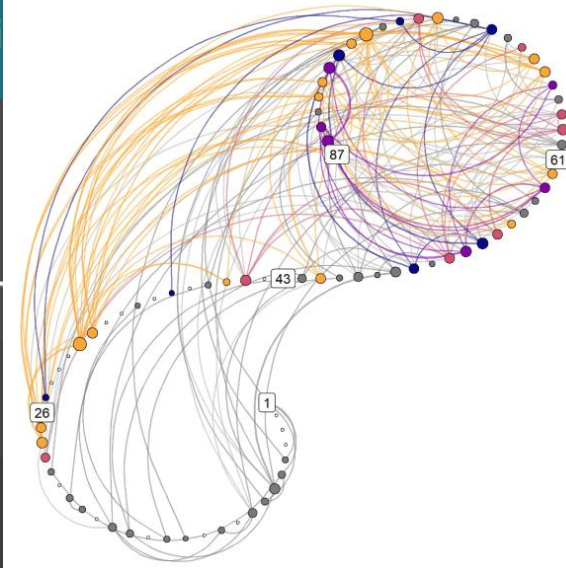
Aczel's Anti-Foundation Axiom (1988)
(hyperset theory, circular causality, complexity analysis)



Studying behaviour change mechanisms under complexity

AUTHORS

Matti Heino, Keegan Knittle, Chris Noone, Fred Hasselman, Nelli Hankonen



Empirical solutions

To model intensive longitudinal data, models developed with

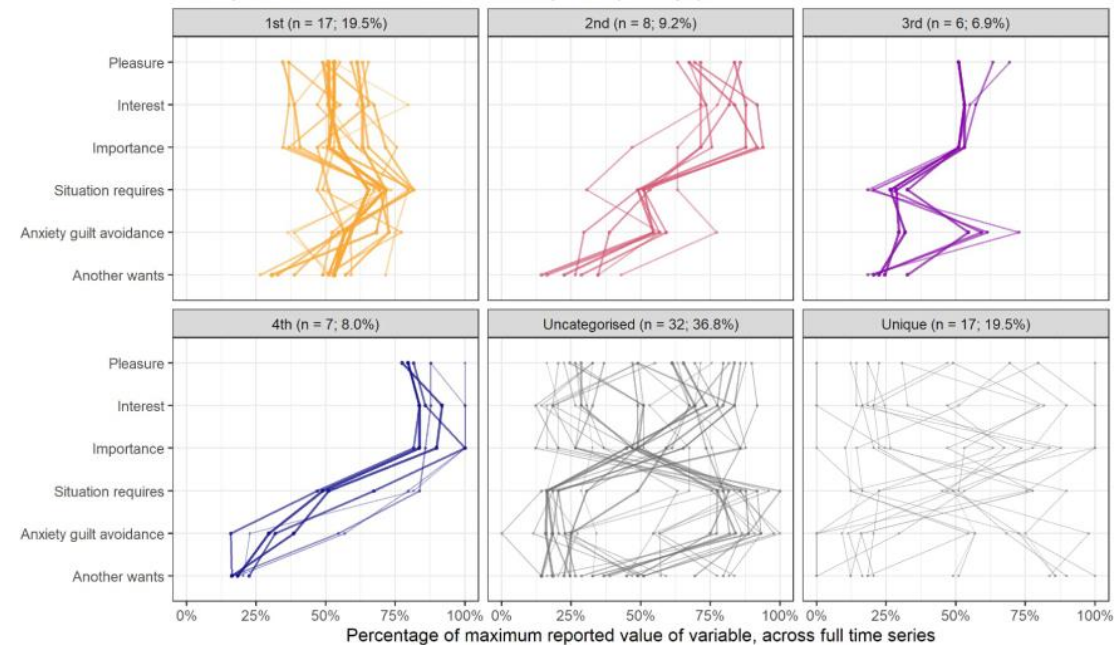
series analysis are necessary (Bradley & Kantz, 2015; Wright & Wo

this case is a sequence of values representing one variable in one ind

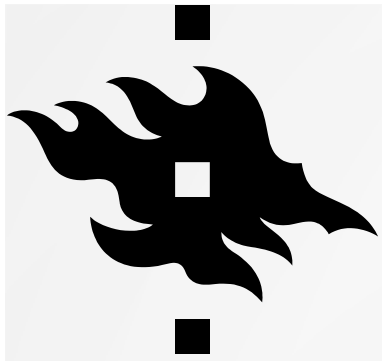
analysis consists of methods for studying time evolution of one or m

processes.

Participant "Moti13" - based on 87 data points (49 days)



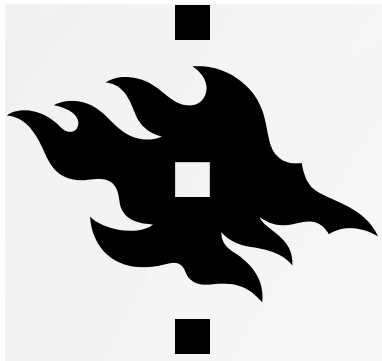
<https://psyarxiv.com/fxgw4>



TO SUM UP...

- Which approaches are suitable for characterising behaviour change phenomena?
- Given possible compound mechanisms of action, intertwining, synergistic effects...? Nonlinear effects? Time-varying dynamics?
- **Given individual variation** in the predicted causal relationships -> need for theorising and empirical research attention for this as well
- What will all this mean to our formal theories, our intervention programme theories, logic models, and evaluation designs?

Exciting times lie ahead 😊



THANK YOU FOR YOUR ATTENTION!