

# Within and Between Independent Sampling Unit Factors

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## Learning Objectives

Define between-independent sampling unit factors.

Define within-independent sampling unit factors.

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## Many kinds of factors

A factor is a dimension of the study on which the observations vary.

Factor values define scales which are **categorical** (Drug A vs Drug B), **ordinal** (spinal cord, cerebellum) **interval** (degrees centigrade), or **ratio** (degrees Kelvin).

Interval and ratio are grouped as **continuous**.

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**Review of the concept of an independent sampling unit**

**(ISU)** An independent sampling unit

has observations which are statistically independent from observations from any other unit.

p. 101, Muller and Stewart, 2006

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**A longitudinal study is a good example of within- and between-independent sampling unit factors**

**Within-independent sampling unit factors** are values which vary within independent sampling units.

**Between-independent sampling unit factors** occur at different levels, for each independent sampling unit as a whole.

Bray and Maxwell, 1985  
Doncaster and Davey, 2007

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**Examples: within-independent sampling unit factors may be any scale**

Variable over **time**: Measurements of distance walked per day over one month

Variable over **space**: Measurements of blood vessel diameter at three distances from the heart

Variable over **location**: Measurements of each digit of the hand

Nominal, ordinal, or continuous scales?

Bray and Maxwell, 1985  
Doncaster and Davey, 2007

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**Between-independent sampling unit factors vary between groups.**

Examples:

Treatment: Drug, Placebo

Education: Pre-school, Grade School, High School

Drug Dose: 0, 5mg/kg, 10mg/kg

Bray, James H. and Scott E. Maxwell  
Doncaster, C. Patrick and Andrew J. H. Davey

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**Researchers further classify factors to identify the source of variation**

**Observational factors:** pre-existing factors which are naturally-occurring

**Interventional factors:** factors which are introduced by experimental design

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**Researchers classify study designs based on their inclusion of between and within-ISU factors**

Pure within-ISU factor design

Pure between-ISU factor design

Between-by-within ISU factor design

Note: ISU = Independent sampling unit

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**Pure within-ISU factor design**

Consider a cross-over design comparing drug A and drug B.

Half of the participants receive drug A, then a washout period, then drug B.

Half of the participants receive drug B, then a washout period, then drug A.

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**Pure between-ISU factor design**

Randomly assign participants to receive either drug A only or drug B only.

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**Between-by-within ISU factor design**

Randomly assign participants to receive either drug A alone, or drug B alone.

Measure the participant once per week for five weeks.

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**Pure within-ISU designs can include observational or interventional factors**

Example: Observational, within-ISU factors

Sample	Women (N=100)
# Study conditions	None
# Measurements	3 per woman
Between-ISU factor	None
Within-ISU factor	Time

Note: ISU = Independent sampling unit

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**Pure within-ISU designs can include observational or interventional factors**

Example: Interventional, within-ISU factors

Sample	Women (N=100)
# Study conditions	3 (Treatments A, B, C)
# Measurements	3 (A, B, C)
Between-ISU factor	None
Within-ISU factor	Treatment

Note: ISU = Independent sampling unit

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**Similarly, pure between-ISU designs can include observational or interventional factors**

Example: Observational, between-ISU factor

Sample	Men (N=100) Women (N=100)
# Study conditions	None
# Measurements	1 per participant
Between-ISU factor	Gender
Within-ISU factor	None

Note: ISU = Independent sampling unit

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Similarly, **pure between-ISU designs** can include **observational or interventional factors**

Example: Interventional, between-ISU factor

Sample	Coloradans (N=200)
# Study conditions	2 (Treatments A, B)
# Measurements	1 per participant
Between-ISU factor	Treatment
Within-ISU factor	None

Note: ISU = Independent sampling unit

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**Between-by-within independent sampling unit designs are common**

Inclusion of **both** between and within-independent sampling unit factors allows investigators to answer more complex research questions about the **pattern** of response to treatment over a factor (such as time) within an independent sampling unit.

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**We consider how between and within-ISU factors shaped the following longitudinal studies:**

1. An observational longitudinal study
2. An interventional longitudinal study

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**1. Consider the following observational longitudinal study**

**Vignette 1**

Researchers planned a nine month, longitudinal study reducing pain in root canal patients. Investigators wanted to know whether it was equally effective in men and women.

Hypothetical extension of Logan et al., 1995

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**Vignette 1**

A sample of 50 men and 50 women agreed to participate in the study. Each participant required a root canal. Patients were asked to report pain experienced at months 3, 6, 9, and 12 following the procedure.

\*Hypothetical extension of Logan et al., 1995

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**Vignette 1**

Researchers wanted to test the effects of gender and time.

\*Hypothetical extension of Logan et al., 1995

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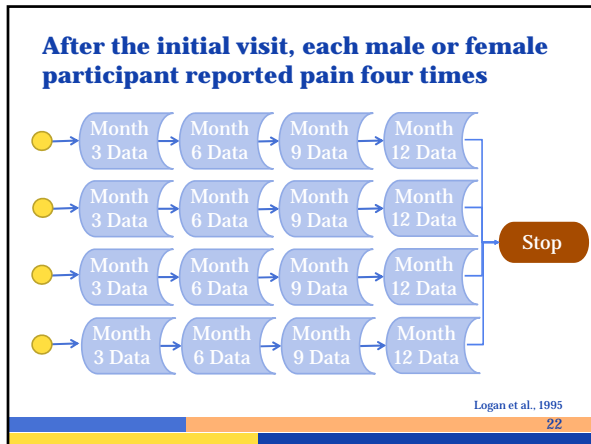
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**Analysis evaluated differences in pain experience associated with the within-ISU factor time.**

Within-ISU analysis evaluated differences over time.

Note: ISU = Independent sampling unit

\*Hypothetical extension of Logan et al., 1995

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**Analysis evaluated differences in pain experience associated with the between participant factor in the study**

Between-ISU analysis compared average pain reported in females to pain reported in males.

\*Hypothetical extension of Logan et al., 1995

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**Analysis evaluated differences in pattern of pain over time due to gender.**

Between-by-within ISU analysis compared the pattern of patients' pain over time (gender-by-time interaction).

\*Hypothetical extension of Logan et al., 1995

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**2. Consider the following interventional longitudinal study**

Participants were selected and randomly assigned to either intervention or no intervention.

Logan et al., 1995

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**Vignette 2**

Patients in the **intervention group** listened to automated audio instructions to pay close attention only to the physical sensations in their mouth.

Patients in the **no intervention group** listened to automated audio instruction on a neutral topic to control for media and attention effects.

Logan et al., 1995

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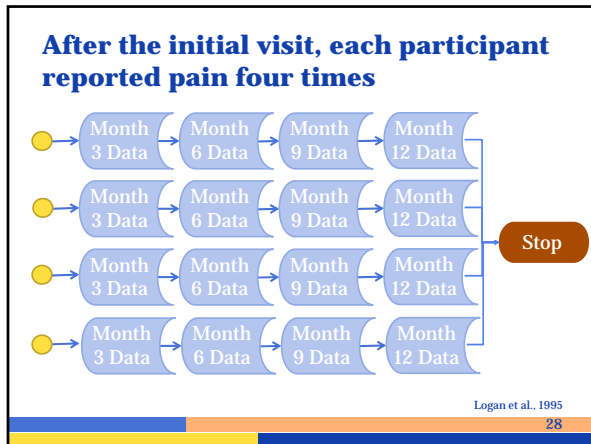
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**Analysis evaluated differences in pain experience associated with each of the study's ISU factors**

**Within-person factors** were used to compare the pattern of pain over time.

**Between-person factors** were used to compare mean pain reported in the sensory focus treatment to mean pain reported in the standard-of-care treatment group.

Logan et al., 1995  
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**Both studies used repeated measures, but their between-ISU factors differed**

Feature	Interventional	Observational
Sample	General population (N=100)	Men (N=50) Women (N=50)
# study conditions	2 (Sensory focus, standard of care)	None
# measurements	4 per participant	4 per participant
Between-ISU factor	Treatment	Gender
Within-ISU factor	Time	Time

Note: ISU = Independent sampling unit

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**REVIEW OF LEARNING OBJECTIVES**

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**Indicate whether the following scenarios define between- or within-factors**

We measure the height of each individual participant at ages 8, 12 and 16.

**BETWEEN**      **WITHIN**

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**Indicate whether the following scenarios define between- or within-factors**

We compute the average height for males and females.

**BETWEEN**      **WITHIN**

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