Modelling contemporaneous relations between ESM items measured in different timeframes

Yong Zhang[1], Jojanneke A. Bastiaansen[2], Laura F. Bringmann[1, 2], Anja F. Ernst[1]

[1] Department of Psychometrics and Statistics, University of Groningen; the Netherlands
[2] Interdisciplinary Center Psychopathology and Emotion regulation, University of Groningen, University Medical Center Groningen; the Netherlands

Introduction

Background

Two common timeframes of ESM items: `momentary` and `retrospective`.

Vector autoregressive (`VAR`) models are powerful tools for testing **contemporaneous** and **lagged** effects among momentary variables.

When there is any retrospective variable involved, the definitions of neither contemporaneous nor lagged effects were clear enough due to the `asynchrony` among variables.

ESM studies combining measures in both timeframes are common. Yet problems of overly relying on VAR models in such studies are not dealt with sufficiently.

The current study

Using data from a single-case study which included both momentary and retrospective measures, we explored the feasibility of a structural VAR (`SVAR`) model by comparing its **model fit indices** and performance in **cross-validation** with the corresponding VAR model.

The two models are observationally equivalent models and thus showed identical model fit indices.

Results of cross-validation suggest that the two models perform equally well in terms of predictive accuracy.

Based on the results, we recommend that researchers consider the more theory-driven approach of modelling the unidirectional contemporaneous effect in relevant future applications.

Data collection and preprocessing

1. N = 1, fixed interval sampling (3h), 5 times/day, 28 days
2. Measurement: 0-100 VAS

- Positive affect (PA): "I feel cheerful/content *right now*." `momentary`
- Physical activity: "I have been physically active *in the past 3 hours*." `retrospective`

3. Example question: can the level of physical activity predict subsequent PA?

- PA_t ~ $Physical_t$ + controls (lagged variables)

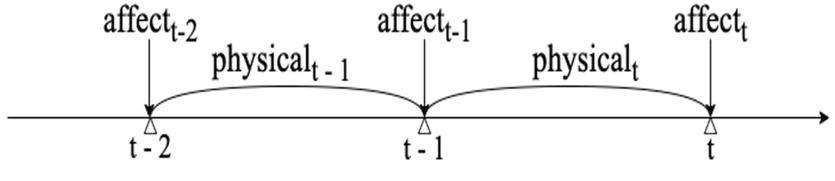

Figure 1. Illustration of the data structure

Model specifications and results

1. Two ways of modelling contemporaneous relations

- **Model 1: as correlated residuals in a standard VAR model**
- **Model 2: as a directed path in a structural VAR model**

2. Coefficients: see Figure 2

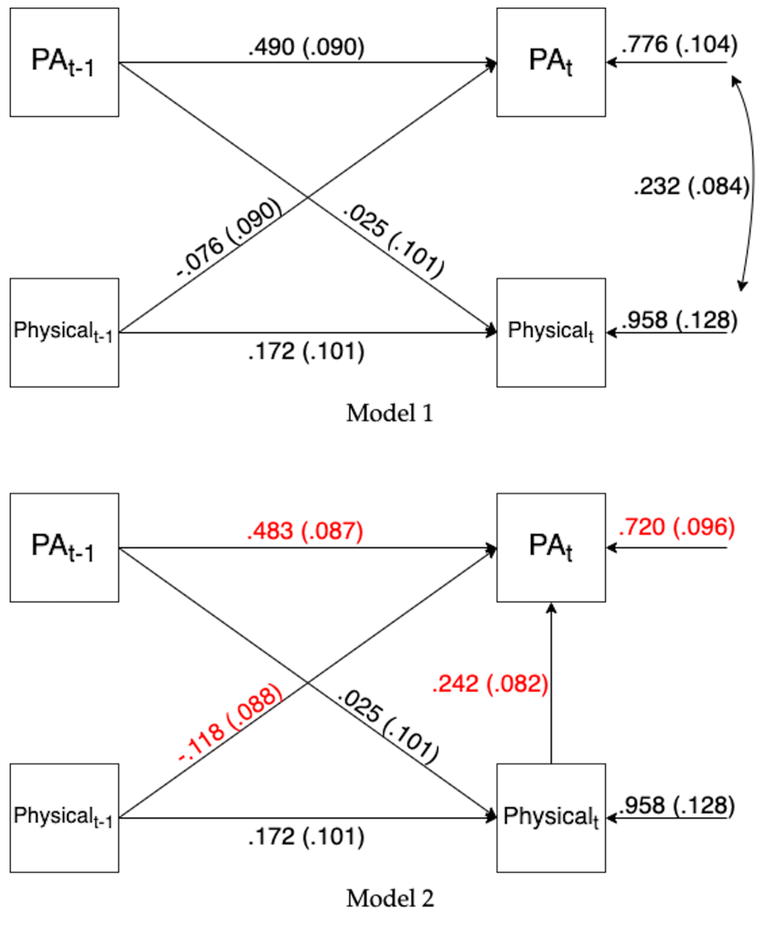

Figure 2. Illustration of the data structure

Model comparison

1. **Model fit indices**: identical for the two models; χ^2 (5) = 39.661, CFI = 1.00, RMSEA = .00, SRMR = .00.
   The two models are *equivalent models* (Pearl, 2009): Model 1 can generate every probability distribution that Model 2 can generate.

2. **Blocked cross-validation** (Snijders, 1988): highly similar performance between the two models (see Figure 3)

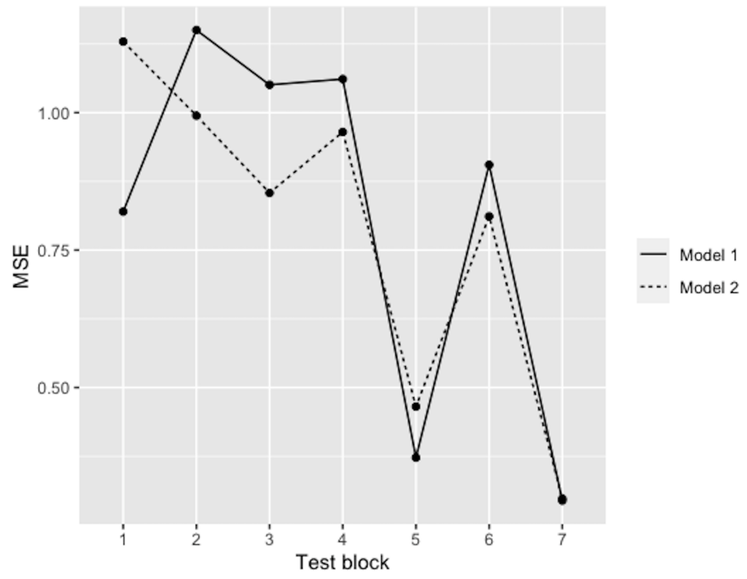

Figure 3. Mean squared error (MSE) of blocked cross validation for the two models

Conclusion and discussion

Between the two models

Highly similar model fit and predictive accuracy yet **Model 2** is more helpful for causal reasoning and further clinical implications. Therefore, when using VAR models with variables measured in different timeframes, consider:

Adapting the terminology used: the effect of physical activity on **subsequent** PA is different from the traditional definition of both **lagged** (similar meanings, different notations) and **contemporaneous** (different meanings, similar notations) effects.

Adapting model specifications based on theories: use SVAR models to model the effect of interest as a directed path.

Future directions

This is the "simplest" example: N = 1, the retrospective period is the same as the interval between two momentary measurements.

Consider doing such model comparisons in N > 1 studies by integrating multilevel analysis.

Digital phenotyping and passive physiological measures which can collect data at a higher temporal resolution than subjective measures are increasingly used nowadays. How to aggregate the data from passive measures is then an additional key question.

Supplemental materials

Data and the R script can be accessed via : https://github.com/YongZhangYZ/ESM-Network-meeting-poster.git