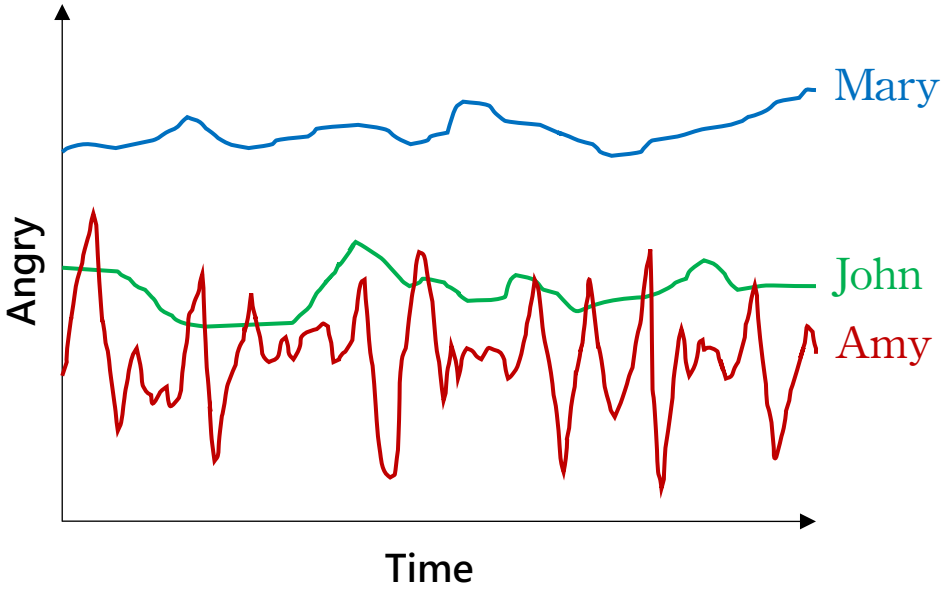
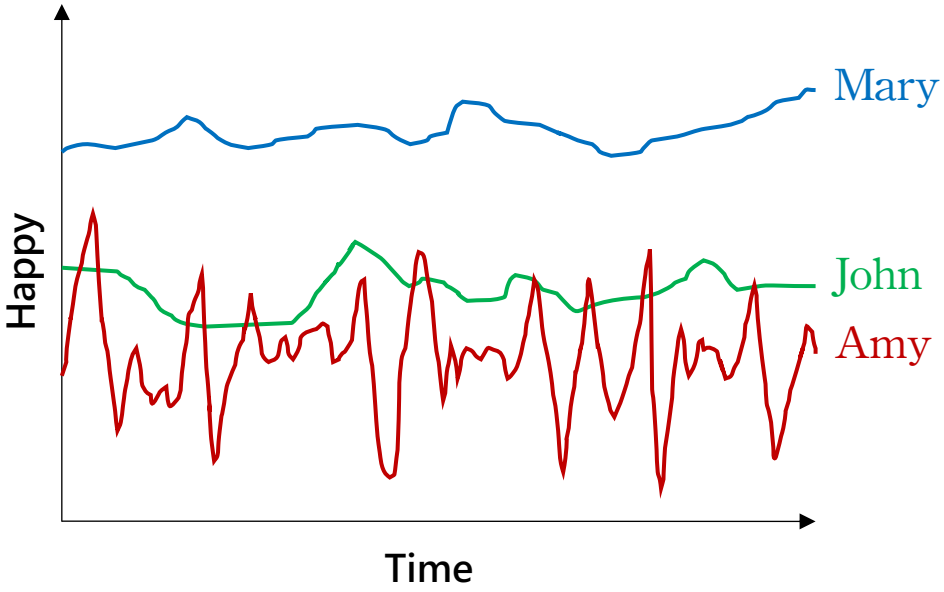
Extracting individual's affective dynamic features

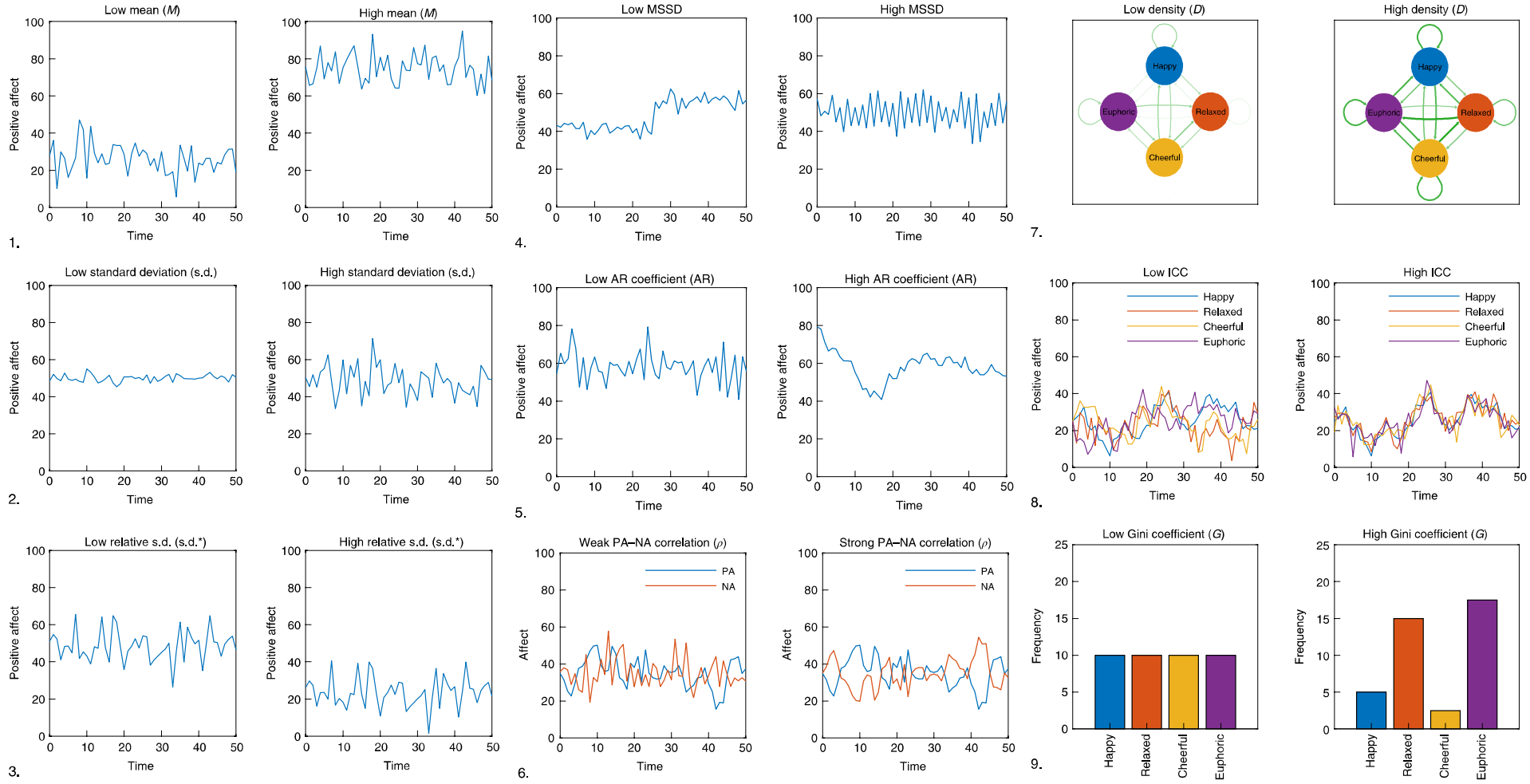
Qi-Wen Ding

Individual differences in affective dynamics





Features of emotion dynamics



Dejonckheere et al. (2019, Figure 1). *Nature Human Behaviour*

Features of emotion dynamics

Feature	Definition	Index
Average intensity	How strong an emotion is felt on average, both between emotions within an individual and bet. individuals	Mean score over time
Variability	Intensity varies across time for a single person	Within-person variance or *SD*
Inertia	Tendency of an emotion to carry over from one moment to the next (i.e., resistance to change)	Autocorrelation
Cross-lag	Augmentation: emotion A↑ ↔ emotion B↑ Blunting: emotion A↑ ↔ emotion B↓	Cross-lag cor. between 2 emotions
Granularity	Ability of differentiating between different emotions	▪ # of PCs between emotions of a single person ▪ *Var* unexplained by 1st PC ▪ Cor. or cov. between 2 emotions within a person ▪ ICC between all emotions

Krone et al. (2018). *Emotion*

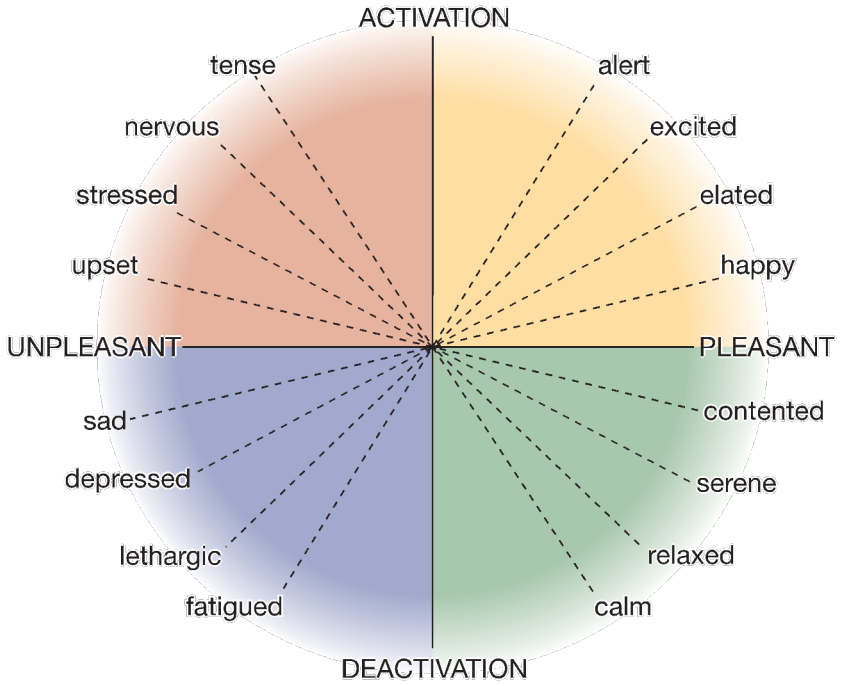
Features of emotion dynamics & mental health

Features	Relationships
Average intensity ($\boldsymbol{\mu}_{i,\,n}$)	For NA: Neuroticism, depression, … For PA: Emotion regulation, extraversion, agreeableness, conscientiousness
Variability ($\boldsymbol{\Sigma}_{ii,\,n}$)	Stress level, mood disorder (+) Age, emotional well-being (-)
Inertia ($\boldsymbol{\Phi}_{ii,\,n}$)	Rumination (+) Emotional regulation (-)
Cross-lag ($\boldsymbol{\Phi}_{ij,\,n}$)	Increase in major depression patients in terms of higher levels of overall emotion network density
Granularity ($\boldsymbol{\Sigma}_{ij,\,n}$)	Emotion regulation, more effective coping mechanisms (+) Neuroticism, social anxiety disorder, depression (-)

Krone et al. (2018). *Emotion*

Data

- 104 participants (44 female, 7 NA)
- Age 20 ~ 52
- 7 days
- 6 time intervals in each day
- Two emotions: **Valance** & **Arousal**



Bayesian dynamic model

Observation equation

$$\mathbf{y}_{t,n} = \boldsymbol{\mu}_n + \boldsymbol{\theta}_{t,n} + \boldsymbol{\varepsilon}_{t,n} \quad \boldsymbol{\varepsilon}_{t,n} \sim N(\mathbf{0}, \mathbf{H}_n)$$

Average intensity

Indep.

System equation

$$\boldsymbol{\theta}_{t,n} = \boldsymbol{\Phi}_n \times \boldsymbol{\theta}_{t-1,n} + \boldsymbol{\eta}_{t,n} \quad \boldsymbol{\eta}_{t,n} \sim N(\mathbf{0}, \mathbf{Q}_n)$$

Inertia & Cross-lag

Model-implied covariance

$$\mathrm{vec}(\boldsymbol{\Sigma}_n) = (\mathbf{I} - \boldsymbol{\Phi}'_n \otimes \boldsymbol{\Phi}'_n)^{-1} \mathrm{vec}(\mathbf{Q}_n + \mathbf{H}_n)$$

Variability & Granularity

t: time
n: individual

Krone et al. (2018). *Emotion*

Bayesian dynamic model

[**H** = diag(**τ**)**Ω**diag(**τ**), where **τ** ~ *Cauchy*(0, 2.5) & **Ω** ~ *LKJ*(2)]
LKJ prior for the corr. matrix of **H**
Half-Cauchy prior for the scale parameter of **H**

N(5, 2^2)

$$\mathbf{y}_{t,n} = \boldsymbol{\mu}_n + \boldsymbol{\theta}_{t,n} + \boldsymbol{\varepsilon}_{t,n} \quad \boldsymbol{\varepsilon}_{t,n} \sim N(\mathbf{0}, \mathbf{H}_n)$$

$$\boldsymbol{\theta}_{t,n} = \boldsymbol{\Phi}_n \times \boldsymbol{\theta}_{t-1,n} + \boldsymbol{\eta}_{t,n} \quad \boldsymbol{\eta}_{t,n} \sim N(\mathbf{0}, \mathbf{Q}_n)$$

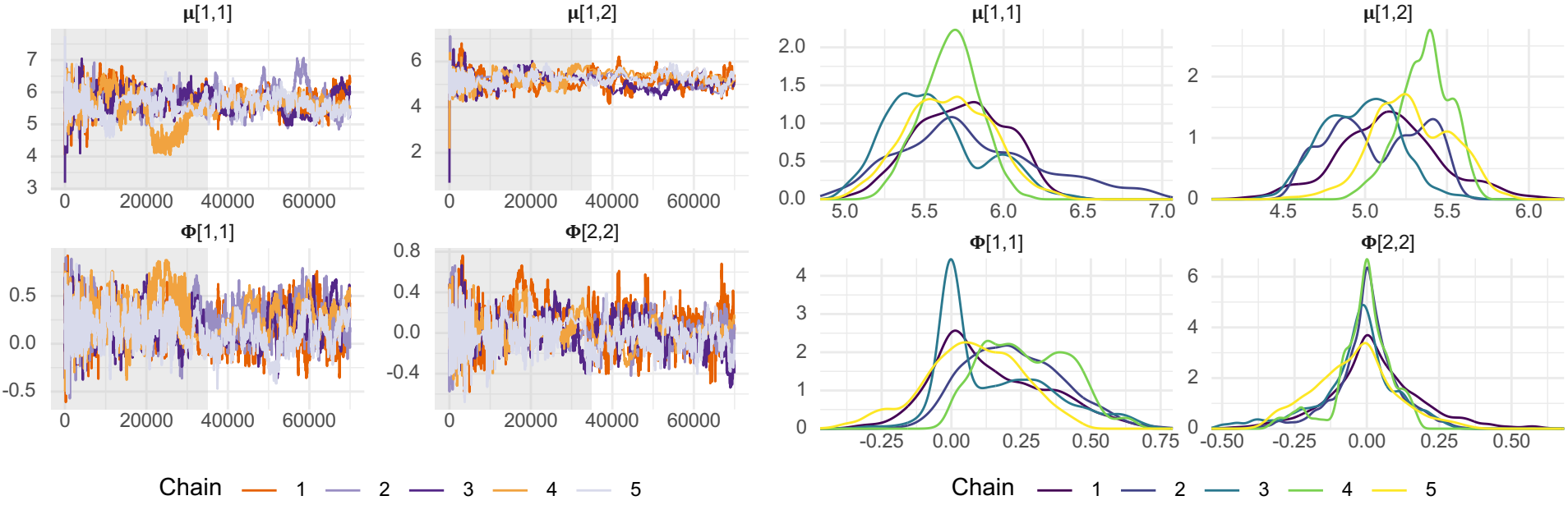
U(-1, 1)

diag[*Gamma*(3, 3)]

Krone et al. (2018). *Emotion*

MCMC

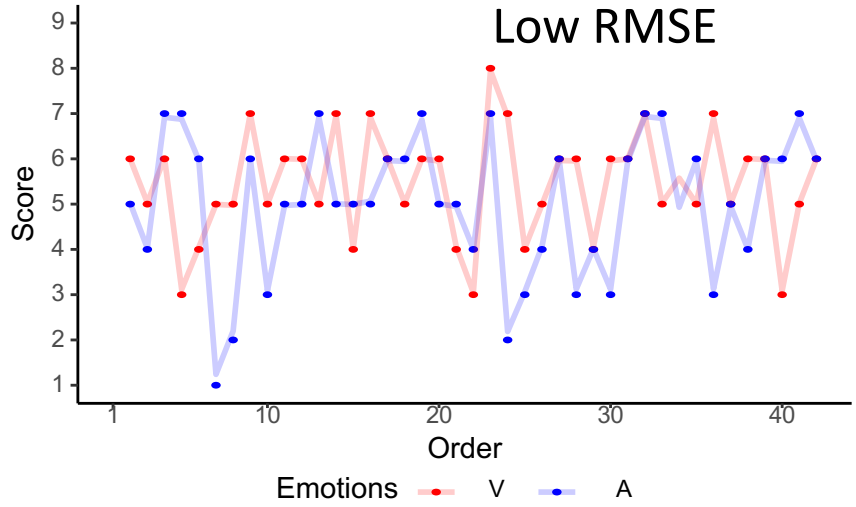
Take subject no. 15 for example



# of chains = 5
Iteration for each chain = 70000 (warm-up / burn-in first 35000 sample)
Thin = 10
Posterior samples = [(70000 – 35000)/10] × 5 = 17500
$\widehat{R}$: 1.00 ~ 1.89 for the 15th participant

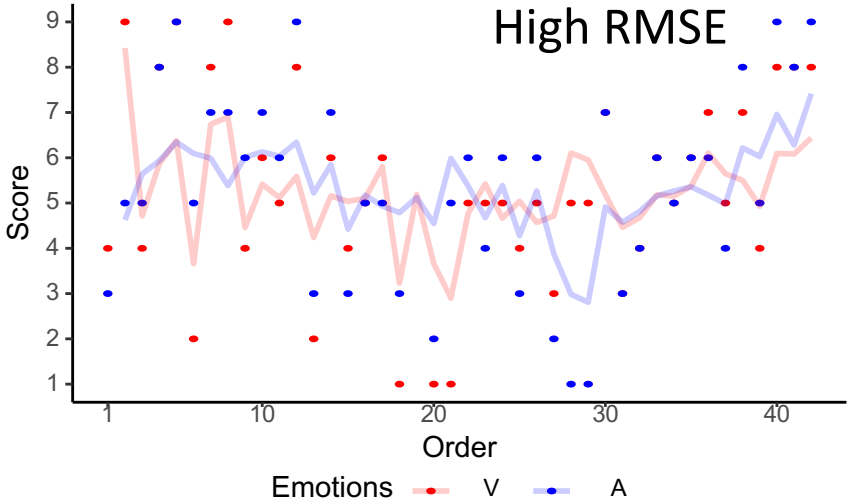
Model fit

ID = 9
Points = observed scores; line = predictive scores

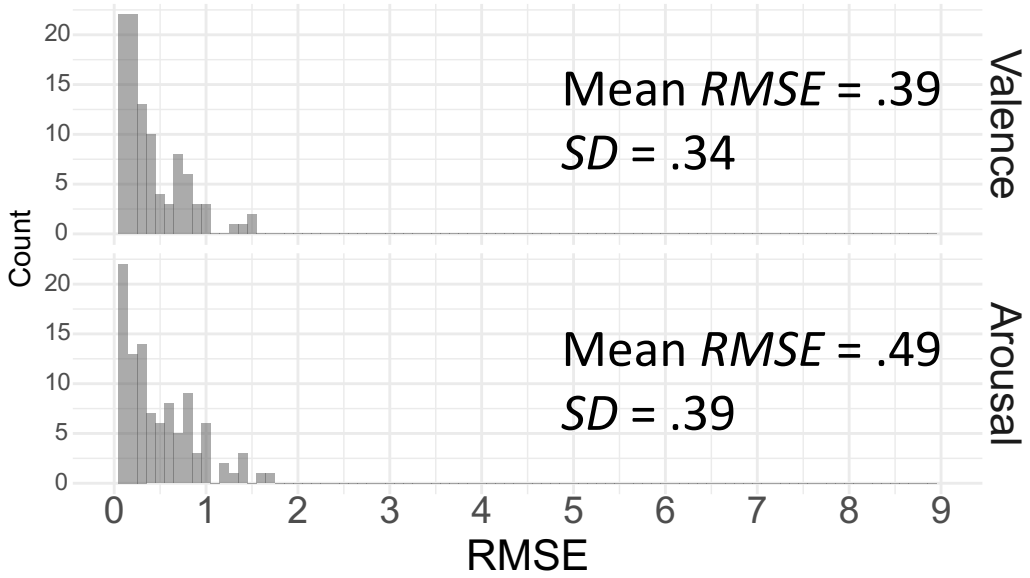


RMSE: V = 0.0434; A = 0.0869

ID = 22
Points = observed scores; line = predictive scores



RMSE: V = 1.3933; A = 1.4302



*V = Valance; A = Arousal

Result: Descriptive Statistics ($N = 104$)

Features	Emotions	Mean (*SD*)
Average intensity ($\boldsymbol{\mu}_{i,\,n}$)	Valence	5.70 (0.86)
	Arousal	5.11 (0.91)
Variability ($\boldsymbol{\sum}_{ii,\,n}$)	Valence	2.96 (1.99)
	Arousal	4.10 (2.14)
Inertia ($\boldsymbol{\Phi}_{ii,\,n}$)	Valence	0.12 (0.19)
	Arousal	0.11 (0.22)
Cross-lag ($\boldsymbol{\Phi}_{ij,\,n}$)	$\text{Valence}_{t-1} \longrightarrow \text{Arousal}_{t}$	0.02 (0.21)
	$\text{Arousal}_{t-1} \longrightarrow \text{Valence}_{t}$	0.05 (0.18)
Granularity	Corr(Valence, Arousal)	0.21 (0.23)

Result: *K*-means clustering