Variance Drop Test: Because the KCP solution by construction improves with more change points (because variance will be decreased when window sizes are smaller and more homogeneous), the variance drop test tests whether the drop in variance by adding an additional change point in the raw data exceeds the drop in variance in the permuted data sets in at least 97.5% of cases.

Steps: 1. Calculate moving window correlations.

2. Calculate Gaussian similarity of correlations within all possible combinations of windows.

3. Repeat steps 1 and 2 for 1000 permutations of the raw data.

4. Perform the Variance test using the Gaussian similarity when K = 0.

5. Perform the Variance drop test using the max drop in average Variance of Gaussian similarity ($\hat{R}$).

6. Make a conclusion on whether there is a change point using a combination of 4 and 5.

Statistical models

Gaussian Similarity Measure:

$$Gk(\mathbf{R}_i, \mathbf{R}_j) = exp\Big(\frac{-||\mathbf{R}_i - \mathbf{R}_j||^2}{2h_R^2}\Big)$$

where, h_R is obtained by computing the median Euclidean distances between all R_i's.

Calculating variance within a window:

$$\hat{V}_{p,\tau_1,\tau_2,...,\tau_K} = (\tau_p - \tau_{p-1}) - \frac{1}{\tau_p - \tau_{p-1}} \sum_{i=\tau_{p-1}+1}^{\tau_p} \sum_{j=\tau_{p-1}+1}^{\tau_p} Gk(\mathbf{R}_i, \mathbf{R}_j)$$

Calculating average variance within a window:

$$\hat{R}(\tau_1, \tau_2, ..., \tau_K) = \frac{1}{n} \sum_{p=1}^{K+1} \hat{V}_p, \tau_1, \tau_2, ..., \tau_K$$

Choosing the Change Points

$$\tau_1, \tau_2, ..., \tau_K = arg\ min\ \hat{R}(\tau_1, \tau_2, ..., \tau_K) = arg\ min \frac{1}{n} \sum_{p=1}^{K+1} \hat{V}_p, \tau_1, \tau_2, ..., \tau_K$$

Calculating the Variance Test:

$$P_{variancetest} = \frac{\#(\hat{R}_{min,K=0} > \hat{R}_{min,K=0,perm})}{B}$$

Calculating the Variance Drop Test:

$$P_{variancedroptest} = \frac{\#(max\ variance\ drop_{perm} > max\ variance\ drop)}{B}$$

where $max\ variance\ drop = \hat{R}_{min,K} - \hat{R}_{min,K-1}$

Transformations

Items noted above with a "(-)" will be reverse coded.

Follow-up analyses

Inference criteria

We are using a permutation based approach that involves two tests (the variance drop test and the variance test). As such, we will use a Bonferroni correction ($\frac{\alpha}{2}$), such that the raw observed value should be greater than 97.5% of the permuted values (variance and variance drop).

Data exclusion

Participants with fewer than 25 responses will be excluded because of inadequate power to detect change.

Missing data

Missing data will left as missing to prevent correlating across uneven time windows.

Exploratory analyses (optional)

As a follow up, we will test whether identified change points coincide with life event experiences.

It is possible that only a small subset of the population will show reliable change points. Of those that do, it is likely that only a subset will report one of the 7 life events we collected. Of those that do, we will report the proportion of individuals whose life event experiences fall +/- 2 weeks from the empirically derived change points.

Analysis scripts (optional)

Attached with this preregistration is an R script with a series of functions written to succinctly run the KCP permutation procedure given a data frame of multivariate time series data.