Changes in Response Behavior Over Time in ESM Studies: Is There Reason for Concern?

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Context

- ESM/EMA places high burden on participants [1–3]
- strategies to reduce this burden may include:
  - responding less often overall
  - responding at 'convenient' moments
  - increased backfilling (if possible)
  - choosing a 'standard' response
  - responding randomly
- but ESM may also lead to increased self-focused attention, self-awareness, and hence higher 'accuracy' [4]
- there may also be a 'calibration' process
- changes in the response behavior of participants may provide evidence for the occurrence of such phenomena

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Data

- used first four days from pooled dataset of 9 ESM studies
- each study used 10 semi-random signals per day (07:30 - 22:30)
- 1438 subjects (four different mental health status groups)
- positive and negative affect as primary outcomes (1 to 7 scale)
- (un)pleasant of events as the predictor of interest (-3 to +3 scale)
- 42,702 assessments with complete data on PA/NA (73.8%)
- 37,505 assessments with complete data on predictor (65.2%)

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Data Structure

Subject	Day	Beep	PA	NA	EP	Day1	Day2	Day3	Day4
1	1	1	5	2	0	1	0	0	0
1	1	2	6	2	1	1	0	0	0
1	1	.	.	.	.	.	.	.	.
1	1	10	2	4	-2	1	0	0	0
1	2	1	3	3	0	0	1	0	0
1	2	2	4	1	0	0	1	0	0
1	2	.	.	.	.	.	.	.	.
1	2	10	4	2	1	0	1	0	0
.	.	.	.	.	.	.	.	.	.

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Mixed-Effects Models

- let y_{ijk} be the response of person i on day j at beep k
- model allowing for change in mean level over days:

$$y_{ijk} = \alpha_1 \text{Day1}_{ij} + \alpha_2 \text{Day2}_{ij} + \alpha_3 \text{Day3}_{ij} + \alpha_4 \text{Day4}_{ij} + a_i + e_{ijk}$$

where $a_i \sim \text{N}(0, \tau^2)$ and $e_{ijk} \sim \text{N}(0, \sigma^2)$

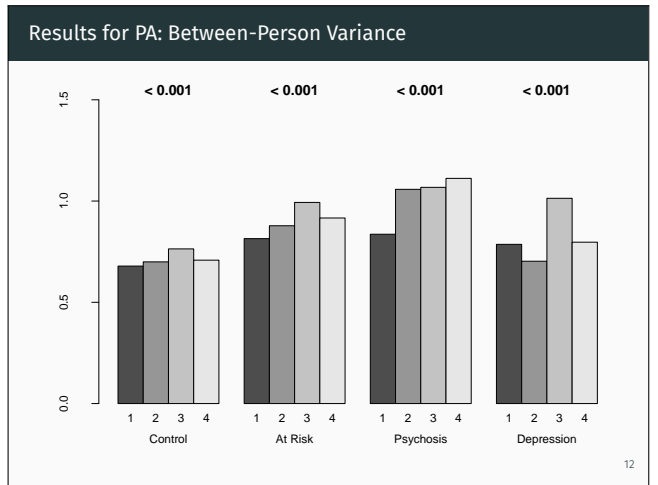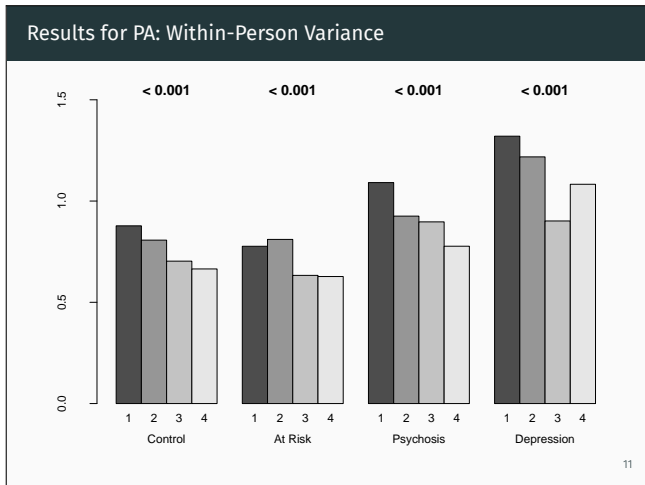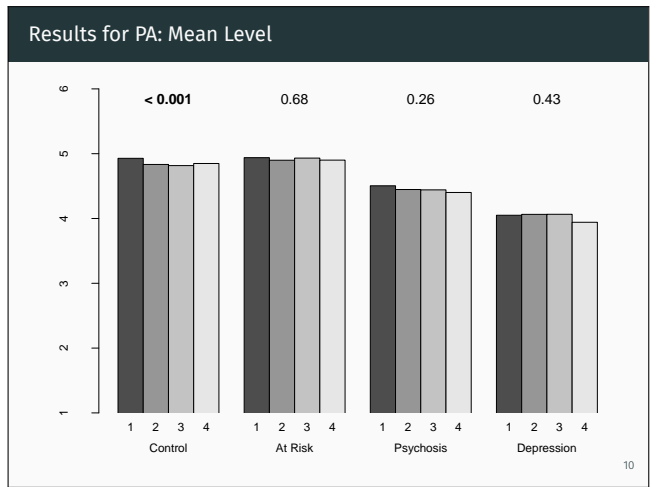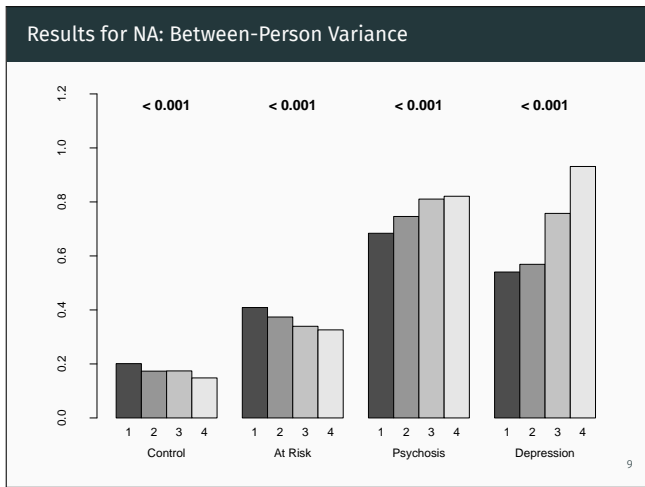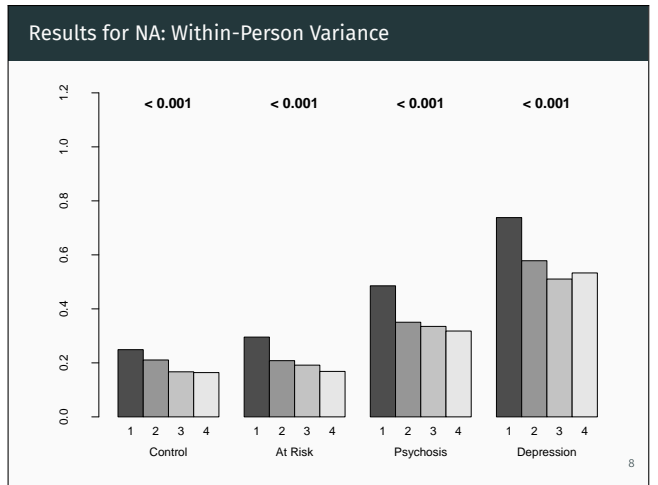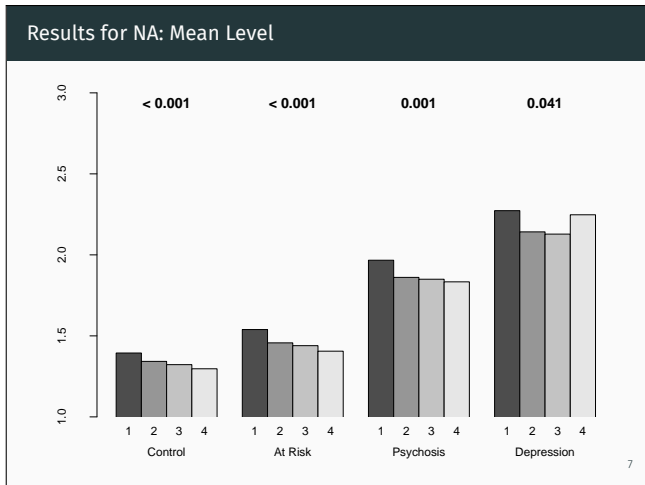- now allow each day to have its own random intercept:

$$y_{ijk} = \alpha_1 \text{Day1}_{ij} + \alpha_2 \text{Day2}_{ij} + \alpha_3 \text{Day3}_{ij} + \alpha_4 \text{Day4}_{ij} +$$
$$a_{1i} \text{Day1}_{ij} + a_{2i} \text{Day2}_{ij} + a_{3i} \text{Day3}_{ij} + a_{4i} \text{Day4}_{ij} + e_{ijk}$$

where $[a_{1i}, a_{2i}, a_{3i}, a_{4i}]' \sim \text{MVN}(0, G)$ and $e_{ijk} \sim \text{N}(0, \sigma^2)$

- finally let $e_{ijk} \sim \text{N}(0, \sigma_j^2)$ which allows the within-person variance to change over days

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Inference Methods

- test for change in mean level:
  Wald-type test of $H_0 : \alpha_1 = \alpha_2 = \alpha_3 = \alpha_4$

- test for change in between-person variance:
  likelihood ratio test of $H_0 : \tau_1^2 = \tau_2^2 = \tau_3^2 = \tau_4^2$
  $$H_0 : \text{diag}(G) = \tau^2$$

- test for change in within-person variance:
  likelihood ratio test of $H_0 : \sigma_1^2 = \sigma_2^2 = \sigma_3^2 = \sigma_4^2$

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Results for NA: Mean Level

Results for NA: Within-Person Variance

Results for NA: Between-Person Variance

Results for PA: Mean Level

Results for PA: Within-Person Variance

Results for PA: Between-Person Variance

Model for Change in the Within-Person Association

- model allowing for change in association over days:

$$
\begin{aligned}
y_{ijk} = \ & \alpha_1 \text{Day1}_{ij} + ... + \alpha_4 \text{Day4}_{ij} + \\
& a_{1i}\text{Day1}_{ij} + ... + a_{4i}\text{Day4}_{ij} + \\
& \beta_1 \text{Day1}_{ij}\text{EP}_{ijk} + ... + \beta_4 \text{Day4}_{ij}\text{EP}_{ijk} \\
& b_{1i}\text{Day1}_{ij}\text{EP}_{ijk} + ... + b_{4i}\text{Day4}_{ij}\text{EP}_{ijk} + e_{ijk}
\end{aligned}
$$

where

- $[a_{1i}, a_{2i}, a_{3i}, a_{4i}, b_{1i}, b_{2i}, b_{3i}, b_{4i}]' \sim \text{MVN}(0, G)$
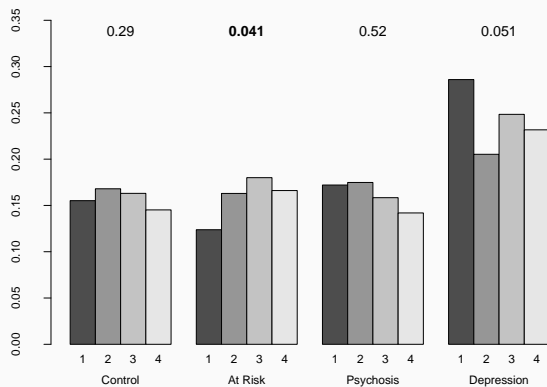- $e_{ijk} \sim \text{N}(0, \sigma_j^2)$

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Results for NA: Within-Person Association
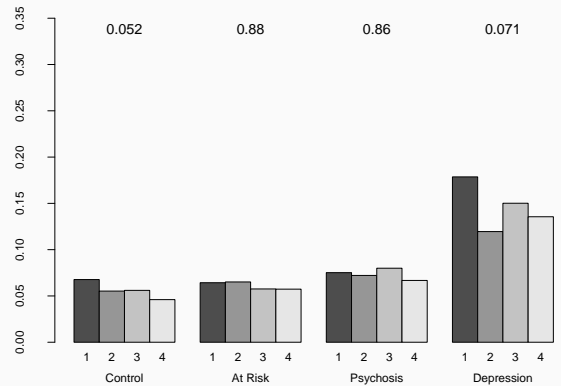
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Results for PA: Within-Person Association

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Model for Change in the Autocorrelation
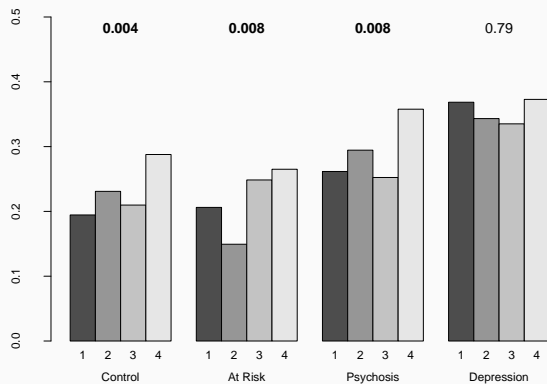
- model allowing for change in autocorrelation over days:

$$
\begin{aligned}
y_{ijk} = \ & \alpha_1 \text{Day1}_{ij} + ... + \alpha_4 \text{Day4}_{ij} + \\
& a_{1i}\text{Day1}_{ij} + ... + a_{4i}\text{Day4}_{ij} + \\
& \beta_1 \text{Day1}_{ij}y_{ij,k-1} + ... + \beta_4 \text{Day4}_{ij}y_{ij,k-1} \\
& b_{1i}\text{Day1}_{ij}y_{ij,k-1} + ... + b_{4i}\text{Day4}_{ij}y_{ij,k-1} + e_{ijk}
\end{aligned}
$$

where

- $[a_{1i}, a_{2i}, a_{3i}, a_{4i}, b_{1i}, b_{2i}, b_{3i}, b_{4i}]' \sim \text{MVN}(0, G)$
- $e_{ijk} \sim \text{N}(0, \sigma_j^2)$
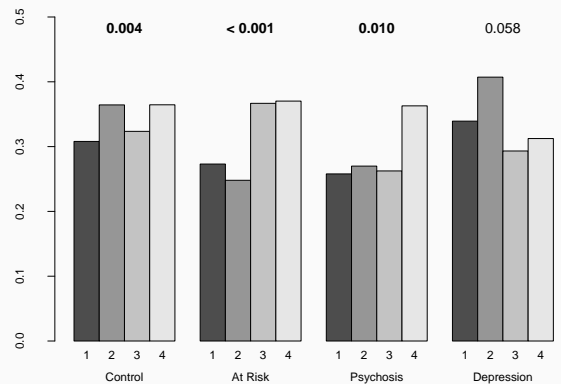- assessments included in analysis: 49.7% for NA, 49.8% for PA

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Results for NA: Autocorrelation

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Results for PA: Autocorrelation

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Logistic Mixed-Effects Model for Dichotomous Outcome
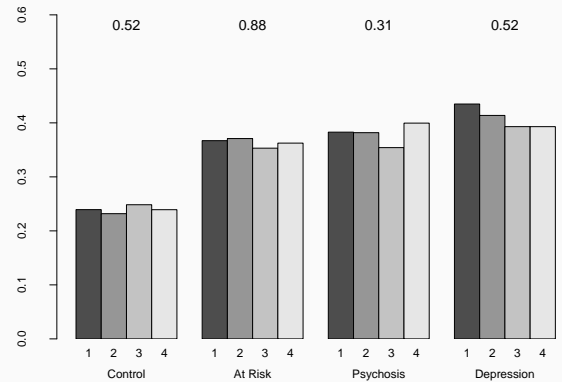
- model allowing for change in a dichotomous outcome:

$$\text{logit}(\pi_{ijk}) = \alpha_1 \text{Day1}_{ij} + ... + \alpha_4 \text{Day4}_{ij} +$$
$$a_{1i}\text{Day1}_{ij} + ... + a_{4i}\text{Day4}_{ij}$$

  where $[a_{1i}, a_{2i}, a_{3i}, a_{4i}]' \sim \text{MVN}(0, G)$
- examined if probability of being alone and being at home increased over time (might indicate increased responding at convenient moments)
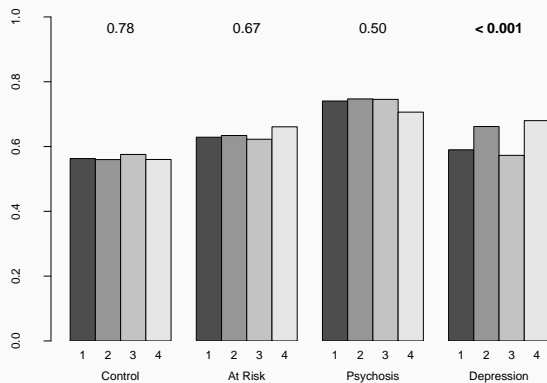
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Results for Being Alone: Mean Level (Probability)

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Results for Being At Home: Mean Level (Probability)

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Summary

- decreases in outcomes (esp. NA) are consistent with the **initial elevation effect** reported by Shrout et al. (2018) [5]
- **decreases in within-person variance** (30-40% in NA; 10-15% in PA) are consistent with findings by Napa Scollon et al. (2003) [2]
- evidence for some **changes in between-person variance and autocorrelation** (but inconsistent across groups/outcomes)
- no evidence for increased responding at convenient moments
- decreases in within-person variance either suggest increased tendency to give standard responses or calibration process
- evidence for changes in within-person association is weak (which points towards **calibration process**, not careless responding)

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References

1. Bolger, N., Davis, A., & Rafaeli, E. (2003). Diary methods: Capturing life as it is lived. *Annual Review of Psychology, 54*, 579–616.

2. Napa Scollon, C., Kim-Prieto, C., & Diener, E. (2003). Experience sampling: Promises and pitfalls, strengths and weaknesses. *Journal of Happiness Studies, 4*(1), 5–34.

3. Shiffman, S., Stone, A. A., & Hufford, M. R. (2008). Ecological momentary assessment. *Annual Review of Clinical Psychology, 4*, 1–32.

4. Brandstaetter, H. (1983). Emotional responses to other persons in everyday life situations. *Journal of Personality and Social Psychology, 45*(4), 871–883.

5. Shrout, P. E., Stadler, G., Lane, S. P., McClure, M. J., Jackson, G. L., Clavel, F. D., ... Bolger, N. (2018). Initial elevation bias in subjective reports. *Proceedings of the National Academy of Sciences of the United States of America, 115*(1), E15–E23.

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Thank You!

Questions, Comments, Suggestions?

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