Three ways of conducting BOR studies: variance, process and modelling

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What are the goals of Behavioural OR?

- To provide **a more accurate description** of *how people work, perform tasks*, *make decisions*, or otherwise *behave in OR-supported settings*.

# OR-supported settings

Desk-based modelling & model use

Individual elicitation

Meetings
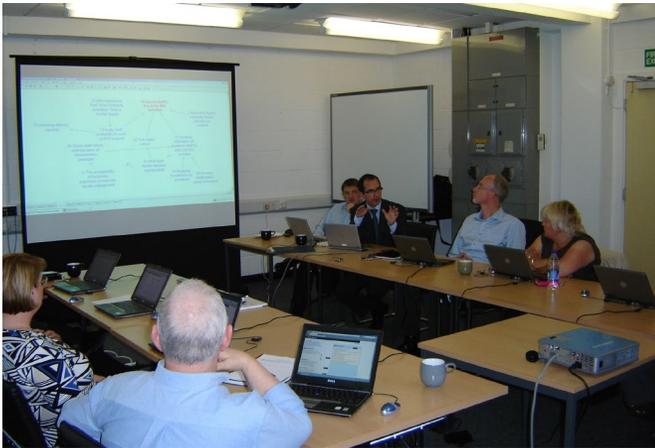
Modelling & model use

Group elicitation

Presentations

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How experts and novices build OR models?

(e.g. Willemain OR 1995; Willemain et al JORS 2007; Powell et al JORS 2007; Waisel et al JORS 2008; Tako & Robinson EJOR 2010; Tako JORS 2015)

Image by mohamed Hassan from Pixabay

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- To **design, deploy and evaluate (behavioural) theory-informed** *interventions* that can *help people make better decisions* and *improve performance in OR-supported settings.*
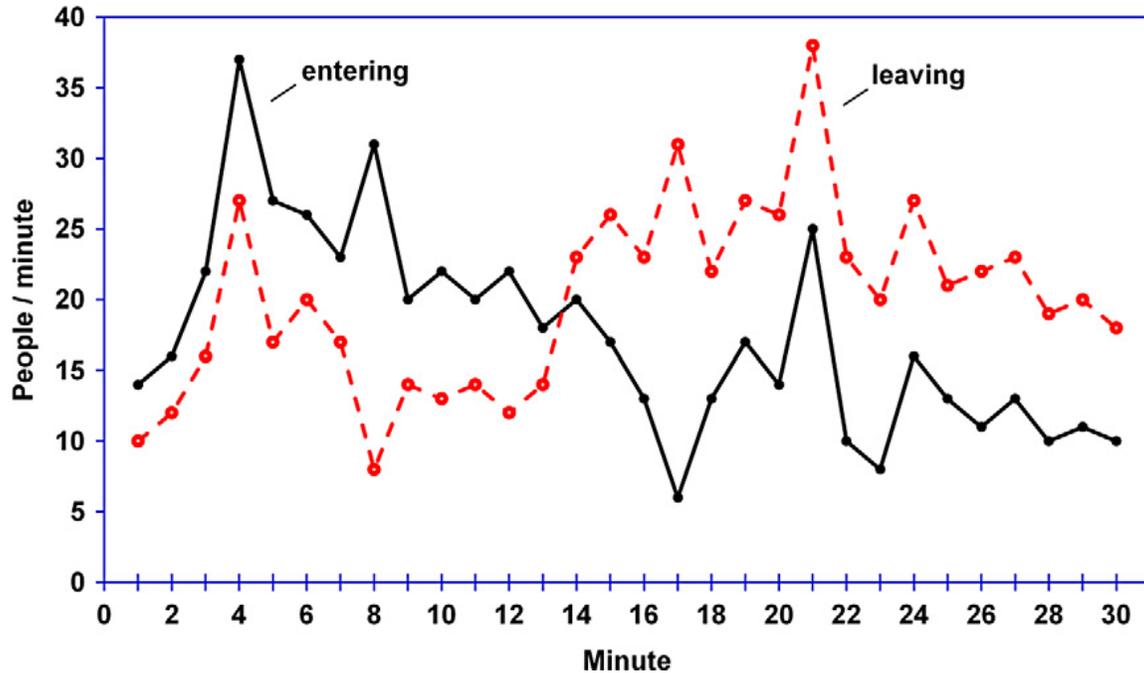
Changing wording and information display (graphs) formats reduces misperceptions of accumulation
(Hämäläinen et al EJOR 2013)

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- To **develop and use** *behavioural models* to *explore the best possible solutions* to complex problems in business and society.

Example of a behavioural model

- Yu et al (MS 2017) uses a dynamic structural model to study the **effect of delay announcement on customers' abandonment behaviour** in a call centre:

  - delay announcements impact both **customers' beliefs** about system *and* their **waiting costs**.

  - It **may not be necessary** to provide **announcements** with **very fine granularity**.

A sample of (prescriptive) behavioural models

MANSCIE/OPSRES:

- Fairness and channel coordination (Cui et al., 2007).
- Measuring the effect of queues on customer behaviour (Lu et al., 2013).
- Markdown or everyday low price? The role of behavioral motives (Özer & Zheng, 2016).
- Advance selling when consumers regret (Nasiry & Popescu, 2012).
- Structural estimation of callers' delay sensitivity in call centers (Akşin et al., 2013).
- Dynamic pricing strategies with reference effects (Popescu & Wu, 2007).
- Dynamic pricing with loss-averse consumers and peak-end anchoring (Nasiry & Popescu, 2011).
- Routing and staffing when servers are strategic (Gopalakrishnan et al., 2016).
- Impact of delay announcements in call centers (Akşin et al., 2017).

A sample of (prescriptive) behavioural models

POM/MSOM:

- Revenue and cost management for remanufactured products (Ovchinnikov, 2011).
- Trust and information sharing in supply chains (Ebrahim-Khanjari et al., 2012).
- Pricing and capacity rationing with customer disappointment aversion (Liu & Shum, 2013).
- Newsvendor selling to loss-averse consumers with stochastic reference points (Baron et al., 2015).
- Managing posterior price matching: The role of customer boundedly rational expectations (T. Huang et al., 2017).

A sample of (quasi-prescriptive) behavioural models

MANSCIE/EJOR/JORS/SDR:

- Incorporating human behaviour in simulation models of screening for breast cancer (Brailsford, Harper, & Sykes, 2012).
- Impacts of knowledge on online brand success (Jiang, Tadikamalla, Shang, & Zhao, 2016).
- An agent-based simulation model to evaluate alternative co-payment scenarios for contributing to health systems financing (Sonnessa, Tànfani, & Testi, 2017).
- Combining stock-and-flow, agent-based, and social network methods to model team performance (Anderson Jr, Lewis, & Ozer, 2018).
- Acquisitions, node collapse, and network revolution (Hernandez & Menon, 2018).

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Research approaches to study behaviour *in OR-supported settings*
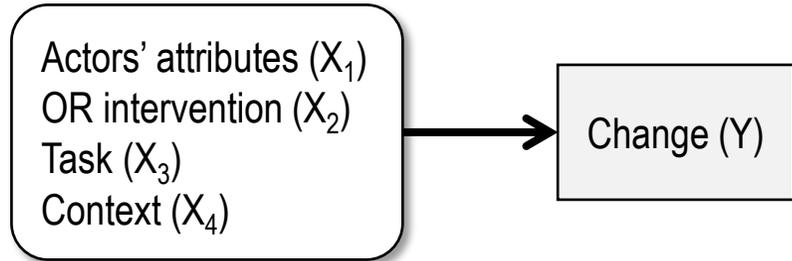
Variance

Actors' attributes (X_1)
OR intervention (X_2)
Task (X_3)
Context (X_4)

$\rightarrow$ Change (Y)

$Y = f(X_1, X_2, X_3, X_4)$

Modelling

Process

OR-supported process

Initial state $\rightarrow$ Events Activities Choices $\rightarrow$ End state

$T_0 \longrightarrow T_1$

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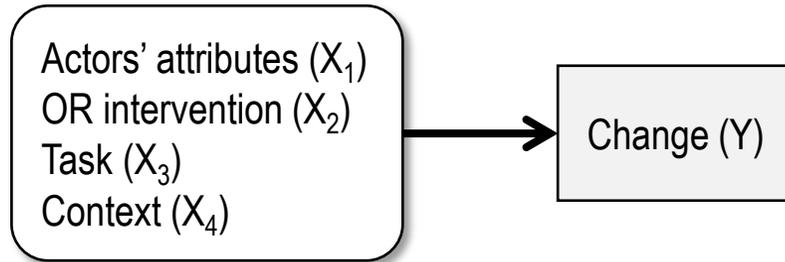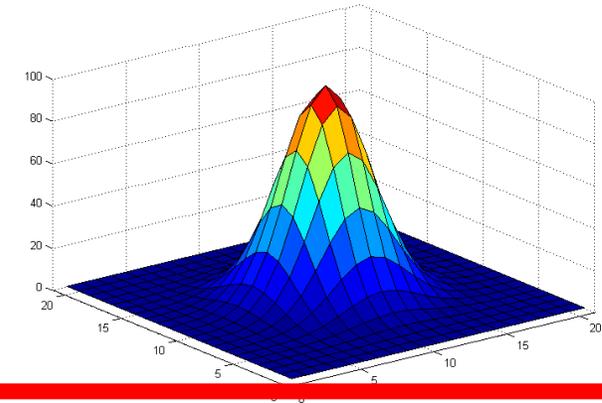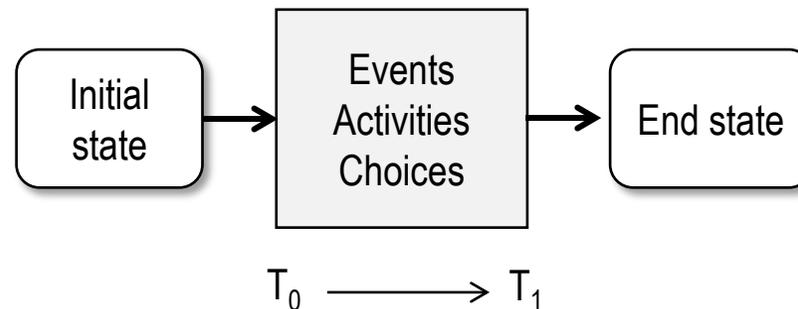
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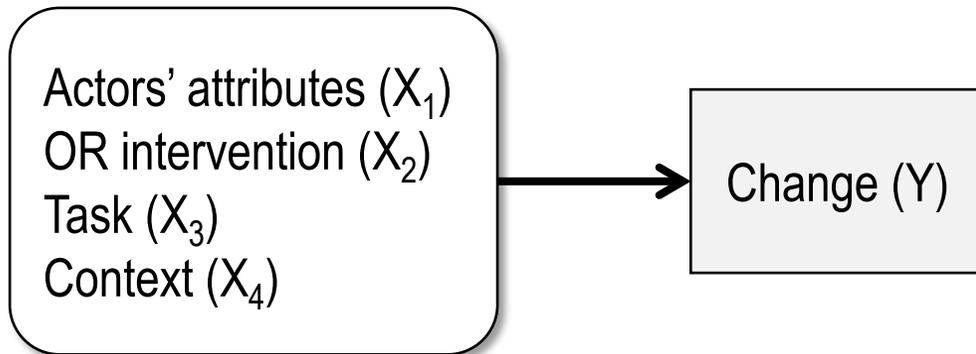
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- Focus on variables that link attributes of entities (e.g. actors, intervention, task, context) to outcomes.

- Used in experimental and survey designs.

- Developing reliable and valid measures of variables is critical.

- Data analysis methods are quantitative.

- Produces *causal explanations* through deduction.

- Generality depends on uniform application of causal explanation across a range of cases and contexts.

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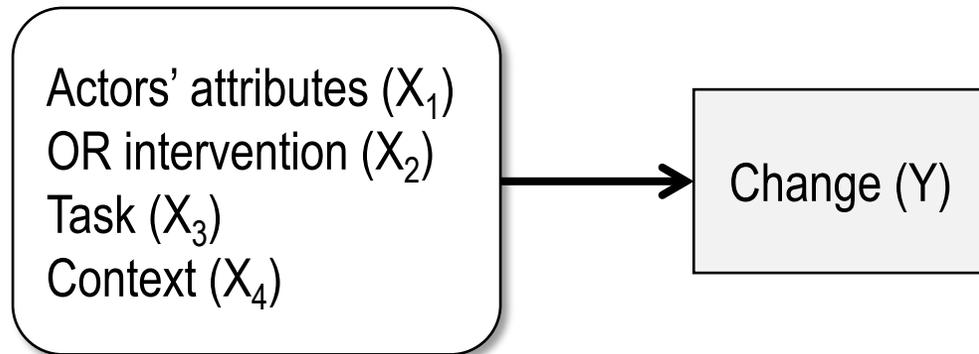
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- Examines questions such as:

  - What are the behavioural effects of reconfiguring different aspects of an OR-supported intervention?

  - What is the impact of individual differences on the use of, and perceptions about, OR methods, processes and tools?

  - What are the behavioural impacts of OR-supported interventions?

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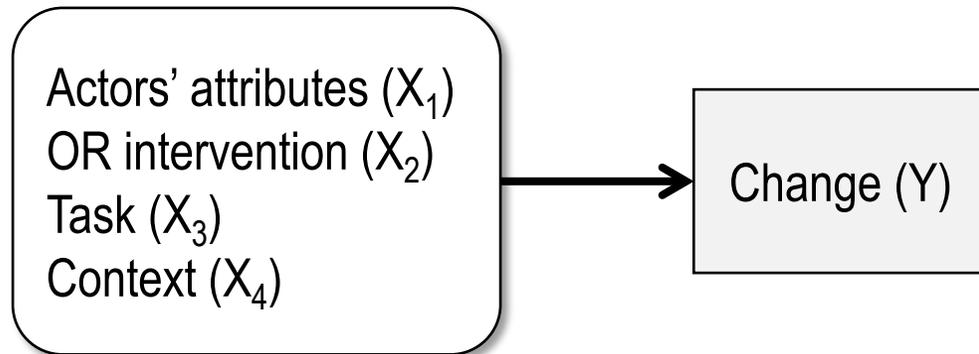
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Examples of re-configurations examined in the lab

1. Changing type of model-generated feedback information.

2. Changing model and information display presentations.

3. Using different weight elicitation procedures and/or implementing same weight elicitation procedure differently.

4. Using various external stimuli.

5. Involving client involvement in modelling.

6. Varying restrictiveness in model-driven group support systems.

Changing model-generated feedback information

The type of information provided by models affects individuals' performance in dynamic decision making environments.

Skraba et al.'s (SDR 2003)

- Study of the effect of feedback information on a SD-supported group process:

- Task was to determine best strategy.

- The use of group feedback information, in addition to using the SD model:
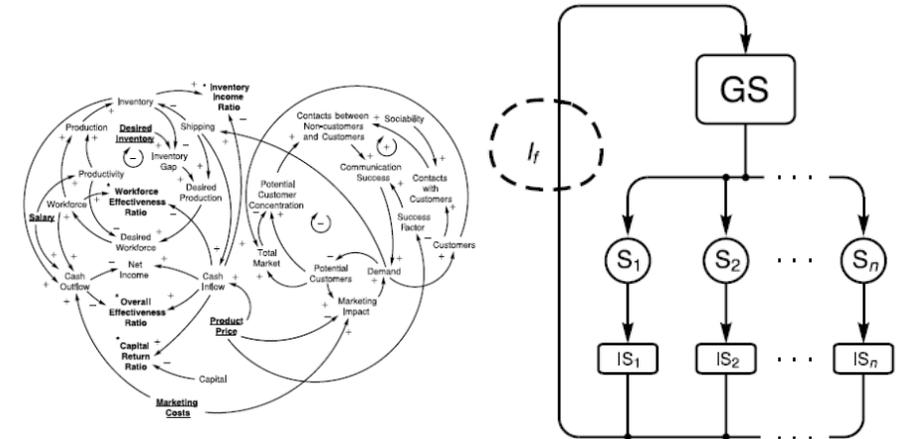
  - positively influenced convergence of the decision process;

  - contributed to higher (individual) performance.
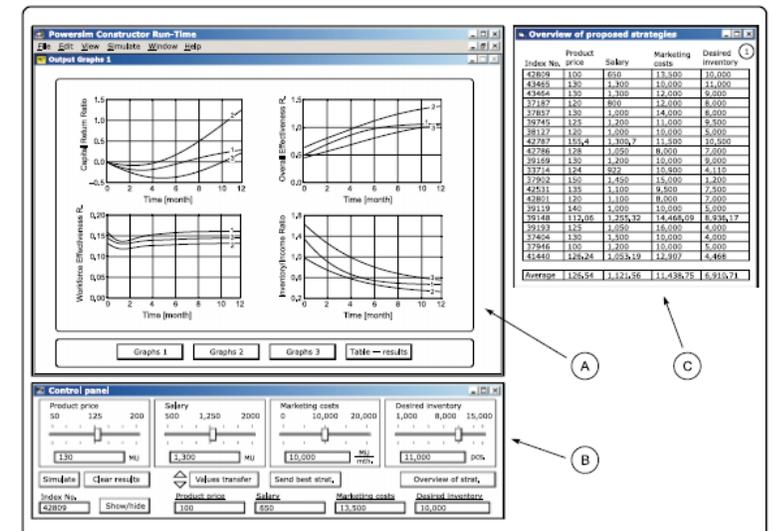
Changing model-generated feedback information

The type of information provided by models affects individuals' performance in dynamic decision making environments.

Model-driven support systems embedded with appropriate guidance can improve individual and group performance.

Changing model and information display formats

Use of appropriate model and information representation formats can lead to better decisions and negotiations.

Weight elicitation procedures

Different weight elicitation procedures, and the way in which they are implemented, yield different attribute weights, and lead to rankings or choices with varying levels of consistency and stability.

Using external stimuli

The use of appropriate external stimuli can improve performance and better communication of expert knowledge and beliefs.

Involving clients in modelling

Model building with client involvement produces higher benefits in terms of model-supported experimentation and learning than model building without involvement.

Varying restrictiveness in model-driven GSS

Increasing restrictiveness in a model-driven group support system induces more 'faithful 'appropriations' of the system, which in turn affects outcomes, performance and perceptions of the system.

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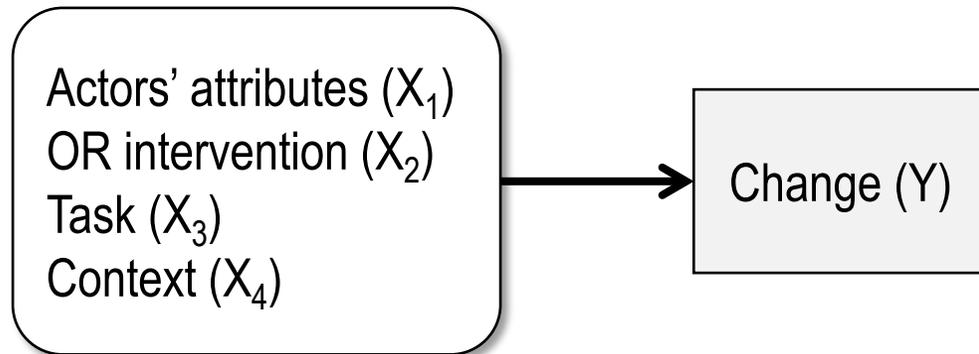
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Individual differences

There is mixed evidence that individual differences have an impact on the outcomes of, and perceptions about, a model-supported intervention.

Franco, Rouwette & Korzilius (EJOR 2016)

- Studied impact of *need for closure* (NFC) on self–facilitated model-supported GDM.
  - Compared to High NFC groups, Low NFC groups engaged in more effective conflict management
  - High NFC groups had more conflict, and tended to re-appropriate/discard the model to make their decision.
  - Both groups reported high level of consensus change (!)

NFC

↓

Conflict management

↓

Consensus

Fasolo & Bana e Costa (Omega 2014)

- Study of *individual differences* in *numeracy* and *fluency*.

- Higher numeracy individuals expressed values more easily when assisted by numerical techniques (direct rating).

- Higher fluency individuals found value elicitation easier with non-numerical techniques (MACBETH).
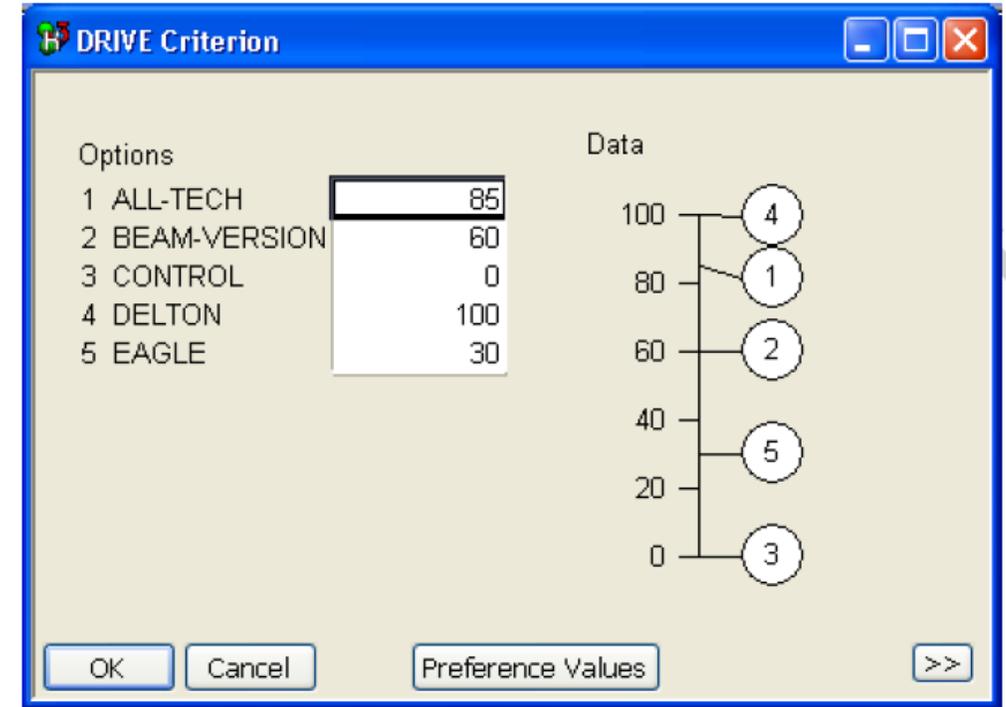
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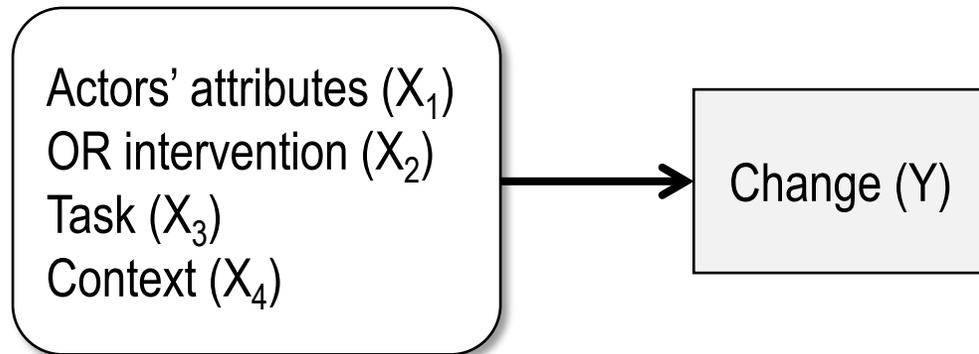
Variance

```
┌─────────────────────────┐              ┌─────────────────┐
│ Actors' attributes (X₁) │              │                 │
│ OR intervention (X₂)    │ ──────────►  │   Change (Y)    │
│ Task (X₃)               │              │                 │
│ Context (X₄)            │              └─────────────────┘
└─────────────────────────┘
```

$$Y = f(X_1, X_2, X_3, X_4)$$

- Examines questions such as:

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  - What is the impact of individual differences on the use of, and perceptions about, OR methods, processes and tools?

- *What are the behavioural impacts of OR-supported interventions?*

Rouwette et al's (SDR 2011)

- Field* study of the *impact of GMB on workshop participants' behaviour*.

- Sample of seven GMB workshops.

- GMB changes attitudes, norms and intentions.

- Inconclusive results regarding participants' perception of control.

Note this is a variance study that uses survey data from the applications the field.
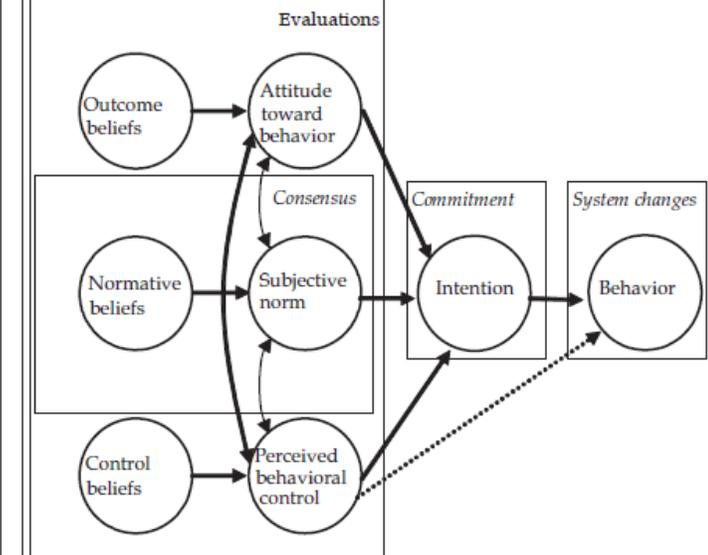
De Gooyert et al (2021)

- Field* study of the *impact of facilitated modelling (FM) on workshop participants' behaviour*.

- 8 FM workshops; pre- and post- test design.

- Overall, FM *successful in bringing about cognitive change and consensus*.

- BUT, at the level of individual FM workshops:
  - *Experienced consensus* significantly correlated with *observed consensus*.
  - *Experienced cognitive change* not significantly correlated with *observed cognitive change.*

Note this is a variance study that uses survey data from the applications the field.

Workshop:	1		2		3		4		5		6		7		8	
N:	10		9		10		9		14		12		8		14	
Before/after:	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a
Strategic ends																
1	s	s	s	s	s	s	s	s	s	s	n	s	n	n	n	s
2	s	s	n	s	s	s	s	s	s	s	s	s	n	s	s	s
3	s	s	s	s	s	s	s	s	s	s	s	s	n	s	n	s
4	s	s	s	s	n	s	n	s	s	n	s	s	s	s	n	s
5	s	s	n	s	s	s	s	s	s	s	s	s	n	s	s	s
6	n	s	s	s	s	s	s	s	s	s	s	s	n	s	s	n
7	s	s	s	s	n	n	s	s	n	s	n	s	n	s	n	s
8	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s
9	s	s	s	s	s	s	s	s	s	s	s	n	s	s	s	s
Technological means																
10	n	n	s	s	n	s	n	s	n	s	n	n	n	n	n	n
11	n	n	n	n	n	n	n	n	s	n	n	n	n	n	n	n
12	s	n	s	s	n	s	n	s	n	n	n	n	n	n	n	n
13	s	s	s	s	s	s	n	s	n	s	n	s	n	s	n	s
14	n	n	n	n	n	s	n	s	n	s	n	s	n	n	n	n
15	s	s	s	n	s	s	n	s	s	s	n	s	n	s	n	n
16	n	s	s	s	s	s	s	s	n	s	n	n	s	s	n	s
17	s	n	s	s	s	s	s	s	n	s	s	s	n	s	n	s
18	s	n	s	n	n	s	n	n	s	s	s	n	s	s	n	s
19	n	s	n	s	n	s	s	s	s	n	s	s	n	s	n	s
20	s	s	s	s	s	s	s	s	n	s	s	s	n	s	s	n
21	n	s	s	s	s	s	n	s	s	s	s	s	n	s	s	s
22	n	n	s	s	n	s	s	s	s	s	n	s	n	s	n	s
23	s	s	s	s	n	s	n	s	n	s	s	s	s	s	n	s
24	n	s	n	s	n	n	s	s	n	s	n	s	n	s	s	s
25	s	s	s	s	s	s	s	s	n	s	s	s	s	s	s	s
26	s	s	s	s	n	s	s	s	n	s	n	s	s	s	n	s
27	s	s	s	s	n	s	s	s	s	s	n	s	n	s	n	n
28	n	s	n	s	n	n	n	s	n	n	s	s	n	s	s	n
29	n	s	n	n	n	s	n	n	n	n	n	n	s	n	n	s
30	n	n	s	s	n	s	s	n	n	s	s	s	n	s	s	s
31	s	s	n	s	n	s	n	n	n	n	s	s	n	s	s	s
32	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s
33	s	s	s	s	s	s	s	s	s	s	s	n	n	s	s	s
34	s	n	s	s	s	s	s	s	s	s	s	s	n	s	n	s
Policy means																
35	s	s	n	s	s	s	s	s	s	s	c	n	s	n	n	s
36	s	n	n	s	n	s	s	s	s	s	s	s	s	n	n	s
37	s	s	s	s	s	s	s	n	s	s	s	s	s	s	s	s
38	n	n	n	n	n	n	n	s	n	s	n	n	n	n	s	n
39	s	s	n	s	n	s	s	s	n	s	n	s	n	n	n	s
40	s	s	s	s	n	s	s	s	s	s	n	s	s	n	n	s
41	s	s	s	s	n	s	s	s	s	s	s	s	n	s	s	n
42	s	s	s	s	s	s	n	s	s	n	s	s	n	n	s	n
43	s	s	s	s	s	s	s	s	s	s	s	s	s	n	s	s
44	s	s	s	s	n	s	s	s	n	s	s	s	n	s	n	s
45	n	s	s	s	n	s	n	s	n	s	s	s	s	n	s	n
46	s	s	s	s	s	s	s	s	n	s	n	s	s	n	s	s
47	n	s	n	s	s	s	n	s	n	n	n	n	n	s	n	n

N = number of participants; b = before; a = after; s = shared cognition (IQR<=1); n = no shared cognition (IQR>1)

Variance approach: Pros & cons

- Makes use of familiar data analysis methods, i.e. the general linear model (GLM) underlying most common statistical methods.

- Useful for studying *rapid* individual/group level change in OR-supported settings.

- Disadvantages:

  - Difficult to study how change unfolds in interaction, moment by moment.

  - Rule out influence of factors that might figure in an OR-supported process.

Syndicate group task

- In groups, discuss how would you apply the variance approach to investigate a research idea worth pursuing.
- Be prepared to share the challenges (not the idea) you would encounter and how you would address them.

# Research approaches to study behaviour *in OR-supported settings*

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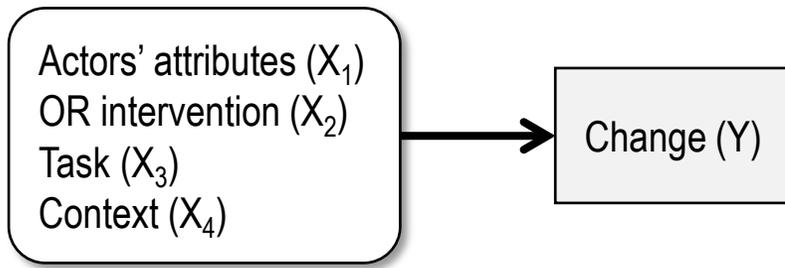
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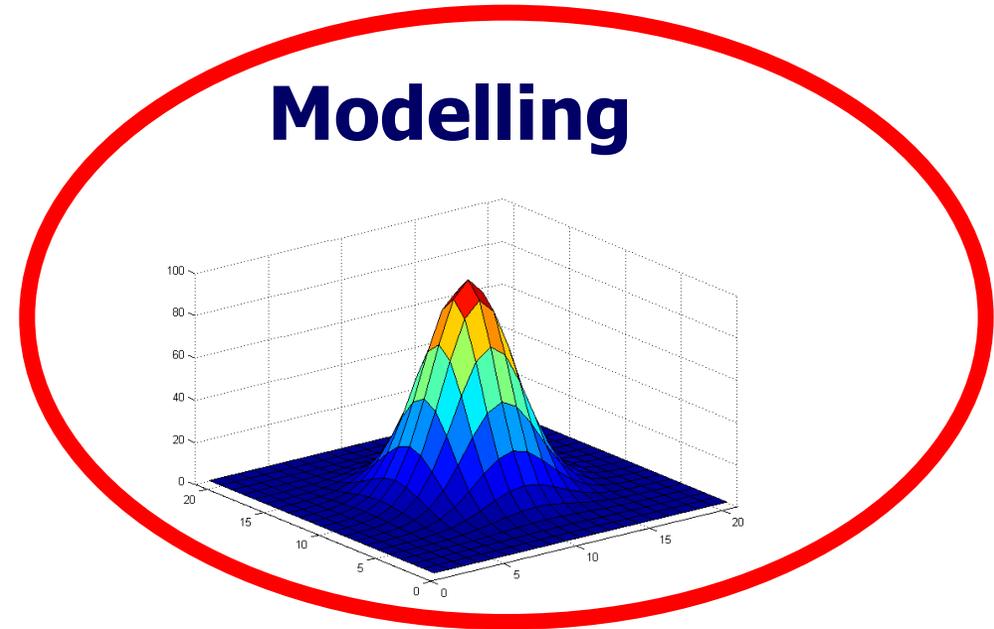
Modelling

Research approaches to study behaviour *in OR-supported settings*

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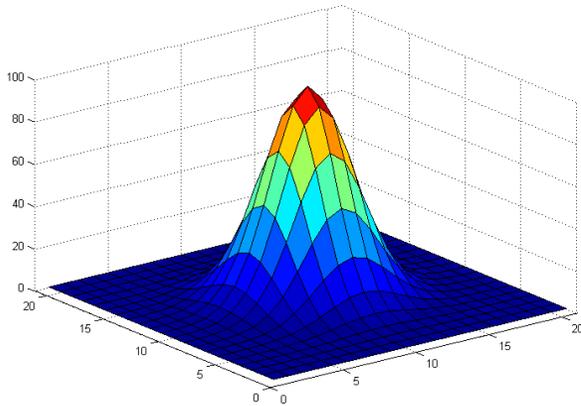
- Explicitly articulates generative mechanisms responsible for change (variance approach);
- Describes progression of events (process approach).
- Can be used inductively and/or deductively.
- Models are theory-driven.
- Different types of models available (Dooley 2004):
  - dynamic models (e.g. SD, Markov); computational models (e.g. Cellular Automata, Rugged Landscape); Self-organising models; Complex Adaptive System (CAS) models.

Modelling approach: Pros and cons

- Models can be built to better explain actors' behaviour in OR-supported settings, and/or OR interventions outcomes.
  - It can answer both the "how" and "why" of the impact of OR-supported processes.
- Useful for exploring macro-level effects from a BOR study's micro-level findings.
- Useful for deriving implications of behavioural theories that cannot be deduced from their verbal forms.
- Disadvantages:
  - simpler than reality;
  - does not model conversation (only information transfer).

Modelling approach: Current status within BOR

- To our knowledge, there is no BOR study that applies a modelling approach to understand behaviour in an OR-supported setting (speak up in you know any!).

- Few studies have used modelling to examine *un-aided* group decision making processes…

Larson (SGR 2007)

- An agent based model (ABM) is used to study the *effect of diversity on un-aided group decision making performance*.

- *Diverse* groups *better than homogeneous groups*, and even their best individual members;

- *Cooperative behaviours benefit* performance of *diverse groups*, but *impair* performance of *homogeneous groups*.

Mean Solution Value Found by Simulated Diverse (A-B-C) and Homogeneous (A-A-A, B-B-B, and C-C-C) Groups on Five-Dimensional Value-Seeking Problems
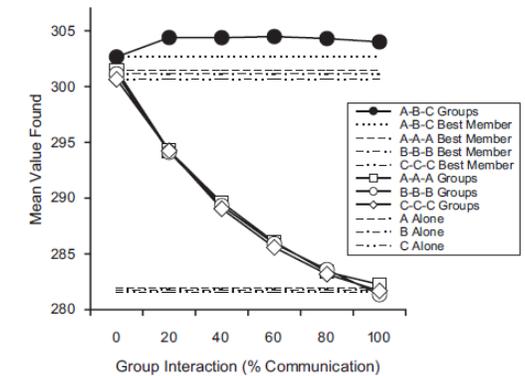
Percentage of Simulated Diverse (A-B-C) and Homogeneous (A-A-A, B-B-B, and C-C-C) Groups Finding the Maximum Solution Value on Five-Dimensional Value-Seeking Problems
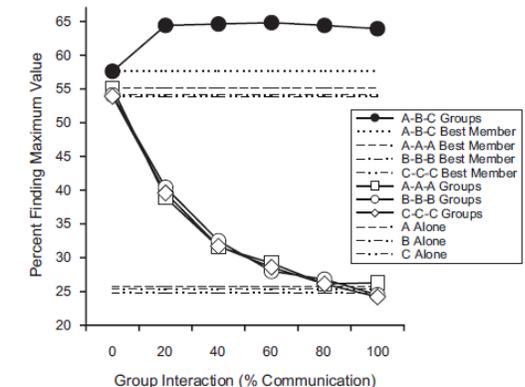
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- Few studies have used modelling to examine **_un-aided_** group decision making processes…:

- This area has great, yet untapped, potential for BOR studies.

Implications

- The three approaches should be seen as being *complementary* rather than as competing or opposite.
  - Each approach seeks to answer different questions.
  - Each approach provides a different, but partial, understanding of behavioural dimension of OR-supported processes.
- There is no one 'right' way to study behaviour in OR-supported settings:
  - combining the pluralistic insights from the three approaches can provide a richer understanding of behaviour in OR-supported setting than any one approach can provide by itself.

Thank you!

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