Research Methodology

Measurement Errors

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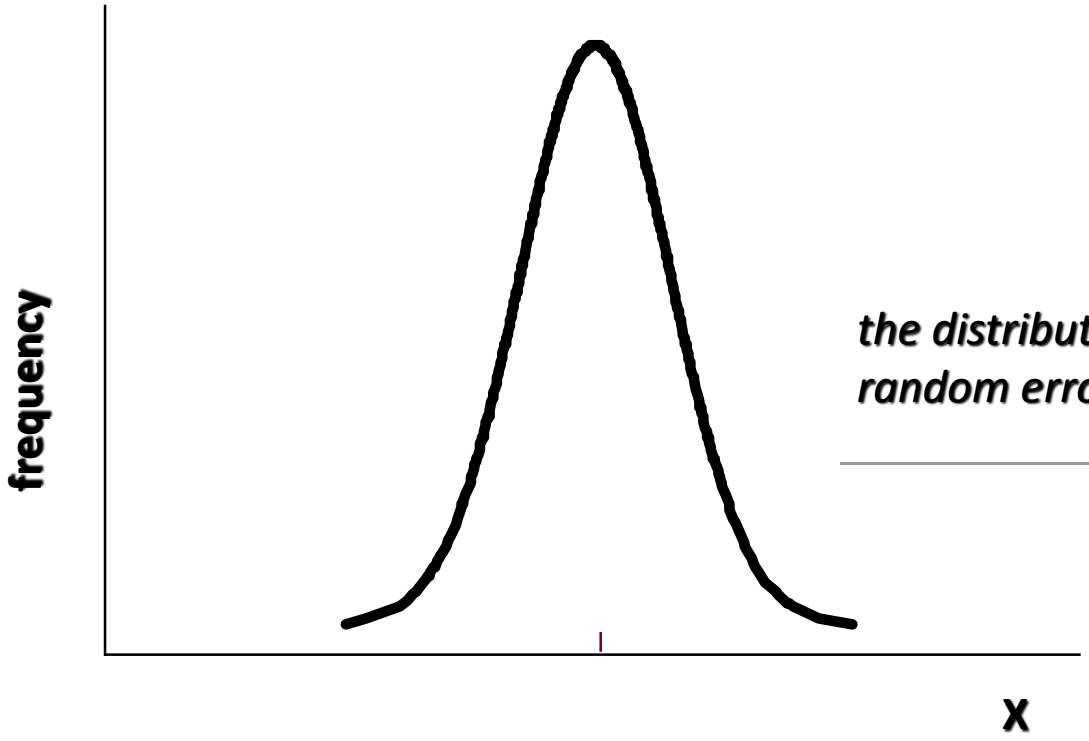
Measurement Error

Errors in Research

Systematic	Random	Confounding
• Cause in: Invalidity & Spurious association	• Cause in: unreliability & Diluted association	Cause in: a relationship but not causal association

Random Error

Deviations from the true value that occur in a random chance pattern



the distribution of X with no random error

Random Error

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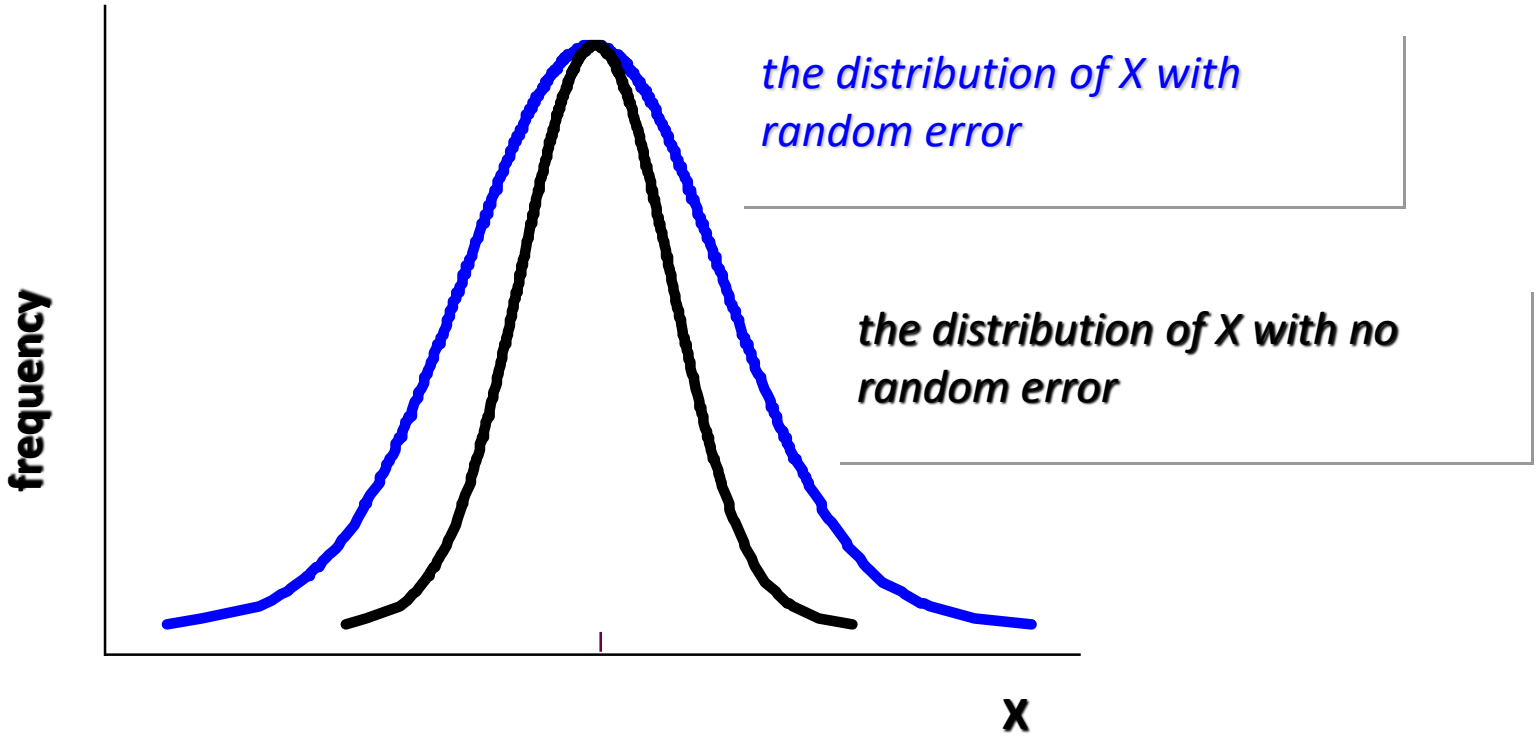

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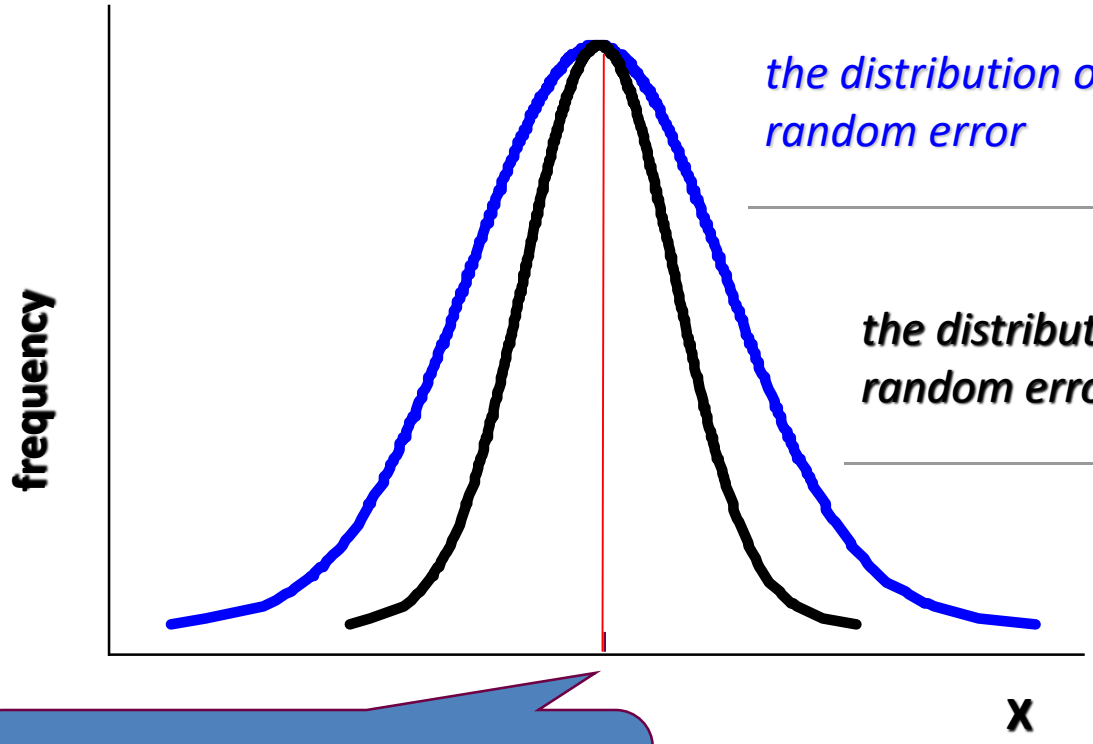
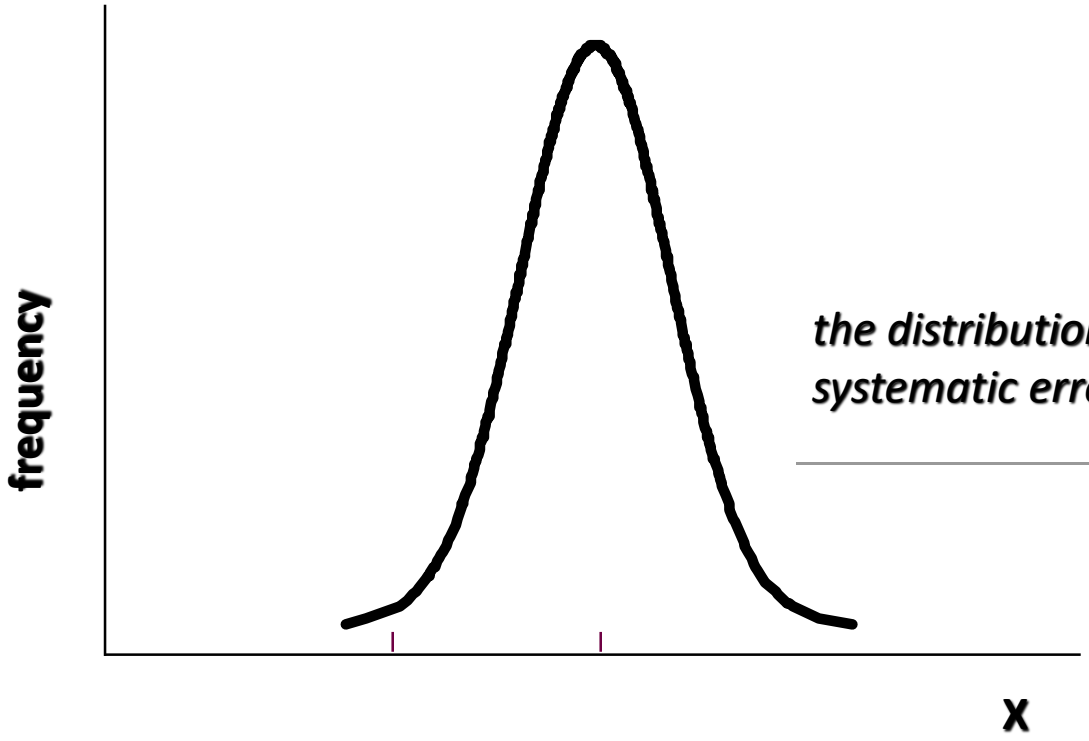


Notice that random error doesn't affect the average, only the variability around the average

Systematic Error

Any process at any stage of inference which tends to produce results or conclusions that differ systematically from the truth



the distribution of X with no systematic error

Systematic Error

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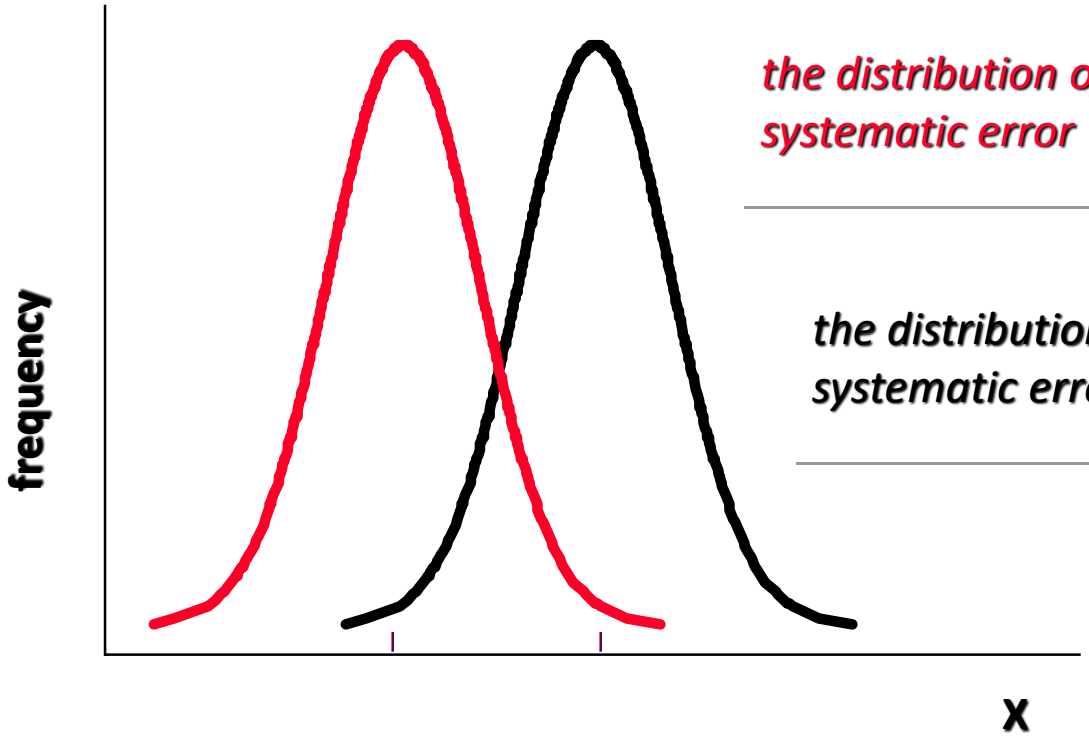

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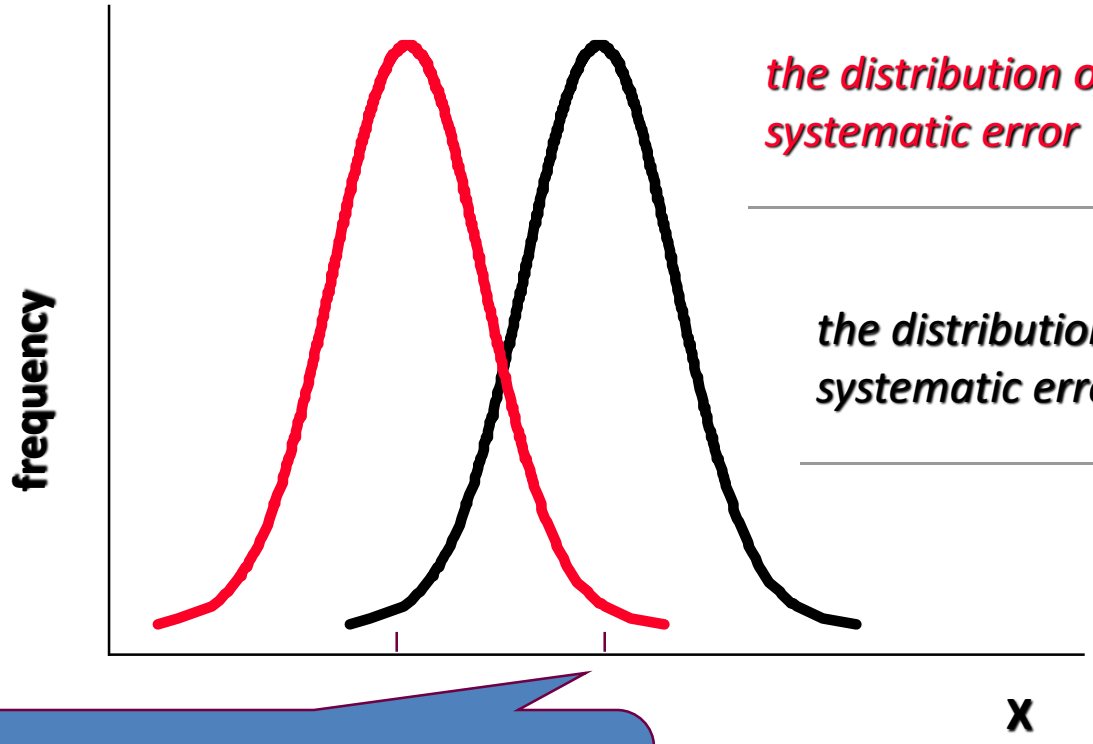
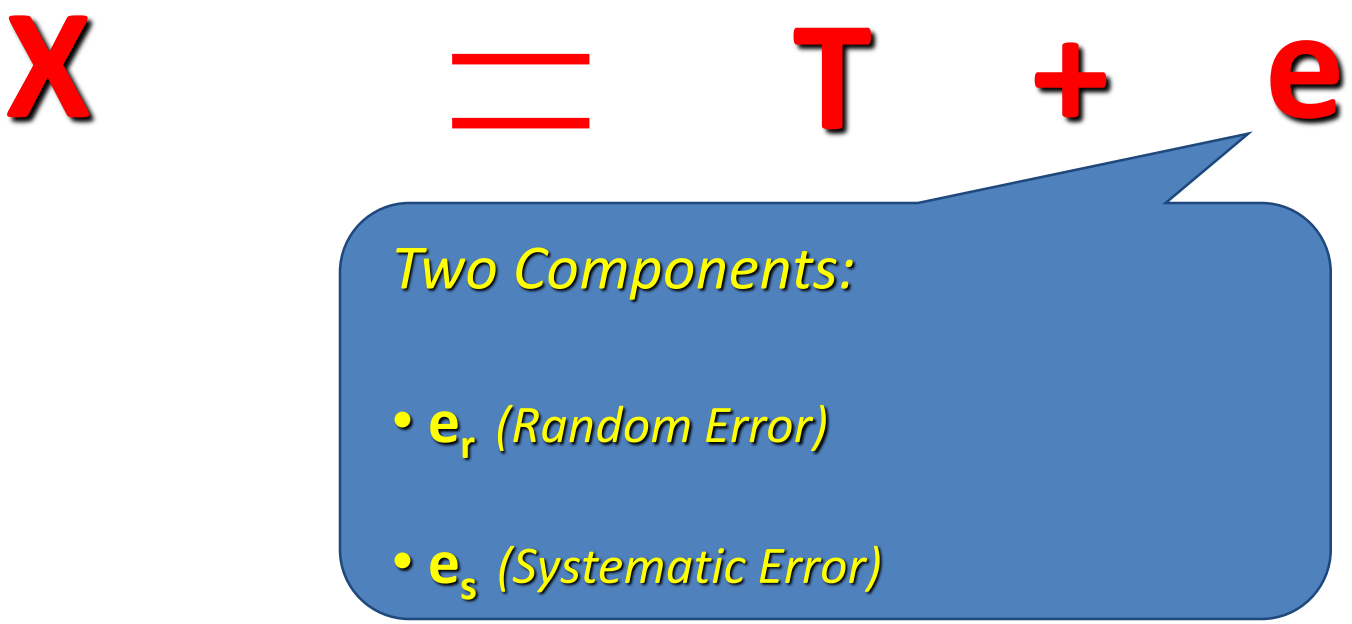


the distribution of X with systematic error

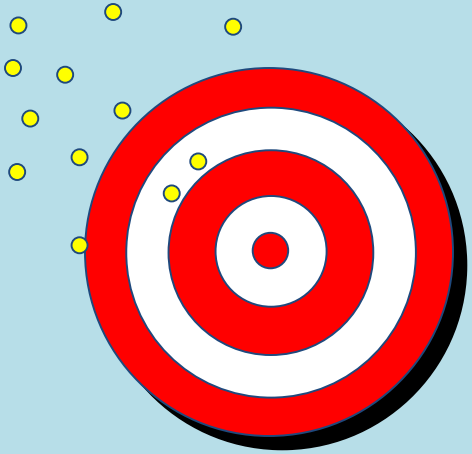
the distribution of X with no systematic error

Notice that systematic error does affect the average -- we call this a bias

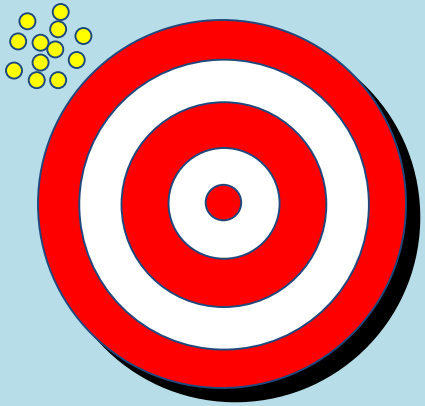
The Error Component



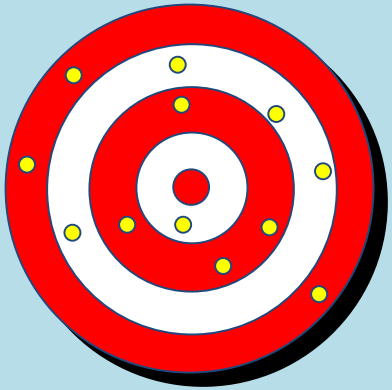
RELIABILITY AND VALIDITY



Not reliable
Biased (Not valid)



Reliable
Biased (Not valid)



Not reliable
Somehow valid

Reliable
Valid

In Random error measurement is not reliable.

In Systematic error measurement is biased (not valid).

Errors in Research

Systematic	Random	Confounding
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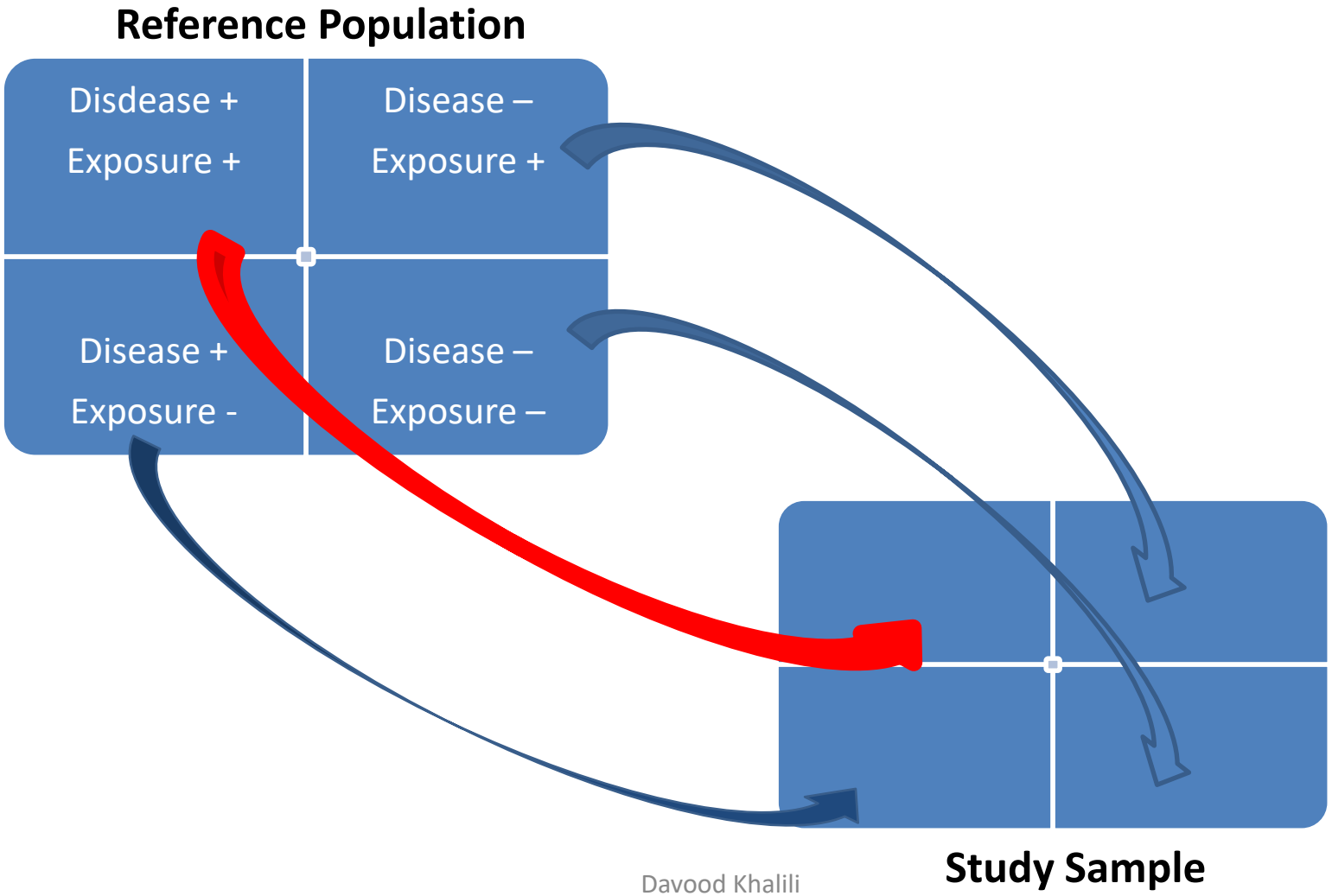
Selection Bias

the way in which cases and controls, or exposed and nonexposed individuals, are selected such that an apparent association is observed



Selection Bias

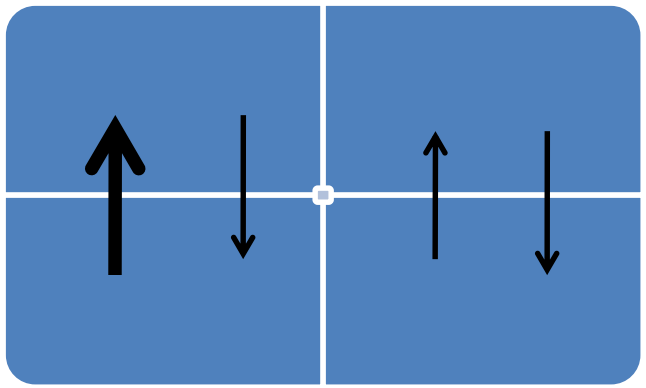
- Non-response Bias
- Exclusion Bias
- Berksonian Bias
- Healthy worker effect
- Differential losses to follow-up

Information Bias

a systematic tendency for individuals selected for inclusion in the study to be erroneously placed in different exposure/outcome categories, thus leading to *misclassification.*

Reference Population

Disdease + Exposure +	Disease – Exposure +
Disease + Exposure -	Disease – Exposure –



Study Sample

Information Bias

- **Exposure Identification Bias:**

  - **Recall Bias**

  - **Interviewer Bias**

- **Outcome Identification Bias:**.

  - **Observer Bias**

  - **Respondent Bias**

- Systematic errors nearly always cannot be corrected.

- Sometimes they can be estimated using some advanced epidemiological methods.

Errors in Research

Systematic	Random	Confounding
• Cause in: Invalidity & Spurious association	• Cause in: unreliability & Diluted association	Cause in: a relationship but not causal association

- Random errors almost always cannot be corrected.

- Routinely, they are estimated using statistical methods (i.e. Confidence Interval and p-value)

(Background)

Errors in Research

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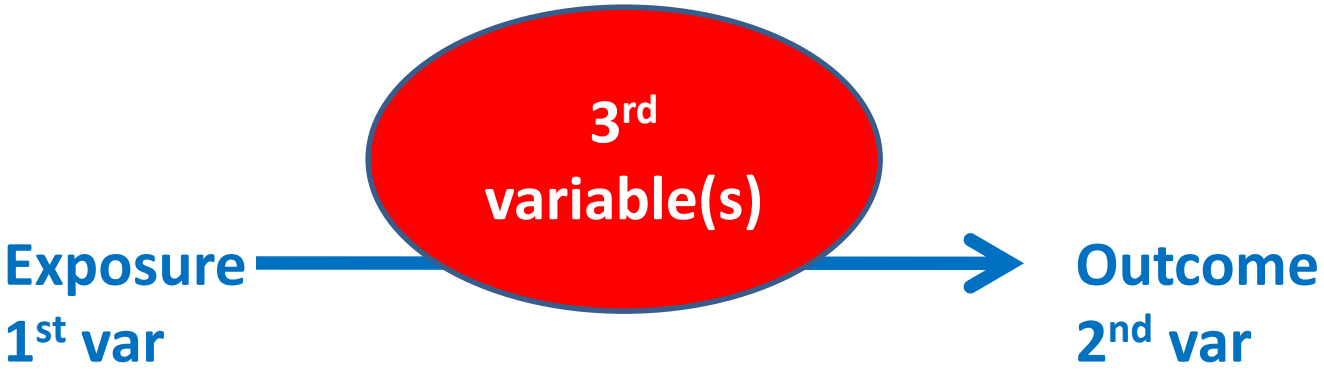
Considering

3rd Factor(s)

in Causality



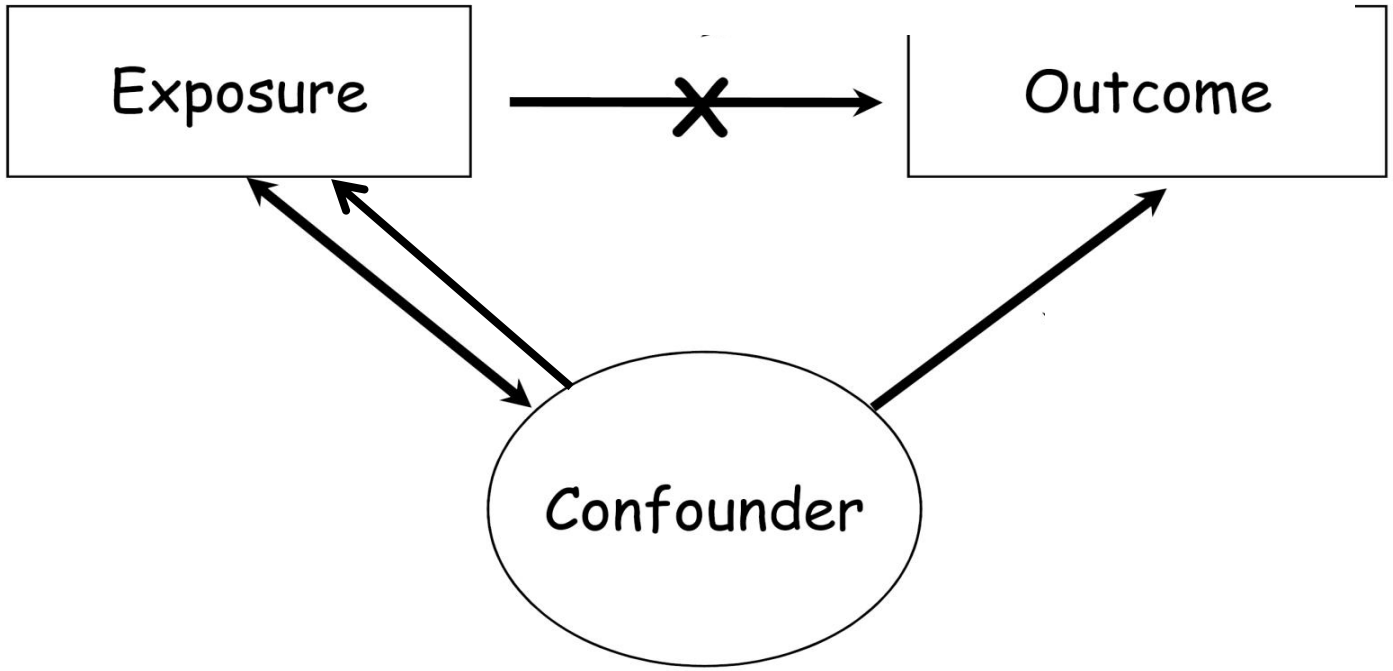
Kinds of RELATIONSHIPS OF 3rd VARIABLE(S) IN RESEARCH

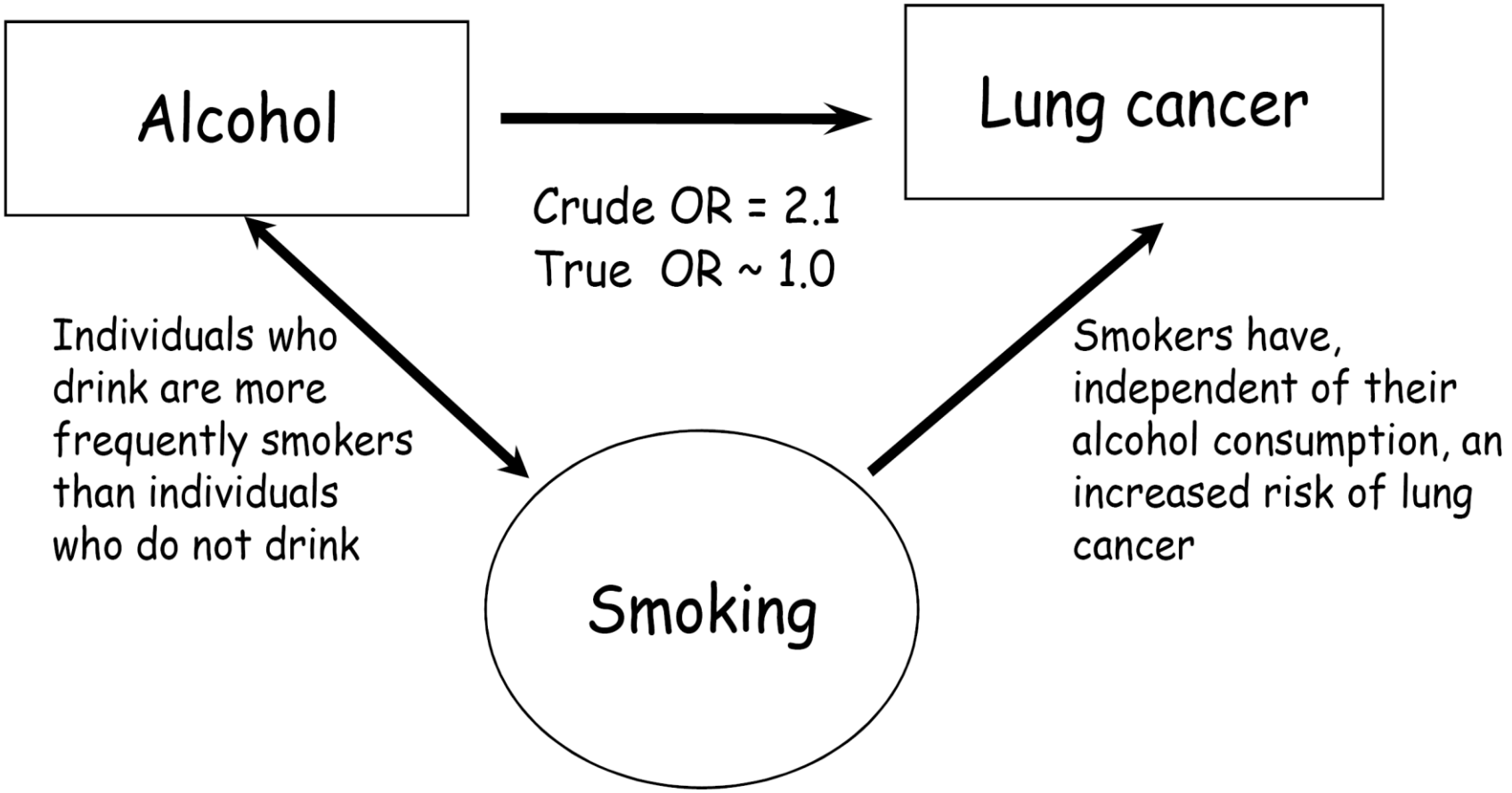
- ❑ CONFOUNDING
- ✓ MEDIATION
- ✓ COLLINEARITY

- ❑ EFFECT MODIFICATION
  (INTERACTION OR MODERATION)

CONFOUNDING

A confusion of effect




Alcohol
Lung cancer
Crude OR = 2.1
True OR ~ 1.0
Individuals who drink are more frequently smokers than individuals who do not drink
Smokers have, independent of their alcohol consumption, an increased risk of lung cancer
Smoking

Control of confounding

IN DESIGN

- Randomization
- Restriction
- Matching

IN ANALYSIS

- Standardization
- Stratification
- Multivariate analysis

The most applicable method