An empirical comparison of emotion theories on physiological activation and dynamics using a state space approach

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I. Background

Emotion specificity of physiological activation has been long debated in psychological research (Kreibig, 2010; Levenson, 1992)

Five theoretical models can be distinguished:

1. ***Null model =*** non-emotional (neutral) and emotional physiology are indistinguishable
2. ***Emotion model =*** physiological activation is different for non-emotional and emotional episodes
3. ***Valence model =*** physiological activation is different for positive and negative emotional episodes
4. ***Avoidance-approach model =*** physiological activation is different for approach emotions and avoidance emotions
5. ***Specificity model =*** physiological activation is specific for each emotion

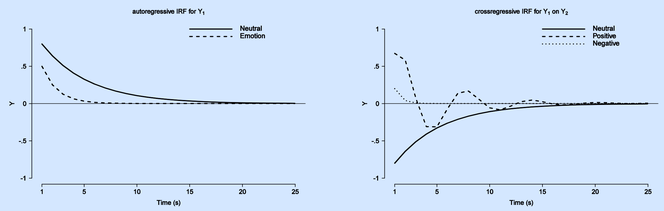
II. Research Questions

Dimensions of specificity:

✓ A first dimension describes the **degree of emotional distinction**, as explained above in the five theoretical models

✓ A second dimension concerns the **aspects of the data which are affected by the specificity**

- Most often, one looks merely at mean physiological activation
- We extend this dimension to specificity in the mean, variance and dynamics of process (the latter is interesting in the context of emotional inertia; Kuppens et al., 2010)
- Dynamics can be visualized with impulse response functions:



Research questions:

✓ ***Dimension 1:*** *Which theoretical model on specificity in physiology is dominant? Is this different for depressed and healthy subjects?*

✓ ***Dimension 2:*** *On what aspects of the data can we interpret specificity? Mean, variance or dynamics?*

III. Data Collection

Oregon adolescent interaction data

✓ Conducted at Oregon Research Institute by Nicholas Allen & Lisa Sheeber

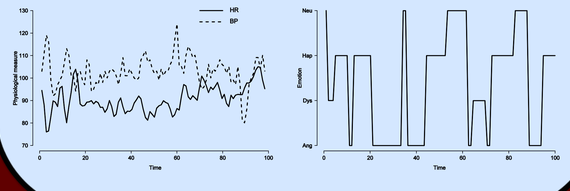
✓ 33 depressed + 24 healthy adolescents

✓ Real-life social interaction task with parents

✓ Second-to-second measurements

- **Cardiovascular:** heart rate (HR) and blood pressure (BP)
- **Behavioral:** LIFE coding system was applied to code verbal & non-verbal behavior with emotions {Neutral, Happy, Dysphoric, Angry}

✓ Example data:



IV. Analysis

General approach requires advanced analysis using time series analysis and model selection

State space modeling:

✓ Estimation of latent states of the observed processes based on Bayesian Kalman filter

✓ Analysis of **dynamic properties** of states

✓ Extended with **regime switching** component, which allows one to estimate different sets of parameters for different time episodes (e.g., emotion episodes)

Deviance information criterion (DIC):

✓ Bayesian **model selection criterion** to select the optimal model among various estimated models

✓ Comparable to AIC and BIC: model fit + model complexity penalty

V. Question 1

"Which theoretical model on specificity in physiology is dominant? Is this different for depressed and healthy subjects?"

✓ For each individual, five models were estimated and compared

✓ Each model was characterized with a different configuration of regimes

✓ The best model was selected for each individual, based on the value of DIC

✓ The **null model is most popular**, rarely more complex models chosen

✓ Finding is very **similar for healthy controls and depressed adolescents**

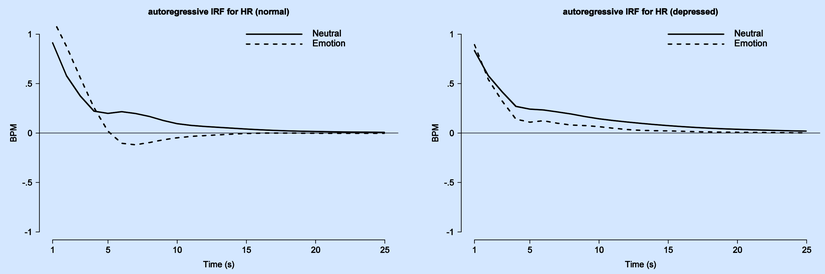
	Neutral	Happy	Angry	Dysphoric	% controls	% depressed
M1: Null model					.96	.85
M2: Emotion model					.04	.09
M3: Valence model					0	0
M4: Approach/avoidance model					0	.06
M5: Specificity model					0	0

VI. Question 2

"On what aspects of the data can we interpret specificity? Mean, variance or dynamics?"

✓ Study of cases is difficult, as there are few cases for which data implies specificity and no clear general patterns of specificity could be identified

✓ Illustrative comparison of HR impulse response functions for a healthy control and a depressed adolescent for the selected emotion model:



✓ Future challenge

- Narrow down by comparing models that estimate specificity for only means, variances or dynamics
- Identifying explanatory variables that are related to presence or absence of specificity