2009 German Stata Users Group Meeting

Performing within and between analysis (WABA) in Stata

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Outline

- **Introduction**
  Where are constructs in hierarchical data really associated?

- **Within and between analysis**
  - The basic idea
  - Simple ANOVA
  - Partitioning of correlations
  - Graphical demonstration

- **`wabacorr.ado` in Stata**

Introduction

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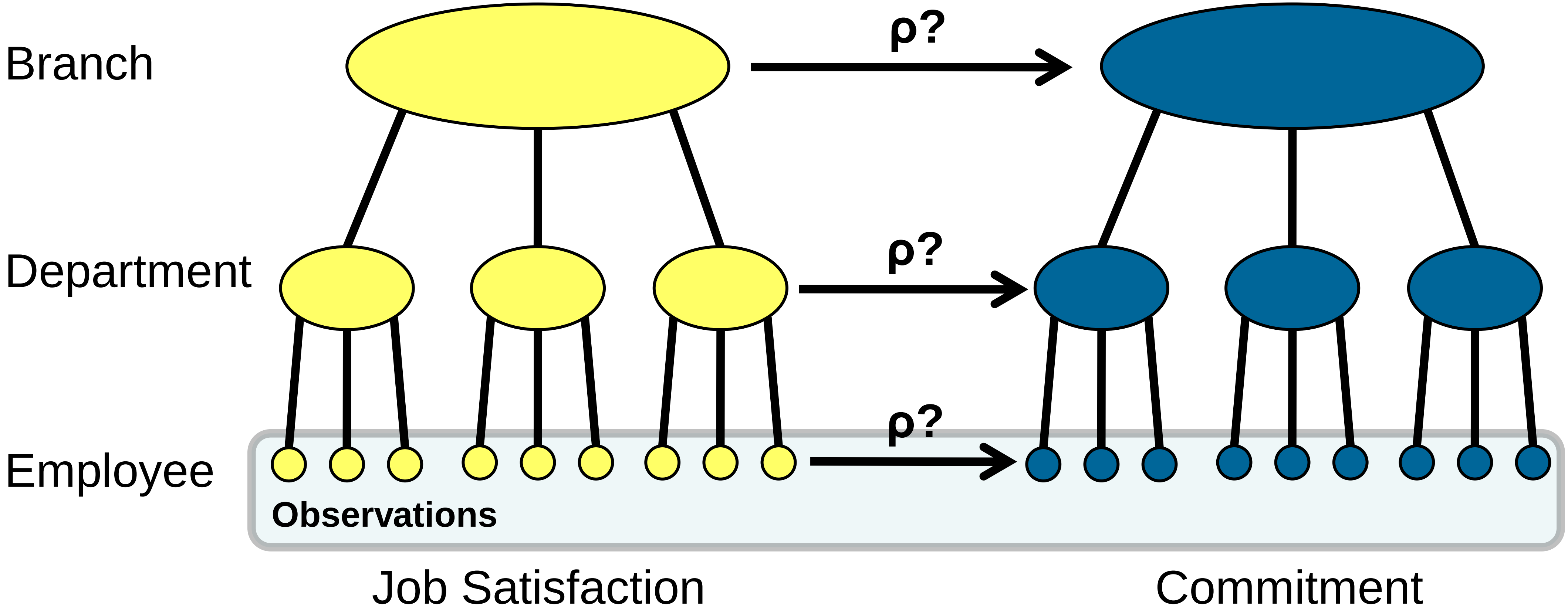
- **Many names for one common problem:**
  Fallacy of composition, ecological fallacy, atomistic fallacy, individualistic fallacy, Simpson's paradox, …
  → **Fallacies of the wrong level**

- **Therefore global correlations potentially misleading**
  - E.g. Corr(Job Satisfaction, Commitment) = .72
  - But at which level is the association?
    Individuals? Work groups? Departments?

- **Particularly problematic in applied settings**
  - No simple random samples
  - **Interventions**

Introduction

- $r_{\text{Job Satisfaction,Commitment}} = .72$



- **At which level is the association?**

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The basic idea

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- **The idea:**
  Let's split up the total correlation into a component within the groups and another component between the groups

  → similar to idea behind analysis of variance (ANOVA)

- **Simply needs to be adjusted to correlations**

- **Data prerequisites:**
  variables in question must be metric and levels must be nested

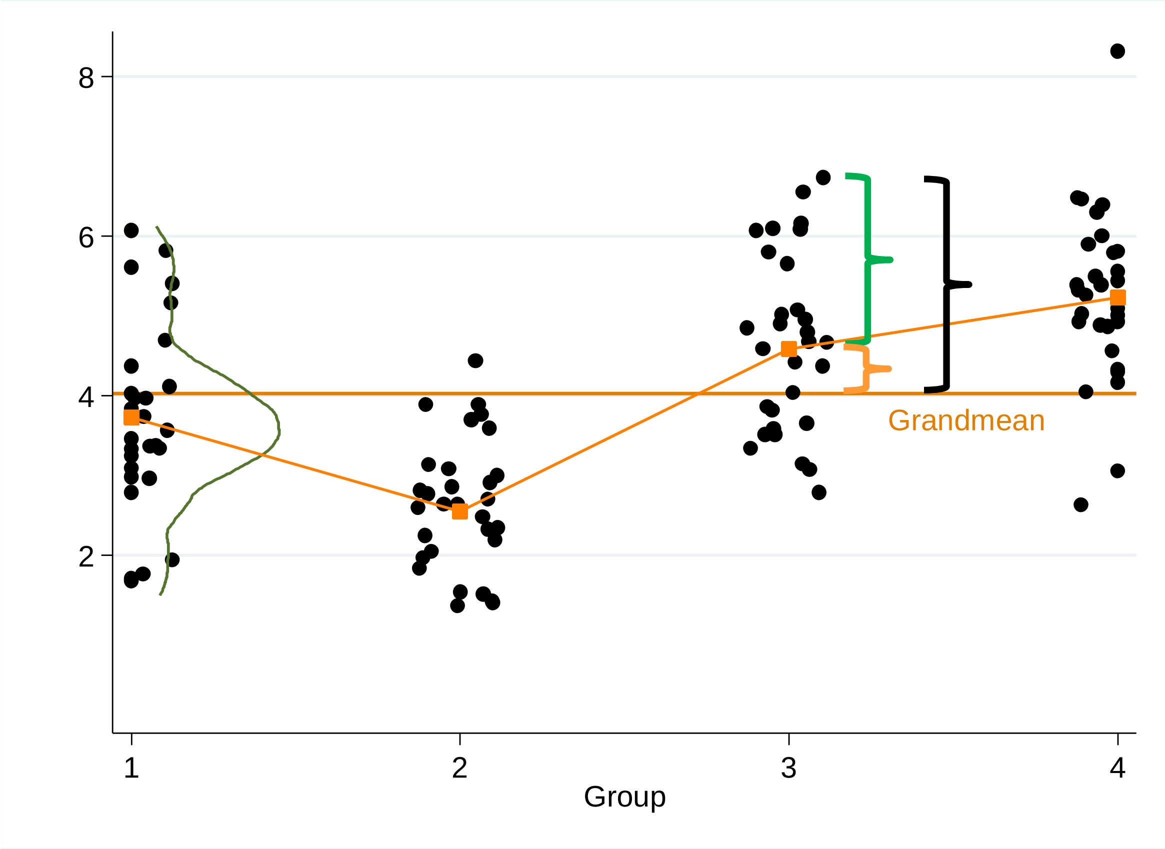
Simple ANOVA

- $X_{ij} = (X_{ij} - \mu_{\bullet j}) + \mu_{\bullet j}$

- $SS_{Total} = SS_{Error} + SS_{Group}$
  $(X_{ij} - \mu_{\bullet\bullet})^2 = (X_{ij} - \mu_{\bullet j})^2 + (\mu_{\bullet j} - \mu_{\bullet\bullet})^2$

- $\eta^2 = SS_{Group} / SS_{Total}$

==> η^2 between measure



Partitioning of correlations

- **Adjusted to correlations:**

$$r_{xy} = \eta_{Bx} * \eta_{By} * r_{Bxy} + \eta_{Wx} * \eta_{Wy} * r_{Wxy} \quad \Leftrightarrow$$

$$r_{xy} = C_B + C_W$$

  - $\eta_B = \text{corr}(\mu_{\bullet j,} X_{ij})$
  - $\eta_W = \text{corr}[(X_{ij} - \mu_{\bullet j}), X_{ij}]$

- **Central question: is between or within component (i.e. higher or lower level, or both) of total correlation more important?**

Partitioning of correlations

- **Typical procedure in 3 steps:**

1. Univariate comparison of the within and between variances

   $r_{xy} = \eta_{Bx} * \eta_{By} * r_{Bxy} + \eta_{Wx} * \eta_{Wy} * r_{Wxy}$

2. Bivariate comparison of the within and between correlations

   $r_{xy} = \eta_{Bx} * \eta_{By} * r_{Bxy} + \eta_{Wx} * \eta_{Wy} * r_{Wxy}$

3. Summary judgment on the importance of the within and between components for the total correlation

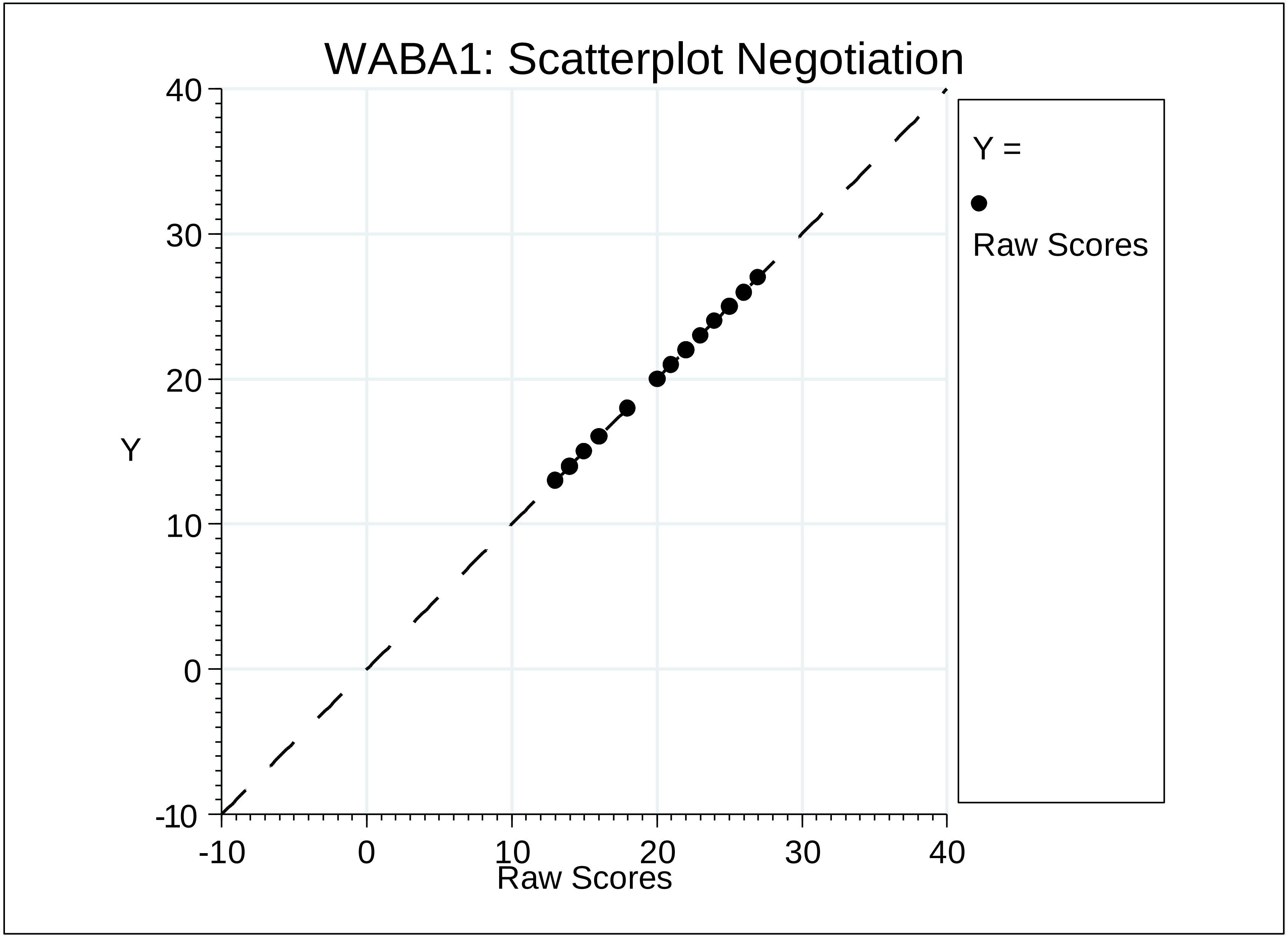
   $r_{xy} = C_B + C_W$

Partitioning of correlations

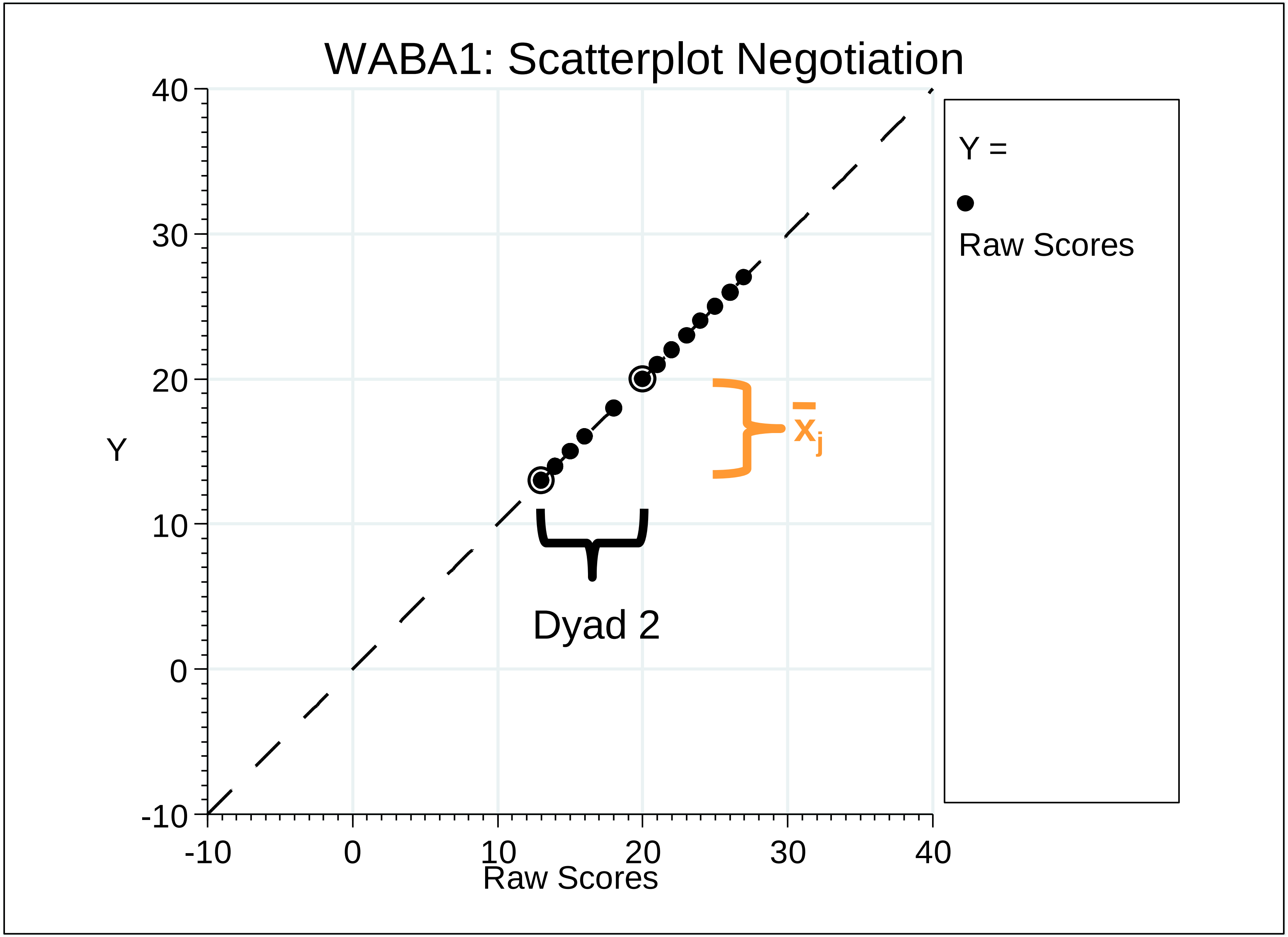
4 possible outcomes/inductions:

1. Parts → lower level/within
2. Wholes → higher level/between
3. Equivocal → meaningful association at both levels
4. **Inexplicable → noise**

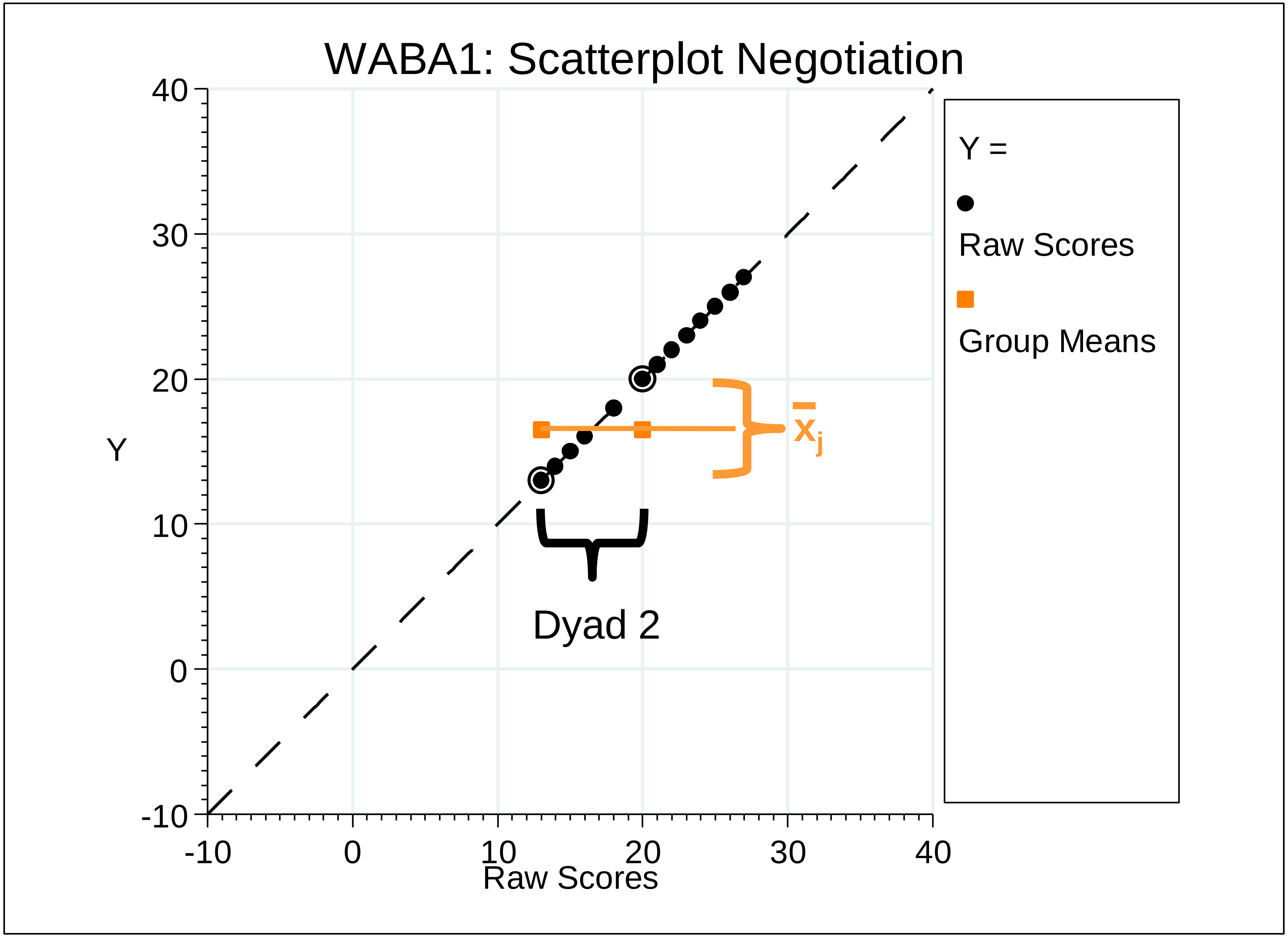
Graphical illustration: Step 1



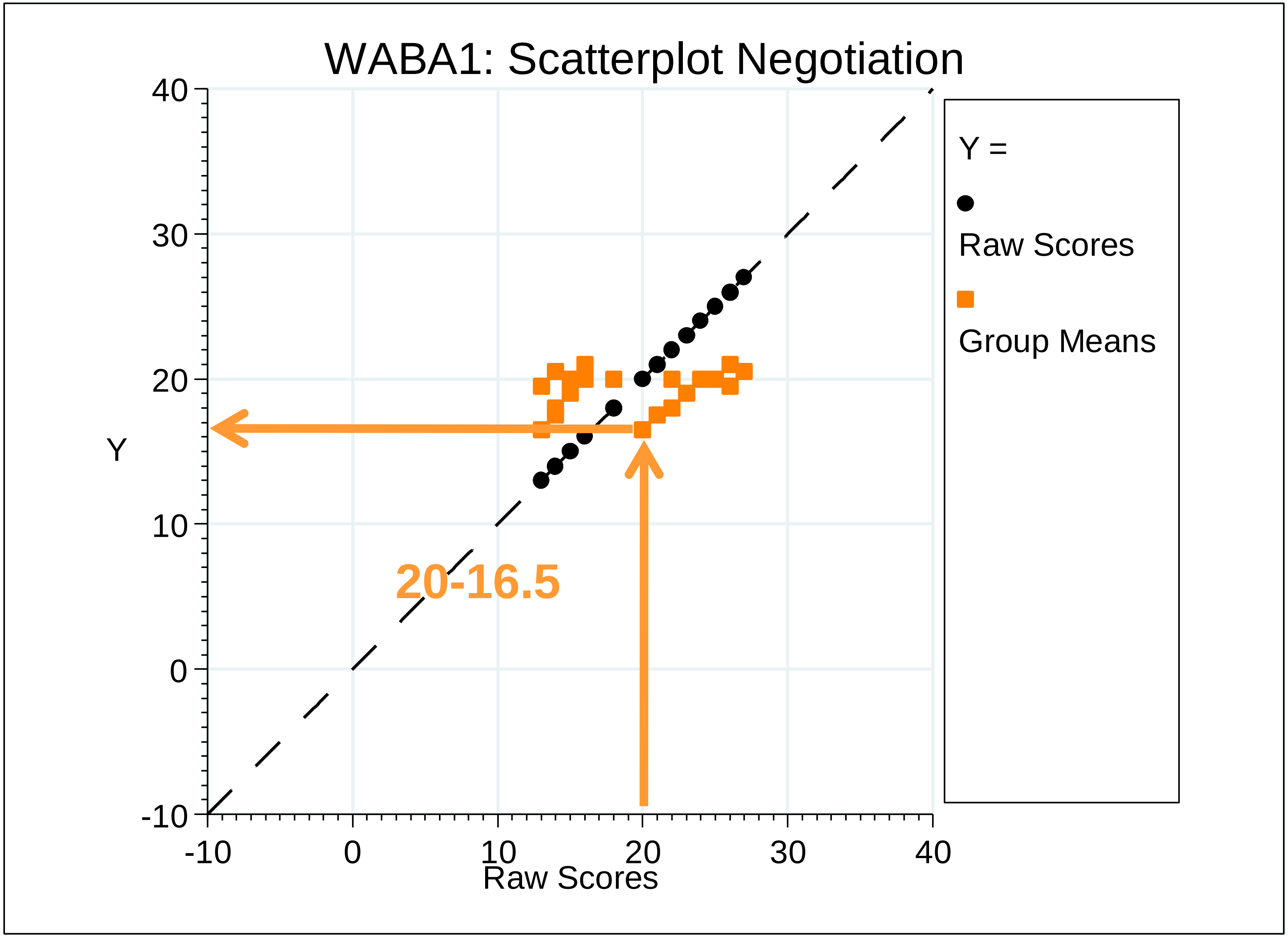
Graphical illustration: Step 1 (η_B)



Graphical illustration: Step 1 (η_B)



Graphical illustration: Step 1 (η_B)



Graphical illustration: Step 1 (η_W)

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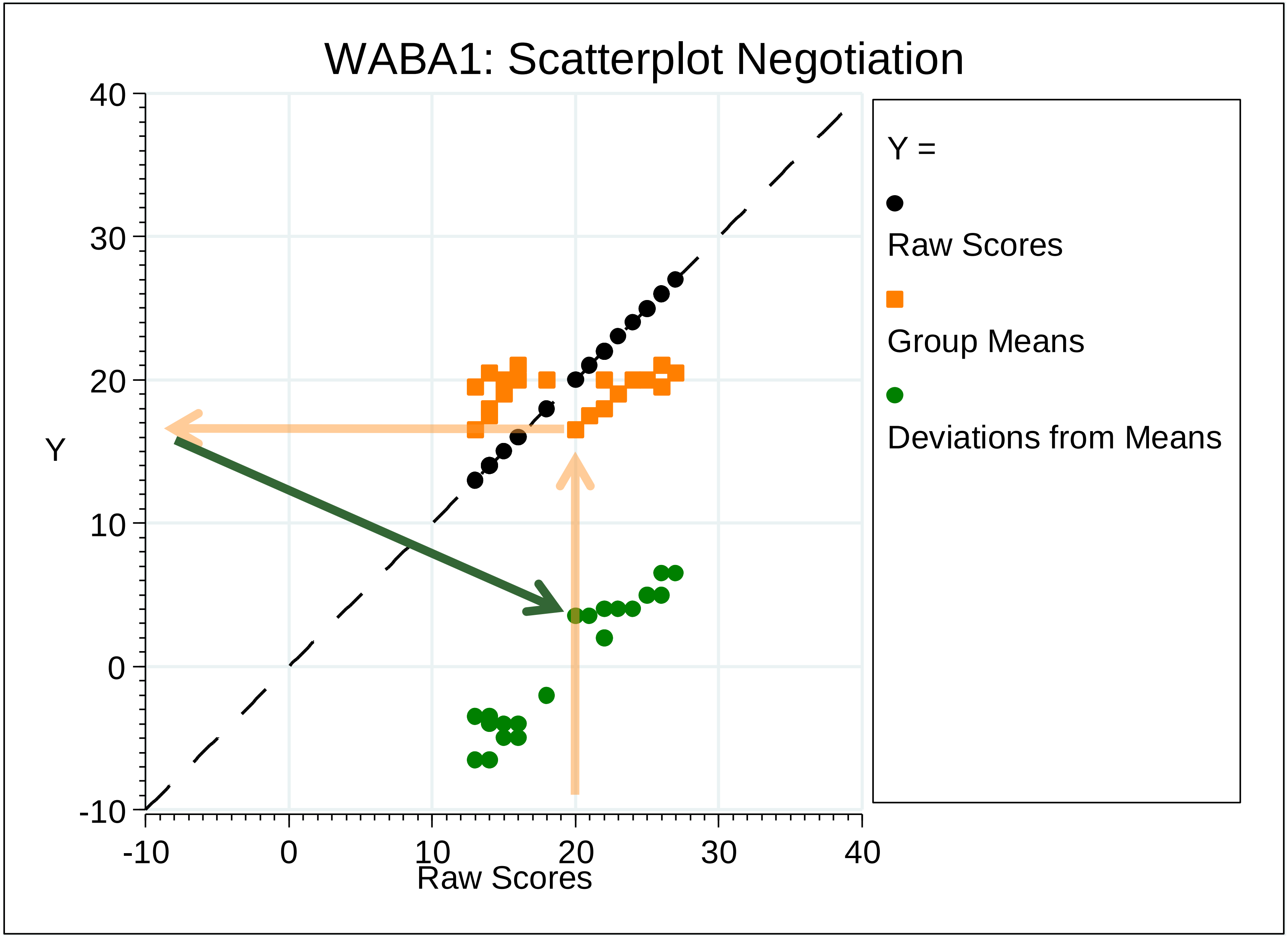
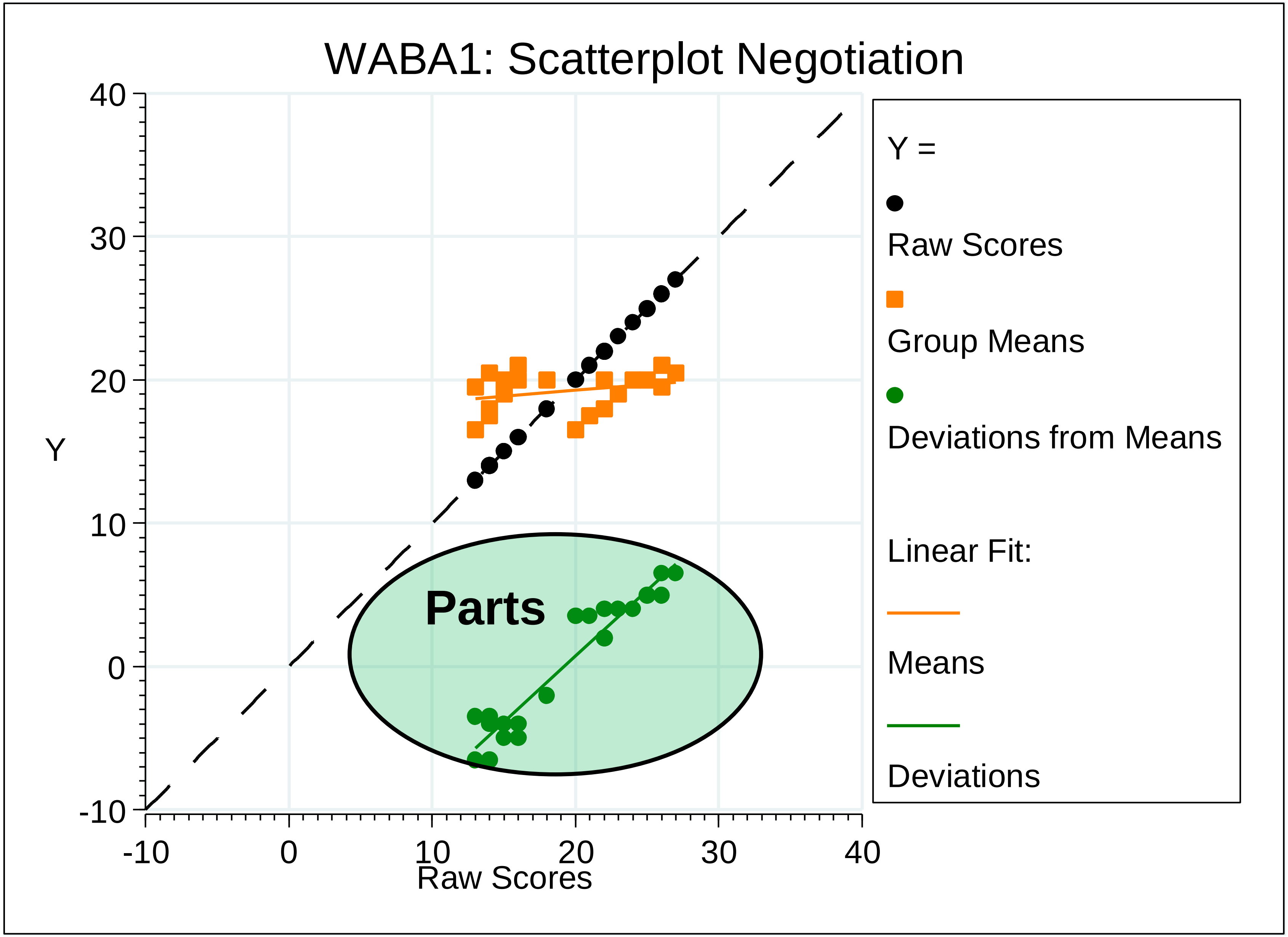
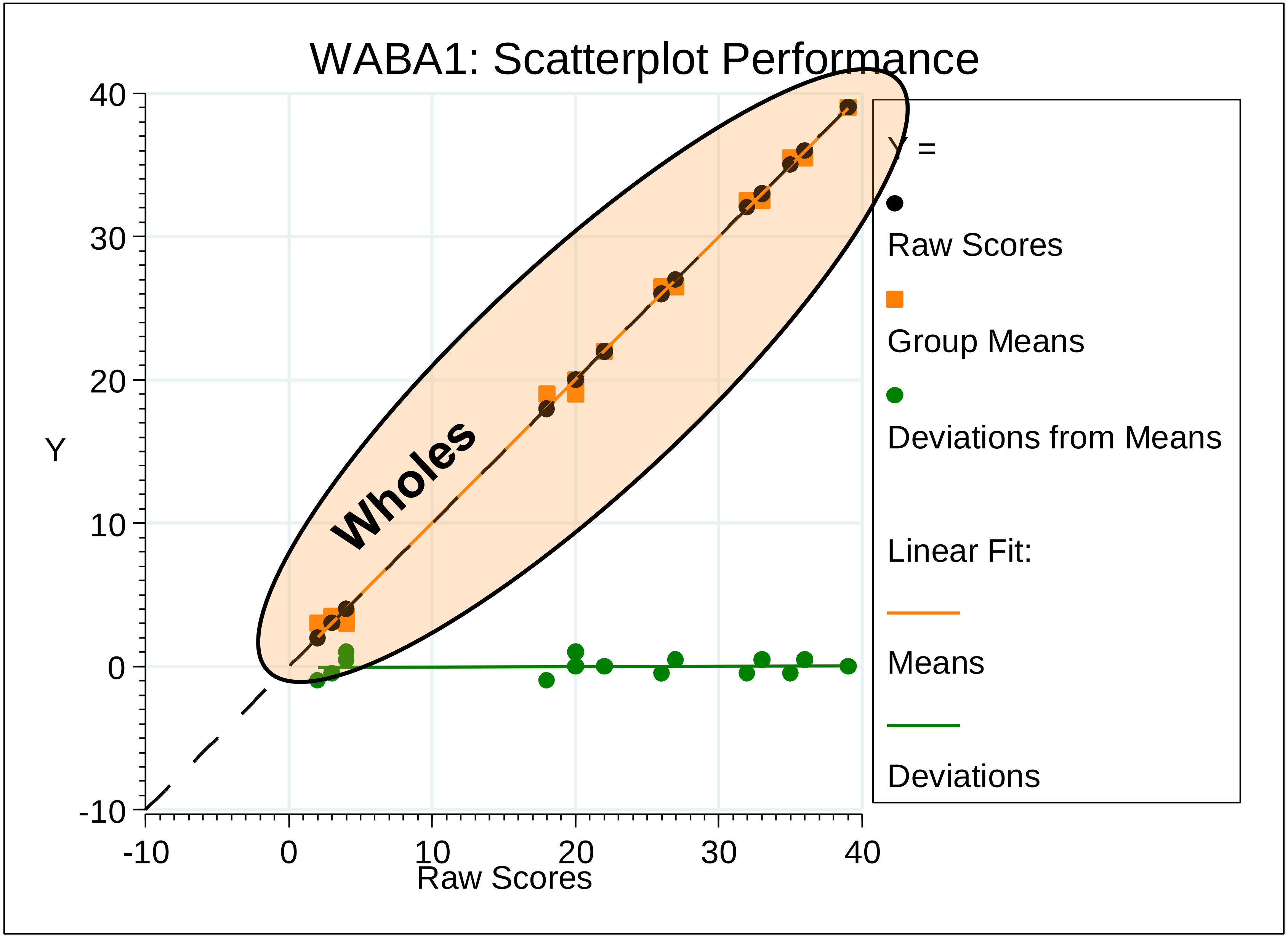


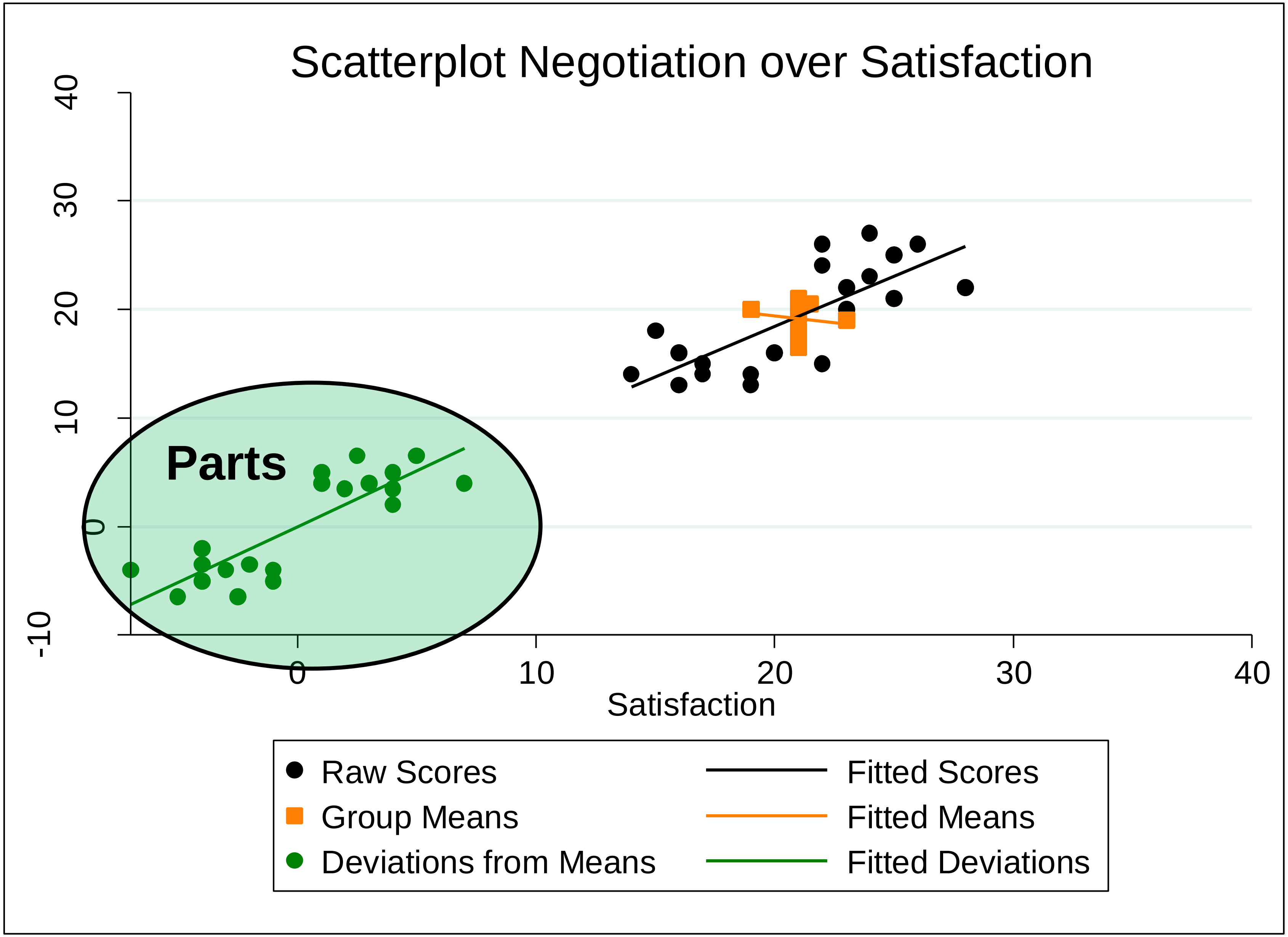
Graphical illustration: Step 1



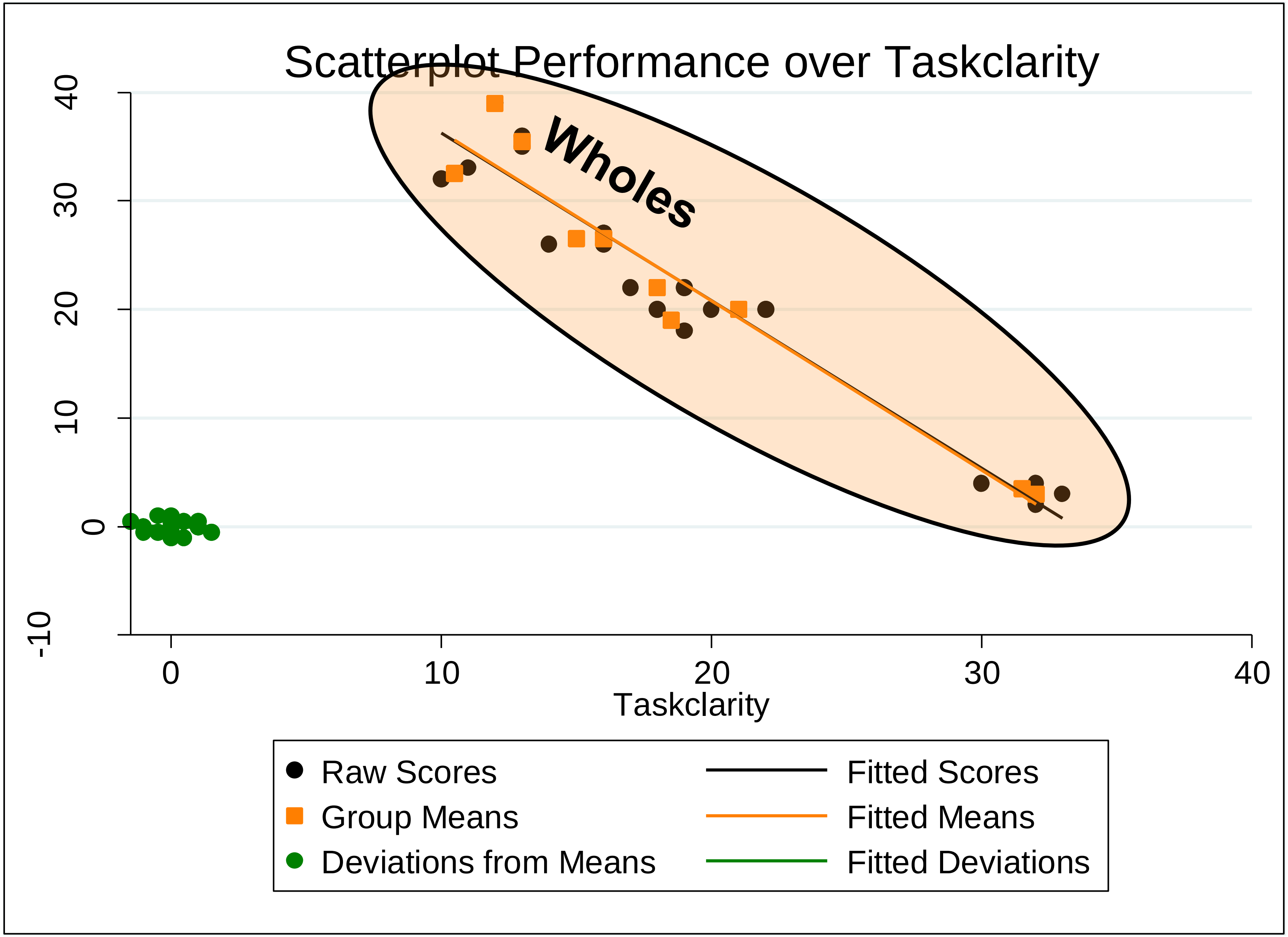
Graphical illustration: Step 1



Graphical illustration: Step 2



Graphical illustration: Step 2



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- **`wabacorr.ado` in Stata**

wabacorr.ado in Stata

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- **General syntax:**

```
wabacorr varlist [if] [in] [fweight], by(grpvar) [detail]
```

- **Examples based on Detect Data set A**
  - 40 persons in 20 dyads in 10 groups in 4 collectivities
  - 4 metric variables: negotiation, satisfaction, performance, taskclarity

W I P

wabacorr.ado in Stata

```
. wabacorr  negotiation satisfaction performance taskclarity, by(dyad)

Within and between analysis                      Number of obs      =       40
Group variable: dyad                             Number of groups   =       20

                                                 Obs per group: min =        2
                                                                avg =      2.0
                                                                max =        2


Within- and between-groups Etas and Eta-squared values:

-------------------------------------------------------------------------------
        Variable |  Eta-betw   Eta-with    Eta-b^2    Eta-w^2          F       p>F
-----------------+-------------------------------------------------------------
     negotiation |    0.2846     0.9586     0.0810     0.9190    10.7769    0.0000
    satisfaction |    0.2783     0.9605     0.0774     0.9226    11.3170    0.0000
     performance |    0.9988     0.0493     0.9976     0.0024   431.6194    0.0000
     taskclarity |    0.9944     0.1054     0.9889     0.0111    93.7529    0.0000
-------------------------------------------------------------------------------
```

⇒ Parts

wabacorr.ado in Stata

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```
Within- and between-groups correlations:

--------------------------------------------------------------------
                   Variables |   r-betw    r-with          z'       p>z'
-----------------------------+--------------------------------------
   negotiation-satisfaction |  -0.1973    0.8441     -3.0614     0.0011
    negotiation-performance |   0.1413   -0.0477      0.2794     0.3900
    negotiation-taskclarity |  -0.0589    0.0502      0.0257     0.4897
   satisfaction-performance |  -0.0346    0.0695     -0.1037     0.4587
   satisfaction-taskclarity |   0.0526    0.1568     -0.3119     0.3776
    performance-taskclarity |  -0.9679   -0.1157      5.7429     0.0000
--------------------------------------------------------------------
```

⇒ Parts

⇒ Noise

⇒ Wholes

wabacorr.ado in Stata

Total correlation and components:

Variables	r-total	betw-comp	with-comp	z'	p>|z'|
negotiation-satisfaction	0.7616	-0.0156	0.7772	-3.0239	0.0025
negotiation-performance	0.0379	0.0402	-0.0023	0.1122	0.9107
negotiation-taskclarity	-0.0116	-0.0167	0.0051	0.0343	0.9726
satisfaction-performance	-0.0063	-0.0096	0.0033	0.0187	0.9851
satisfaction-taskclarity	0.0304	0.0145	0.0159	-0.0039	0.9969
performance-taskclarity	-0.9620	-0.9614	-0.0006	5.8045	0.0000

⇒ Parts

- Induction for the correlation between negotiation and satisfaction is parts
- Thus variables should not be aggregated, but higher level information could be disregarded without a big loss

`wabacorr.ado` in Stata

- **What if induction is wholes (as with performance and taskclarity) or equivocal?**

- **If possible repeat WABA at the next higher level until induction is parts**
  - New number of cases N equals the number of groups M during the previous analysis
  - Input/initial values are correspondingly the means $\mu_{\bullet j}$ of the previous analysis
  - This is called *multiple* WABA
  - In *unbalanced data* the means must be *weighted* to avoid distortions (`wabacorr` supports frequency weights)
  - Aggregate data no higher than level of first parts induction, but do not disregard levels where inductions were equivocal

- **Stata again:**

`wabacorr.ado` in Stata

```
. collapse (mean) performance taskclarity group collectivity
    (count) obs=performance, by(dyad)

. wabacorr performance taskclarity [fweight=obs], by(group)

Within and between analysis                        Number of obs      =        20
Group variable: group                              Number of groups   =        10

                                                   Obs per group: min =         2
                                                                  avg =       2.0
                                                                  max =         2

Number of weighted obs =          40     Weighted obs per group: min =         4
                                                                  avg =       4.0
                                                                  max =         4

:::
Output omitted
:::

. collapse (mean) performance taskclarity collectivity
    (rawsum) obs [fweight=obs], by(group)

. wabacorr performance taskclarity [fweight=obs], by(collectivity)
```

wabacorr.ado in Stata

```
. wabacorr performance taskclarity [fweight=obs], by(collectivity)

Within and between analysis                             Number of obs      =          10
Group variable: collectivity                            Number of groups   =           4

                                                        Obs per group: min =           2
                                                                       avg =         2.5
                                                                       max =           3

Number of weighted obs =          40     Weighted obs per group: min =           8
                                                                       avg =        10.0
                                                                       max =          12

:::
Output omitted
:::
```

- Induction remains wholes even at the highest level
- Data could thus be aggregated by collectivities

Example for an Analysis: Dansereau et al. (2006)

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TABLE 3
Hypothesis 2: Illustration of Group Parts Result for Trustworthiness (x) and Delegated Activities (y)

Number of persons	40	
Number of groups	20	
Total correlation (individual level; from Table 1)	.76**	→ Initial value
Between-group model		
Between-group correlation (r_{BXY})	–.197	→ Step 2
Between-group variation		
Trustworthiness (*eta* η_{BX})	.285	→ Step 1
Delegated activities (*eta* η_{BY})	.278	
Between-group component		
$(r_{BXY})(\eta_{BX})(\eta_{BY})$	(–.197)(.285)(.278) = –.02	→ Step 3
Within-group model		
Within-group correlation (r_{WXY})	.844**	→ Step 2
Within-group variation		
Trustworthiness (*eta* η_{WX})	.959	→ Step 1
Delegated activities (*eta* η_{WY})	.961	
Within-group component		
$(r_{WXY})(\eta_{WX})(\eta_{WY})$	(.844)(.959)(.961) = .78	→ Step 3
Differences		
Between correlation versus within correlation		
A test	–.81††	→ Step 2
Z test	–3.06**	
Trustworthiness		
Between variation versus within variation		
E ratio = η_B/η_W	.30††	→ Step 1
F ratio = $(1/E^2)(J-1)/(N-J)$	10.78**	
Delegated activities		
Between variation versus within variation		
E ratio = η_B/η_W	.29††	→ Step 1
F ratio = $(1/E^2)(J-1)/N-J$	11.32**	
Induction	Group parts	

†θ° > 15°. ††θ° > 30°. *$p < .05$. **$p < .01$.

W I P

Conclusions I

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- **Within and between analysis**
  - provides a detailed picture of patterns of associations between variables at different levels in nested hierarchical data instead of an all-or-nothing decision as with ANOVA or intra-class correlations (ICC)
  - has its greatest added value in equivocal cases
  - can reveal important results even if total correlation is nil
  - can be employed at two levels (single WABA) or successively at more levels (multiple WABA)
  - can also be employed in multivariate contexts like regression analysis (cf. Dansereau et al. (2006))
  - can inform further analyses, like the choice of levels in multi level modeling (MLM), and selection of starting points for interventions

Conclusions II

- **`wabacorr.ado`**
  - performs WABA of correlations in Stata 9.2 or higher
  - also provides tests of practical significances with ‘detail’ option
  - supports frequency weights to allow multiple WABA with unbalanced data
  - stores results for further use by the user

Further sources

- **Method:**
  - Dansereau, F., Cho, J. and Francis J. Yammarino. (2006). Avoiding the "Fallacy of the Wrong Level": A Within and Between Analysis (WABA) Approach. *Group & Organization Management, 31,* 536 - 577.
  - O'Connor, B. P. (2004). SPSS and SAS programs for addressing interdependence and basic levels-of-analysis issues in psychological data. *Behavior Research Methods, Instrumentation, and Computers, 36 (1),* 17-28.
  - Detect software: http://www.levelsofanalysis.com

- **`wabacorr.ado`:**
  - http://www.wip-mannheim.de/
  - http://www.svenoliverspiess.net/stata

  - Soon: Statistical Software Components

Thank you!