



# Using planned replication within A&F MetaLab members to efficiently advance science

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Brigitte Vachon, PhD, OT

School of Rehabilitation, Université de Montréal

Jeremy Grimshaw, PhD, MD

OHRI, Department of Epidemiology, University of Ottawa

# Objectives

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1. Understand what is, and what is not replication research.
2. Differentiate various replication aims and study types
3. Recognize barriers to replication and strategies to increase replication in research.



- What is the problem?

- Lack of replication being conducted
- Overconfidence in single study results
- Lack of reproducibility of findings



Review

# Changing research culture toward more use of replication research: a narrative review of barriers and strategies

Brigitte Vachon <sup>a</sup>  , Janet A. Curran <sup>b</sup>, Sathya Karunanathan <sup>B</sup>, Jamie Brehaut <sup>c</sup>, Ian D. Graham <sup>c</sup>, David Moher <sup>c</sup>, Anne E. Sales <sup>d</sup>, Sharon E. Straus <sup>e</sup>, Michele Fiander <sup>B</sup>, P. Alison Paprica <sup>f</sup>, Jeremy M. Grimshaw <sup>c</sup>

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# Results – Barriers to replication research

Barriers to replication research	Researchers/professors	Editors	Funders
<b>Knowledge</b>			
• Misconceptions of replication which is often understood to consist of strict replication	X	X	X
• Lack of conceptual clarity in the literature	X	X	X
• Lack of understanding of replication purposes and usefulness	X	X	X
• Overgeneralization of single study results	X	X	X
• Misinterpretation of the concept of originality	X	X	X
<b>Skills</b>			
• Lack of skills to design replication studies	X		
• Lack of methodological training	X	X	
• Lack of skills to interpret replication research findings	X	X	
• Lack of editors' skills to review and evaluate the quality of replication studies		X	

# Results – Barriers to replication research

Barriers to replication research	Researchers/professors	Editors	Funders
<b>Beliefs about consequences</b>			
• Fear of social and career-related risks	X		
• Fear of exposing original study flaws	X		
• Fear to impute the reputation of original study authors	X		
<b>Social influences</b>			
• Scientific culture that values positive results	X	X	X
• Replication is not recognized as a valuable research activity	X	X	X
• Graduate students and new scientists are not sufficiently aware of the importance of replication	X		
• Editors and reviewers prefer publishing original and positive study results		X	
<b>Emotions</b>			
• Fear of attacking another researcher	X		
• Fear to impute the reputation of original authors	X		
• Reluctance to share data due to fear the replication will show false results	X		
• Excessive emphasis on detecting false or fake results	X		
• Fear to be perceived by a lack of trust in colleagues	X		

# Results – Barriers to replication research


Barriers to replication research	Researchers/professors	Editors	Funders
Environmental context			
• Poor reporting of original research	X		
• Lack of validated measurement tools can make certain types of replication difficult	X		
• No substantive guidelines available to support the conduct of replication research	X	X	
• Confidentiality agreements limit data sharing	X	X	
• Limited journal space	X	X	
• Lack of systems and policies to facilitate data sharing			
• Lack of specific funding for replication			X





Replication Research Series

Replication Research Series

# Replication Research Series-Paper 1 : A concept analysis and meta-narrative review established a comprehensive theoretical definition of replication research to improve its use

Brigitte Vachon <sup>a</sup>  , Janet A. Curran <sup>b</sup>, Sathya Karunanathan <sup>c</sup>, Jamie Brehaut <sup>c, d</sup>, Ian D. Graham <sup>c, d</sup>, David Moher <sup>c, d</sup>, Anne E. Sales <sup>d</sup>, Sharon E. Straus <sup>e, f</sup>, Michele Fiander <sup>c</sup>, P. Alison Paprica <sup>g</sup>, Jeremy M. Grimshaw <sup>c, d</sup>

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# Results

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- 153 papers included
  - Most were conceptual papers
  - Disciplinary fields: Health (n=43); Psychology (n=39); Social science (n=31), Business (n=16); Education (n=14)
  - Published between 1950 and 2018
  - Most papers published in Social Sciences in the 90'; in Health in the 00' and in Psychology in 10'
  - Increased interest for the subject, replication crisis since 2010

# Distinctions between replication research and similar concepts

Repetition

Duplication

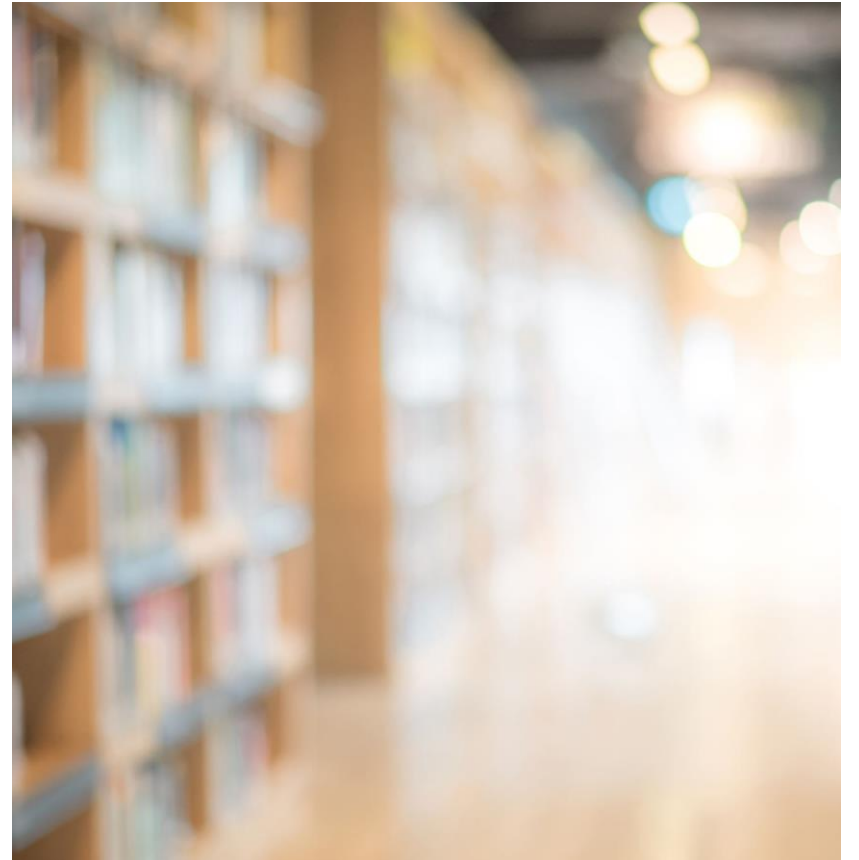
Reproduction

Reproducibility of research findings

# Definition of replication research

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- *A replication study is a study that is **methodologically or conceptually similar to an earlier one**. It is a **deliberate repetition of an index study in whole, in part or conceptually**. It provides a means to assess the reliability, validity and/or generalizability of previous findings or theory. A replication study may not only **verify** earlier research, but also may **broaden the scope** of the findings and test whether the original findings can stand as general principles. It is possible to describe how much variation exists between index and replication studies in terms of the amount of **planning** of the study, the **distance** between the investigators, the **similarity** between the research questions or hypothesis and methods of the index study.*



# Attributes of replication research

## 1. Amount of planning of the replication study

Incidental

Planned

## 2. Distance between the investigators

Same investigators

Independent investigators

## 3. Similarity between the research question or hypothesis

Identical question

Related question

## 4. Compliance with the methods

Same methods

Different methods

# Definitions of replication research

- Three major different uses of the concept
  - *Replication as the repetition of a previous study*
    - *Check the reproducibility of research findings or how results have been affected by validity threats or generalizability within the same population or context*
  - *Replication as the extension of a previous study*
    - *Evaluate possible generalization and extension of previous research findings by making minor or more important changes to the study*
  - *Replication as the road-testing of a theory*
    - *Test whether original findings can stand as general principal*

# Replication types

- Multiple replication typologies were found in different disciplinary fields
  - 32 labels for replication types
  - Analysed across disciplinary fields
- Development of a replication research framework informed by domains suggested by Shaddish, Cook and Campbell (2002) for drawing generalized conclusions about causal connections

***Internal Validity:*** The validity of inferences about whether observed covariation between A (the treatment) and B (the outcome) reflects the causal relationship from A to B as those variables were manipulated or measured

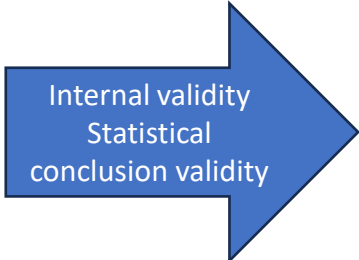
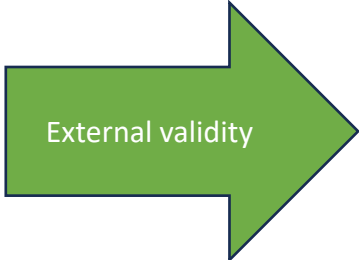
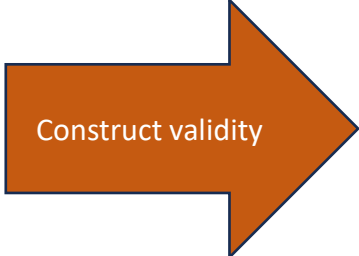
***Statistical Conclusion Validity:*** The validity of inferences about the correlation (covariation) between treatment and outcome

***External Validity:*** The validity of inferences about whether the cause-effect relationship holds over variation in persons, settings, treatment variables, and measurement variables

***Construct Validity:*** The validity of inferences about the higher order constructs that represent sampling particulars.

# How to use the framework?

- First .... Ask yourself “why do you want or should you conduct a replication study?”

Why do you wish to conduct a replication study?	
 <p>Internal validity Statistical conclusion validity</p>	<p>Do you want to test the reliability or reproducibility of findings of a previous study?</p> <p>To test the reliability of research methods used in a previous study</p> <p>To check the reliability of the statistical analysis</p>
	<p>Do you have concerns about the observed effects in a study?</p> <p>To increase the credibility of findings by conducting the same study on another sample of the same population</p>
	<p>Do you want to improve the empirical generalization of findings of a previous study?</p> <p>To identify attributes of the population, setting, treatment and outcome that are irrelevant (do not change the generalization of findings) or discriminate (limit the generalization of findings)</p> <p>To identify attributes that support or limit generalization of findings to <u>another</u> population, setting, treatment and/or outcome</p>
 <p>External validity</p>	<p>Do you want to improve the theoretical generalization of findings of a previous study?</p> <p>To verify the ways in which concept operationalizations or definitions influence theoretical generalization</p> <p>To verify, modify, or reject the underlying theoretical processes of a previous study</p> <p>To verify theoretical extension of a theory</p>
	<p>Do you want to improve the theoretical generalization of findings of a previous study?</p> <p>To verify the ways in which concept operationalizations or definitions influence theoretical generalization</p>
	<p>Do you want to improve the theoretical generalization of findings of a previous study?</p> <p>To verify, modify, or reject the underlying theoretical processes of a previous study</p> <p>To verify theoretical extension of a theory</p>
 <p>Construct validity</p>	<p>Do you want to improve the theoretical generalization of findings of a previous study?</p> <p>To verify the ways in which concept operationalizations or definitions influence theoretical generalization</p> <p>To verify, modify, or reject the underlying theoretical processes of a previous study</p> <p>To verify theoretical extension of a theory</p>

# How to use the framework?

- Second .... select the appropriate replication type which describes the more specific purpose for the replication study

<p>Do you want to test the reliability or reproducibility of findings of a previous study?</p> <p>Do you have concerns about the observed effects in a study?</p>	To test the reliability of research methods used in a previous study	Retest replication	<p>Uncovering inconsistencies and errors in procedures.</p> <p>Testing to see if the methods described in the primary study can produce the same results in another study.</p>	<p><u>Intrastudy</u></p> <p>Collect data on two subsamples of the population at the same time</p>
	To check the reliability of the statistical analysis	Statistical replication	Finding errors in the analysis of the data	<p><u>Interstudy</u></p> <p>Repeat the exact same study procedures on another subsample of the population</p>
	To increase the credibility of findings by conducting the same study on another sample of the same population	Close replication	Checking the validity of the results of a previous study with a <u>similar</u> or <u>as close to possible</u> population, setting, treatment, design, outcomes, and analysis.	<p><u>Intrastudy</u></p> <p>Repeat the same data analysis procedures with the original data set</p>
				<p><u>Interstudy</u></p> <p>Repeat the study with making no or minor changes to the population, setting, treatment, design, outcomes, analysis</p>



Do you want to improve the empirical generalization of findings of a previous study?	To identify attributes of the population, setting, treatment and outcome that are irrelevant (do not change the generalization of findings) or discriminate (limit the generalization of findings)	Assumed replication	Checking boundary of independent variables	<u>Intrastudy/</u>  Reanalyse the data of the original study to test the influence of possible confounding variables on the results
				<u>Interstudy</u>  Repeat a study and make changes to the methods as needed to test the influence of possible confounding variables on the results
	To identify attributes that support or limit generalization of findings to <u>another</u> population, setting, treatment and/or outcome	Replication with extension	Checking the applicability of the findings of a previous study to a <u>different</u> population, setting, treatment, outcomes with the same or different design	<u>Interstudy</u>  Repeat a study while intentionally making some changes to either the population, setting, treatment, design, outcomes and/or analysis

Do you want to improve the theoretical generalization of findings of a previous study?	To verify the ways in which concept operationalizations or definitions influence theoretical generalization	Construct replication	Checking if the ways in which concepts were operationalized and documented in the first study influenced the validity of the results	<u>Interstudy</u> Repeat a study while changing construct(s) definition(s) and assessment method that may have influenced the results obtained in the original study
	To verify, modify, or reject the underlying theoretical processes of a previous study	Theoretical replication	Checking the validity of a theoretical model or framework  to support the constructs under investigation	<u>Interstudy</u> Conducting a new investigation that begins with a similar hypothesis but uses new methods of measurement and design to demonstrate that true relationship exists between variables in a population. Investigators deliberately avoid imitation of the original study methodology (sampling design, measurement tools, analysis techniques, etc.)
	To verify theoretical extension of a theory	Theoretical extension	Extending an existing theoretical model or framework to test empirical fact or relationships previously established under widely varied conditions	<u>Interstudy</u> Conduct a new investigation based on the same theory as the original study however using different procedures and drawing a sample from a different population and setting from those of the original study

# Example

JAMA Internal Medicine | [Original Investigation](#)

## Effect of Antibiotic-Prescribing Feedback to High-Volume Primary Care Physicians on Number of Antibiotic Prescriptions A Randomized Clinical Trial

Kevin L. Schwartz, MD; Noah Ivers, MD; Bradley J. Langford, PharmD; Monica Taljaard, PhD; Drew Neish, MSc; Kevin A. Brown, PhD; Valerie Leung, BScPhm; Nick Daneman, MD; Javed Alloo, MD; Michael Silverman, MD; Emily Shing, MPH; Jeremy M. Grimshaw, PhD; Jerome A. Leis, MD; Julie H. C. Wu, MSc; Gary Garber, MD

Retest replication	Statistical replication	Close replication	Assumed replication	Replication with extension	Construct replication	Theoretical replication	Theoretical extension
Same study on another sample of physicians	Repeat data analysis	Same study in another province where practices are similar	Redoing the analyses to test the influence of unattached patients or ER visits	Changing the target population i.e. not only the highest prescribers	Defining adequate prescribing and not adequate prescribing	Assessing the influence of peer-comparison to assess the validity of the intervention mechanisms	Testing the intervention on another behavior: retinopathy screening recommendation

## Validation of a diagnostic prediction tool for colorectal cancer: a case–control replication study

[Elinor Nemlander](#), [Andreas Rosenblad](#), [Eliya Abedi](#), [Jan Hasselström](#), [Annika Sjövall](#), [Axel C Carlsson](#),<sup>✉</sup> and [Marcela Ewing](#)

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In 2016 Ewing et al.<sup>15</sup> published a case–control study based on regional health care databases from the southwestern Swedish Region Västra Götaland (1.7 million inhabitants) and the National Swedish Cancer Register (SCR), resulting in a Swedish CRC Risk Assessment Tool (SCCRAT) for non-metastatic CRC in individuals aged  $\geq 50$  years old for use in PHC.

The aim of the present study was to validate the SCCRAT on patients with CRC by replicating the already developed risk algorithm in a population in a different region, Region Stockholm, Sweden as well as examine if the risk marker patterns diverge depending on sex and age. We also aimed to compare the results from Region Stockholm with Region Västra Götaland.



# Conclusion

As illustrated by Schmidt, a cumulative science should be built on its foundations in a systematic way: “Adding a brick here and another brick there without much regard for the space between them may result in an unstable building with weak parts, leakages and unnecessary parts that will require a major effort later on to effect their removal.”

# Consequences or outcomes of replication studies

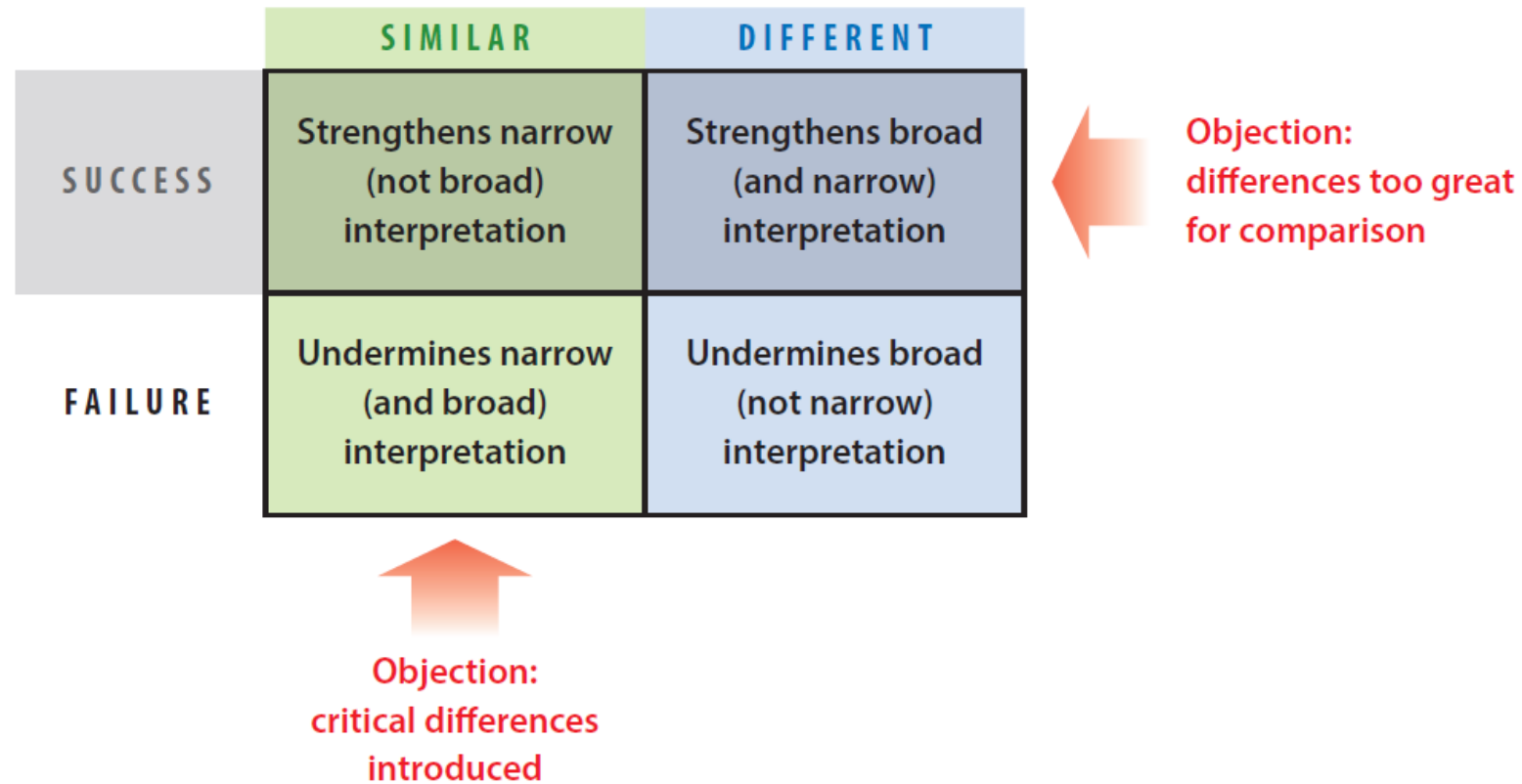


Figure 1

Replication success and similarity on interpretation.

# Strategies to improve use of replication

- For all actors
  - Education to improve understanding of the concept
  - Development of a consortium dedicated to replication
- For researchers
  - Development of guidelines or framework to plan the conduct of replication studies
  - Teaching replication methods and providing opportunities to conduct replication to graduate students
  - Commitment to data sharing
  - Clear identification of replication studies
  - Inclusion of replication research in research program

# Strategies to improve use of replication

- For editors
  - Development of policies about publishing replication studies (data archiving and sharing)
  - Provision of space or special issue for replication research
  - Improvement of editors and reviewers skills to assess replication studies
  - Identification of important studies that should be replicated
- For funders
  - Increase funding for dedicated to replication research
  - Commission of replication studies in specific research fields



# Discussion

- Informal social norms are shared by researchers, funders, and editors and are maintained even if multiple authors have called for the necessity of more replication
- Need to change at the community level and opportunities for replication will need to be provided at multiple levels
  - Advisory groups
  - Policies
  - Champions, researchers role models
  - Training