FROM THE RESEARCH BENCH

What is interference? When one unit changes another unit's outcome

Interference occurs when one unit’s outcome depends on another unit’s treatment. Define exposure, groups, and estimands before reading spillover.

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MANAGEMENT SUMMARY

Interference occurs when one unit's potential outcome can depend on treatment assigned to another unit. It challenges the no-interference part of the stable-unit-treatment-value assumption and changes which causal comparison is meaningful. Hudgens and Halloran distinguish direct, indirect, total, and overall effects under interference-aware treatment designs. This article translates that boundary into a synthetic exposure ledger with own assignment, other-unit assignment, exposure mapping, outcome window, and estimand. The ledger and commercial examples are author synthesis. They do not establish that proximity means exposure, supply a spillover rate, determine a universal bias direction, or show that a current campaign, territory, account, or network experienced an uplift.

Keywords: Interference · Spillover Effect · SUTVA · Direct Effect · Indirect Effect · Network Interference

A treatment can be assigned to one account and still reach another. A message can circulate through a buying committee. A territory intervention can change a competitor's response. A cluster-level program can alter every unit's environment. If the outcome of one unit depends on treatment assigned elsewhere, the individual comparison is no longer an isolated one.

Interference occurs when one unit's outcome depends on another unit's treatment or exposure. It is a change to the causal question, not a synonym for positive spillover.

The incrementality article owns the counterfactual boundary for a treatment effect. This page owns the condition in which units are connected and the counterfactual must include more than one assignment.

What does interference mean?

Many causal designs write a unit's potential outcome as if only its own treatment mattered. That is a useful simplification when it is credible. Hudgens and Halloran develop estimands for settings where the no-interference assumption fails. They distinguish direct, indirect, total, and overall effects and show that the treatment design and group structure determine which comparison is being estimated (Hudgens & Halloran, 2008).

The practical question is not "Are these units near each other?" It is:

1. Which units can affect one another?
2. Which treatment combinations can occur?
3. What exposure does each combination create?
4. Which outcome window can contain the effect?
5. Which estimand matches the decision?

SUTVA is often used as shorthand for stable treatment values and no interference in a declared setup. The shorthand is not a substitute for the setup. A network, cluster, territory, account, or household needs its own unit and exposure definition.

What are direct, indirect, total, and overall effects?

Keep the estimands apart:

Table 1 What are direct, indirect, total, and overall effects?

Effect	What changes	Decision question
Direct effect	A unit's own treatment, holding the relevant other-unit exposure condition fixed	What happened to this unit because its assignment changed?
Indirect effect	Treatment assigned to other units, with own treatment held in the declared condition	What happened to this unit because connected units were treated?
Total effect	Own and other-unit treatment together under the declared design	What is the combined effect for a unit in the group?
Overall effect	Population-level outcome under alternative assignment mechanisms	What changes for the population when the program is assigned differently?

Table from this essay. Sources and interpretation are given in the article.

The same treatment label can therefore name different objects. Individual assignment, cluster assignment, and network exposure are not interchangeable simply because the intervention is called "the same."

What does an exposure map do?

An exposure mapping translates own and other-unit assignments into the exposure condition used by the analysis. For a simple group, it might distinguish untreated, own treatment only, neighbor treatment only, and both treated. For a network, it might use links, distance, dosage, or a threshold. The map is a declared model choice. It is not discovered automatically from a proximity label.

A nearby account can remain unexposed if the message did not reach its decision-makers. A distant unit can be exposed through a shared buying committee or a common sales representative. Proximity is a candidate mechanism, not an exposure measurement.

What does an interference ledger look like?

The six rows below are synthetic. They contain no campaign, territory, customer, or network outcome data.

Figure 1 The synthetic interference exposure ledger

ID	Unit and group	Own assignment	Other-unit assignment	Exposure rule	Outcome window	Estimand
I-01	Account A in buying group G1	Treated	No other treatment	Own message delivered; no group exposure	14 days	Direct effect
I-02	Account B in buying group G1	Untreated	Account A treated	Shared decision-maker receives message	14 days	Indirect effect
I-03	Account C in territory T1	Treated	Neighboring accounts treated	Territory saturation above declared threshold	30 days	Total effect
I-04	Account D in territory T2	Untreated	No neighboring treatment	No exposure map condition met	30 days	Comparison under design
I-05	Member E in cluster K1	Untreated	Cluster K1 treated	Cluster assignment defines exposure	60 days	Overall effect under cluster assignment
I-06	Account F in network N1	Treated	One linked node treated	One-hop link exposure; link timestamp recorded	21 days	Direct effect conditional on exposure

Author's synthetic exposure ledger grounded in Hudgens and Halloran (2008). Assignments, exposure rules, windows, and estimands are illustrative; no commercial outcome is represented.

I-02 is not an untreated control in the simple sense if the shared decision-maker receives the treatment. I-03 is not the same estimand as I-01 because the surrounding assignment changes. I-05 is evaluated at the cluster assignment level. I-06 requires a link definition and timestamp, not only an account ID.

Is interference the same as contamination?

Contamination describes treatment crossing an intended boundary. Spillover describes an outcome pathway through another unit’s treatment or exposure. Network interference describes a structure of connected units. A cluster design may intentionally assign a shared environment. These terms can describe related mechanisms, but they do not name the same estimand.

Interference is also not a guaranteed bias direction. If treatment spreads beneficial information, a no-interference analysis may understate a program-level effect. If treatment creates competition or substitution, it may overstate an isolated-unit effect. The sign belongs to the exposure and outcome model.

How should a team review a connected test?

1. Declare the unit, group or network, treatment, comparator, and outcome.
2. List the other units whose assignment could affect the outcome.
3. Record own and other-unit assignments with timestamps.
4. Define the exposure map before inspecting the outcome.
5. Choose direct, indirect, total, or overall effect to match the decision.
6. Report the outcome window and any units whose exposure is unknown.
7. Use a cluster or network design, sensitivity analysis, or narrower claim when the simple comparison cannot carry the intended estimand.

Hudgens and Halloran's contribution is a discipline of specification. The paper does not tell a sales team that every connected account interferes, and this page does not estimate a commercial effect. Interference means the counterfactual must include the relevant other-unit assignment. The first task is to map that exposure, not to label the spillover good or bad.

The selection-bias article addresses the different problem created when entry into the comparison set is selective.

Hudgens, M. G., & Halloran, M. E. (2008). Toward causal inference with interference. Journal of the American Statistical Association, 103(482), 832-842. https://doi.org/10.1198/016214508000000292

END OF ESSAY

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