BIOPSYCHOSOCIAL APPROACHES OF MEASURING STRESS

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Outline

- Define Stress
- Define Measures or Outcomes of Stress
- Study 1: Modeling Daily Stressors: Effects on Psychological Distress
- Study 2: Modeling Daily Stressors: Associations with Physiological Markers
- Future Directions
- Conclusions
Daily Stressors

How was your day, dear?

AVERAGE.
Why Study Daily Stressors?

- Defined as routine everyday challenges
- Have minor but immediate and direct effects on one’s well-being (Zautra, 2003)
- Pile up over time and form foundations for major health outcomes (Lazarus & Folkaman, 1984)
- Little is known about immediate impact of daily stressors and its spillover onto other areas of life & health
Some Definitions

■ Stressors:
  – Problematic conditions or situations that pushes one’s emotional, cognitive and physical capacities to the limit

■ Distress:
  – Failure to cope with stressors that results in immediate and long-term consequences on one’s behavioral, psychological and physical well-being
Distress Outcomes

■ Behavioral Aspects
  – Spillover of Stressors in Other Life Domains, Poor Health Behaviors

■ Psychological Aspects
  – Depression, Anxiety

■ Physiological Aspects
  – Physical Symptoms, Changes in Immune System, Imbalance of the Allostatic Load
Stress Spillover or Proliferation

Background & Contextual Factors

- Caregiving Situation
- Primary Stressor Objective
- Primary Stressor Subjective
- Secondary Stressors Role Strains
- Secondary Stressors Intrapsychic Strains
- Outcome

Buffering Sites

- Aneshensel, Pearlin, Mullan, Zarit & Whitlatch, 1995
- Pearlin, 1989; Pearlin, Mullan, Semple, & Skaff, 1990
Hans Selye: Eustress vs. Distress
A. Exposure and Appraisal of Stressors

B. Psychological or Affectual Stress Responses

C. Daily Health Behaviors & Changes

D. Short-term Stress Response

E. Prolonged Activation of Stress Response

F. Long-term Effects on Markers of Chronic Illness

Figure 1. A Biopsychosocial Stress Process Model (Savla & Zarit, 2016)

Background Characteristics; Relationship History; Size of Family; Care History; Cultural/Normative Beliefs

Daily Objective Stressors
- Primary Stressors
- Secondary Stressors

Subjective Appraisal of Stressors

Daily Psychological Distress

Allostasis
- Activation of the Autonomic Nervous System (e.g., Activation of HPA Axis)

Allostatic Overload
- Dysregulation of the stress response systems

Repeated exposure and Increased Chronicity

Coping efforts, Personal Resources: Coping Strategies, Cognitive Resources and Social Support buffer the pathways

Risk for Morbidity and Mortality

Contextual Variables

Poor Sleep Quality
- Poor Health Habits

TIME
Daily Diary Design

- Obtain **Repeated** Measures during **Daily Lives**
- Examine Ongoing Experiences in **Natural** and **Spontaneous** Context
- Improve **Accuracy of Recall**
- Link Event and Experience
- Assessment of **Within-Person Processes**
MODELING DAILY STRESSORS I: EFFECTS ON PSYCHOLOGICAL STRESS

Savla, Almeida, Davey & Zarit (2008); Savla, Zarit & Almeida (under review)
Stress Proliferation to Everyday Living

■ Whether caregiving is occasional or repetitive and chronic, it causes disorder in other domains.

■ Impingement of caregiving role on other domains of life provide foundations for stress spillover or proliferation

(Pearlin, 1989; Pearlin, Aneshensel & LeBlanc, 1997).
Research Questions

■ How are role-related experiences affected by type of day i.e. caregiving vs. non-caregiving day?
■ After controlling for daily role-related experiences and person-level variables, is psychological distress higher on caregiving days than non-caregiving days?
National Study of Daily Experiences (Wave 1)

- National Study of Daily Experiences
  - Subsample of Midlife in the United States (MIDUS)
  - Almeida, Wethington & Kessler, 2002

- 8 consecutive daily diary interviews via CATI
  - Time Use
  - In-depth assessment of Everyday Stressors
  - Physical Health Symptoms
  - Psychological Health Symptoms

- 529 people in MIDUS said they provided care to a parent
  - 113 provided care during the collection of daily diaries
  - 416 did not provide any care on the daily diary days
## Role-Related Experiences on Caregiving vs. Non-caregiving days

<table>
<thead>
<tr>
<th>Variables</th>
<th>Non-caregiving Day</th>
<th>Caregiving Day</th>
<th>t-value</th>
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<tbody>
<tr>
<td>Time Spent on Routine Chores</td>
<td>2.07 (1.65)</td>
<td>2.30 (2.16)</td>
<td>-0.90</td>
</tr>
<tr>
<td>Time Spent on Work</td>
<td>4.63 (3.83)</td>
<td>3.54 (4.02)</td>
<td>2.09*</td>
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<tr>
<td>Time Spent on Leisure</td>
<td>10.90 (3.34)</td>
<td>10.74 (3.81)</td>
<td>0.35</td>
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<tr>
<td>Number of Stressors</td>
<td>0.58 (0.50)</td>
<td>0.77 (0.79)</td>
<td>-2.11*</td>
</tr>
<tr>
<td>Network Stressors</td>
<td>0.07 (0.15)</td>
<td>0.17 (0.32)</td>
<td>-2.90**</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>N</th>
<th>113</th>
<th>113</th>
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<tbody>
<tr>
<td>Days of interviews</td>
<td>567</td>
<td>213</td>
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### Role-Related Experiences on Caregiving vs. Non-caregiving days

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<th>t-value</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>M (SD)</td>
<td>M (SD)</td>
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<tr>
<td>Care Day</td>
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<td>1</td>
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</tbody>
</table>

N 113 113
Days of interviews 567 213
Modeling Daily Psychological Distress

Level 1 (Day-Level/ Within-Person):
\[ Y = B_0 + B_1 \times \text{careday} + B_2 \times \text{everyday situational factors} + R \]

Level 2 (Person-Level/ Between-Person):
\[ B_0 = G_{00} + G_{01} \times \text{background variables} + U_0 \]
\[ B_1 = G_{10} + U_1 \]
\[ B_2 = G_{20} + U_2 \]
Modeling Daily Psychological Distress

- Accurate estimates of regression models depend on normality of outcome variable
- Tobit or Interval Regressions with left censoring more appropriate
Psychological Stress on Caregiving vs. Non-caregiving days

Random Effects Interval Regression Predicting Daily Psychological Distress (N = 529)

<table>
<thead>
<tr>
<th></th>
<th>Full Model †</th>
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<tbody>
<tr>
<td></td>
<td>Coeff.</td>
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<tr>
<td>Care Day</td>
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<tr>
<td><strong>Everyday Situational Factors:</strong></td>
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<tr>
<td>Time Spent on Work</td>
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<tr>
<td>Time Spent on Leisure &amp; Sleep</td>
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<td>Network Stressors</td>
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<td>Between-Person Variance (sigma_u)</td>
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<td>Within-Person Variance (sigma_e)</td>
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<tr>
<td>Intra-class correlation (rho)</td>
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<tr>
<td>Chi-Square</td>
<td>201.62 ***</td>
</tr>
<tr>
<td>df</td>
<td>13</td>
</tr>
</tbody>
</table>

† Controlling for background characteristics such as age of caregiver, gender, marital status, race, number of children, educational attainment, neuroticism and mastery
Pile-Up of Stressors

- Can we test for pile-up effects of stressors?
- Classified caregivers into 2 categories based on continuity of care provision:
  - *Casual Providers* = 1 day of care
  - *Continuous Providers* = 2+ consecutive days of care
- Examined Psychological Distress on Caredays and Non-caredays
Pile-Up of Stressors

Logged Psychological Distress

1 Day 2-8 days

Non-Caregiving Caregiving Days

*
Pile-Up of Stressors

We can speculate that:

- Providing *casual care* does not affect one’s well-being significantly on caregiving days.

- Separate and immediate provision of support followed by piling up of caregiving days could start to exhaust the continuous caregivers.
Measurement-Burst Design of the National Study of Daily Experiences (NSDE)

Burst 1

10 years later

Burst 2

- Provided Assistance in Burst 1
- Provided Assistance in Burst 2
- No Assistance Provided
- Provided Assistance in Burst 1 & 2
How many hours per week do you spend giving unpaid assistance to a parent or parent-in-law?

Instrumental Assistance to Parent or Parent-in-law

<table>
<thead>
<tr>
<th>Wave 1</th>
<th>Wave 2</th>
<th>Wave 1</th>
<th>Wave 2</th>
<th>Wave 1</th>
<th>Wave 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Help in Burst 1 Only</td>
<td>Help in Burst 2 Only</td>
<td>Help in Burst 1 &amp; Burst 2</td>
<td></td>
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<tr>
<td>N = 52</td>
<td>N = 63</td>
<td>N = 43</td>
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</tbody>
</table>
Adult children who provided assistance in both bursts, had higher negative affect on days they provided assistance.
Adult children who provided assistance in both bursts, and provided greater number of days of assistance each burst, experienced greater negative affect.
Summary

- Survey methods traditionally aggregate across contexts
- **Micro-level approach** to examine the association between providing routine assistance amidst everyday circumstance
- Daily diary studies *link* context and experience
A. Exposure and Appraisal of Stressors

B. Psychological or Affectual Stress Responses

C. Daily Health Behaviors & Changes

D. Short-term Stress Response

E. Prolonged Activation of Stress Response

F. Long-term Effects on Markers of Chronic Illness

Figure 1. A Biopsychosocial Stress Process Model (Savla & Zarit, 2015)
Next Steps

- Move from a Psychosocial Model of Stress to a Biopsychosocial Perspective
MODELING DAILY STRESSORS II: ASSOCIATIONS WITH BIOMARKERS
Everyday Stress & Health Effects

Before Work  After Work
Biopsychosocial Model of Stressors

- Stress or Threat triggers a cascade of biobehavioral responses (e.g. behavioral, psychological, biological) to increase chances of survival.
- Biologically wired to immediately activate Sympathetic Nervous System to trigger the “fight-or-flight” response
Two Major Stress Systems

■ **Sympathetic-Adrenal-Medullary System (SAM)**
  - *Activated First and Fast*
  - *Stimulate rapid reaction to threat or challenge*
  - *Measured by Epinephrine (adrenalin) and Norepinephrin, Blood pressure, heart rate, respiration*

■ **Hypothalamic-Pituitary-Adrenal Axis (HPA)**
  - *Activated Slower, but Longer lasting*
  - *Reinforces or Modulates Initial SAM response*
  - *Measured by cortisol from blood, urine or saliva*
Dysregulation of HPA-Axis Activation

- Release of stress hormones mobilizes energy to adapt to stressors
- But, repeated and chronic activation of the stress response system can cause dysregulation of the negative feedback loop
  - E.g. Overproduction of cortisol associated with destruction of hippocampal neurons, leading to problems in memory, learning, attention, depression
Physical or Emotional Stressor

Autonomic Nervous System
- Sympathetic Nervous System Activation
- Parasympathetic Nervous System Withdrawal

Hypothalamic Stimulation → CRH

Anterior Pituitary Stimulation → ACTH

Adrenal Cortex Stimulation → Gluco-Corticoid Release

EPI & NEPI release from Adrenal Medulla

“Fight-or-Flight” Response

Blood Pressure

Heart Rate
Dysregulation of HPA-Axis Activation

Physical or Emotional Stressor

Autonomic Nervous System
- Sympathetic Nervous System Activation
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Hypothalamic Stimulation

CRH

Anterior Pituitary Stimulation

ACTH

Adrenal Cortex Stimulation

Gluco-Corticoid Release

"Fight-or-Flight" Response

"Negative Feedback Loop"
Why Cortisol: Biomarker of Daily Stress

■ End product of one of the major stress-responsive physiological systems of the body (HPA axis)

■ Associated with a variety of health measures in the laboratory and in the field

  – Psychological health: Depression, Anxiety, Attention

  – Physical health: Cardiovascular health, immune function, endocrine regulation

  – Psychosocial functioning: Relationships, marital conflict, chronic burnout, work overload

(Goodyer et al., 2001; Weber et al., 2000; Flinn & England, 1997; Heim et al., 2000; Adam & Gunnar, 2001; Kiecolt-Glaser et al., 1997; Prussner et al., 1999)
Cortisol: Biomarker of Daily Stress

- Individuals differ in their patterns of cortisol secretion
- Momentary assessments of cortisol secretion in an individual also show fluctuations (Pollard, 1995)
  - Measurement time, Dietary factors, General basal cortisol level, Inflammatory process,
- Innovations in saliva assay makes it easy to collect salivary cortisol in everyday life
Modeling the Diurnal Rhythm of Cortisol

**Morning Rise**

**Daily Decline**

**Area Under the Curve**

**Wake**

**30 Min**

**Lunch**

**Bed**

Daily Cortisol (nmol/l)
Alpha Amylase: Biomarker of Emotional Valence and Stress

■ Alpha-amylase production increases in response to psychological and physical stress through interactions with the autonomic nervous system

■ sAA peaks 5-10 mins after a stressor onset and returns to baseline approx. 20 mins. post-stress

■ Diurnal rhythm is characterized
Salivary Alpha Amylase

Adam, Hoyt & Granger, 2011
And you thought there was stress in your life!
A. Exposure and Appraisal of Stressors

B. Psychological or Affectual Stress Responses

C. Daily Health Behaviors & Changes

D. Short-term Stress Response

E. Prolonged Activation of Stress Response

F. Long-term Effects on Markers of Chronic Illness

Contextual Variables

Background Characteristics; Relationship History; Size of Family; Care History; Cultural/Normative Beliefs

Allostasis

Activation of the Autonomic Nervous System (e.g. Activation of HPA Axis)

Dysregulation of the stress response systems

Repetitive exposure and Increased Chronicity

Coping efforts, Personal Resources: Coping Strategies, Cognitive Resources and Social Support buffer the pathways

Figure 1. A Biopsychosocial Stress Process Model (Savla & Zarit, 2015)
NSDE Wave 2

- Wave 2 (2004-2009)
  - 7 days of Diary Interviews
  - 4 days of salivary cortisol

- 4 Measurements/per day = 16 Cortisol Measures
  - Wake-up, 30 Mins. After Wake, Before Lunch, Before Bed

- 3-Level Model (MLM) with Bootstrap Estimates for Estimation of Diurnal Cortisol Slope
Daily Implications of Assistance on Daily Diurnal Cortisol Slope
Daily Diary Study of Care Partners of Persons with Mild Cognitive Impairment

- N=30 care partners
- Mean Age = 72.60, SD = 6.91
- Saliva samples collected
  - 4 Consecutive Days
  - 5 times per day
  - Valid Saliva Samples = 472 out of 600 (79%)
Salivary Alpha-Amylase Among Care Partners Reporting Memory Related Problems

No Memory-Related Problems Reported

Memory Related Problems Among MCI Persons Reported

Salivary Alpha Amylase (nmol/L)

30 Mins after Wake  Lunch  Evening  Before Bed
Symmetry

- Given the connection between HPA and ANS axes at the neural levels, you would expect some degree of symmetry.
- Strong responses in one system = strong responses in other systems
- Recently, researchers have found that asymmetry between the two axes may be a precursor of poor health outcomes (Bauer et. Al., 2002; Gordis et al., 2008).
• Hyperarousal in both systems associated with highest stressor appraisals
• Hypoarousal in both systems associated with lower stressor appraisal
• But, hyperarousal in HPA activity, and hypoactivity in ANS – were not associated with stressor appraisals.
• Buffering role of ANS – that may regulate effect of systemic stressors

Figure 3. Cortisol AUC is more strongly associated with primary objective stressor in presence of higher sAA AUC ($p < .05$).
A. Exposure and Appraisal of Stressors

B. Psychological or Affectual Stress Responses

C. Daily Health Behaviors & Changes

D. Short-term Stress Response

E. Prolonged Activation of Stress Response

F. Long-term Effects on Markers of Chronic Illness Risk for Morbidity and Mortality

Daily Objective Stressors
Primary Stressors
Secondary Stressors

Subjective Appraisal of Stressors

Daily Psychological Distress

Poor Sleep Quality
Poor Health Habits

Allostasis
Activation of the Autonomic Nervous System (e.g., Activation of HPA Axis)

Allostatic Overload
Dysregulation of the stress response systems

Repeated exposure and Increased Chronicity

Background Characteristics; Relationship History; Size of Family; Care History; Cultural/Normative Beliefs

Contextual Variables

TIME

Figure 1. A Biopsychosocial Stress Process Model (Savla & Zarit, 2015)
Short-term and Long-term effect of Providing Assistance on HPA Axis Using Data from the National Study of Daily Experiences

3 Level Spline Model with Quadratic effects for Diurnal Decline (Karlamangla et al., 2013)

- Intercept (30 minutes after awakening)
- Cortisol Awakening Response (Linear)
- Daily Diurnal Decline (Linear)
- Daily Diurnal Decline (Quadratic)

**Cross-Level Interactions**

- Assistance Provided in Burst 1 X CAR *
- Assistance Provided in Burst 2 X CAR *
- Assistance Provided in Burst 1 X DD *
- Assistance Provided in Burst 2 X DD *

*Comparison = Assistance Provided in Both Bursts

N =158; 3553 Saliva Samples

**Controlled for Day-Level Variables:**
- Assistance Provided to a Parent Today
- Assistance to Someone Else Today; # of Cigarettes
- Hours of Sleep
- Wakeup time earlier than usual

**Controlled for Person-Level Variables:**
- Average number of days of assistance
- Age
- Gender
- BMI
Compared to adult children who provided assistance in Burst 1, those who provided assistance in both bursts had flatter morning rise and daily decline.

Adult children who provided assistance in Burst 2, had a slower cortisol awakening response, but had a similar diurnal decline as those from Burst 1.
Limitations & Next Steps

- Limitations
  - Associations with long term health or mortality is not known (but forthcoming)

- Next Steps:
  - Examine Individual Differences in the Processes
  - Implications for Intervention & Prevention Research
Current Directions: Individual Differences

- Biopsychosocial Study of Everyday Stressors
  - Caregivers of Older Parents (Control)
  - Caregivers of Nonnormative Children (Children with Mental or Developmental Disability)
Current Directions: Collaborative Attempts at Coping with Stressors

Electrodermal Activity Monitor
ROLE OF INTRUSIVE THOUGHTS AND COMPASSION ON DEPRESSIVE SYMPTOMS
(Schulz, Savla, Czaja & Monin, in press)
Thank you for your attention!