

Generalisation: From the Conditions Studied to the Target

Juan Segurola

3Dresyns by Resyner Technologies S.L.

© 2026 Juan Segurola. All Rights Reserved.

Correspondence: info@3Dresyns.com · www.3Dresyns.com

INF-012 · Scientific Inference and Experimental Reasoning · Version v0.3

Abstract

An internally valid result does not automatically apply outside the population, setting, scale, material state, time window or intervention conditions in which it was obtained. Generalisation is an additional inferential step linking a study population or experimental system to a defined target. This article distinguishes generalisability within a target frame from transportability to a different population or environment, identifies effect modification and support as central constraints, and explains why procedural replication is not sufficient for external validity. The core discipline is target-first: state where the claim is intended to apply, identify variables that can modify the relevant effect or relationship, determine whether the study represents those states with adequate support, and justify any adjustment used to bridge study and target. When target states are absent from the evidence, modelling cannot create empirical support by extrapolation alone.

Keywords: generalisation; transportability; external validity; target population; effect modification; positivity; extrapolation

1. Internal validity and external validity answer different questions

A randomised trial can estimate an internally valid treatment effect among its participants yet differ from the effect in a target population when participation is associated with effect modifiers. Dahabreh and colleagues show how causal effects can be generalised from randomised trial participants to trial-eligible individuals under explicit assumptions and data on relevant covariates [1]. Extending inference to a new target population similarly requires information about the relation between trial participation, effect modifiers and outcomes [2].

2. Define the target before asking whether evidence generalises

“Does it generalise?” is incomplete without a destination. The target should specify population or system, material or biological state, environment, intervention version, scale, and time horizon relevant to the claim. A study may generalise well to one target and poorly to another. Generalisability is therefore relational, not an intrinsic property of an experiment.

3. Effect modification

A variable is an effect modifier for a chosen effect measure when the causal effect differs across its levels. If effect modifiers are distributed differently in the study and target populations, the average effect can differ even when the causal mechanism is unchanged. Generalisation therefore depends on measuring or otherwise accounting for effect modifiers relevant to the target contrast. The set is claim- and measure-specific; it should not be reduced to a generic demographic checklist [4].

4. Support and positivity

Generalisation becomes fragile when target states have little or no representation in the study. Statistical reweighting can align distributions only where sufficient support exists. If a target subgroup, environmental regime or scale is absent, the inference becomes extrapolative and depends more heavily on structural modelling assumptions. A precise model prediction in an unsupported region is not equivalent to empirical validation in that region.

5. Transportability

Transportability concerns extending causal or scientific conclusions across populations or environments whose distributions or mechanisms may differ. Causal diagrams can make the required invariance assumptions explicit [3]. The key question is which relationships can reasonably be treated as stable and which must be re-estimated in the target. The answer cannot be inferred from similarity of labels alone.

6. Scale, time and process history

Generalisation is not restricted to human populations. In materials and physical experiments, scale, specimen geometry, boundary conditions, process history and environmental exposure can alter the relative importance of mechanisms. HEB-012 owns the diagnostic problem of hidden scale dependence and HEB-015 owns procedural transfer failure. INF-012 uses those lessons constructively: a target claim must specify the state space into which inference is being extended and identify the variables expected to alter the result.

7. Procedural replication is not enough

Repeating the same procedure in a new setting tests whether the procedure can be reproduced there. It does not by itself show that the same target effect or mechanism applies if populations, equipment, boundary conditions, material states or

relevant moderators differ. External validity requires a model of why differences between study and target do or do not matter.

8. Minimum generalisation checklist

- Define the target population or system explicitly.
- State the study-to-target differences that could modify the claimed effect or relationship.
- Identify measured effect modifiers and justify why they are sufficient for the proposed bridge.
- Check overlap/support before weighting or model-based transport.
- Separate interpolation within represented states from extrapolation beyond observed support.
- Report residual target uncertainty rather than presenting transported estimates as direct observations.

References

- [1] Dahabreh, I.J.; Robertson, S.E.; Tchetgen Tchetgen, E.J.; Stuart, E.A.; Hernán, M.A. Generalizing causal inferences from individuals in randomized trials to all trial-eligible individuals. *Biometrics* 75(2), 685-694 (2019). DOI: 10.1111/biom.13009.
- [2] Dahabreh, I.J.; Robertson, S.E.; Steingrimsson, J.A.; Stuart, E.A.; Hernán, M.A. Extending inferences from a randomized trial to a new target population. *Statistics in Medicine* 39(14), 1999-2014 (2020). DOI: 10.1002/sim.8426.
- [3] Pearl, J. *Causality: Models, Reasoning, and Inference*. 2nd ed. Cambridge University Press, 2009. DOI: 10.1017/CBO9780511803161.
- [4] Hernán, M.A.; Robins, J.M. *Causal Inference: What If*. Boca Raton: Chapman & Hall/CRC, 2020. DOI: 10.1201/9781315374932.

Data and materials statement

No new experimental dataset was generated for this article. The article is a methodological analysis based on the cited literature and the frozen ownership architecture of the INF series.