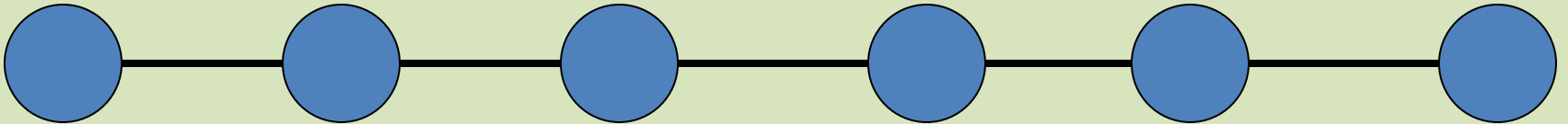


Defining, Measuring, and Dealing with Nonindependence

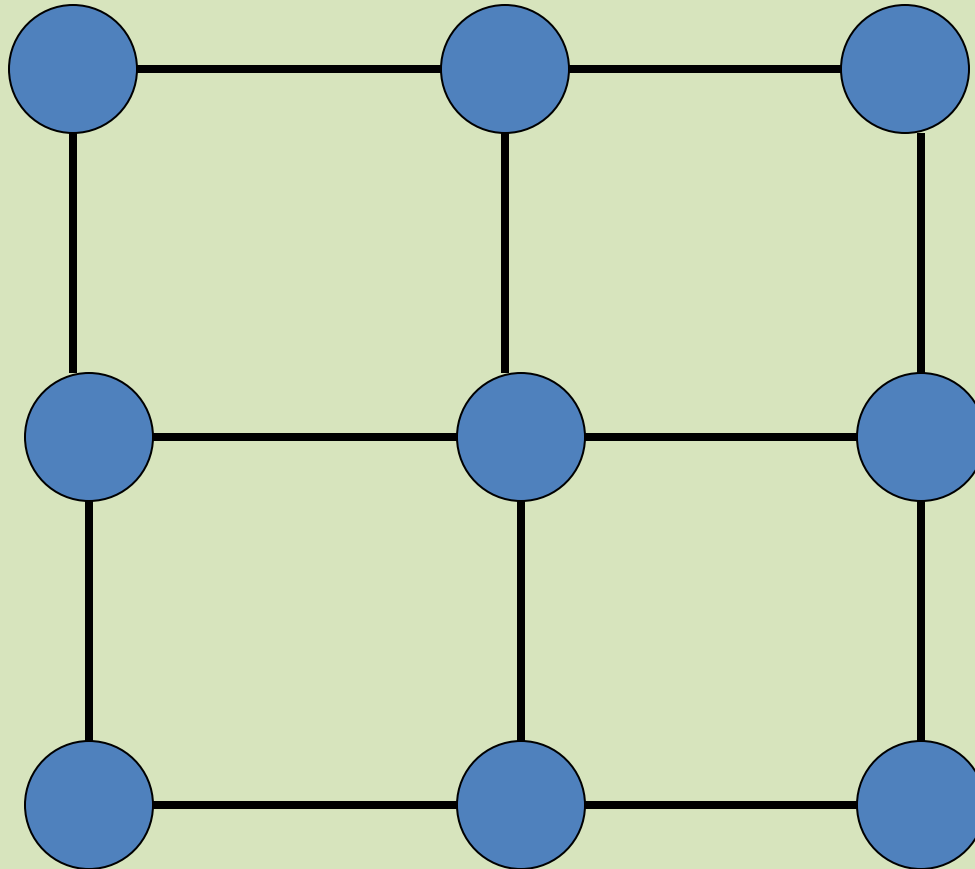
Types of Linkages

- Temporal
- Spatial
- Network
- Group or Dyad

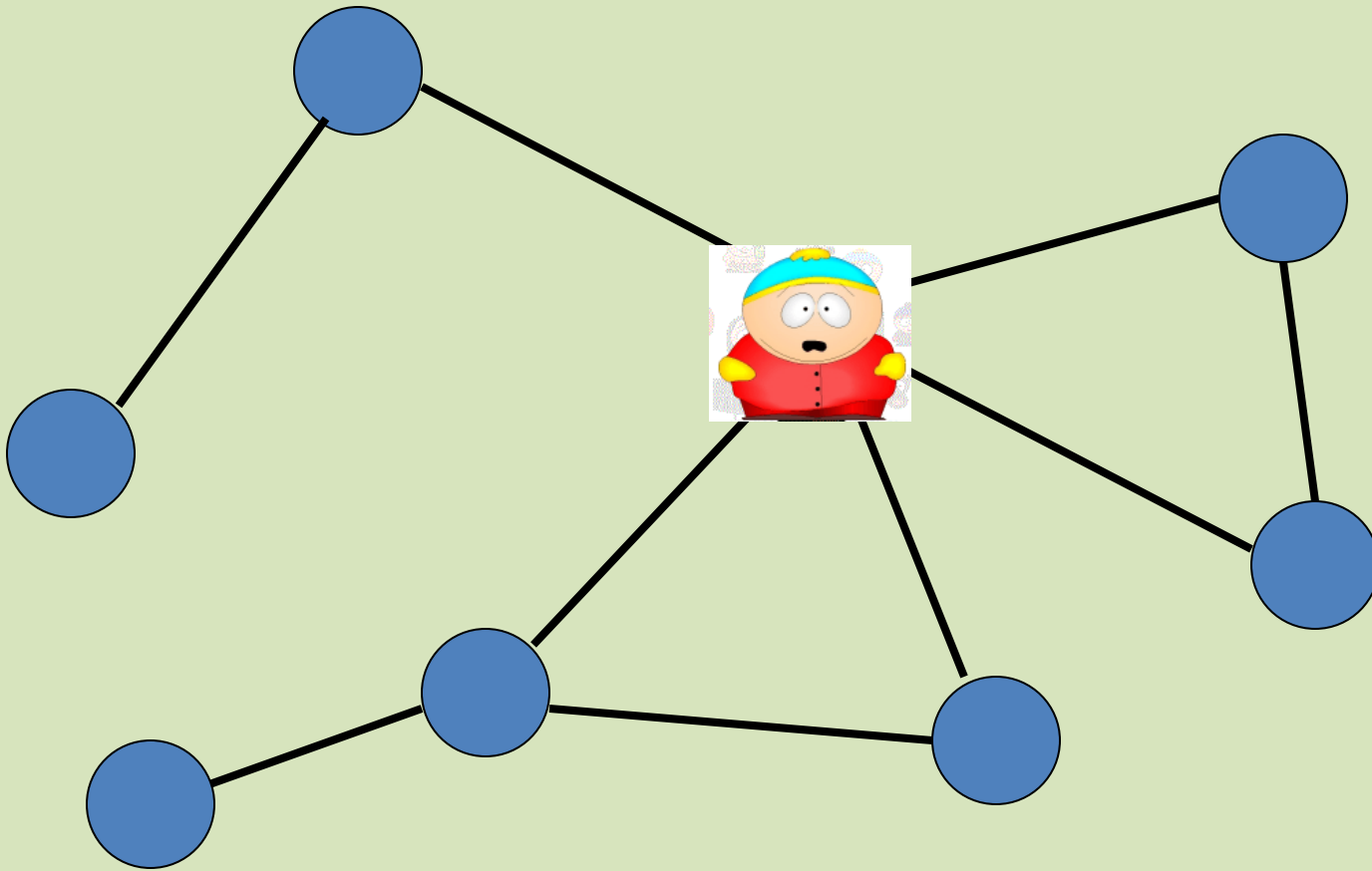
Temporal Linkage

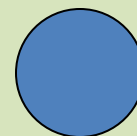
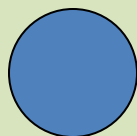
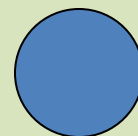
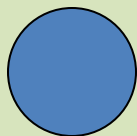


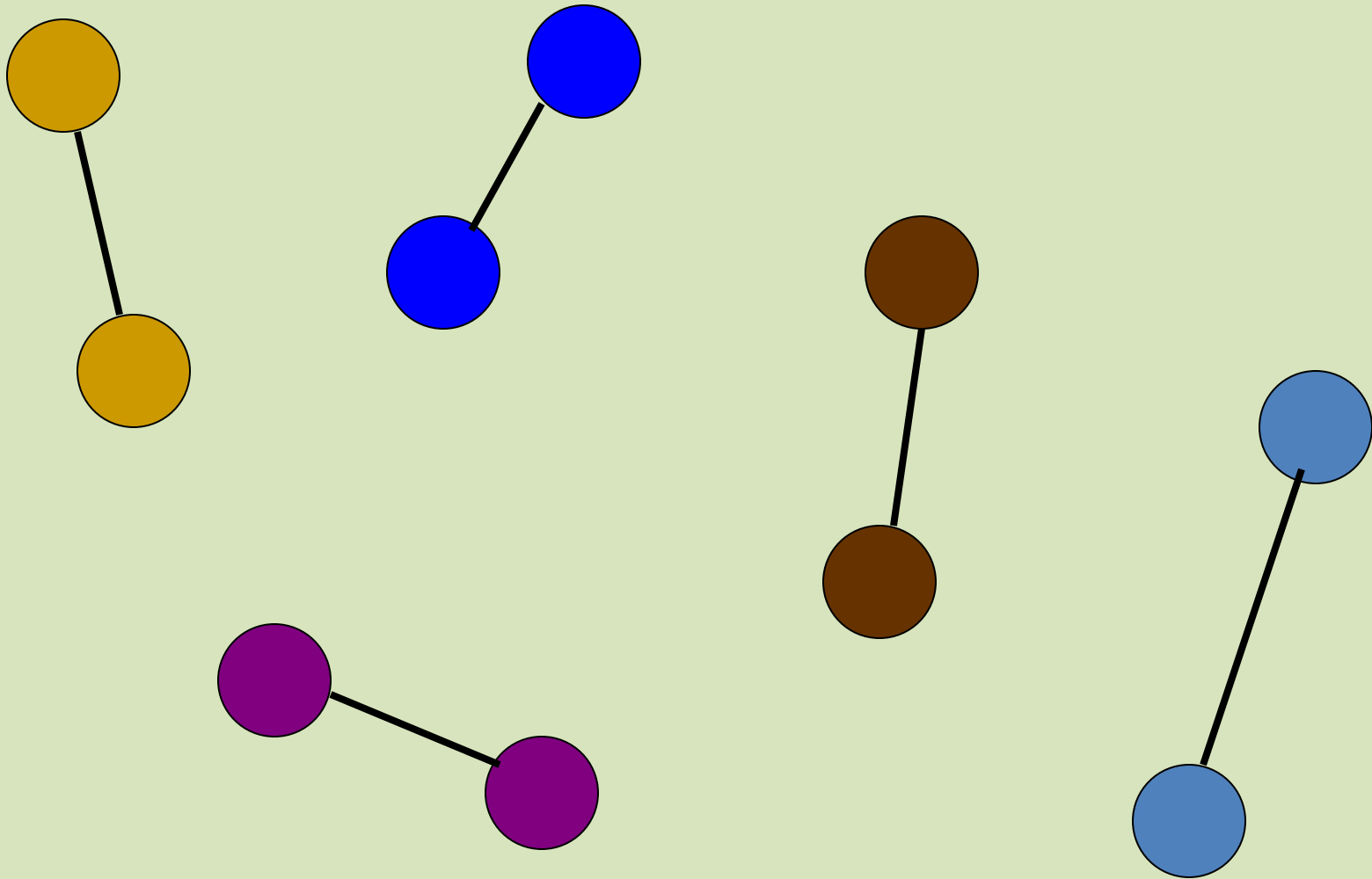
Spatial Linkage



Network Linkage







Defining Nonindependence

- In general
 - When two linked scores are more similar to (or different from) two unlinked scores, the data are nonindependent.
 - The strength of the links is the measure of nonindependence.
- In the Standard Dyadic Design
 - The two scores on the same variable from the two members of the dyad are correlated.

Negative Nonindependence

- Nonindependence is often defined as the proportion of variance explained by the dyad.
- BUT, nonindependence can be negative
- Proportions of variance cannot.

I. How Might Negative Correlations Arise?

- *Compensation:* If one person has a large score, the other person lowers his or her score. For example, if one person acts very friendly, the partner may distance him or herself.
- *Social comparison:* The members of the dyad use the relative difference on some measure to determine some other variable. For instance, satisfaction after a tennis match is determined by the score of that match.

II. How Might Negative Correlations Arise?

- *Zero-sum*: The sum of two scores is the same for each dyad. For instance, the two members divide a reward that is the same for all dyads.
- *Division of labor*: Dyad members assign one member to do one task and the other member to do another. For instance, the amount of housework done in the household may be negatively correlated.

Sources of Nonindependence

- Compositional Effects
 - The dyad members are similar even before they were paired called homophily or assortative mating.
- Partner Effects:
 - A characteristic or behavior of one person affects his or her partner's outcomes.

Sources of Nonindependence (cont.)

- Mutual Influence
 - One person's outcomes directly affect the other person's outcomes and vice versa (reciprocity or feedback).
- Common fate
 - Both members are exposed to the same causal factors.

Measures of Nonindependence

- Distinguishable Dyads
 - Pearson r
- Indistinguishable Dyads
 - Intraclass r
 - Pairwise method
 - ANOVA method

Measures of Nonindependence: Distinguishable Dyads

- If one person's score is X and other person's score is X'
 - Compute Pearson correlation using a dyad dataset
 - Does not assume equal means or variances for X or X'
 - Effect sizes
 - .5 large
 - .3 moderate
 - .1 small

Measures of Nonindependence: Indistinguishable Dyads

- Pairwise Method: Intraclass r
 - Compute a Pearson correlation with a pairwise data set (i.e., the “doubled” data)
- ANOVA: Intraclass r
 - Dyad as the “independent variable”
 - number of levels of dyad variable: n
 - Each dyad has two “participants.”
 - Pairwise or individual dataset

Example: Marital Satisfaction

Distinguishable Dyad Members: $r = .624$

Indistinguishable Dyad Members (Intraclass r : ICC)

Pairwise Method ($r = .616$)

ANOVA Method

$$ICC = (MSB - MSW) / (MSB + MSW)$$

$$.618 = [.39968 - .09422] / [.39968 + .09422]$$

Effect of Nonindependence

Effect Estimates Unbiased

Standard Errors Biased

- Sometimes too large
- Sometimes too small
- Sometimes hardly biased

Loss of Degrees of Freedom

Direction of Bias Depends on

Direction of Nonindependence

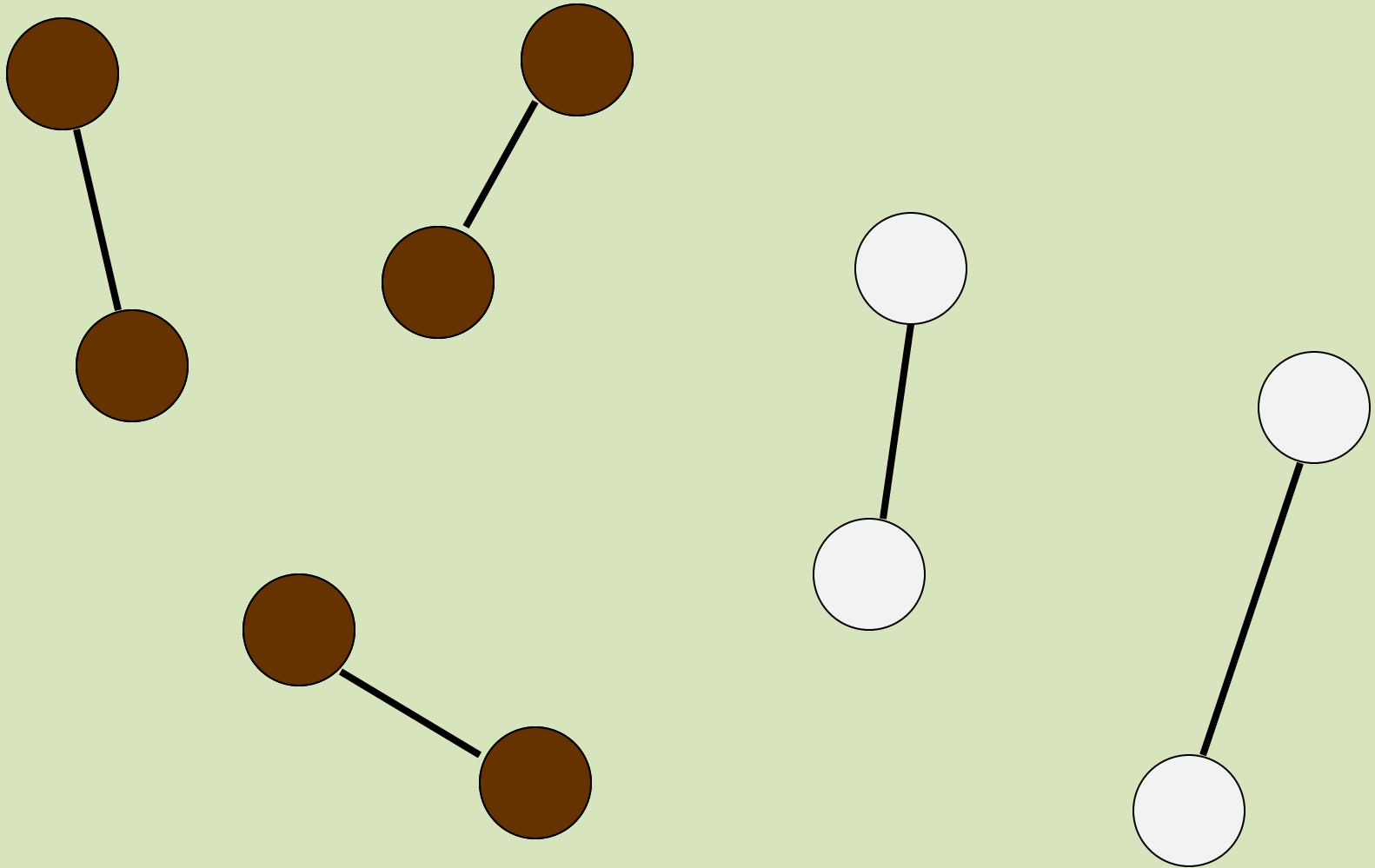
Positive: linked scores more similar

Negative: linked scores more dissimilar

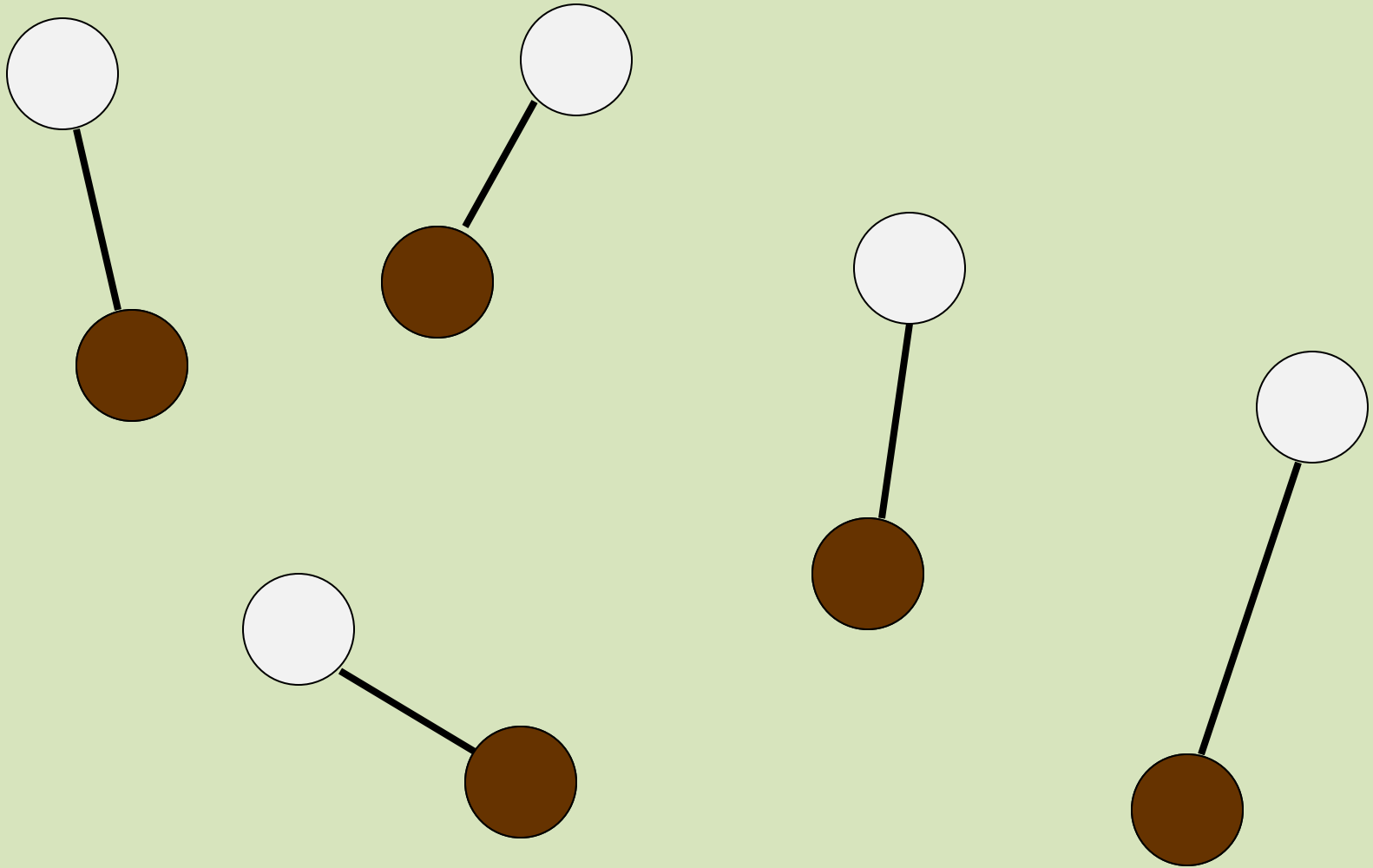
Between and Within Dyads

Between Dyads: linked scores in the same condition

Within Dyads: linked scores in different conditions



Between



Within

Effect of Ignoring Nonindependence on Significance Tests

Positive Negative

Between

Too liberal

Too
conservative

Within

Too
conservative

Too liberal

Intraclass Correlation for Between-Dyads, Within- Dyads, and Mixed Variables

Between-dyads: +1

Within-dyads: -1

Mixed variables: $-1 < r < +1$

Mixed Variables

Measure the intraclass correlation.

If positive, the effect on significance testing is like a between-dyads independent variable.

If negative, the effect on significance testing is like a within-dyads independent variable.

If near zero, relatively little bias in the standard errors.

Consequences of Ignoring Nonindependence

- As seen, there is bias in significance testing and confidence intervals.
- More importantly: Analyses that focus on the individual as the unit of analysis lose much of what is important in the relationship (e.g., reciprocity or mutuality).

What Not To Do!

- Ignore it and treat individual as unit
 - significance tests are biased
- Discard the data from one dyad member and analyze only one members' data
 - loss of precision
 - might have different results if different dyad members were dropped.
- Collect data from only one dyad member to avoid the problem
 - (same problems as above)
- Treat the data as if they were from two samples (e.g., doing an analysis for husbands and a separate one for wives)
 - May be no distinguishing variable to split the sample
 - Presumes differences between genders (or whatever the distinguishing variable is)
 - Loss of power

What To Do!

- The presence of nonindependence invalidates the use of “person as unit.”
- The analysis must include dyad in the analysis.
 - Make dyad the unit (not always possible)
 - Consider both individual and dyad in one analysis
 - Multilevel Modeling
 - Structural Equation Modeling

Traditional Multilevel Model: Random Intercepts

- Model for Persons 1 and 2 in Dyad j
 - $Y_{1j} = b_{0j} + aX_{1j} + bZ_j + e_{1j}$
 - $Y_{2j} = b_{0j} + aX_{2j} + bZ_j + e_{2j}$
 - Note the common intercept which captures the nonindependence.
 - Works well with positive nonindependence, but not negative.

Alternative Model: Correlated Errors

- Model for Persons 1 and 2 in dyad j
 - $Y_{1j} = b_0 + aX_{1j} + bZ_j + e_{1j}$
 - $Y_{2j} = b_0 + aX_{2j} + bZ_j + e_{2j}$
 - where e_{1j} and e_{2j} are correlated; if no predictors, then that correlation is an intraclass correlation
- Estimation
 - Maximum Likelihood (ML)
 - Restricted Maximum Likelihood (REML)

Estimating Nonindependence in Dyadic Data Analysis

Estimate a **model** in which each score has multiple predictors.

Nonindependence: Correlations of errors

Model with no predictors is called the Empty Model

Multilevel: $r = .618$, REML; $r = .616$, ML

SEM: $r = .616$, ML

