

Demonstrating multilevel structural equation modeling for testing mediation: Effects of self-critical perfectionism on daily affect

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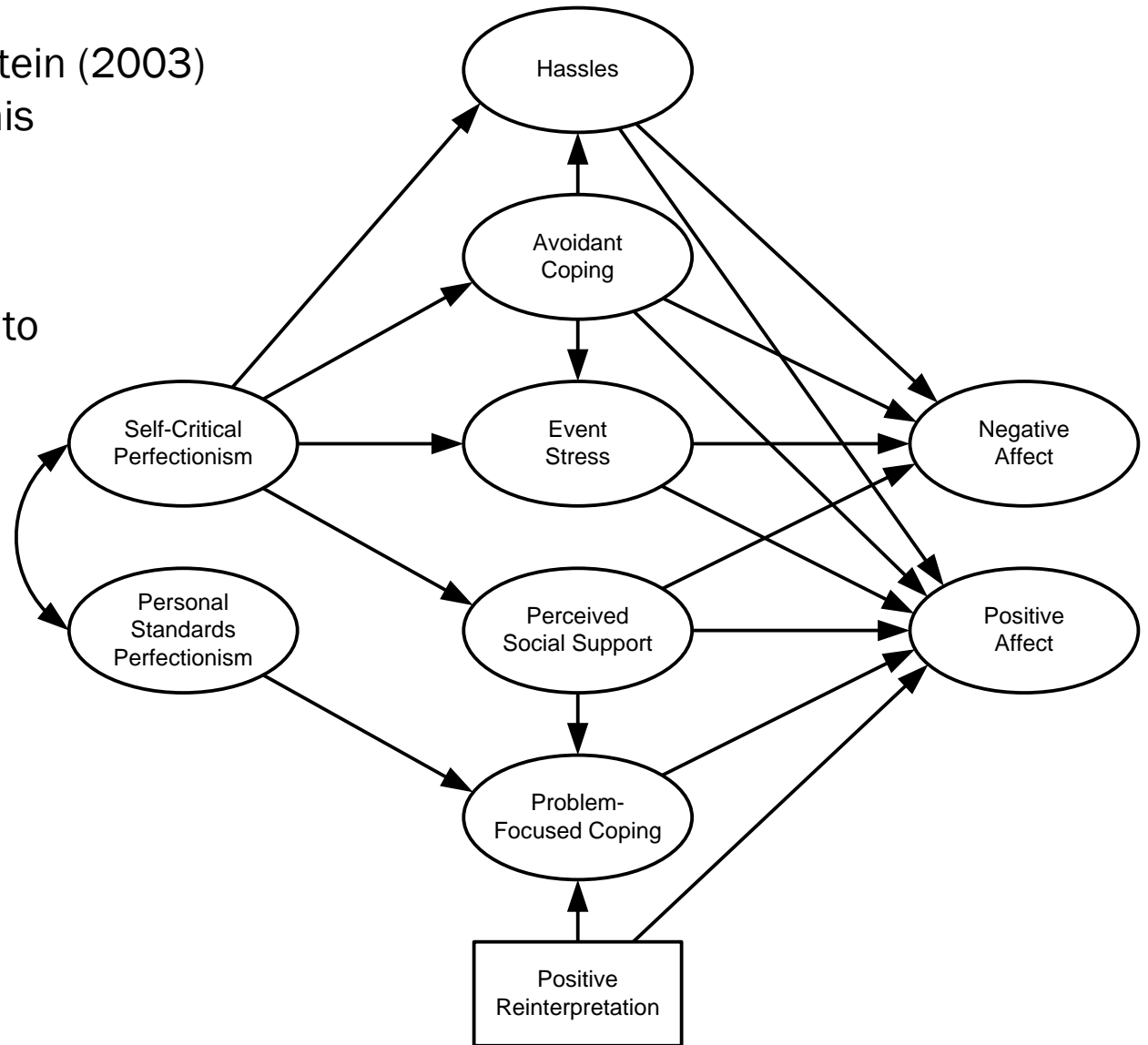
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Motivating example: Dunkley et al. (2003)

Dunkley, Zuroff, and Blankstein (2003) were interested in testing this mediation model.

PS perfectionism: tendency to set high standards and goals for the self.

SC perfectionism: constant and harsh self-scrutiny, an inability to derive satisfaction from performance, and chronic concerns about others' criticism and disapproval.

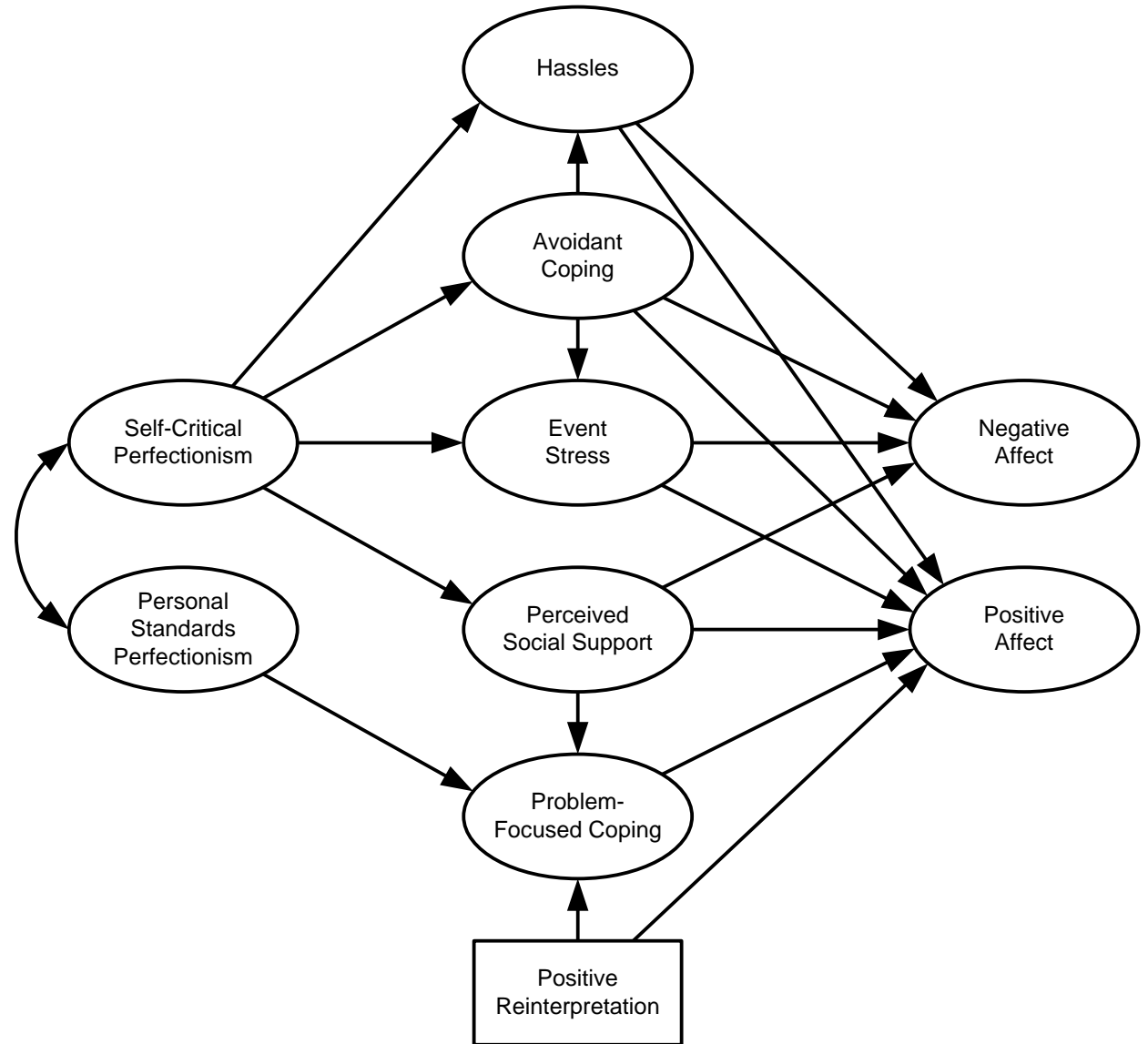


Motivating example: Dunkley et al. (2003)

Hypotheses

SC perfectionism leads to higher negative affect and lower positive affect through maladaptive tendencies.

PS perfectionism leads to higher positive affect by promoting problem-focused coping.



Motivating example: Dunkley et al. (2003)

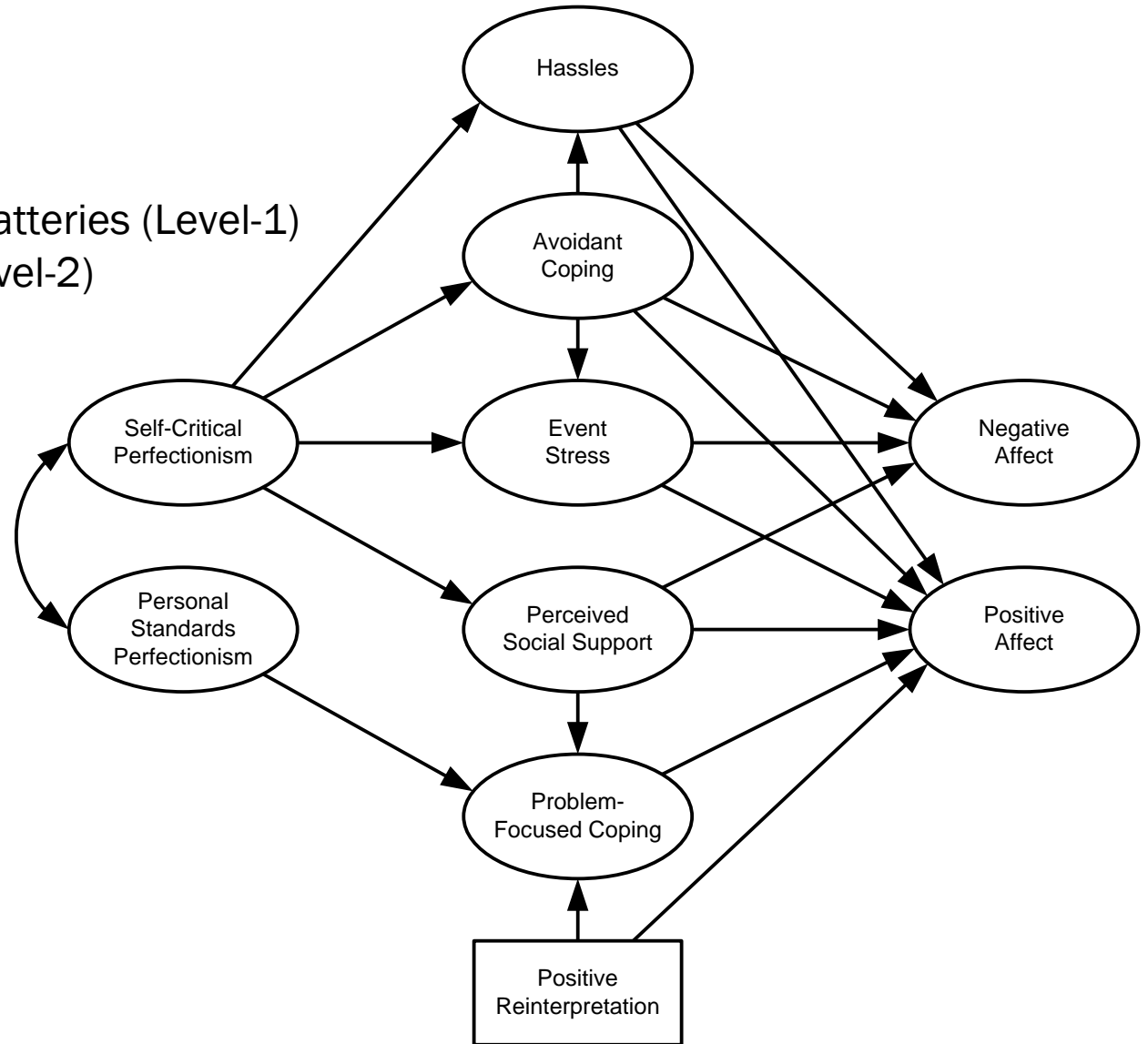
Data complexities:

Their data were nested:

7 repeated questionnaire batteries (Level-1)

179 university students (Level-2)

Also, they typically had 2 to 5 indicators per construct. For a given construct, indicators were either all Level-2 or all Level-1.



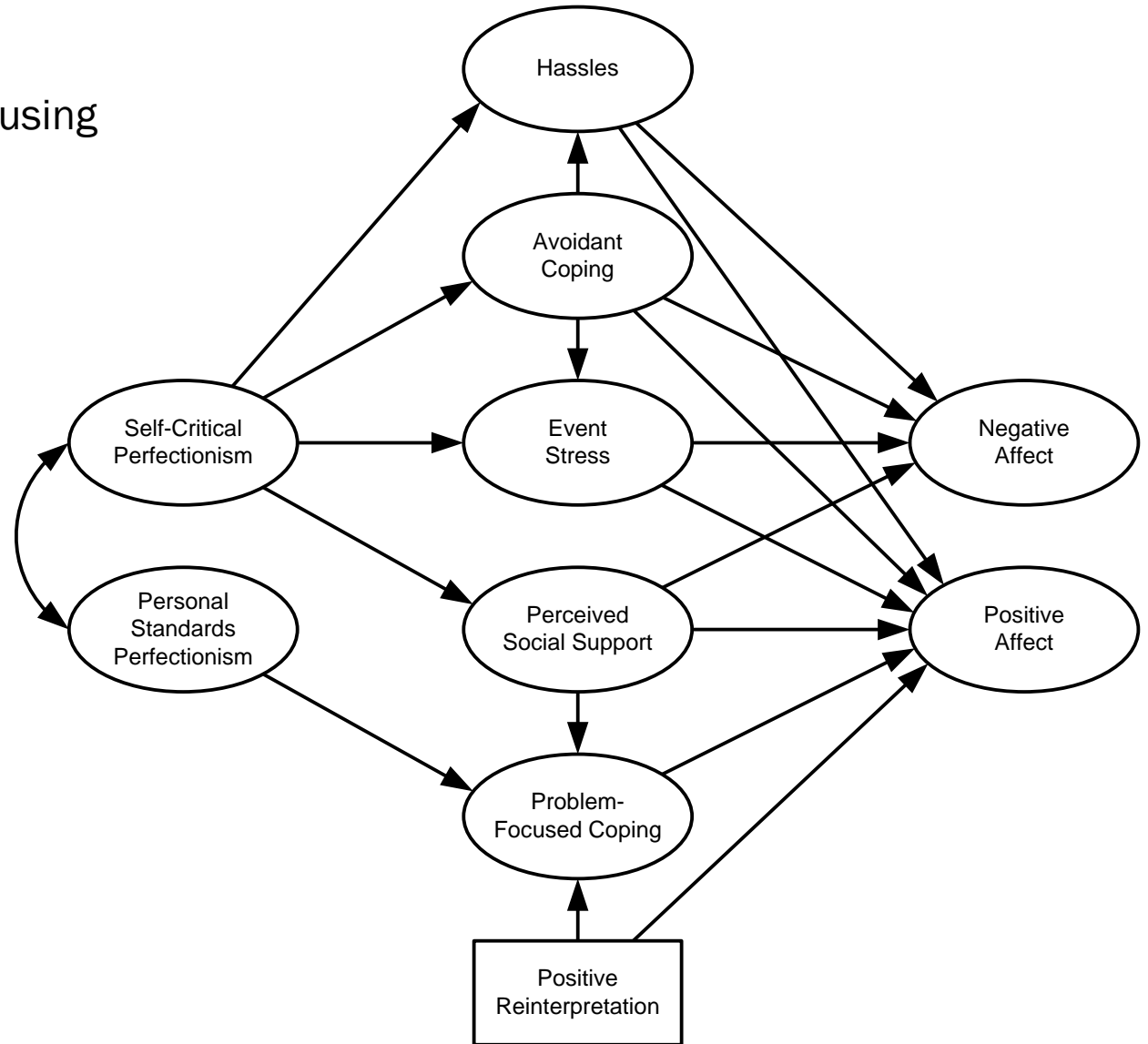
Motivating example: Dunkley et al. (2003)

In some analyses, they accounted for clustering by using **multilevel modeling (MLM)**.

But, MLM does not permit using latent variables or complex causal models.

In other analyses, they included latent variables with multiple indicators by using **structural equation modeling (SEM)**.

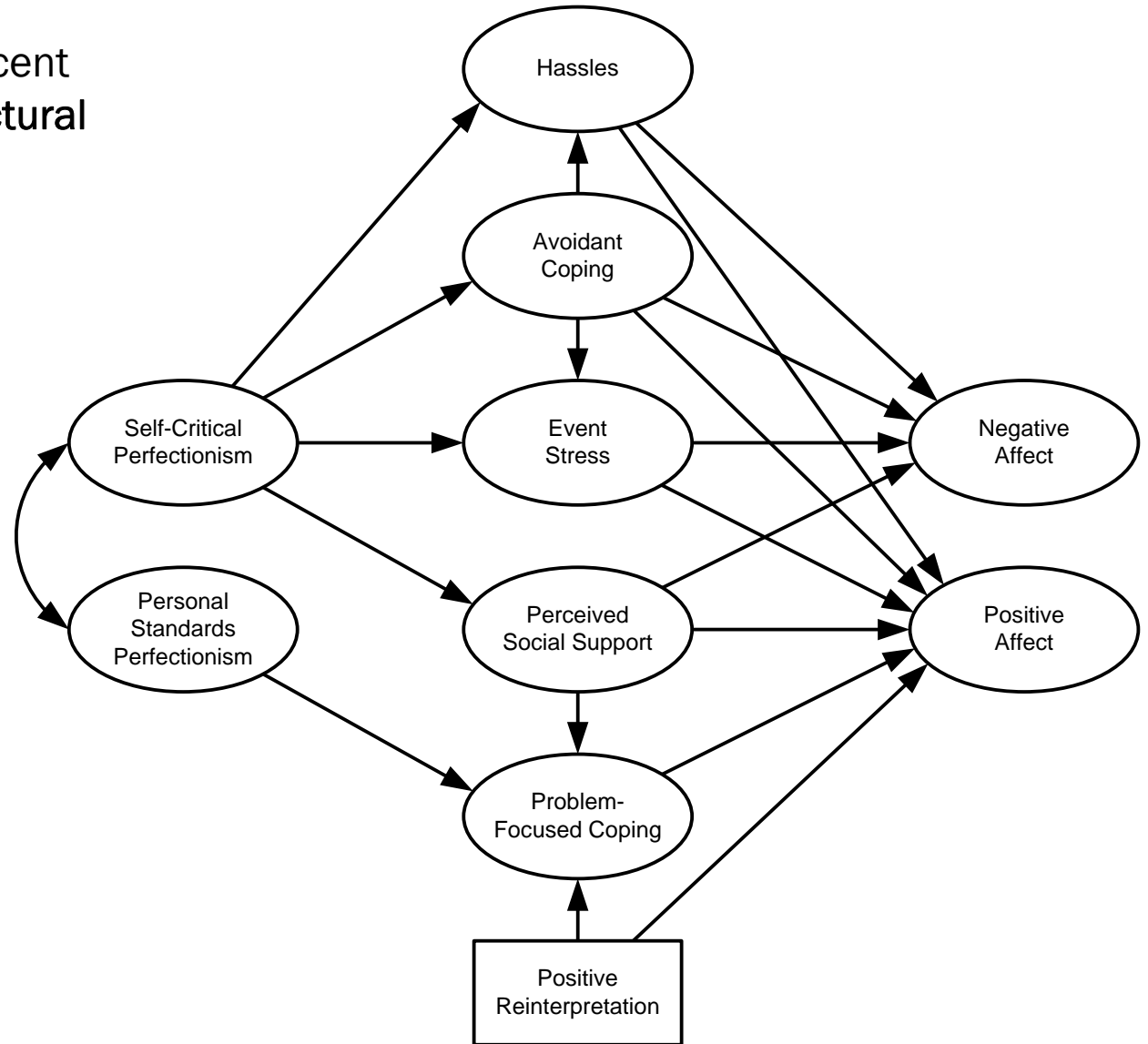
But, SEM does not accommodate nested data.



Motivating example: Dunkley et al. (2003)

In this talk I will describe recent advances in multilevel structural equation modeling (MSEM).

MSEM allows us to test mediation while simultaneously accounting for clustering and permitting all the benefits of SEM (Preacher, Zhang, & Zyphur, in press).



Outline of talk

1. Limitations of two traditional methods for assessing mediation with clustered data
 - Single-level structural equation modeling (SEM)
 - Multilevel modeling (MLM)
2. Advantages of multilevel structural equation modeling (MSEM) for assessing mediation with clustered data.
3. Demonstration of fitting and interpreting MSEM with Dunkley et al.'s (2003) data.

Traditional approach: Single-level SEM

In order to use single-level SEM to assess mediation in clustered data, we must either **disaggregate** the data to Level-1 or **aggregate** the data to Level-2.

- Using single-level SEM with **disaggregated** data will typically yield p -values that are too small.
- Using SEM with **aggregated** data (as in Dunkley et al.) will bias the effects downward due to using unreliable cluster means.
 - In other words, Dunkley et al. (2003) might conclude that **Perceived Social Support** does not mediate the **SC Perfectionism** → **Positive Affect** effect when it does (a **Type II error**).

However, SEM has advantages that Dunkley et al. needed:

- Multiple indicators of latent variables to handle measurement error
- Estimation of model fit
- Complex causal structure with multiple mediators
- Simultaneous estimation of all model parameters

Traditional approach: MLM

The second traditional approach for assessing mediation in clustered data is **multilevel modeling (MLM)**.

Many studies have discussed testing mediation hypotheses with MLM (e.g., Bauer, Preacher, & Gil, 2006; Kenny, Kashy, & Bolger, 1998; Kenny, Korchmaros, & Bolger, 2003; Krull & MacKinnon, 1999, 2001; Pituch & Stapleton, 2008; Pituch, Stapleton, & Kang, 2006; Zhang, Zyphur, & Preacher, 2009).

Using MLM does account for clustering, so p -values will not be systematically underestimated as in single-level models with disaggregated data.

Traditional approach: MLM

However, there still are some limitations of MLM for mediation:

1. When the indirect effect involves a 1→1 path (e.g., Dunkley et al.'s **Perceived Social Support** → **Positive Affect**), MLM conflates Within- and Between-cluster effects, leading to bias (under- or overestimation) in the indirect effect.
2. MLM does not accommodate Level-2 outcomes. Dunkley et al.'s model did not include any Level-2 outcomes, but one could imagine scenarios in which it would be important to specify a Level-2 outcome.

For example, Dunkley et al. could have measured **Positive Affect** at the person level.

Traditional approach: MLM

Furthermore,

3. MLM does not allow for Dunkley et al.'s multiple indicators of latent variables, making it difficult to deal with measurement error.
4. MLM does not allow estimation of model fit.
5. MLM does not make it easy to incorporate complex causal paths with multiple mediators.

Dunkley et al. wanted to include all of these features.

MSEM

We can combine the strengths of the single-level SEM approach (latent variables, model fit, complex models with multiple mediators) with the strengths of the MLM approach (handles clustering) by using **multilevel structural equation modeling (MSEM)**.

The models we will describe use the MSEM formulation of Muthén & Asparouhov (2008).

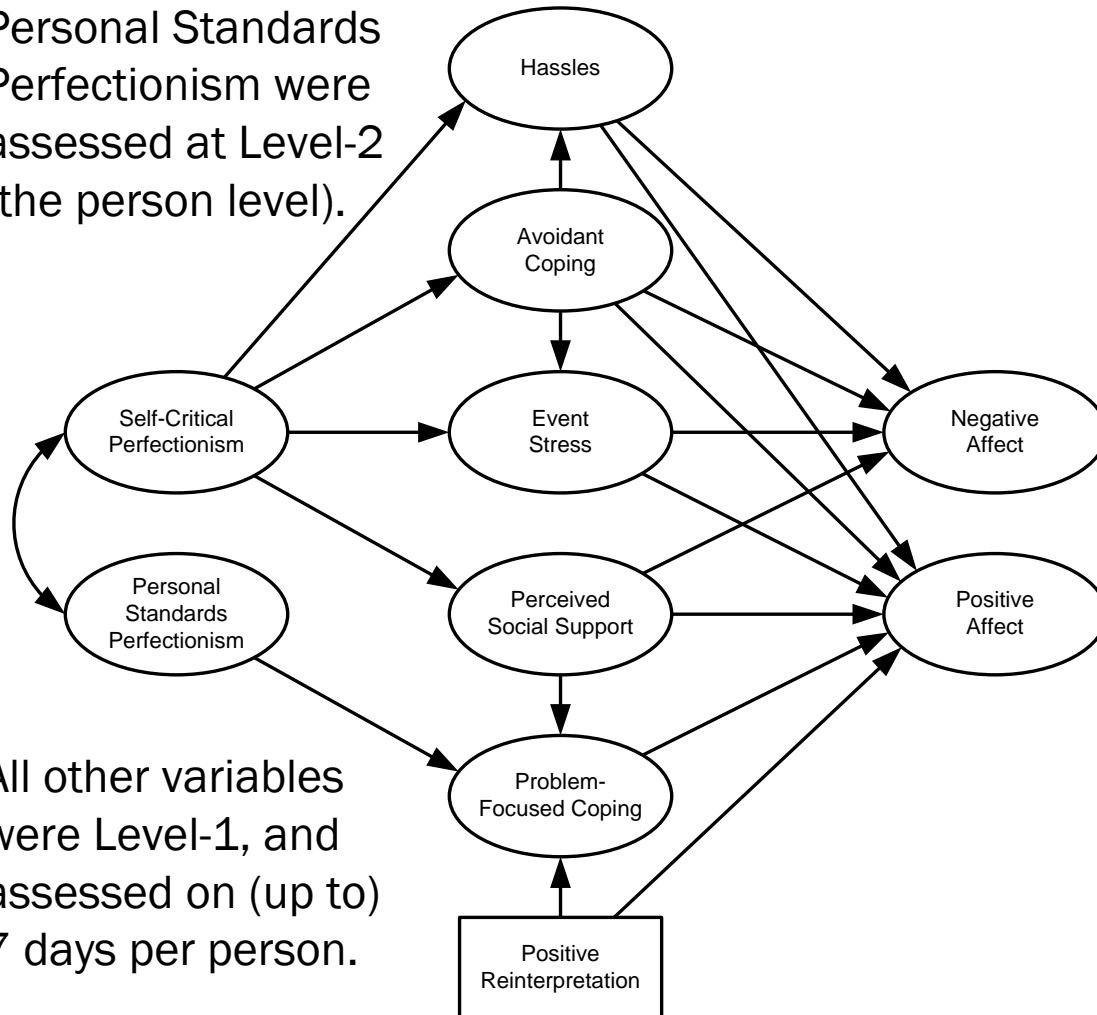
This formulation builds on two decades of developments by Bentler, McDonald, Goldstein, Muthén, and colleagues.

MSEM for Dunkley et al. data

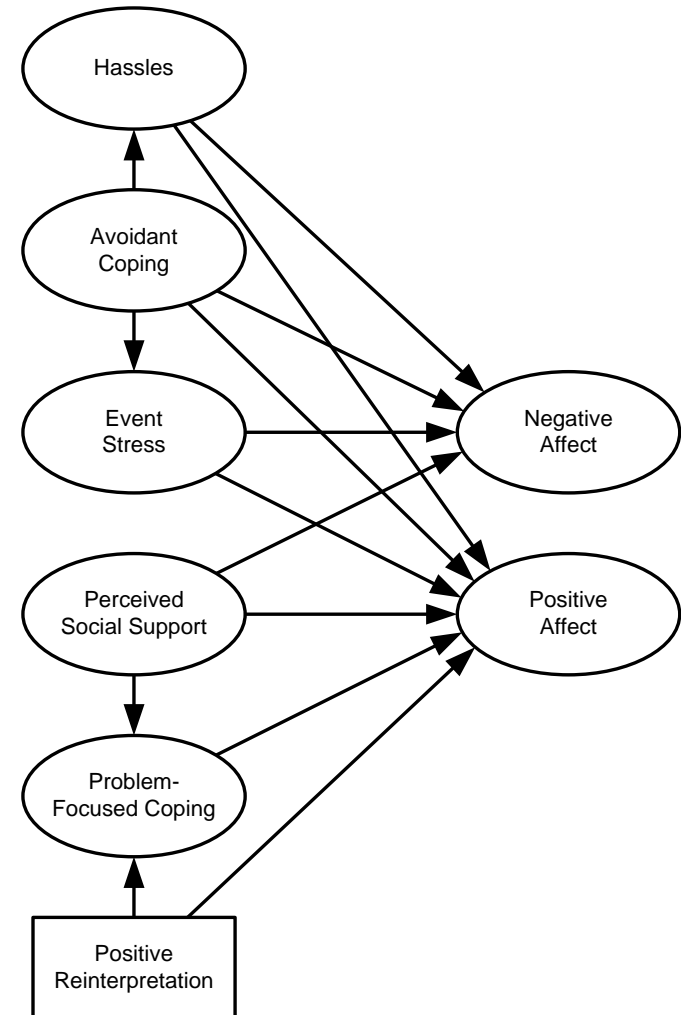
Self-Critical and Personal Standards Perfectionism were assessed at Level-2 (the person level).

All other variables were Level-1, and assessed on (up to) 7 days per person.

Between



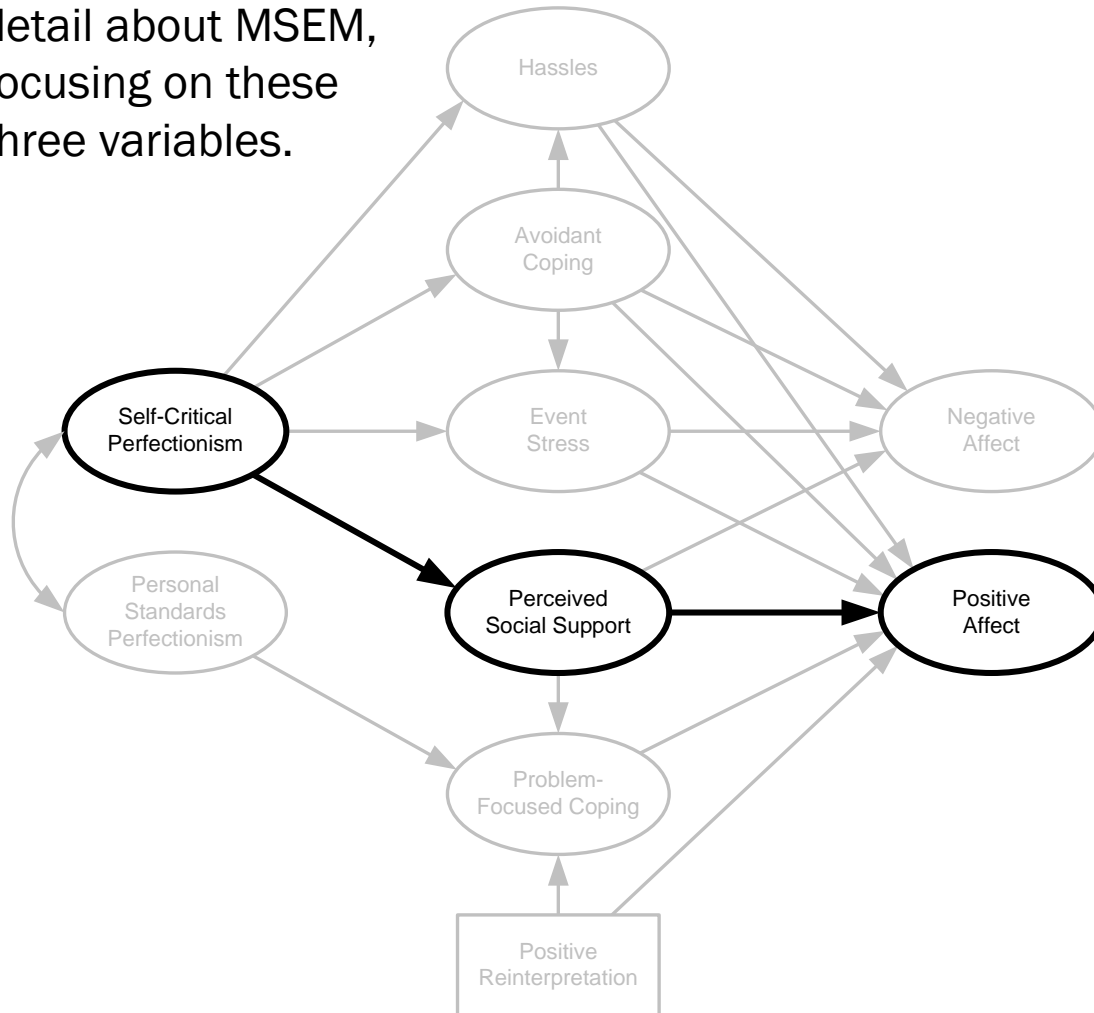
Within



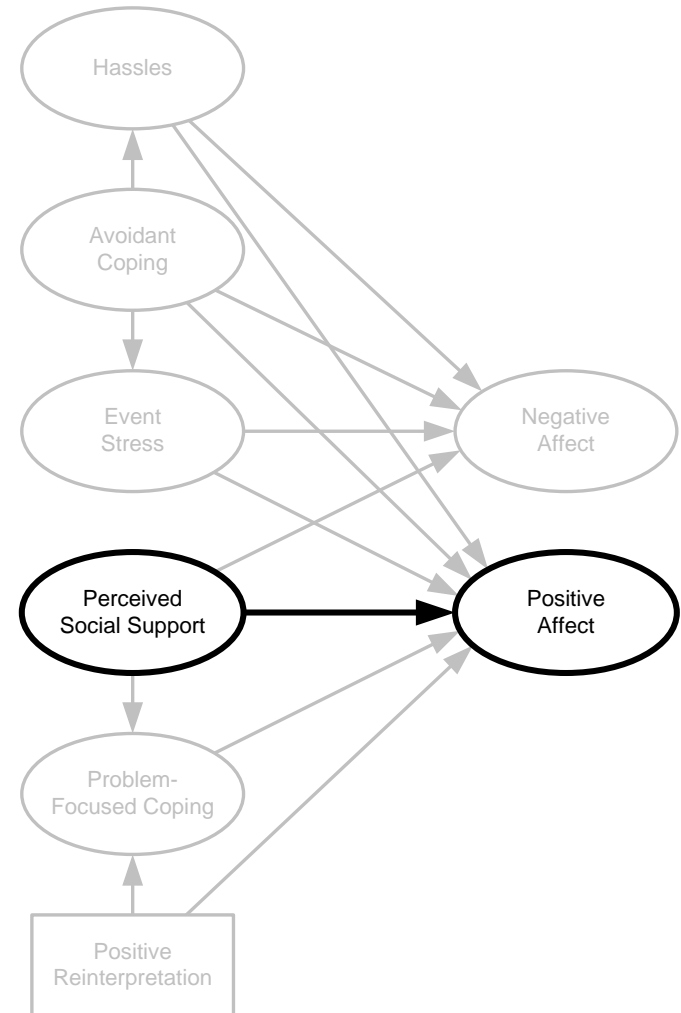
MSEM for Dunkley et al. data

I will talk in more detail about MSEM, focusing on these three variables.

Between



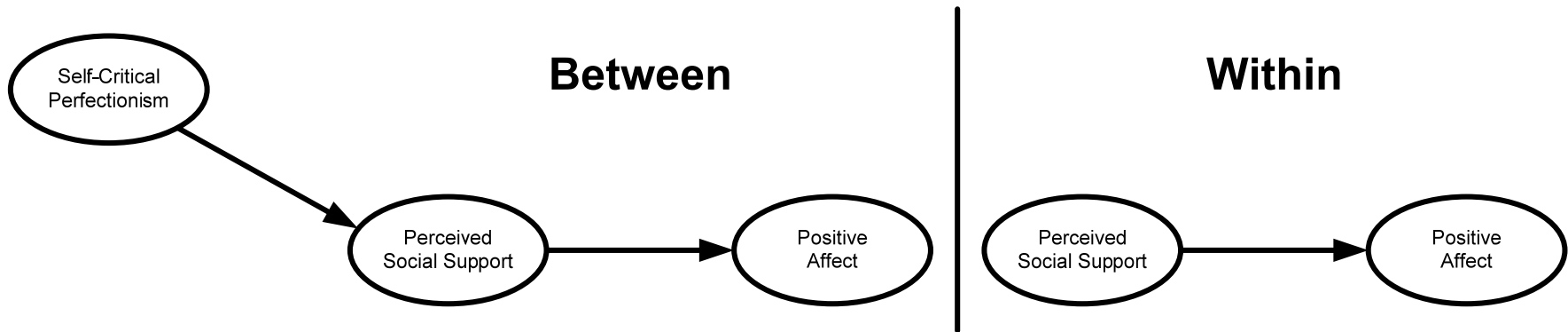
Within



MSEM for Dunkley et al. data

Here we are interested in the effects linking **SC Perfectionism**, **Positive Affect**, and **Perceived Social Support**.

SC Perfectionism is assessed at Level-2, and **Perceived Social Support** and **Positive Affect** are assessed at Level-1 (a 2→1→1 submodel).



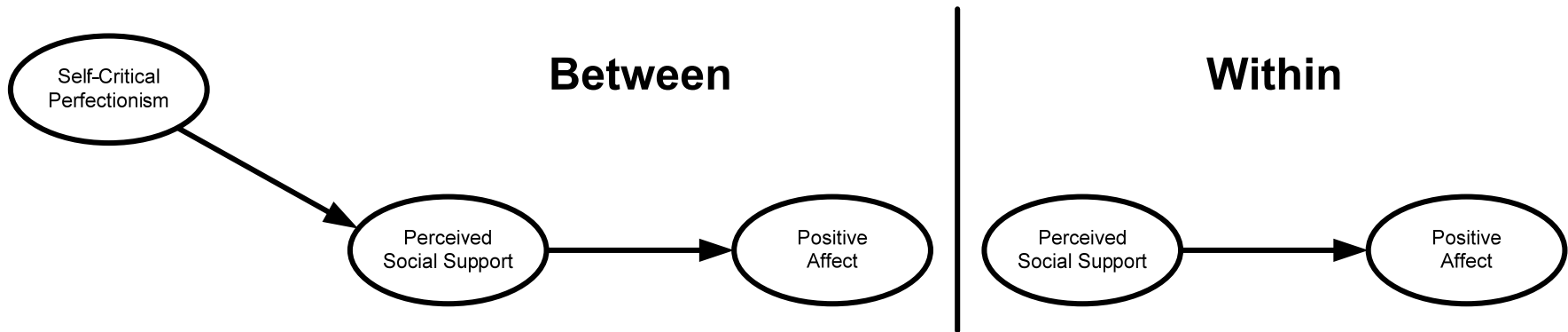
There is potentially a **Between** indirect effect because all three variables have Between-cluster variance components, but no **Within** indirect effect because SC Perfectionism is a strictly Level-2 variable.

MSEM for Dunkley et al. data

In MSEM, the Within-cluster components and Between-cluster components are modeled as orthogonal sets of latent variables.

In the Between model, *person* is the unit of analysis.

In the Within model, *repeated measure* is the unit of analysis.

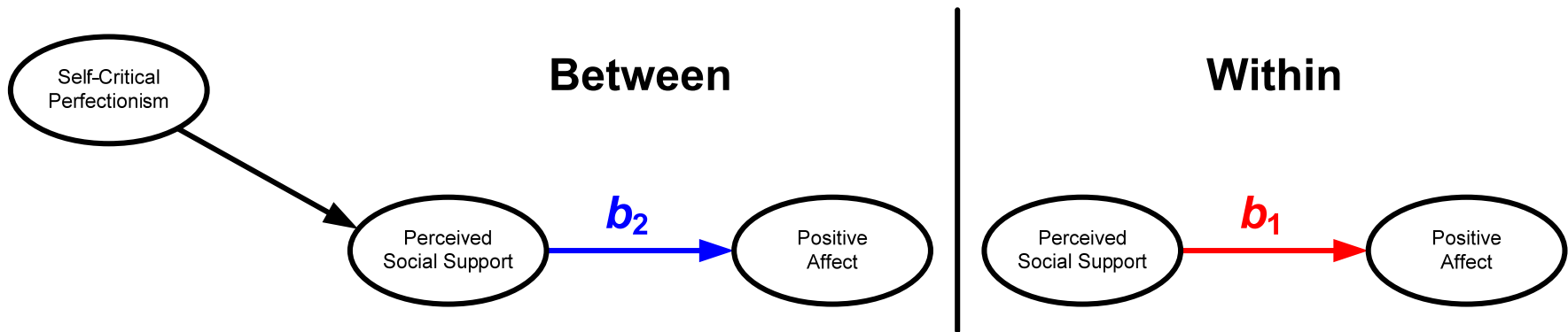


MSEM allows the means of Level-1 variables (**Perceived Social Support** and **Positive Affect**) to vary across Level-2 units (people). Hence, using MLM terminology, these constructs can be thought of as having “random intercepts.”

MSEM for Dunkley et al. data

Different Within and Between models automatically allow Within and Between component effects (b_1 and b_2) to be unconfled.

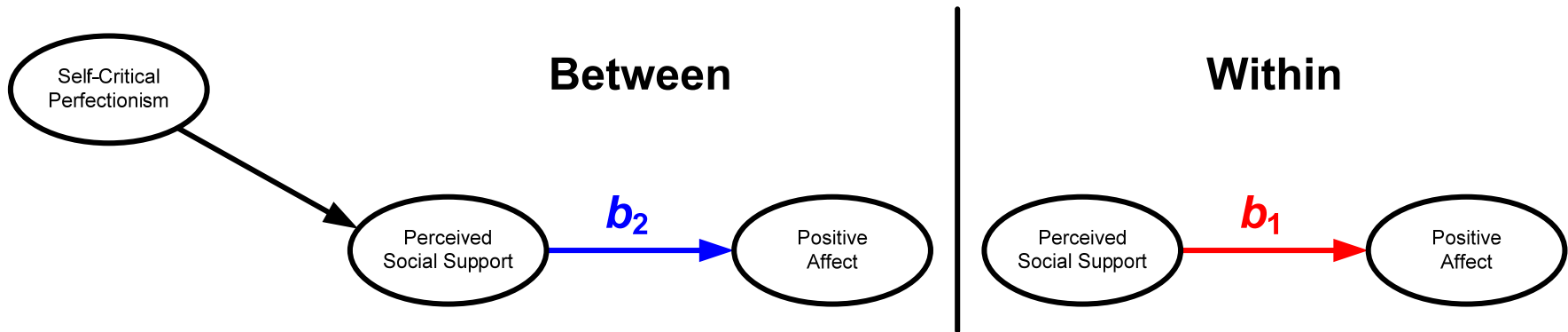
This means that, unlike in MLM, the Between-cluster indirect effect is unbiased.



MSEM for Dunkley et al. data

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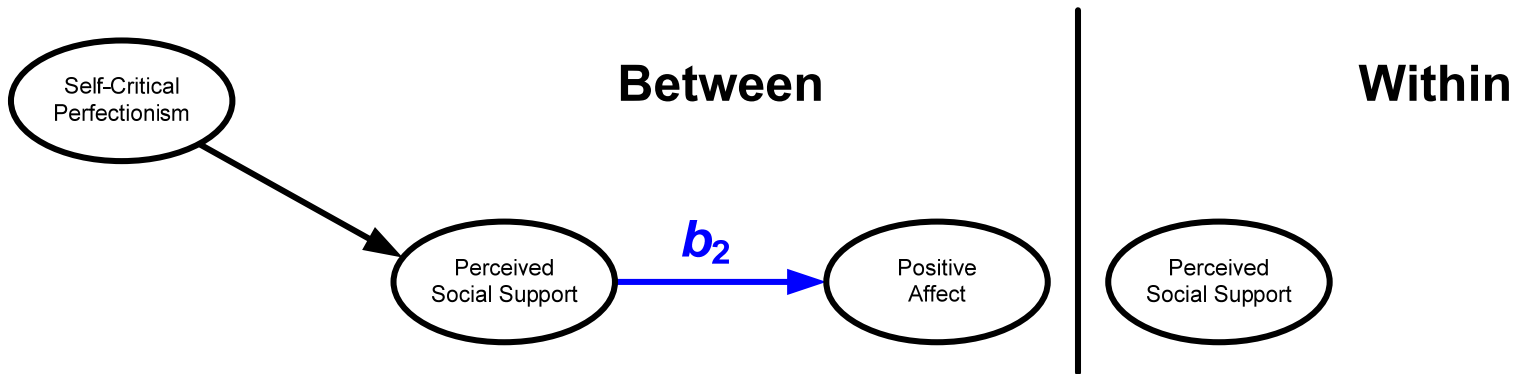


Some procedures exist for unconfounding the Between indirect effect in MLM without using MSEM (Zhang, Zyphur, & Preacher, 2009), but they do not work well when clusters are small or ICCs are low.

Such conditions are common in psychology.

MSEM for Dunkley et al. data

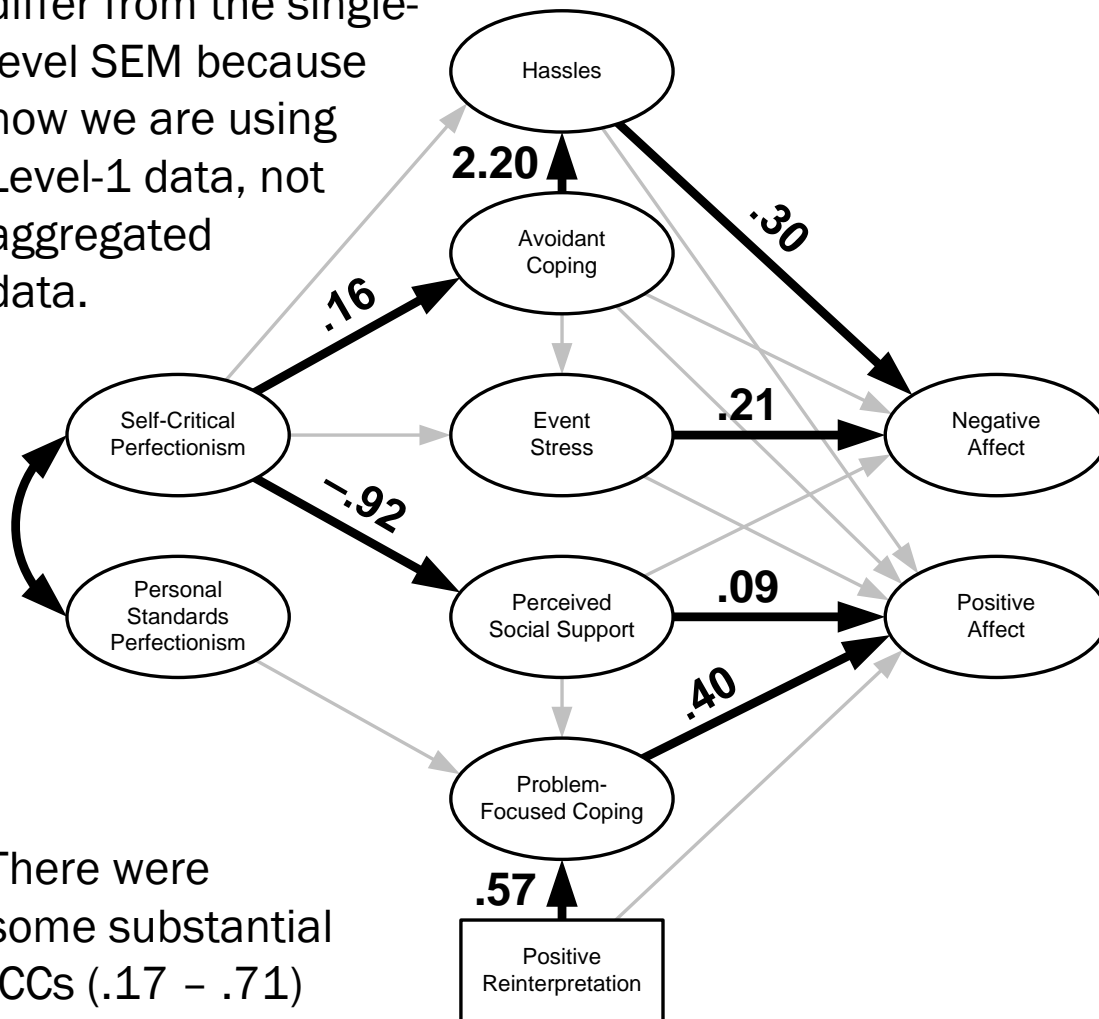
Note also that if **Perceived Social Support** or **Positive Affect** had been Level-2 variables, this would be easy to handle in MSEM, whereas in MLM it would be impossible to include them.



MSEM for Dunkley et al. data

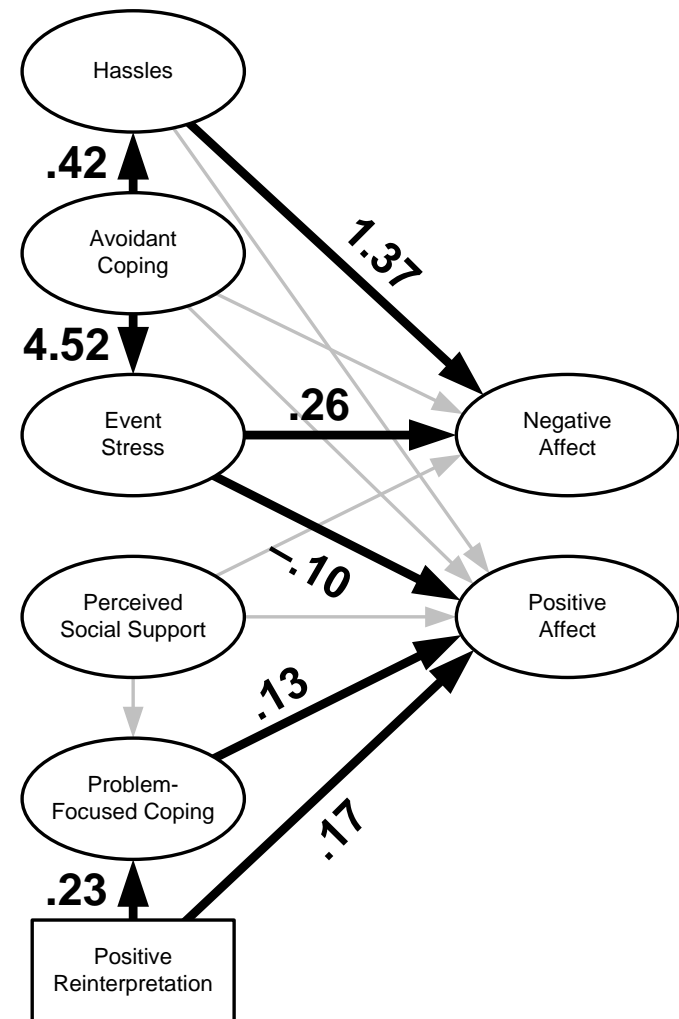
Some Between paths differ from the single-level SEM because now we are using Level-1 data, not aggregated data.

Between



There were some substantial ICCs (.17 - .71)

Within



Summary

We reviewed traditional approaches often used to assess mediation in the presence of clustering (MLM and SEM).

Both methods were used by Dunkley et al. (2003) prior to the availability of this MSEM.

We demonstrated that MSEM was able to (a) estimate parameters unavailable with MLM and (b) avoid bias present in traditional SEM and MLM approaches.

Mplus syntax for the MSEM mediation model presented here: <http://quantpsy.org>

Extensions and future directions

The advantages of MSEM generalize to more complex mediation MSEM:

Extensions:

- Three-level MSEM (Preacher, forthcoming)
- MSEM w/ random slopes (Preacher, Zyphur, & Zhang, in press)
- Bootstrap CI's for multilevel indirect effects (<http://quantpsy.org>)

Future directions:

- Multiple-mediator MSEM
- Moderated mediation in MSEM
- Longitudinal mediation MSEM

References

- Dunkley, D. M., Blankstein, K. R., Halsall, J., Williams, M., & Winkworth, G. (2000). The relation between perfectionism and distress: Hassles, coping, and perceived social support as mediators and moderators. *Journal of Counseling Psychology, 47*, 437-453.
- Dunkley, D. M., Zuroff, D. C., & Blankstein, K. R. (2003). Self-critical perfectionism and daily affect: Dispositional and situational influences on stress and coping. *Journal of Personality and Social Psychology, 84*, 234-252.
- Muthén, B. O., & Asparouhov, T. (2008). Growth mixture modeling: Analysis with non-Gaussian random effects. In G. Fitzmaurice, M. Davidian, G. Verbeke, & G. Molenberghs (Eds.), *Longitudinal data analysis* (pp. 143-165). Boca Raton, FL: Chapman & Hall/CRC.
- Preacher, K. J. (October, 2009). *A multilevel structural equation modeling framework for mediation: Advantages and extensions*. Cattell Award address delivered at the annual meeting of the Society of Multivariate Experimental Psychology, Lincoln City, OR.
- Preacher, K. J., Zhang, Z., & Zyphur, M. J. (submitted). *Alternative methods for assessing mediation in multilevel data: The advantages of multilevel SEM*.
- Preacher, K. J., Zyphur, M. J., & Zhang, Z. (in press). A general multilevel SEM framework for assessing multilevel mediation. *Psychological Methods*.

Thank You