

# EMA Sampling Designs

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# Diary Study Design

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- Overall study design
  - Subject samples, groups, interventions, etc.
- Diary design
  - Focus of assessment
  - Assessment frequency
  - Sampling considerations
  - Triggering diary completion
- Fitting diary design to the research question

# Research Hypotheses

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- Between-subject:
  - Treatment, individual differences
  - Representative, reliable estimation of aggregate
- Within-subject:
  - Often most interested in flow *over time*
  - Natural history, events, correlated processes, interventions
  - Sampling time and contexts, within-person variability
- Interactions

# Targets of Interest & Assessment

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- Discrete events
  - Symptoms: Asthma attacks, vomiting
  - Behaviors: Smoking, eating
  - External events: Social interaction, treatment episode, medication
- Continuous quantity
  - Symptom intensity: Pain, nausea, etc.
  - Psychological state: Mood, self-efficacy

# Sampling Designs

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- Event-based
  - Self-monitoring (e.g., headaches)
- Time-based
  - Fixed time
    - Diary (e.g., every 4 hours, daily)
  - Varying (random) time
    - Experience Sampling Method (e.g., random sampling)

# Event Examples

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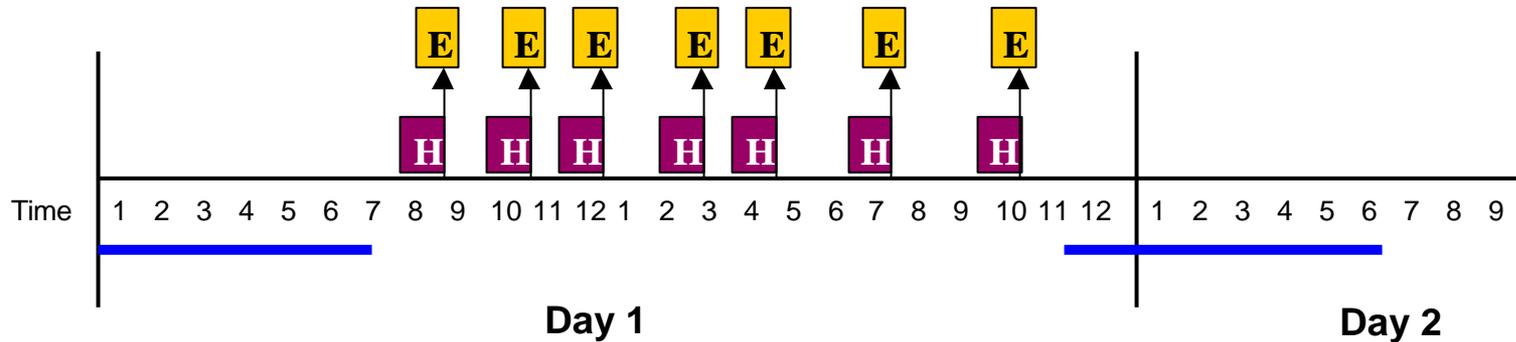
- Asthma attack
- Headache
- Treatment occasion
- Pain exacerbation
- Temptation to eat
- Social interaction
- Eating a meal
- Drinking alcohol
- Sexual intercourse
- Smoking a cigarette
- Taking medication
- Vomiting
- Performing coping

# Purposes

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- Count / frequency
- Description, context
- Antecedents
- Associations
  - Base rate problem
  - Case control designs

# Event-Based



KEY:

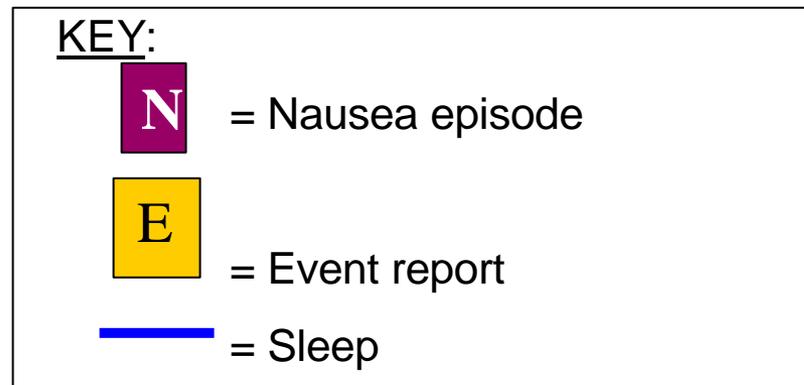
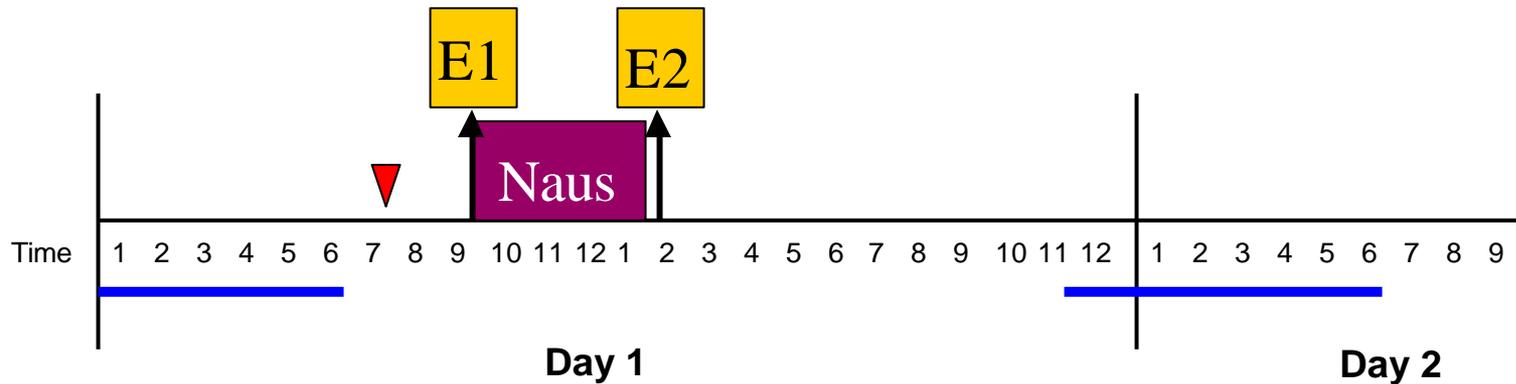
 = Hot flash episode

 = Event report

 = Sleep

- Example:
  - Hot flashes

# Event-Based



- Example:
  - Nausea

# Event Sampling Considerations

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- Frequency
  - Very low: consider daily or less frequent
  - Moderate: event-based reporting
  - Very high:
    - Use Time-based sampling to capture recalled occurrence / frequency
    - Sample events for assessment

# Assessing Events

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- Recording vs. Assessing
  - Assessment increases burden
- Sampling of events for assessment
  - Reducing overall burden
  - Equalizing burden across subjects with differing frequency
  - Sampling schema
    - Random
    - Attribute-based
    - Stratified
  - Sampling rates; higher rates =
    - Precision of estimates
    - Relevant events

# Event Sampling Issues

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- Defining the event
  - Operational definition
  - Thresholds: intensity, duration
  - Device-triggered events (e.g., ischemia)
- When to report
  - Beginning (reactivity, definition)
  - End (recall, forgetting, definition)
  - Both: change, duration
- Difficult to estimate under-reporting, missed episodes
- Possible biases in detection / reporting
  - Intensity, duration
  - Timing and context
- Monitoring for unique events (first lapse)

# Continuous Assessment Targets

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- Pain
- Craving
- Nausea
- Self-efficacy
- Motivation
- Mood
- Thought content
- Guilt
- Cognitive performance
- Fatigue

# Time-Based Strategies

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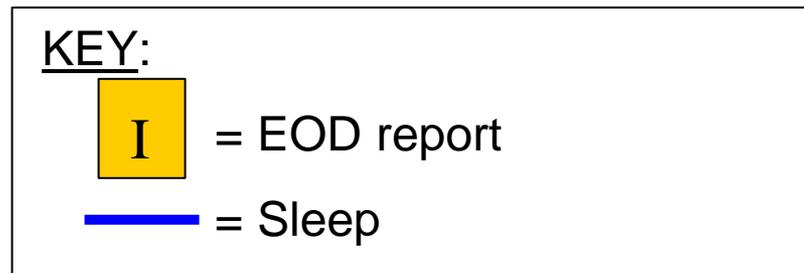
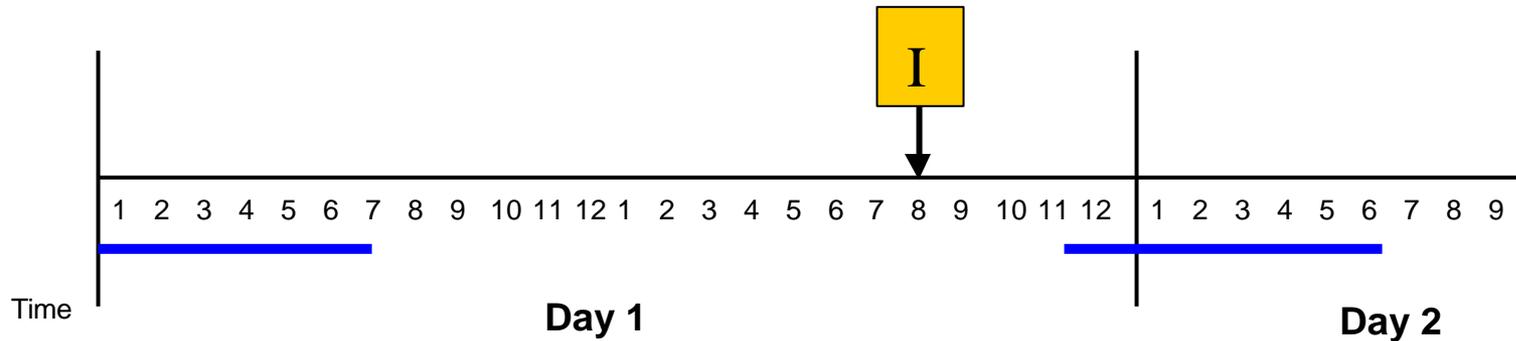
## Fixed intervals

- Regular
- Complete coverage
- Recall
- Triggered by clock or milestone
- Traditional diary

## Varied intervals

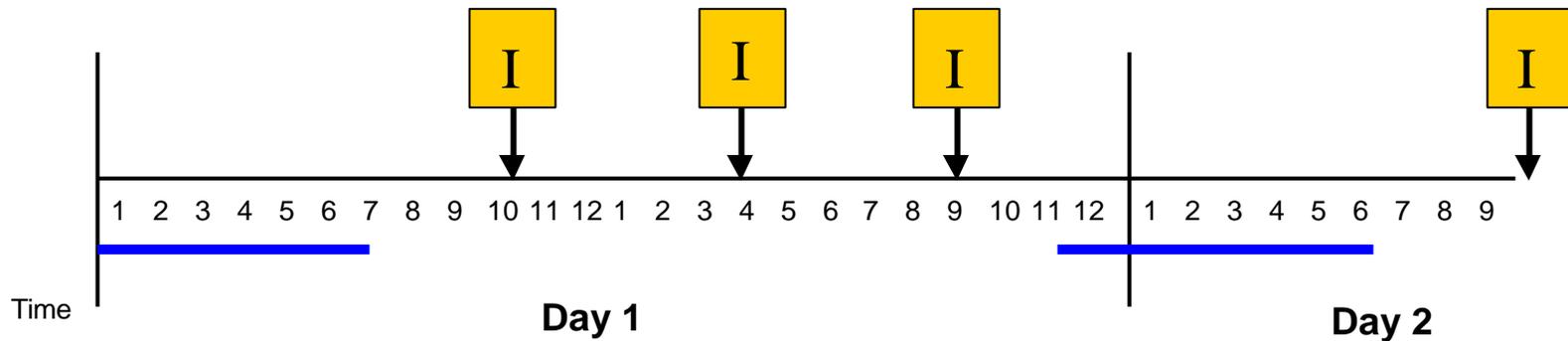
- Random
- Sampling
- Momentary
- Triggered by signal
- Experience  
Sampling Method

# Fixed Interval: Daily



- Example:
  - Consumption of fruits and vegetables; sun exposure; pain; nausea; fatigue

# Fixed Interval: > Daily



KEY:



= Interval-based report

 = Sleep

- Example:
  - Morning/afternoon/evening experience or symptoms: fruits & veggies; sun exposure; pain; nausea; fatigue

# Fixed-Interval Issues

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- Prompting assessments
  - Clock
  - Milestone (“bedtime”)
  - Active prompts
- Specificity of target time or window
  - “Evening”, “Bedtime”
  - 6 p.m. ( $\pm$  10 minutes)
- Potential bias in timing

# Fixed Interval

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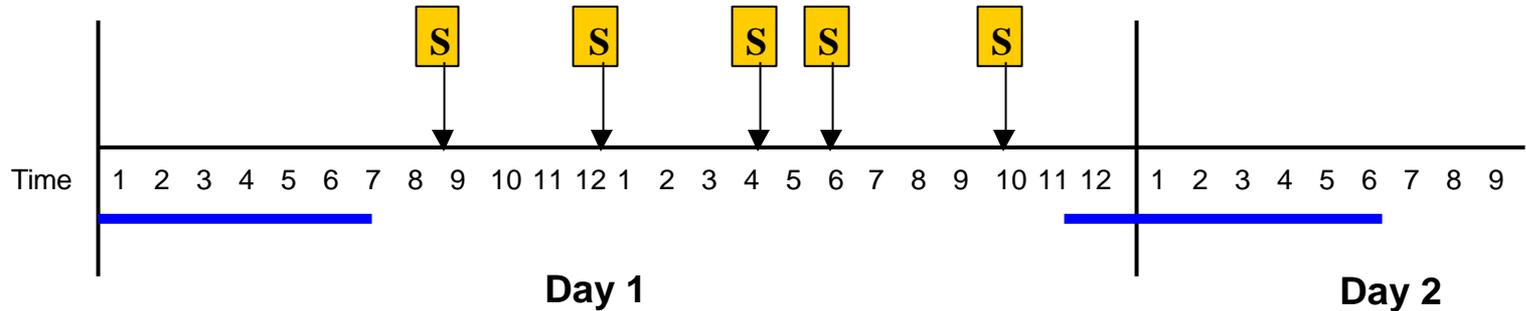
- Predictable demand
- May not be representative; may become entrained to daily rhythms
- Facilitates some types of analyses
- Typically relies on recall
- Inflexible to variations or changes in sleep/work schedule

# Variable Intervals

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- Typically random time-sampling
  - Claim to representativeness
  - Sampling schemes
- Requires devices to handle:
  - Scheduling
  - Prompting

# Signal-Contingent



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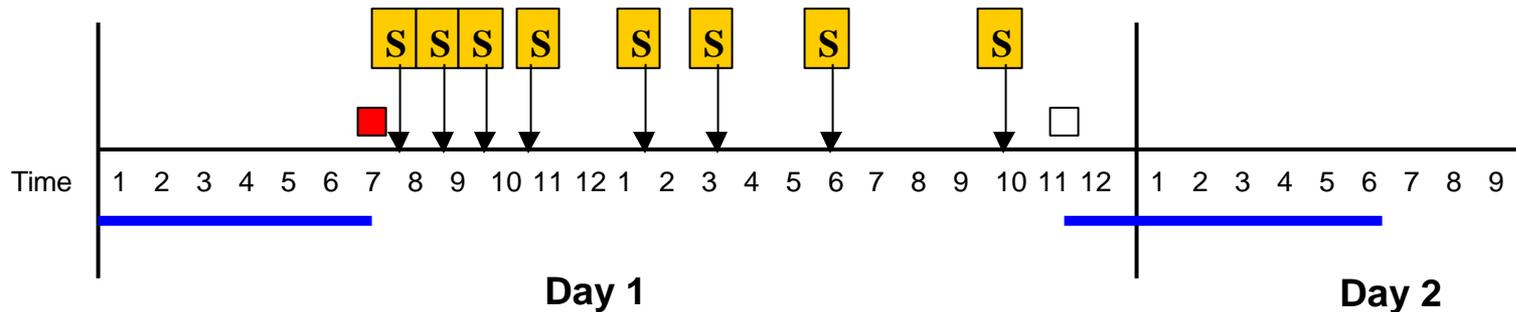
= Signal-based pain report



= Sleep

- Example:
  - Pain; nausea; fatigue; tobacco craving

# Signal Contingent: Over-Sampling



## KEY:

 = Signal-based craving report

  = Patch on / off

 = Sleep

## ● Example:

- Sampling tobacco cigarette craving on 16- or 24-hr nicotine patch
  - Random prompts ~8x/day

# Random Time Sampling

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- Arguably representative
  - May allow full 24/7 coverage
- Variations in sampling plans
  - Stratified sampling ensures better coverage
  - Weighted sampling, based on distribution of phenomenon
- Prompting
  - Device and subject issues
  - Need to provide time-out's
  - Prompting duration & window

# Time-Based Sampling Issues

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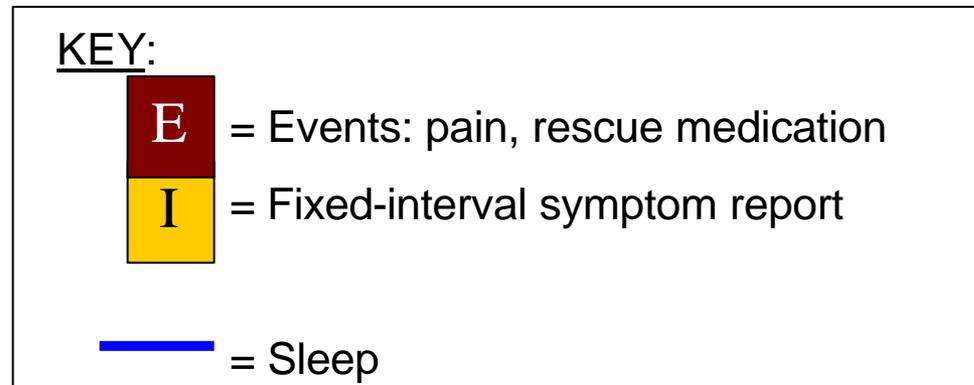
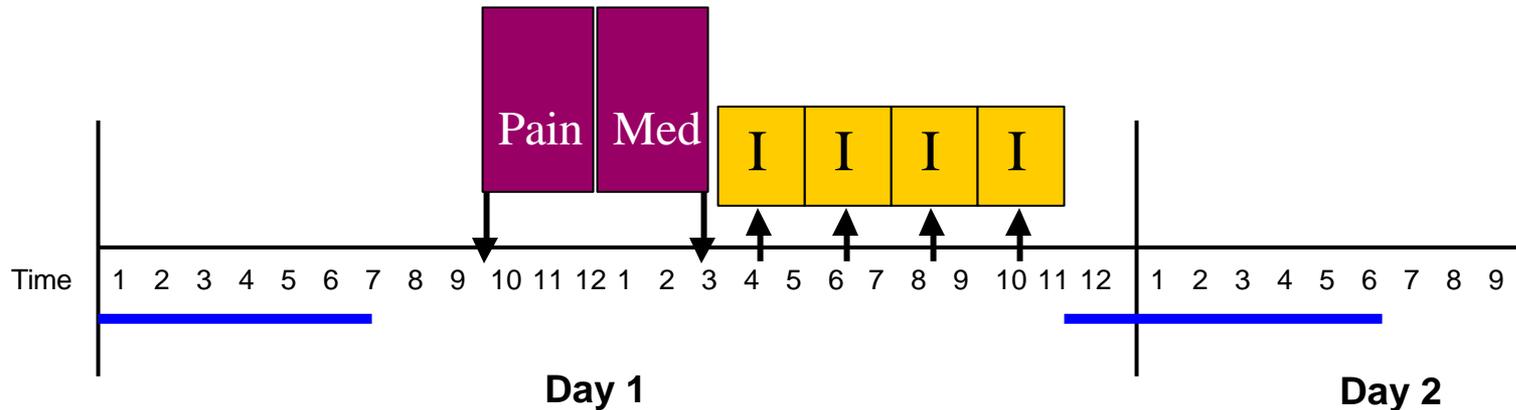
- Recall interval
  - Complete (“since last assessment”)
  - Partial (“last 30 minutes”)
  - Momentary (“right now”)
- Assessment frequency / density
  - Match to expected “time-base” and trajectory of target
  - Frequent assessments can
    - Diminish recall interval
    - Provide more detailed data and time-line
    - Increase precision of estimates
    - Increase subject burden, possibly decrease compliance

# Mix & Match

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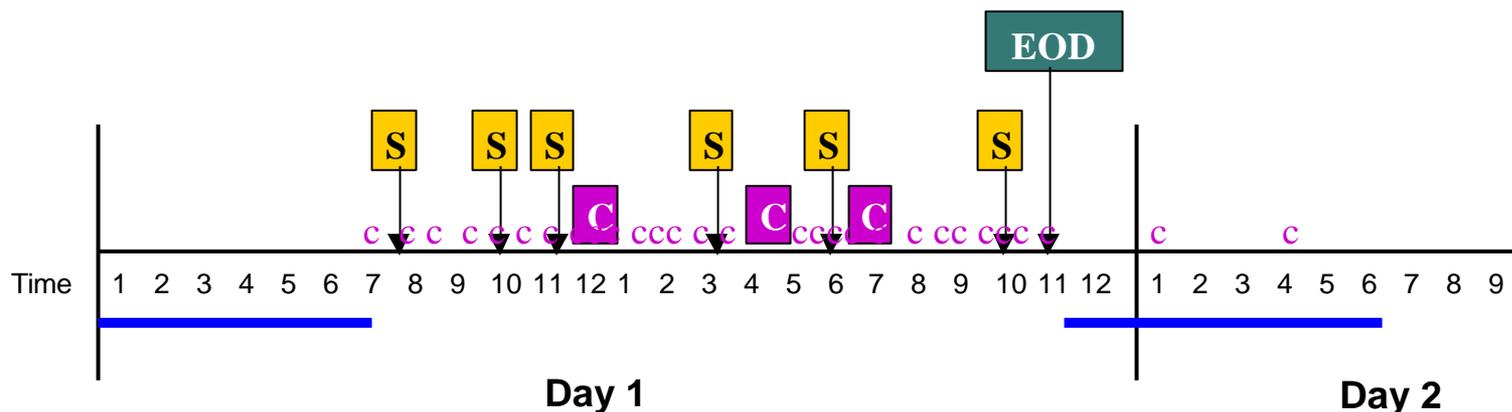
- Can combine sampling schemes to fit research purpose and natural history of the phenomenon under study

# Follow-Up



- Example:
  - Pain time-to-relief

# Events in Context



## KEY:

case-control  
design

**C** = Event report = cigarette, sampled (c)

**S** = Signal-based, random non-smoking assessment

**EOD** = End of Day report, stressful events

**—** = Sleep

- Example:
  - Mood when smoking vs. not smoking

# Multiple Modalities & Designs within One Study

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- Transition driven by ...
  - Researcher (e.g., initiation of treatment)
  - Subject response (e.g., symptom intensity)
  - Time (e.g., after  $n$  days baseline)
  - Device (e.g., ischemia)
- Example from smoking study
  - Baseline ad lib smoking
  - Trying to quit, initiate therapy
  - Abstinent
  - Lapsed
  - Low-level smoking

# Mixed-Design Issues

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- Must consider intersection and interaction of sampling & assessment modes
  - e.g. random prompting in midst of an ‘event’
- Exponential complexity and burden
  - Investigator: Design, programming, analysis, interpretation
  - Subject: Comprehension, compliance
- Can be very good fit to structure of “the problem”

# Sampling summary

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- Event-based
  - Suitable for episodic disorders
  - Capture frequency, characteristics of events/episodes
- Fixed time
  - Time course
  - Time-series analysis
  - Potentially biased sampling
- Variable time, random sampling
  - Most suitable for continuously-varying phenomena
  - Representative sampling; strategic sampling

# Ecological Momentary Experiments

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- Examine immediate effects of manipulation
- Unit of randomization: moment, occasion
  - Headache: take Pill # x
  - Craving: smoke or no
- Pre-post assessments

# How Much Data Do I Need?

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- $N$  Observations =
  - # of observations / day  $\times$
  - # of days  $\times$
  - # of subjects
- Trade-offs
- It depends ... on hypotheses, target frequency, variability

# Inferences from EMA Data

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- Typically still correlational, ecological data
- Improving inferences
  - Temporal sequence
  - Assessing confounding variables
- Common potential confounds
  - Time of day
  - Day of week
  - Concurrent state

# Summary

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- Range of diary designs
- Many critical sampling decisions
- Balance of data hunger and practicality
- Prior knowledge of target phenomenon and/or piloting often needed
- Plan for analysis
- Design must be driven by research questions