State Space Grids and Multivariate Multilevel Survival Analysis

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Emotion Dynamics

- Rise & Fall of one state
  - Onset, Latency, Rise Time, Intensity, Duration, Offset (Thompson, 1990)

- State-to-state Change (Variability)
  - Flexibility/Rigidity, Diversity, Predictability, Inertia
State Space Grids
State Space and Attractors

- State space: “space” of all possible states of a system
- Attractors: “absorbing” states that have a high probability of recurrence
- Repellors: states that rarely, if ever, occur.
Hypothetical State Space

A = Deep ("strong") attractor
B = Shallow ("weak") attractor
C = Attractor basin
D = Repellor

= Mutual Negative
= Mutual Positive
= Permissive
= Harsh
State Space Grid: Dyad

- Hostile
- Mild Neg
- Neutral
- Positive

CHILD AFFECT

MOTHER AFFECT

- Hostile
- Mild Neg
- Neutral
- Positive
Plotting behavior on a State Space Grid

C3_3.trj

Child affect

Negative

Hostile

Mother affect

Hostile  Negative  Neutral  Positive
A well-regulated (flexible) system has many attractors
SSG Variability

More Cells $\rightarrow$ Dispersion

More Transitions

Higher Entropy

Shorter Average Durations

Fewer Cells $\rightarrow$ Dispersion

Fewer Transitions

Lower Entropy

Longer Average Durations
Some Results to Date

• Parent-child rigidity associated with psychopathology and poor outcomes (e.g., Dishion et al., 2004; Hollenstein et al., 2004)

• Dyadic flexibility associated with child’s inhibitory N2 amplitude (Lewis et al., 2012) and improvements due to treatment (Granic et al., 2007)

• Dyadic flexibility better predictor than individual flexibility (van der Giessen et al., in press)

• Patterns may be different in infancy and toddlerhood (Lunkenheimer et al., 2011; Sravish et al., 2014)
Types of Analysis

1. Single cell or region (group of cells)
2. Whole-grid indices (e.g., flexibility)
3. Grid-to-grid change
4. 3 or more dimensions
5. Complementary Analyses: Attractor analysis with MMSA
SR-SCA $r = .80$

($HR-SR = -0.17$  $HR-SCA = -0.25$)
SR-SCA r = -.46

(HR-SR= .37    HR-SCA = -.42)
Three 2D = One 3D
4x4x4 = 4x16 = 64 cells

Parents (Mother/Father)
Triadic Flexibility
(Hollenstein, Allen, & Sheeber, in press)

• Triads with depressed children → more Dispersion and Entropy
  (no Transition differences)
• Not just more negative affect
• Discriminant function analysis to get attractors
• Depressed triads: less triadic matching
3-step changes
T1-T2Δ → T2-T3Δ

Butler, Hollenstein, Shoham, & Rohrbaugh (2013)
Butler, Hollenstein, Shoham, & Rohrbaugh (2013)

• As predicted, double smokers successfully used engagement to down regulate partner negative affect

• Use of protective buffering had unintended effect of up-regulating negative affect
New! State space grids in Mangold
www.behavior-research.com
Multivariate Multilevel Survival Analysis

Courtesy of Jess Lougheed
Hazard Rate

• The hazard rate is the rate at which behaviors happen given that a person is at risk, that is, capable of experiencing the event.

• \( H \) = the likelihood of a person performing the observable target behavior given that they are currently capable of doing so (i.e., they are not currently engaging in the behavior).

• The risk period is referred to as the waiting time or duration.
Note. Mother states include Supportive CR (SCR) and Other (O). Child states include negative affect (NA) and other (O).
Mother supportive co-regulation

(Lougheed, Hollenstein, Lichtwarck-Aschoff, & Granic, in press)

• 8-12 y.o. externalizing children (EXT) and controls

• Supportive Co-regulation = validation, reappraisal, positive emotional directives

• Two models:
  – Mom supportive response to Child NA
  – Transitions out of Child NA following Mom support

(Mills, 2010; Stoolmiller & Snyder, 2006)
Note. Mother states include Supportive CR (SCR) and Other (O). Child states include negative affect (NA) and other (O).
Results Summary

• Group differences:
  – Not on frequency
  – Not on duration
  – Not on overall probability of Mom Support

• Model 1: Mom supportive response to NA
  • EXT less likely to respond supportively to NA

• Model 2: Transitions out of NA following Mom support
  • EXT less likely to transition out of NA when Mom is supportive
State Space Grids
Hollenstein (2013)

- Well-suited to analyses of interaction data
- Can be used on its own as well as in concert with other analyses
- Just beginning to scratch the surface of possibilities...
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Relations of Hazards To Other Obs Measures

• Anger Incidence or Simple Rate = $I_A = \frac{h_A h_{NA}}{h_A + h_{NA}}$. Note that $I_{NA}$ is the same value.

• Anger Average Duration = $D_A = \frac{1}{h_{NA}}$.

• Anger Prevalence or Duration Proportion = $P_A = \frac{h_A}{h_A + h_{NA}}$.

• Entropy = $-[P_A \log(P_A) + P_{NA} \log(P_{NA})]$. 
Emotion Dynamics:
Onset/offset, latency, rise time, intensity, duration, inertia, flexibility

Emotion Components

Cognition

Physiology

Behavior

Emotion Dynamics:
Onset/offset, latency, rise time, intensity, duration, inertia, flexibility

Control Mechanisms

Attention

Evaluation

Arousal

Affect

Distraction

Rumination

Reappraisal

Relaxation

Suppression

Expression

Regulatory Acts

Emotion Components