Theory and Ontology in Behavioural Science

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In a recent Perspective article[1], Muthukrishna and Henrich (MH) argue that an important and overlooked driver for the replication crisis in the social and behavioural sciences is 'the lack of a cumulative theoretical framework'. We have previously written about the importance of theory for human behaviour research[2,3], and agree that harnessing theories helps to enable cumulative science: by coordinating evidence and synthesis, providing a rationale for predictions, and giving a basis for interpreting new findings.[4] The more diverse the nature of the empirical verification that supports the same theoretical conclusion, the more confident we can be that it is true.[5,6] Even so, it will be difficult for researchers across the behavioural sciences to agree on any one theory, as theories vary in their perspective and scope. The ensuant challenge, as we see it, is to identify a framework that can integrate findings arising from different theoretical approaches in order to develop as comprehensive a view as possible about what is known. This depends on systematically linking evidence to theory in a way that allows determination of which theoretical propositions are more or less supported by the available evidence, across the multiple domains, fields or disciplines from which evidence may arise.[6]

Theories have a specific scope and subject matter and describe entities and relationships. They can be formally represented in *ontologies* (Figure 1): structured, computational representations of entities and relationships in a given domain.[7, 8]

As computable representations of knowledge and part of the "data science" family of semantic technologies, ontologies serve as hubs around which evidence can be aggregated and theoretical debates can be resolved. Explicitly defining entities from across different theories enables those theories to be connected. For example, an entity such as 'perceived control' might encompass the entities 'perceived behavioural control' (from the Theory of Planned Behaviour), 'self-efficacy' (from Social Cognitive Theory) and 'control representation' (from the Common Sense Model).[9] Two theories are only *comparable* – and may therefore be congruent or contradictory – to the extent that they are *about the same entities*. Theoretical integration entails identifying the entities of the different theories to determine when different theories are addressing the same, overlapping, distinct – or poorly specified entities. A project that aims to achieve this objective has already been initiated.[3]

MH argue for the benefit of 'unifying overarching theories,' drawing on examples from the natural sciences – special relativity, the periodic table, and Darwin's evolutionary theory. Each of these has its own very specific domain and scope, and their success is due in part to the clear definition of entities and the relations between them, allowing integration with other theories addressing the same entities. In the behavioural sciences, one key challenge with adoption of theory is the plethora of competing alternative entities, and the field lacks a principled approach to integrate across or select between them for use to interpret a given phenomenon. We propose an integrative approach based on ontologies.[10] This requires theory authors to become more explicit about the tenets of their theories and to define the entities and relations therein. Ontology annotation of empirical findings to an integrated knowledge base of theoretical entities then provides a direct connection from entities to evidence, regardless of the theoretical background that led to the generation of the evidence, providing a firm grounding for a cumulative science.

References

1. Muthukrishna, M. and Henrich, J. (2019). "A problem in theory". *Nature Human Behaviour.* 3, 221-229.
2. Davis, R., Campbell, R., Hildon, Z., Hobbs, L. and Michie, S. (2015) "Theories of behaviour and behaviour change across the social and behavioural sciences: a scoping review". *Health Psychology Review*. **9**(3):323-44.
3. West, R., et al. (2019), "Development of a formal system for representing behaviour-change theories". *Nature Human Behaviour.* **3**:526–536.
4. Freedland, K.E. (2019). "The Behavioral Medicine Research Council: Its origins, mission, and methods". *Health Psychology*, **38**(4):277.
5. Munafò, M.R. and Smith, G.D. (2018). "Robust research needs many lines of evidence". *Nature.* **553** (7689):399–401.
6. Munafò, M.R., et al. (2017) "A manifesto for reproducible science", *Nature Human Behaviour* **1**:0021.
7. Michie, S., et al. (2017) "The Human Behaviour-Change Project: harnessing the power of artificial intelligence and machine learning for evidence synthesis and interpretation." *Implementation Science* **12**:121.
8. Hastings, J. (2017) "Primer on ontologies". *Methods in Molecular Biology* **1446**:3-13.
9. Michie S, West R, Campbell R, Brown J and Gainforth H. (2014) *An ABC of Behaviour Change Theories*. London: Silverback Publishing. www.behaviourchangetheories.com
10. Hastings, J. Michie, S., and Johnston, M. (2019) "Theory and Ontology in Building Cumulative Behavioural Science." https://osf.io/9te3x/

Competing interests

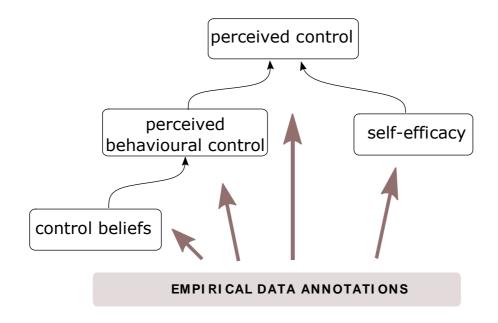The authors declare no competing interests.

Figures

Figure 1: Illustration of an ontology representing entities from different theories.