BIOPSYCHOSOCIAL APPROACHES OF MEASURING STRESS
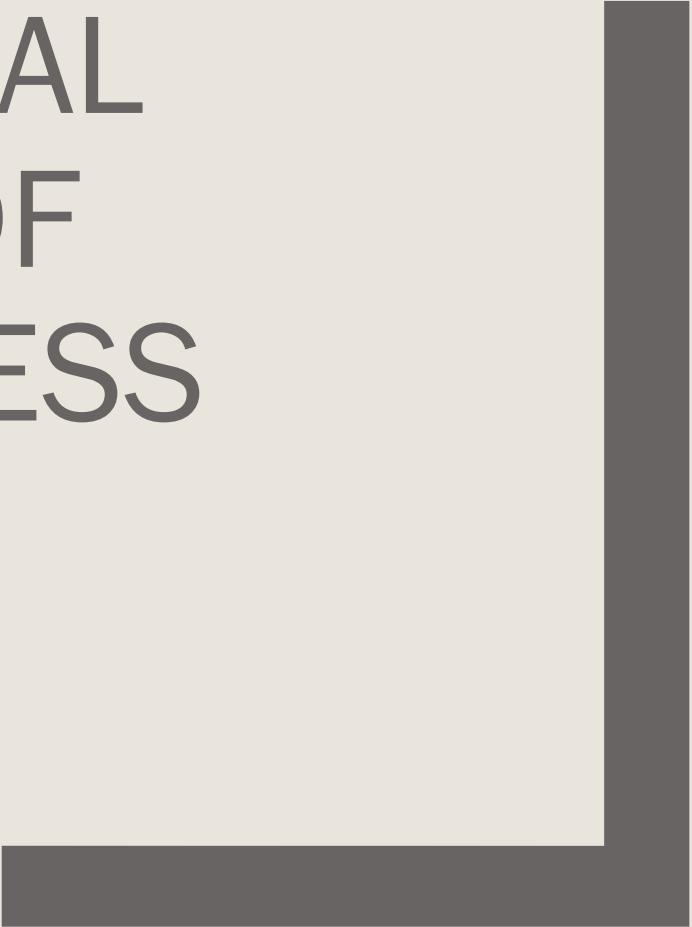
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Center for Gerontology
Department of Human Development
Virginia Tech

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
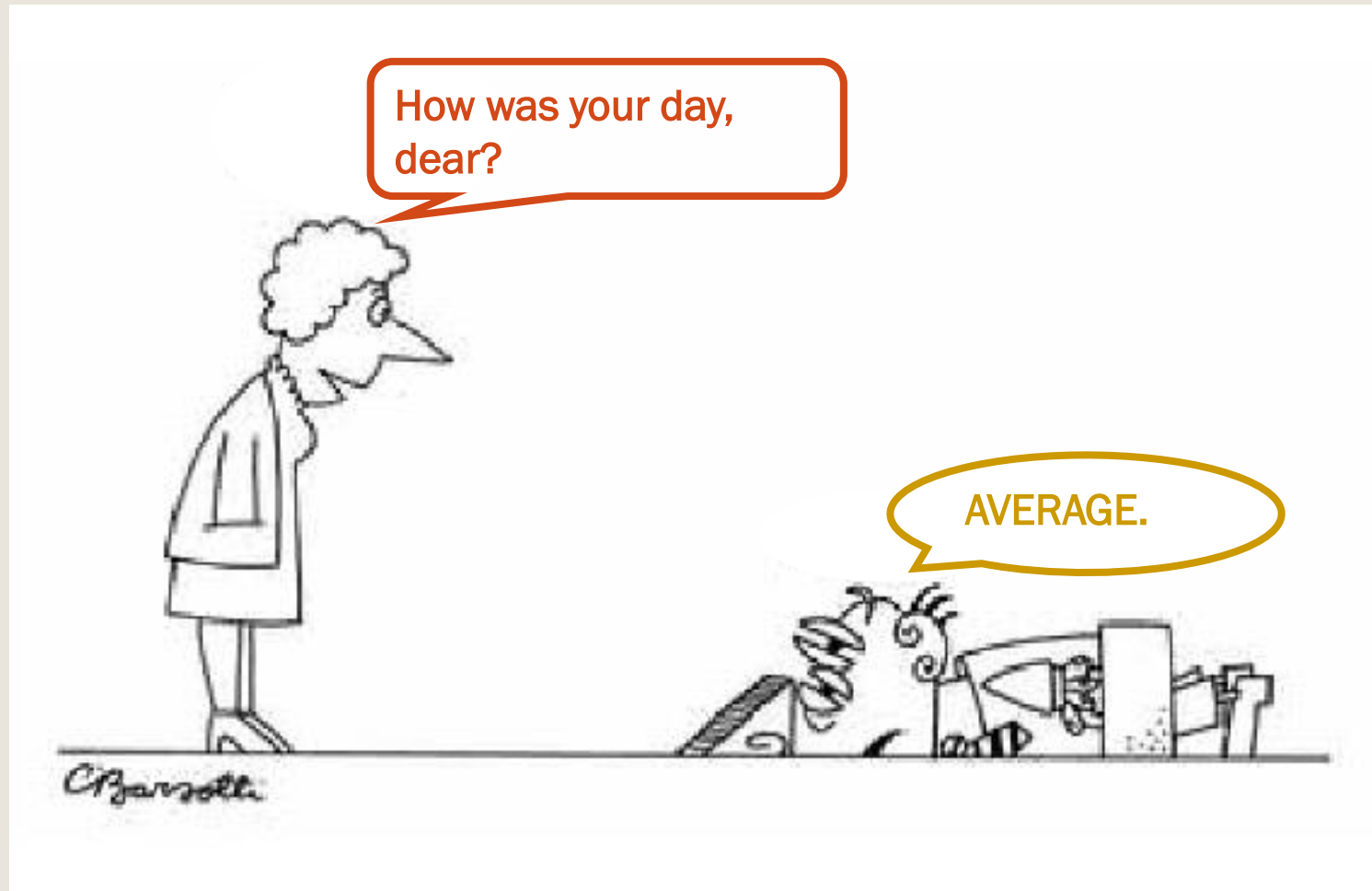
Why Study Daily Stressors?

- 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**
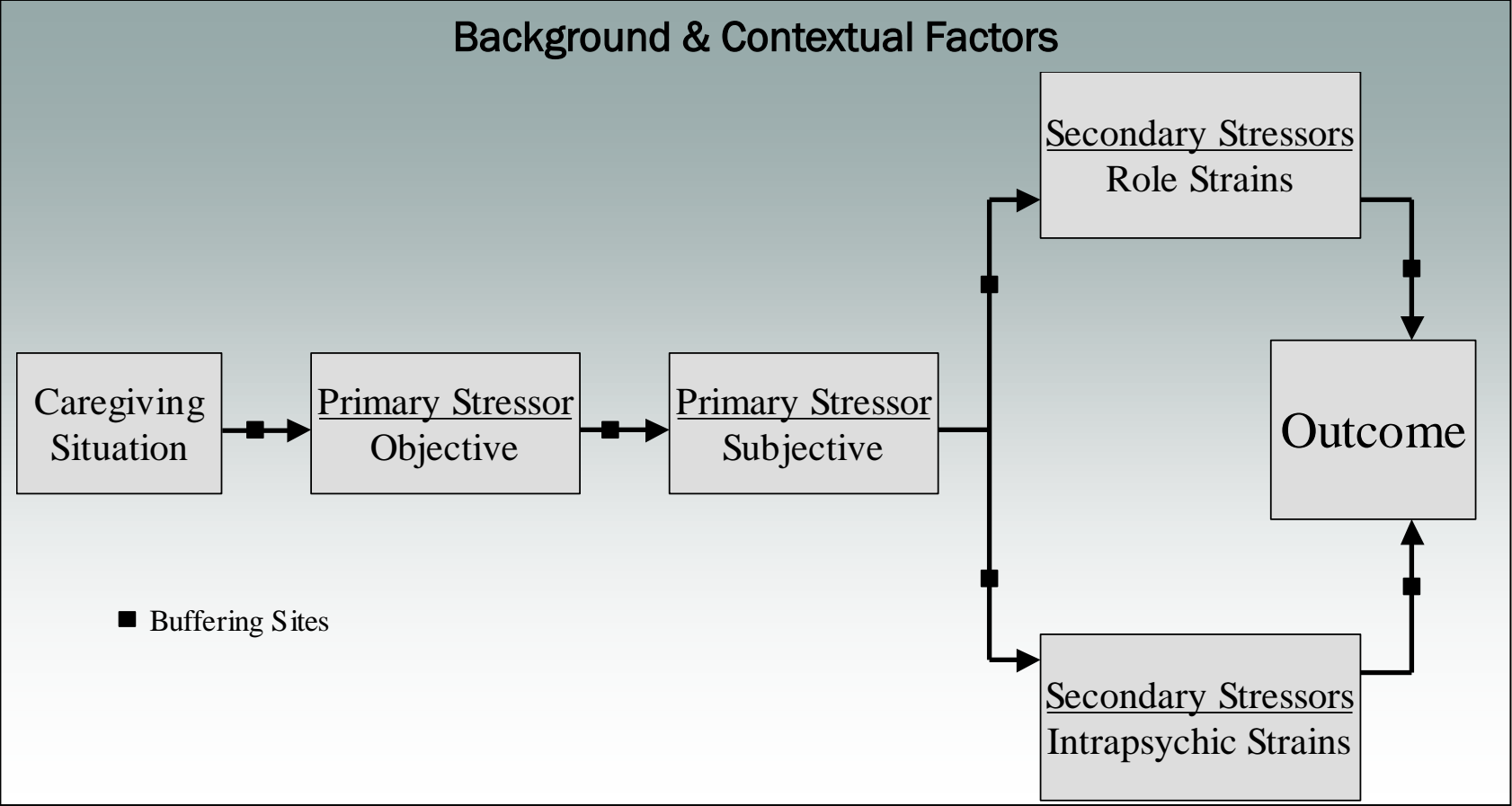 - *Spillover of Stressors in Other Life Domains, Poor Health Behaviors*

- **Psychological Aspects**
  - *Depression, Anxiety*
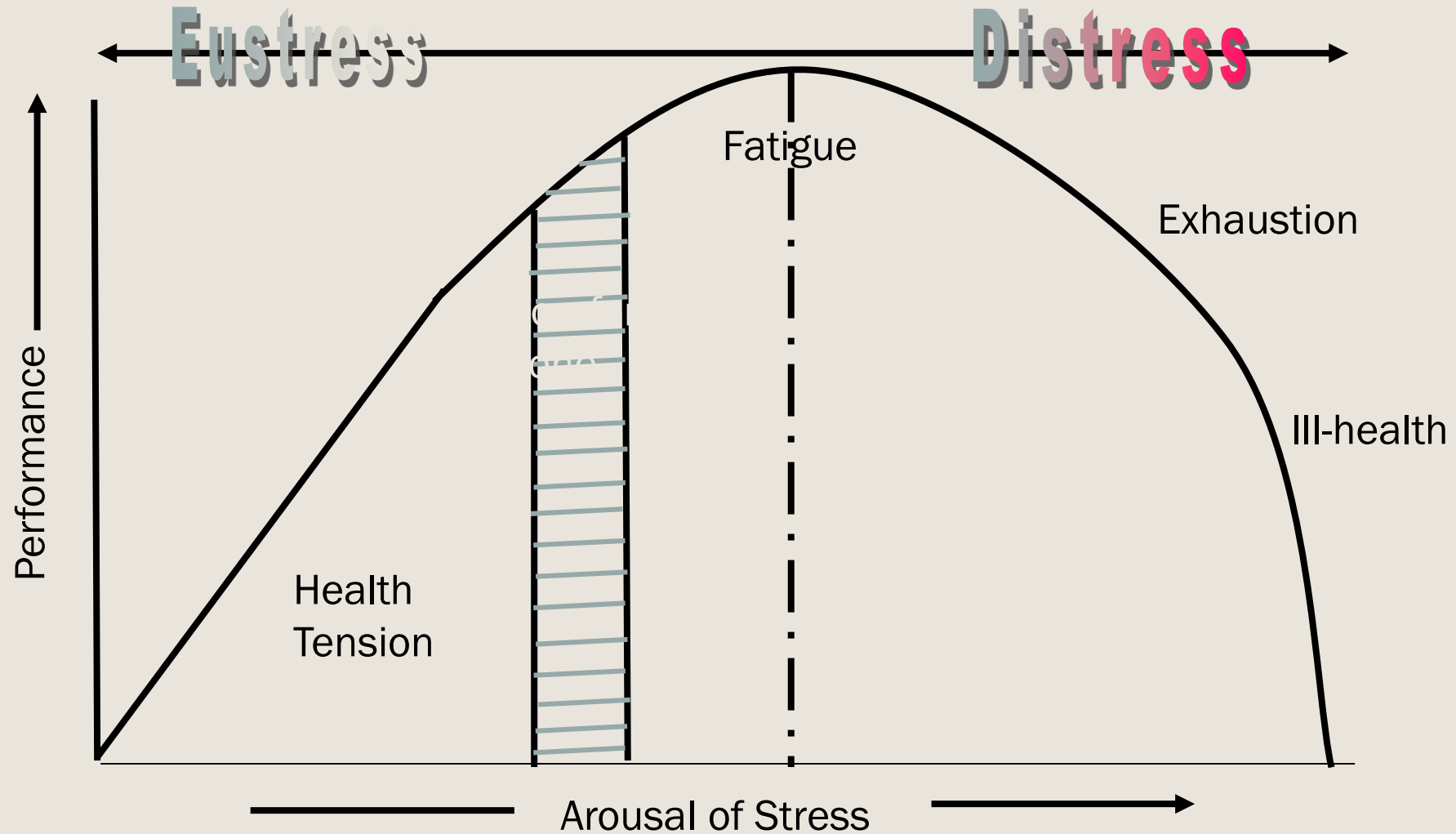
- **Physiological Aspects**
  - *Physical Symptoms, Changes in Immune System, Imbalance of the Allostatic Load*

Stress Spillover or Proliferation

- Aneshensel, Pearlin, Mullan, Zarit & Whitlatch, 1995
- Pearlin, 1989; Pearlin, Mullan, Semple, & Skaff, 1990
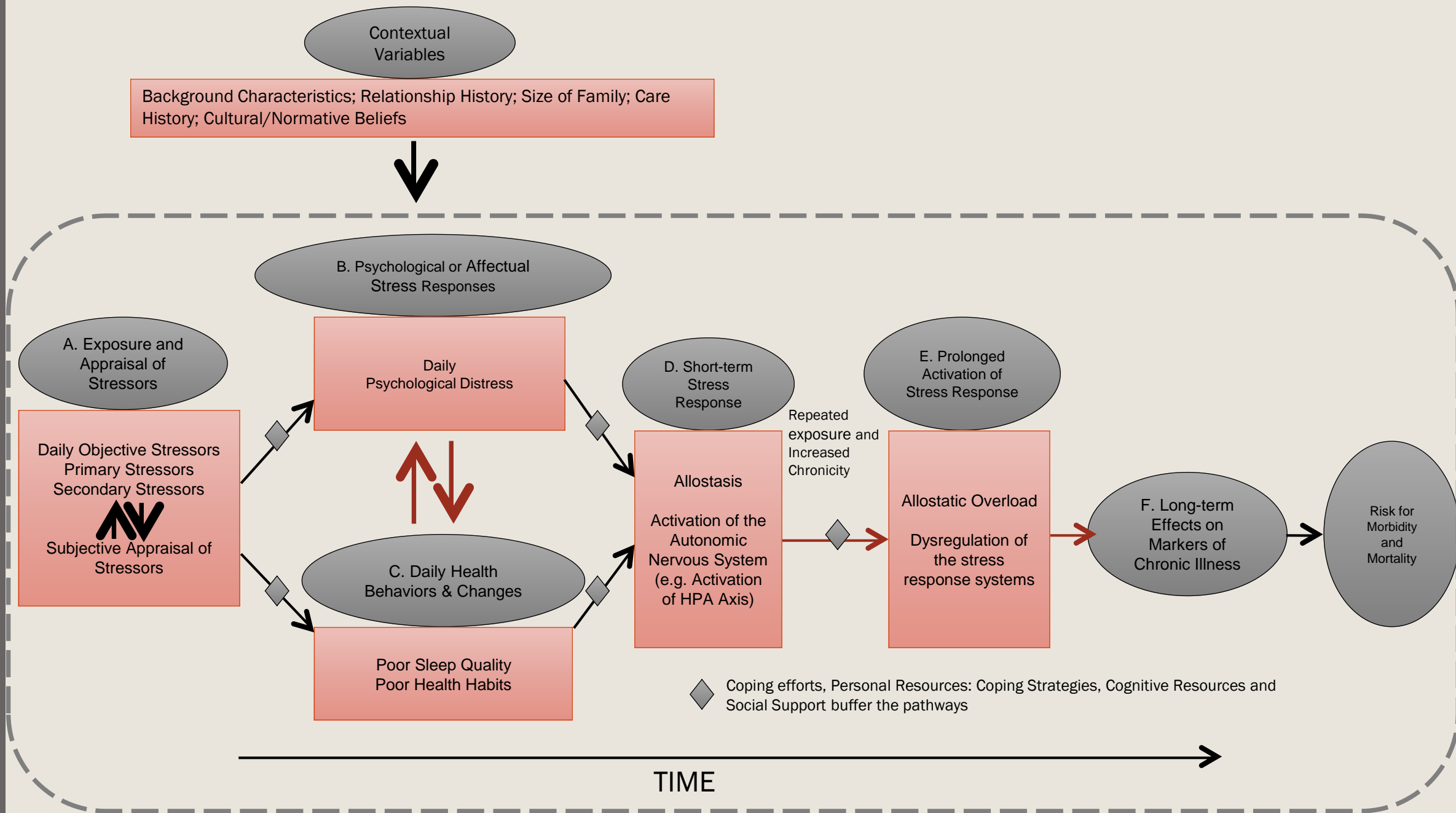
Hans Selye: Eustress vs. Distress

Eustress

Distress

Fatigue

Exhaustion

Ill-health

Performance

Health
Tension

Arousal of Stress

8

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

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).

12

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

Variables	Non-caregiving Day	Caregiving Day	
	M (SD)	M (SD)	t-value
Care Day	0	1	-
Time Spent on Routine Chores	2.07 (1.65)	2.30 (2.16)	-0.90
Time Spent on Work	4.63 (3.83)	3.54 (4.02)	2.09*
Time Spent on Leisure	10.90 (3.34)	10.74 (3.81)	0.35
Number of Stressors	0.58 (0.50)	0.77 (0.79)	-2.11*
Network Stressors	0.07 (0.15)	0.17 (0.32)	-2.90**
N	113	113	
Days of interviews	567	213	

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Modeling Daily Psychological Distress
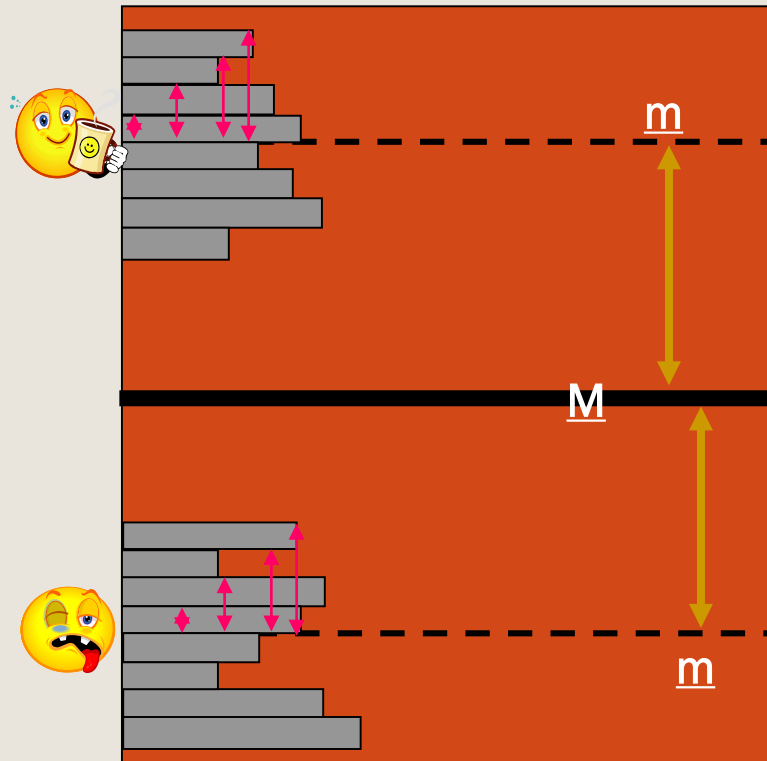
Level 1 (Day-Level/ Within-Person):

$Y = B0 + B1*(careday) + B2*(everyday situational factors) + R$
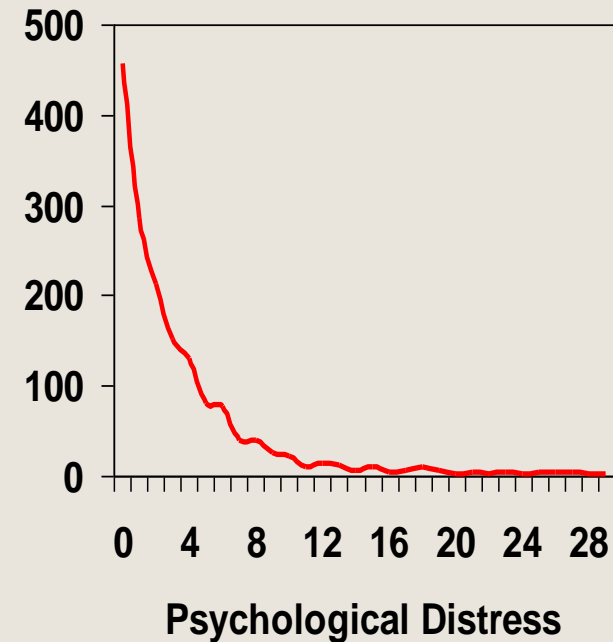
Level 2 (Person-Level/ Between-Person):

$B0 = G00 + G01(background variables) + U0$

$B1 = G10 + U1$

$B2 = G20 + U2$

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 Distress

Psychological Stress on Caregiving vs. Non-caregiving days

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

|	Full Model †	
	Coeff.	SE
Care Day	0.78*	0.33
Everyday Situational Factors:		
Time Spent on Routine Chores	0.13*	0.06
Time Spent on Work	0.12***	0.02
Time Spent on Leisure & Sleep	0.04	0.03
Network Stressors	1.20***	0.32
Between-Person Variance (sigma_u)	3.44	
Within-Person Variance (sigma_e)	3.88	
Intra-class correlation (rho)	0.44	
Chi-Square	201.62 ***	
df	13	

† 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*

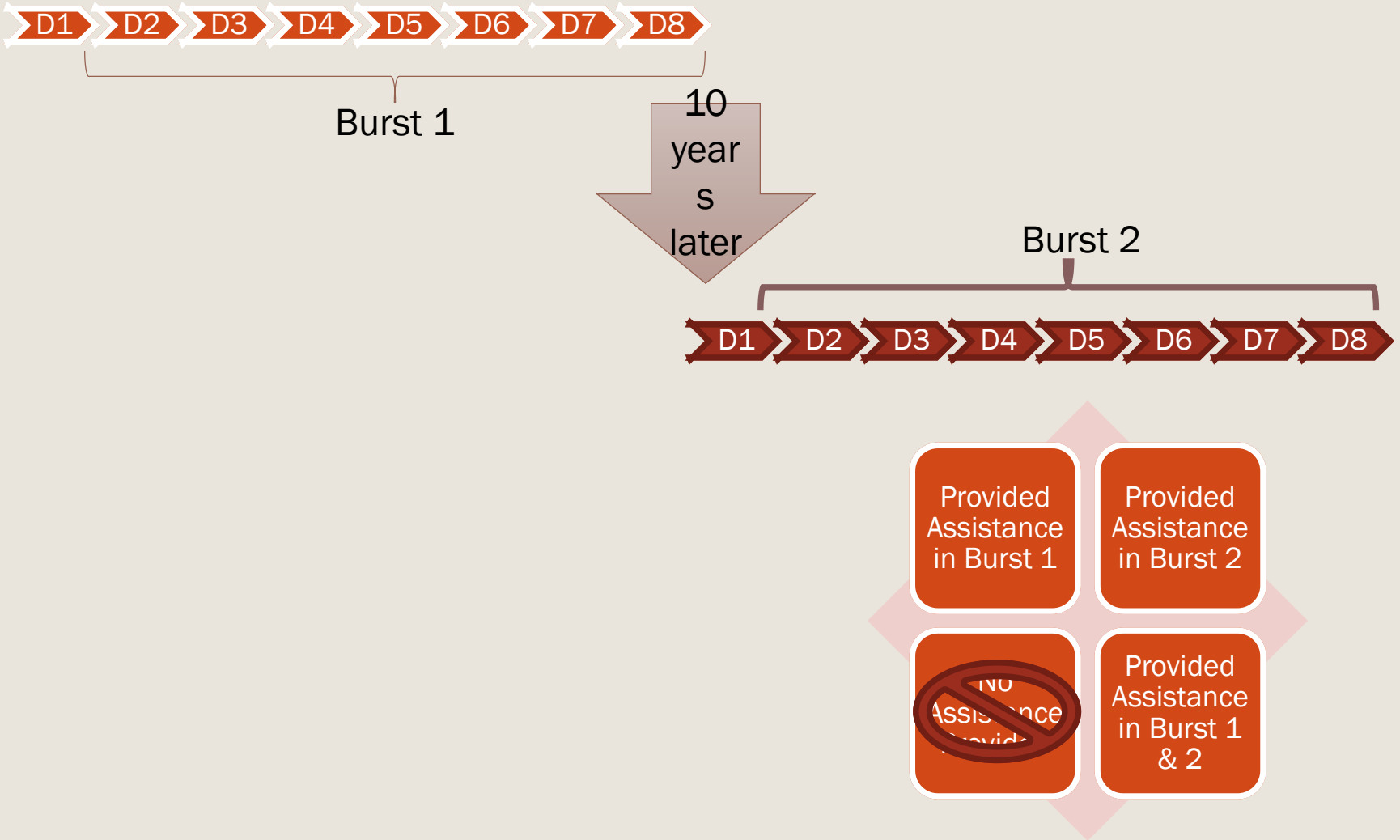■ Examined Psychological Distress on Caredays and Non-caredays
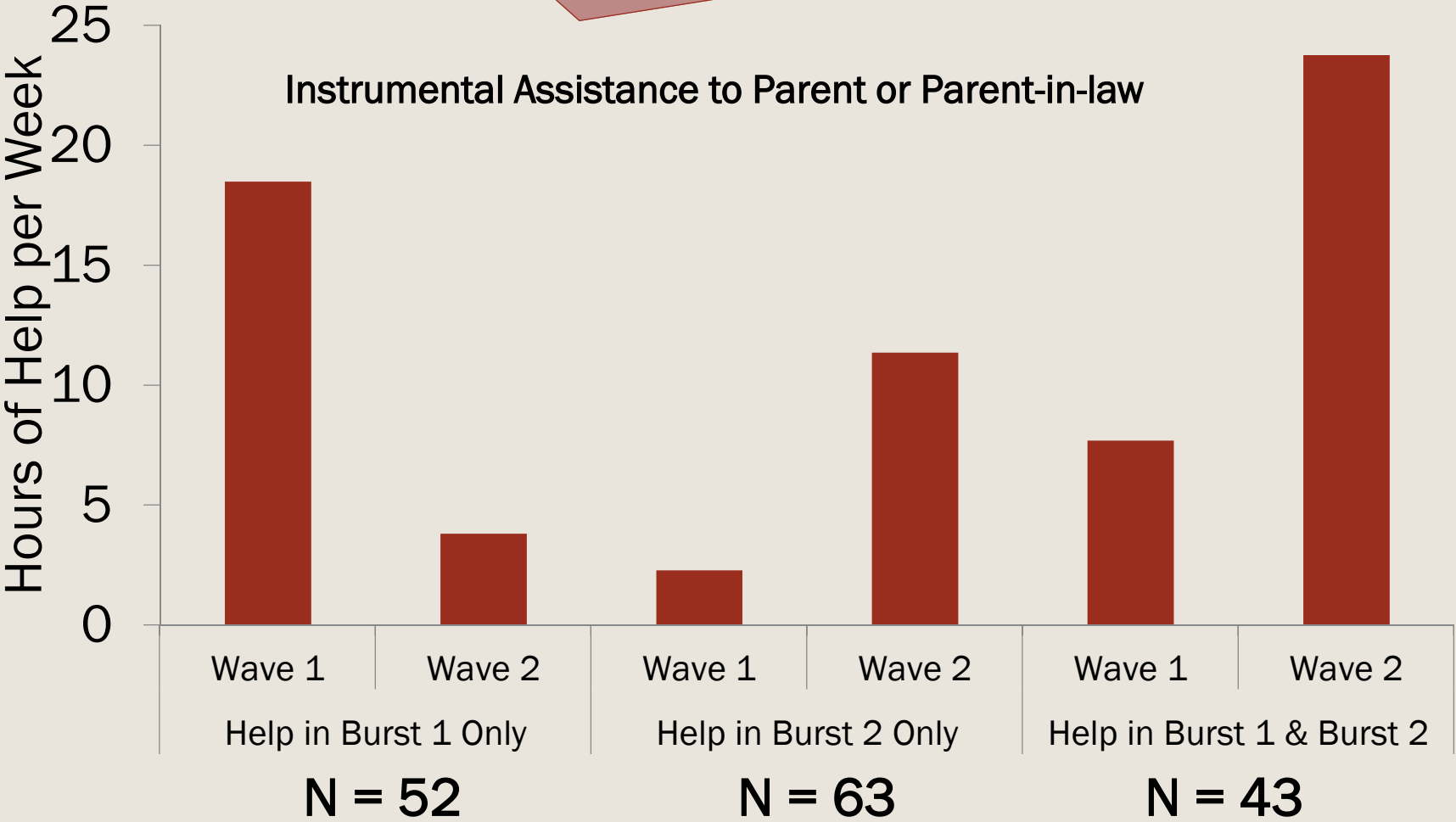
Pile-Up of Stressors

*
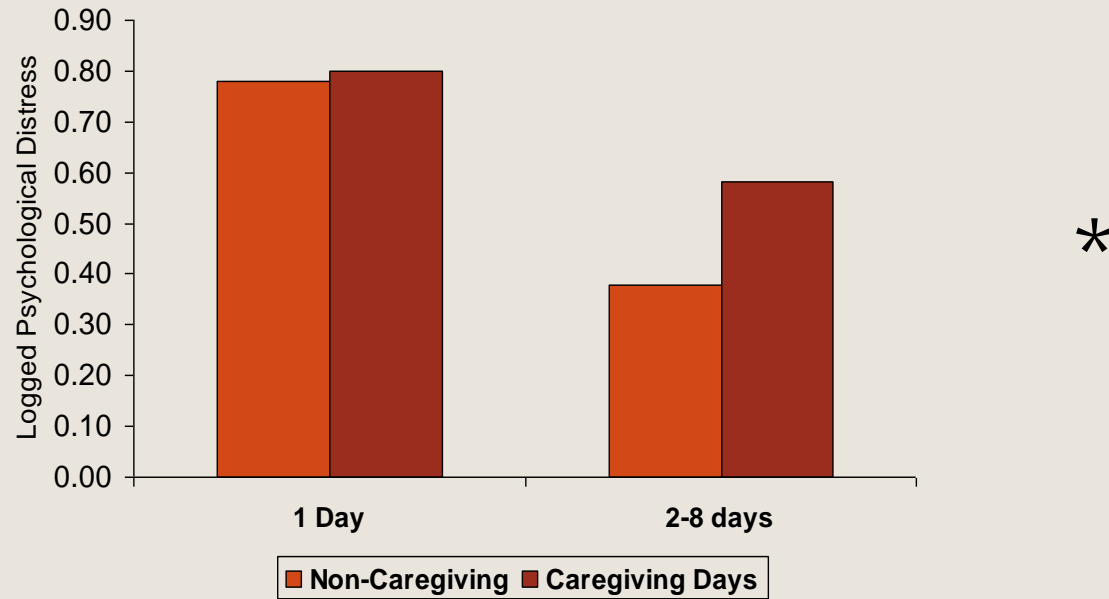
Pile-Up of Stressors

■ 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
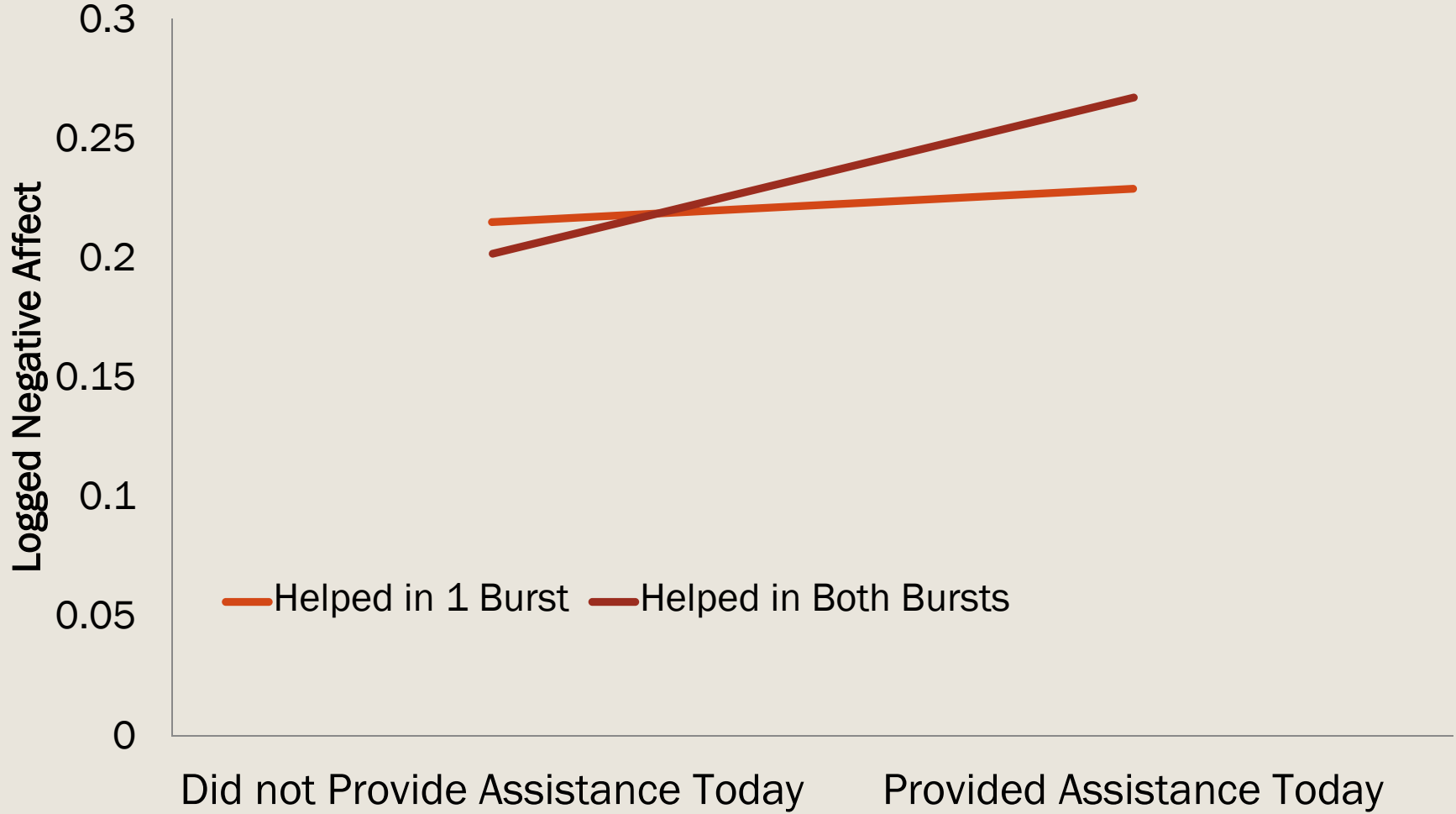
# Measurement-Burst Design of the National Study of Daily Experiences (NSDE)

D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8

Burst 1

10 years later

Burst 2

D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8

Provided Assistance in Burst 1

Provided Assistance in Burst 2

No Assistance Provided

Provided Assistance in Burst 1 & 2

Adult children who provided assistance in both bursts, had higher negative affect on days they provided assistance.

Logged Negative Affect

0.3
0.25
0.2
0.15
0.1
0.05
0

—— Helped in 1 Burst   —— Helped in Both Bursts

Did not Provide Assistance Today   Provided Assistance Today

Adult children who provided assistance in both bursts, and provided greater number of days of assistance each burst, experienced greater negative affect
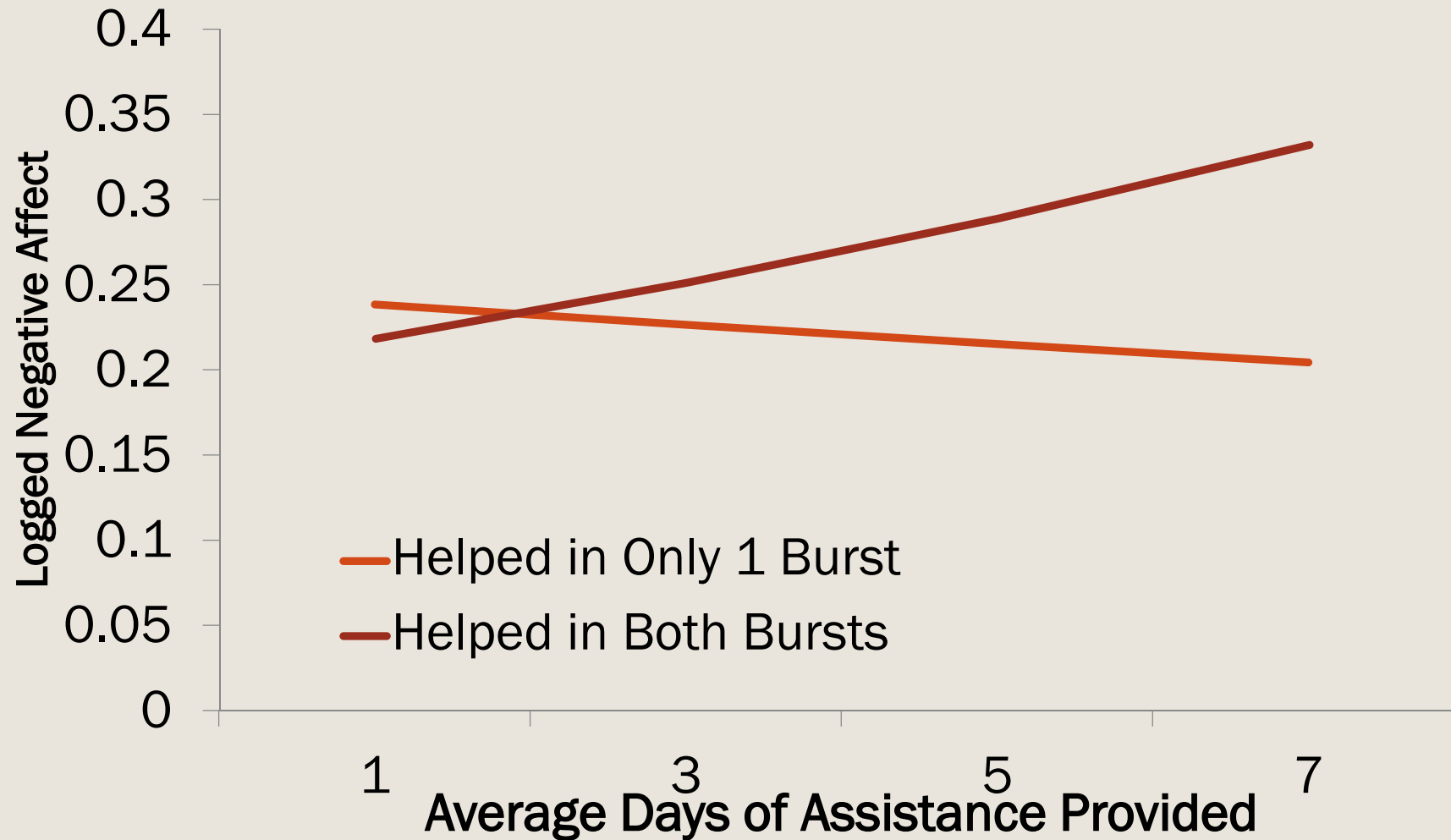
Summary

- Survey methods traditionally aggregate across contexts

- Micro-level approach to examine the association between providing routine assistance amidst everyday circumstance
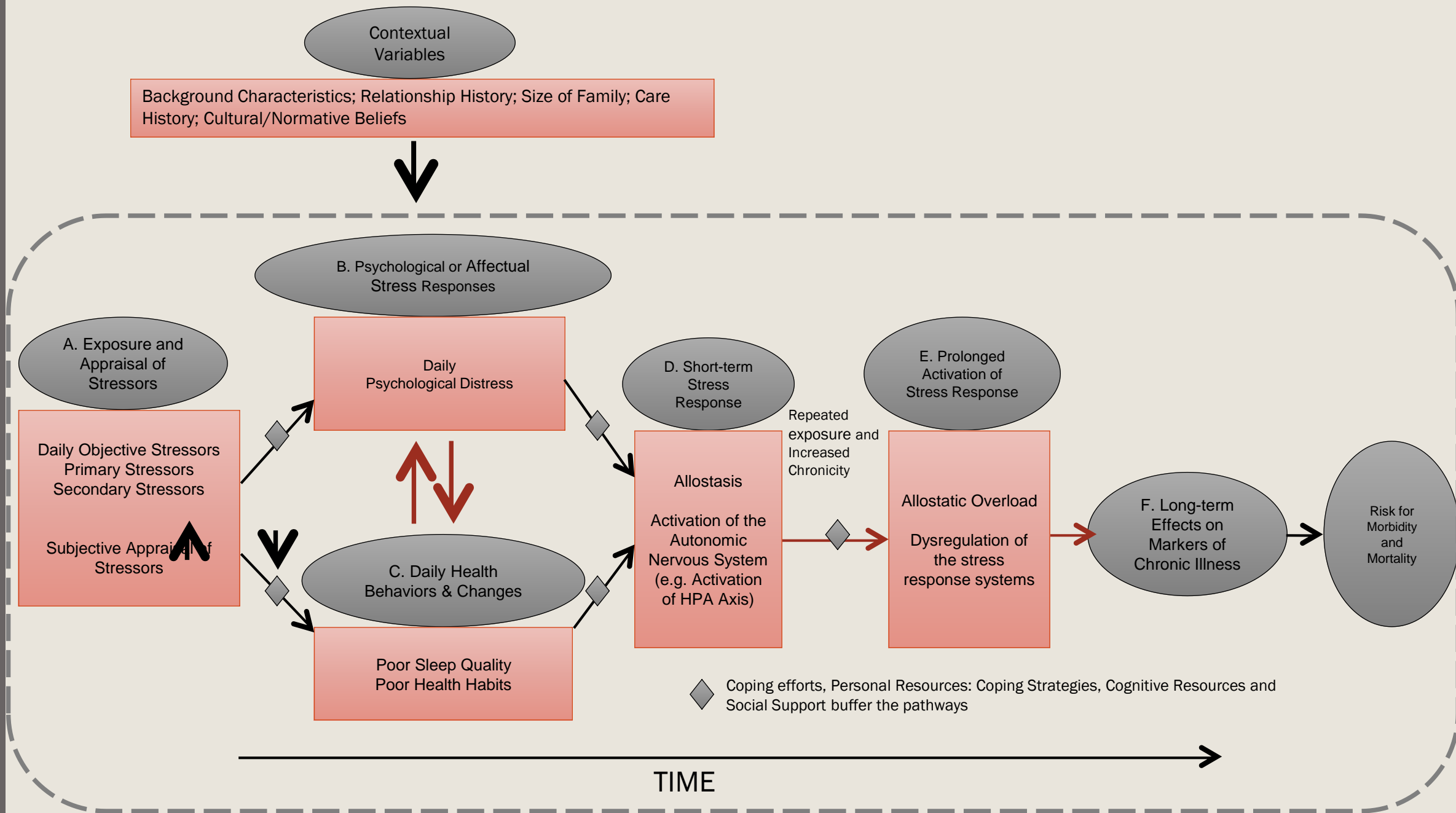
- Daily diary studies *link* context and experience

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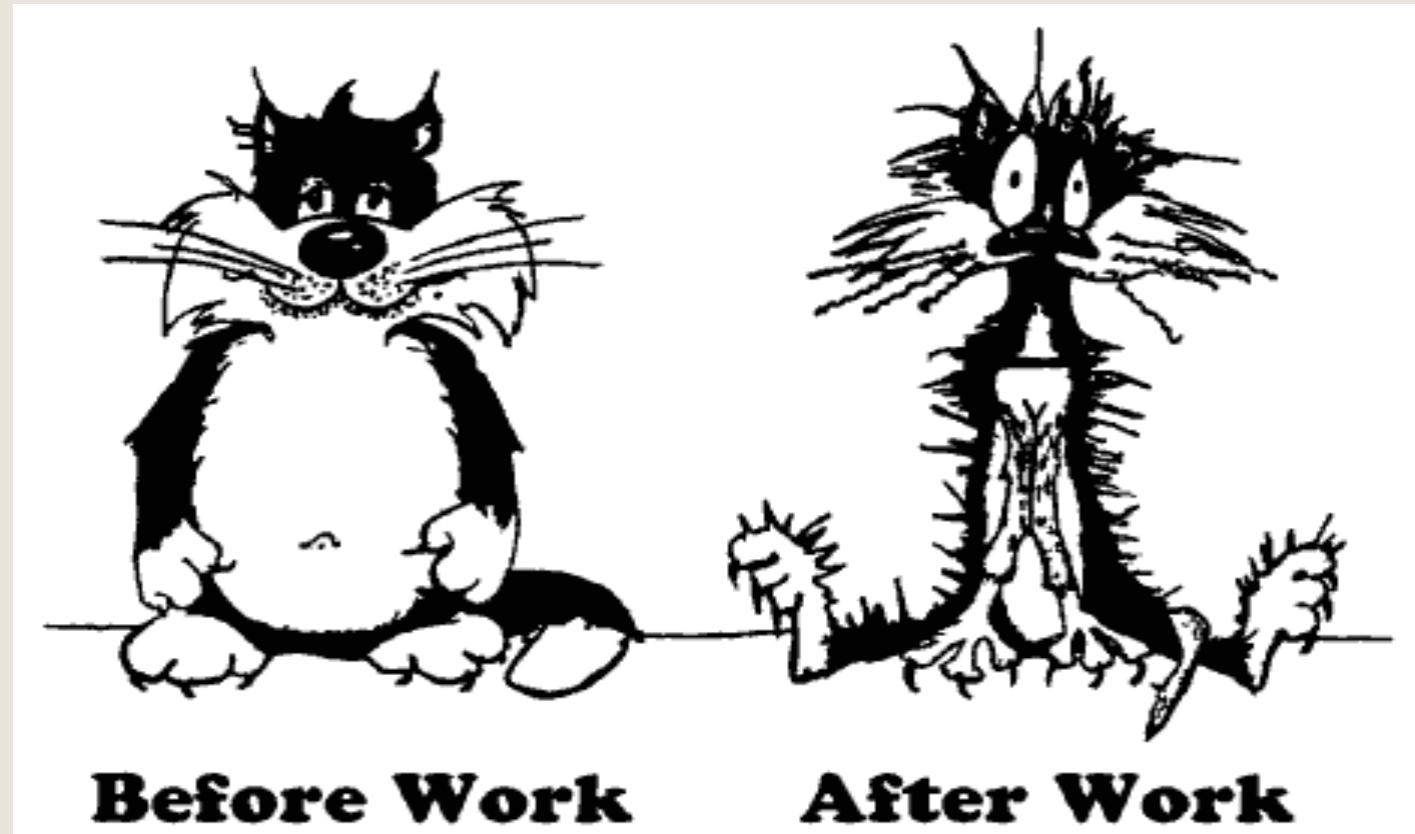
Next Steps

- ■ 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*
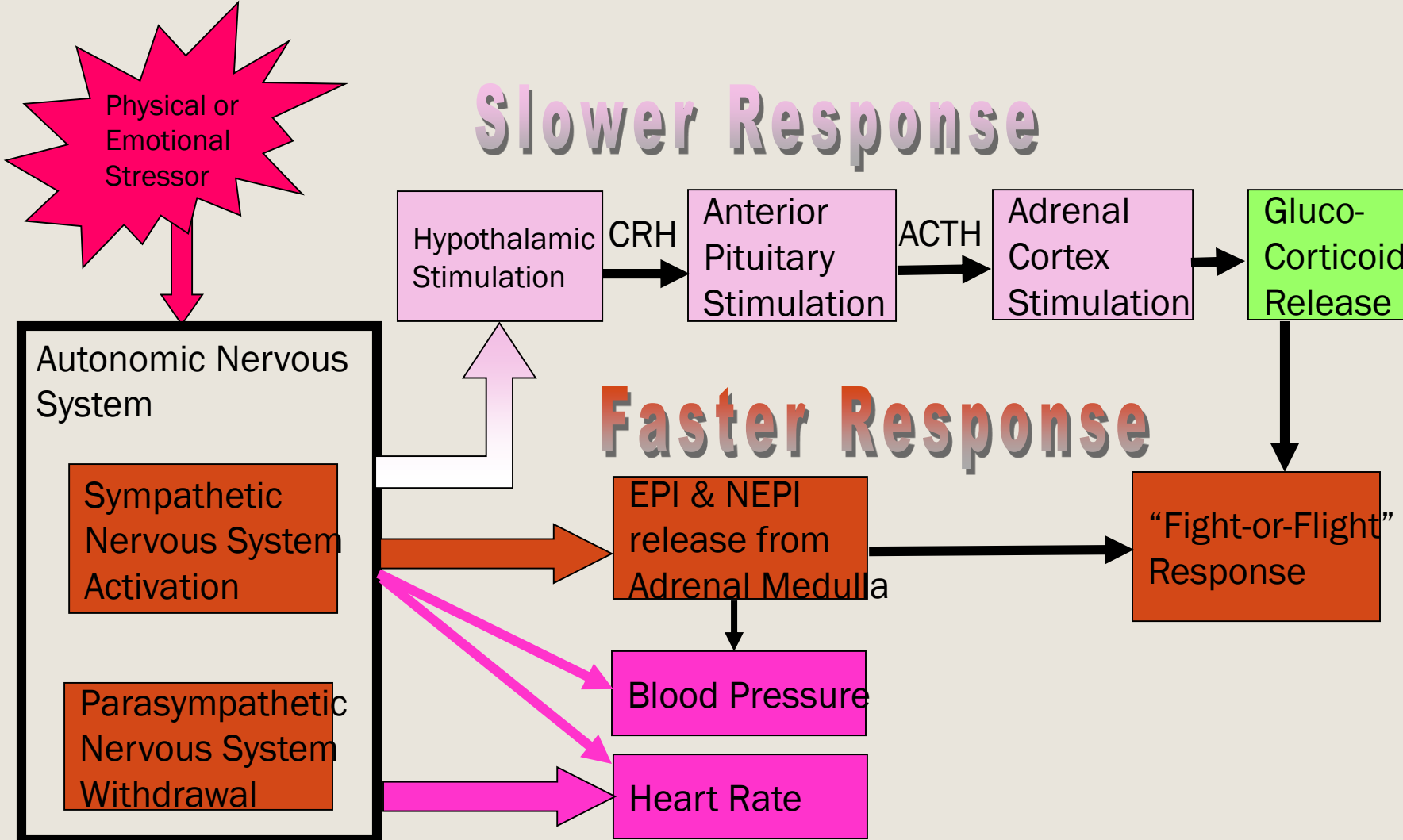 - *Measured by Epinephrine (adrenalin) and Norepinephrin, Blood pressure, heart rate, respiration*

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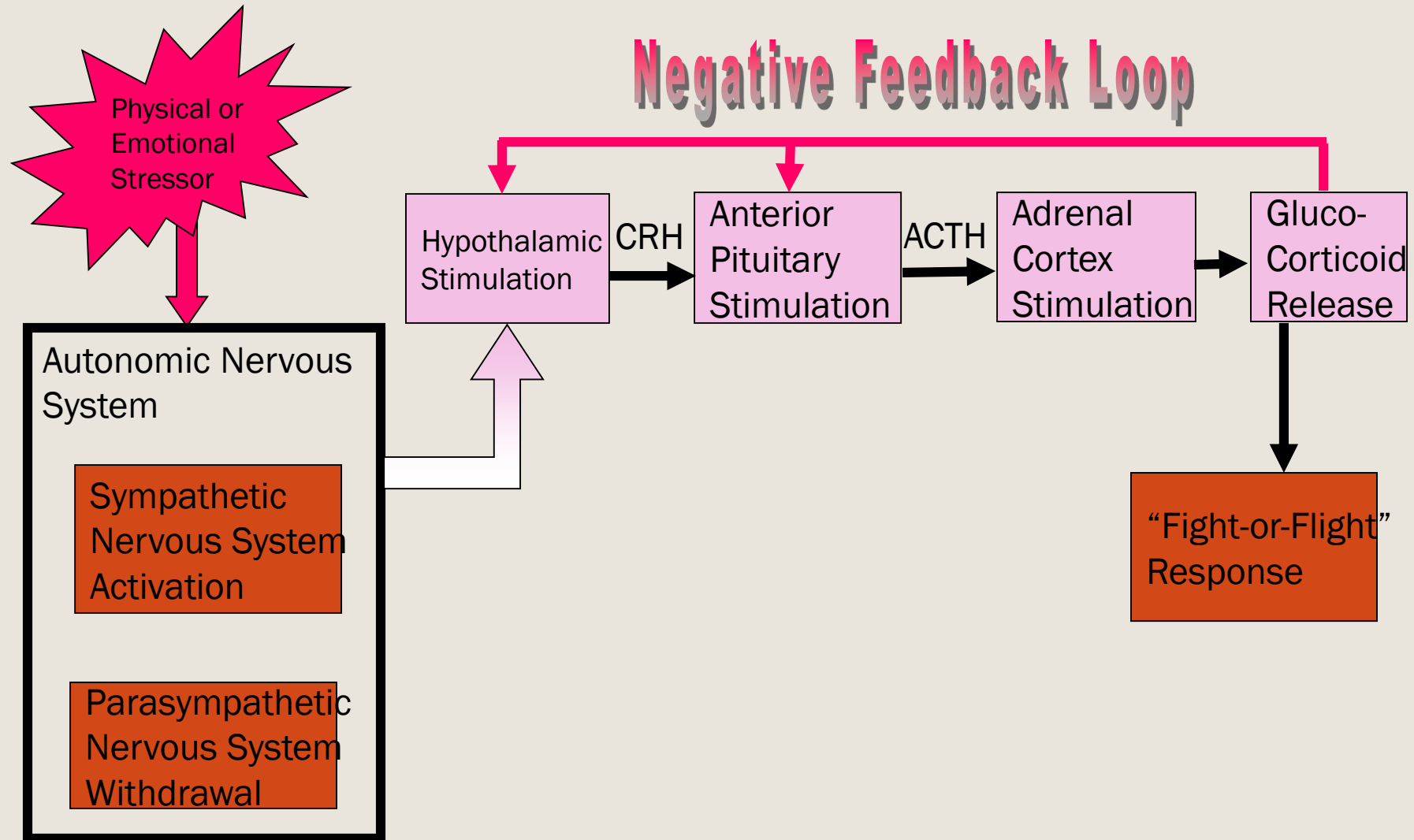 - *Measured by cortisol from blood, urine or saliva*

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*

SAM-Axis & HPA-Axis Activation

# Dysregulation of HPA-Axis Activation

Physical or Emotional Stressor

Negative Feedback Loop

Autonomic Nervous System

Sympathetic Nervous System Activation

Parasympathetic Nervous System Withdrawal

Hypothalamic Stimulation → CRH → Anterior Pituitary Stimulation → ACTH → Adrenal Cortex Stimulation → Gluco-Corticoid Release

"Fight-or-Flight" Response

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
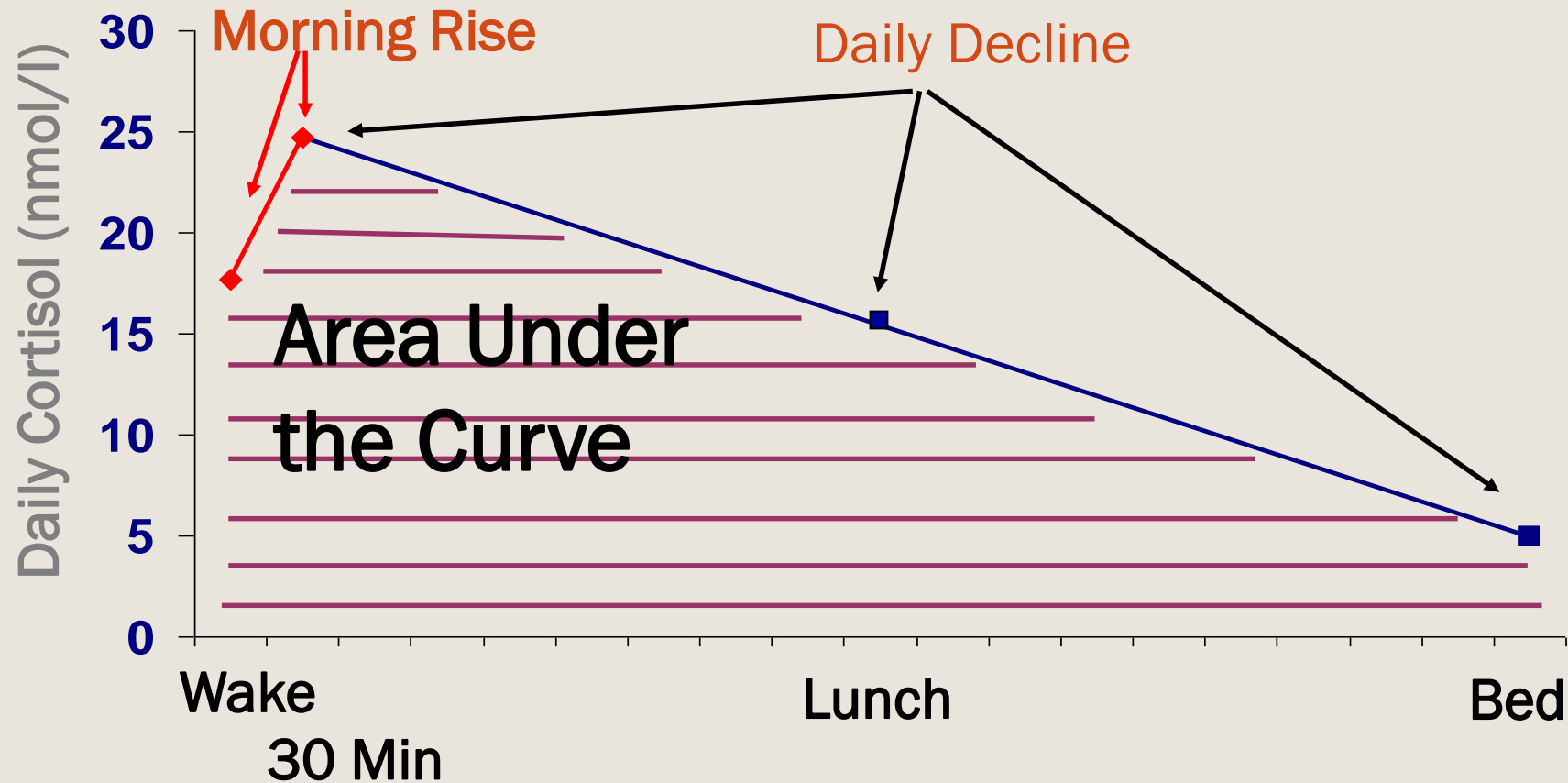
Alpha Amylase: Biomarker of Emotional Valence and Stress

- 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
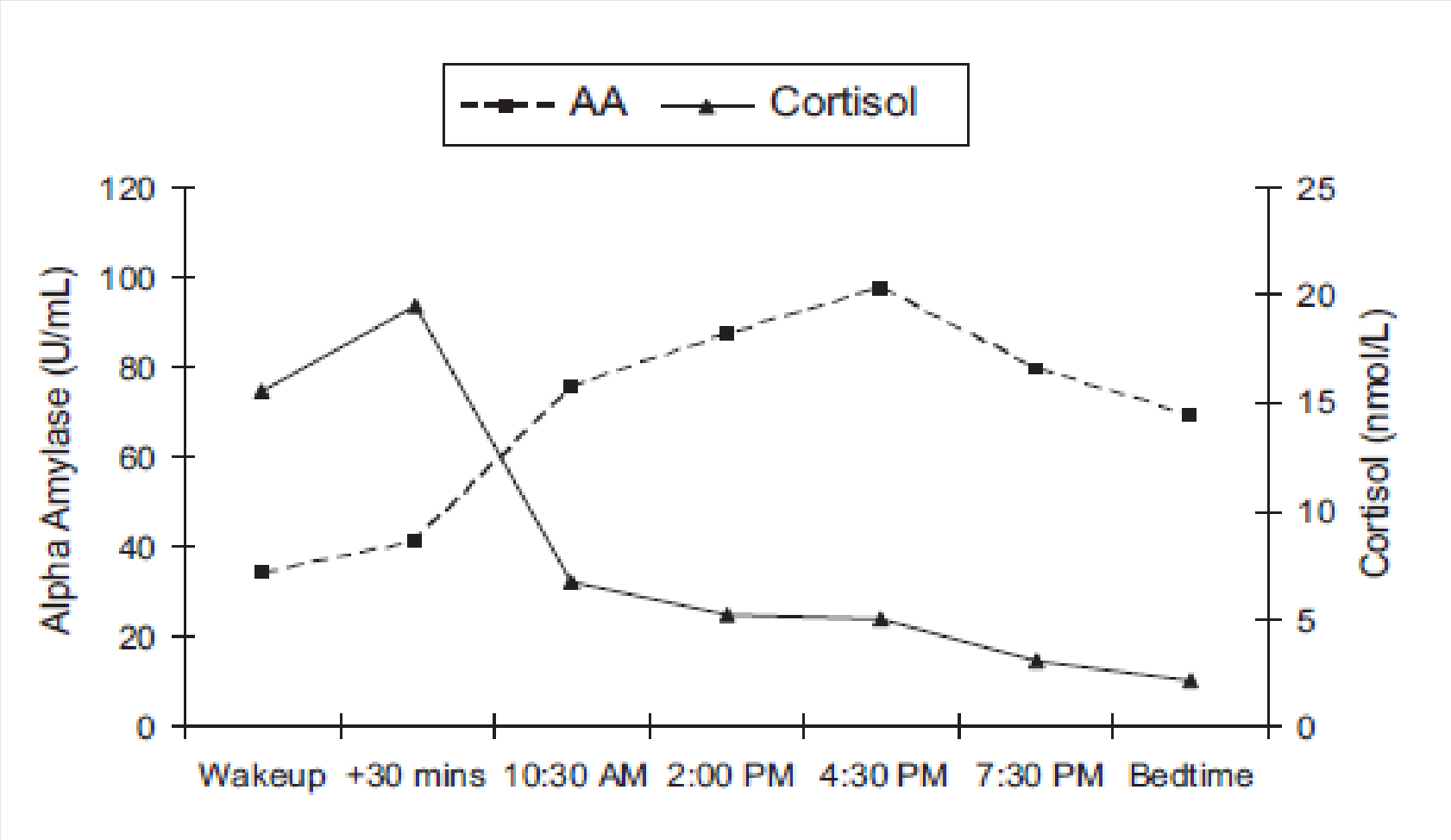
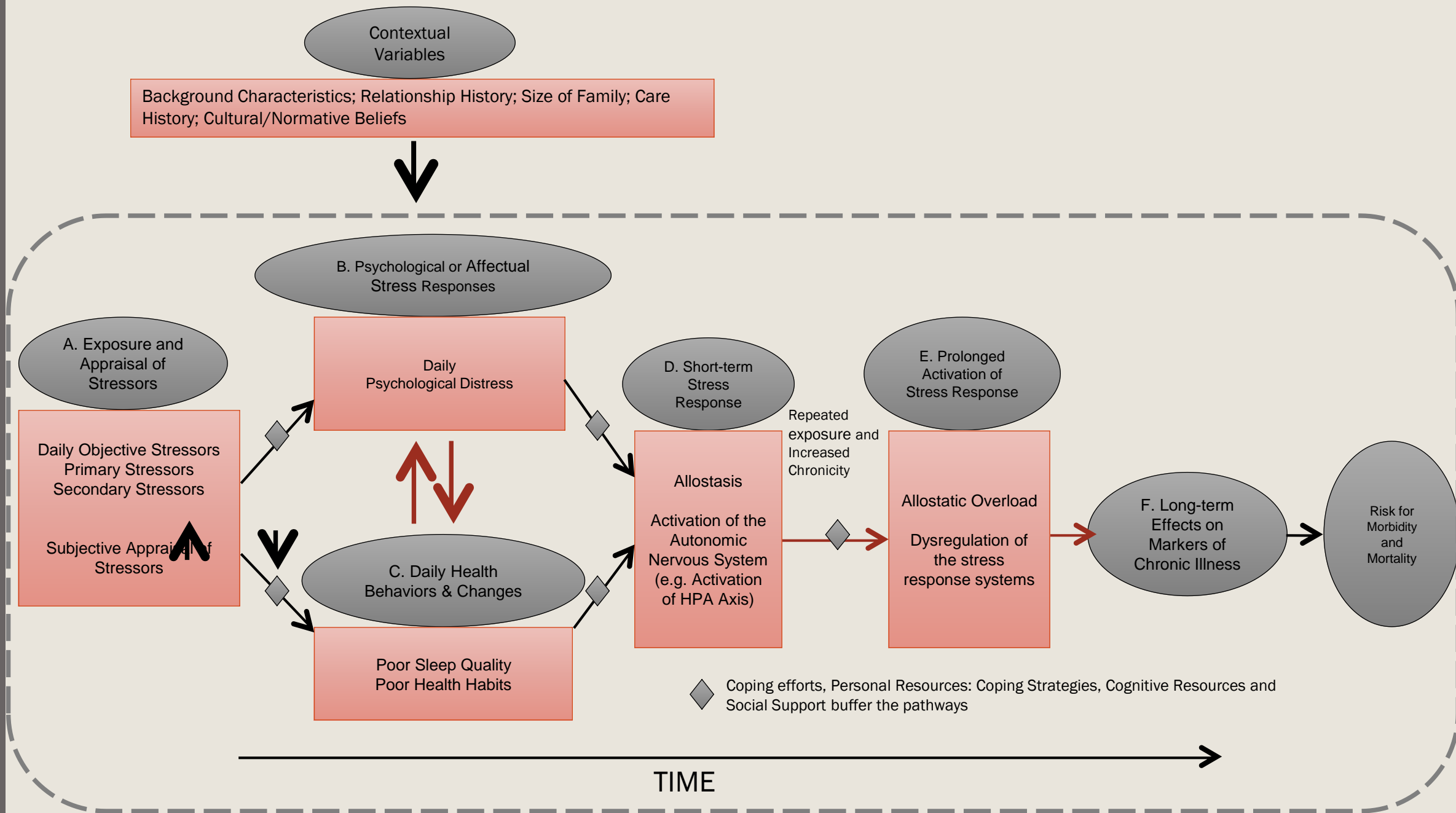Adam, Hoyt & Granger, 2011

And you thought there was stress in _your_ life !

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

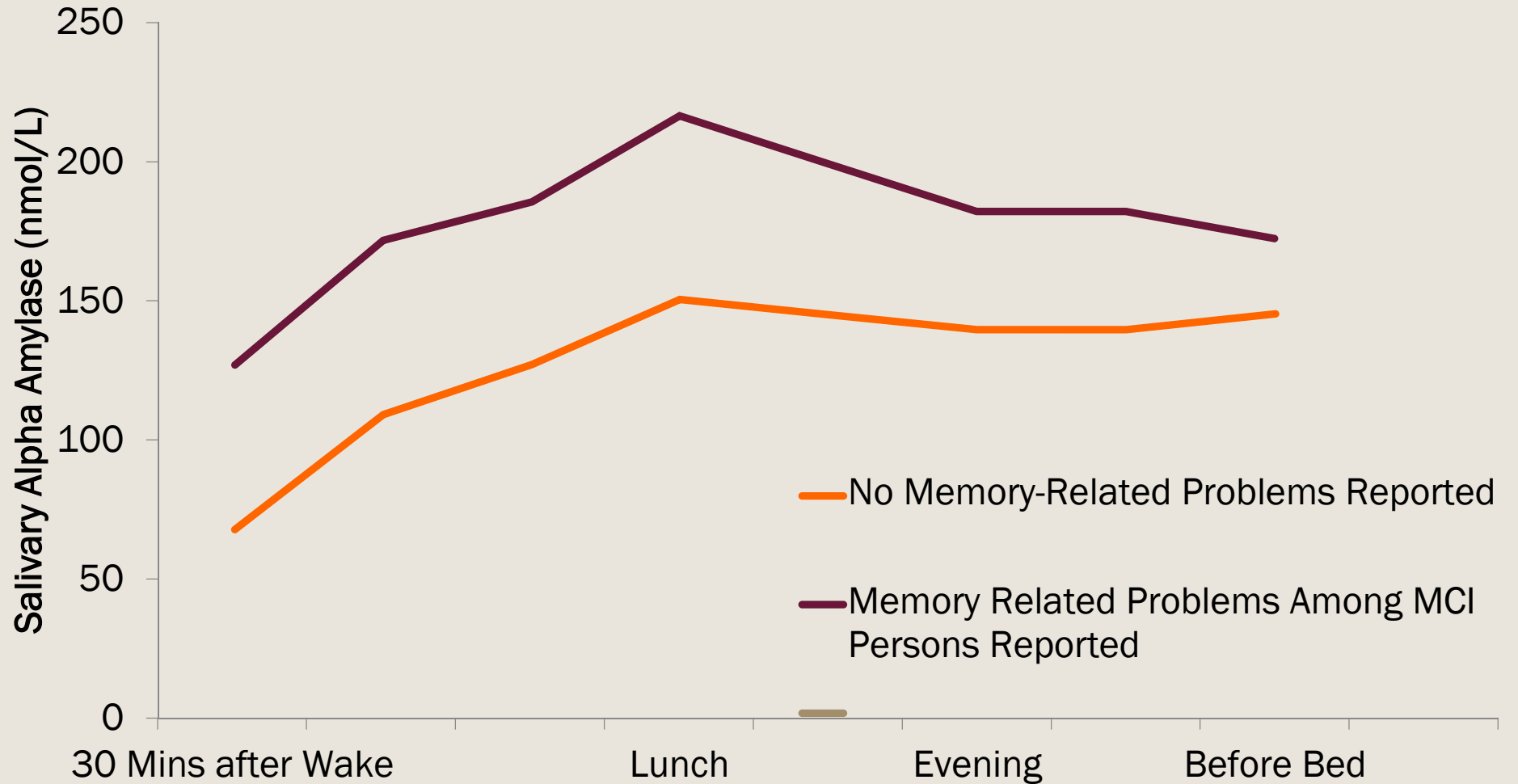Daily Implications of Assistance on Daily Diurnal Cortisol Slope
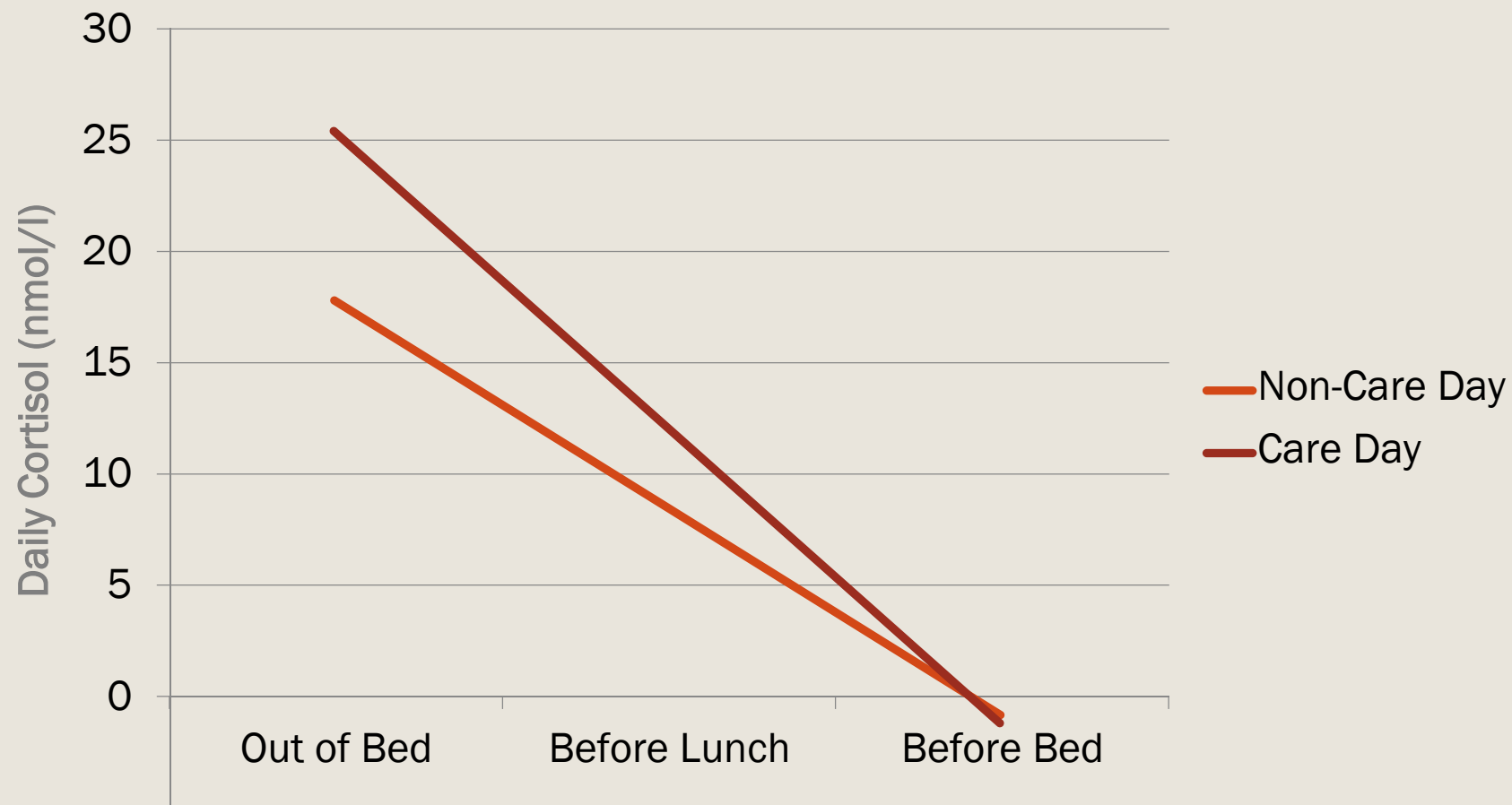
Daily Diary Study of Care Partners of Persons with Mild Cognitive Impairment

- 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%)*
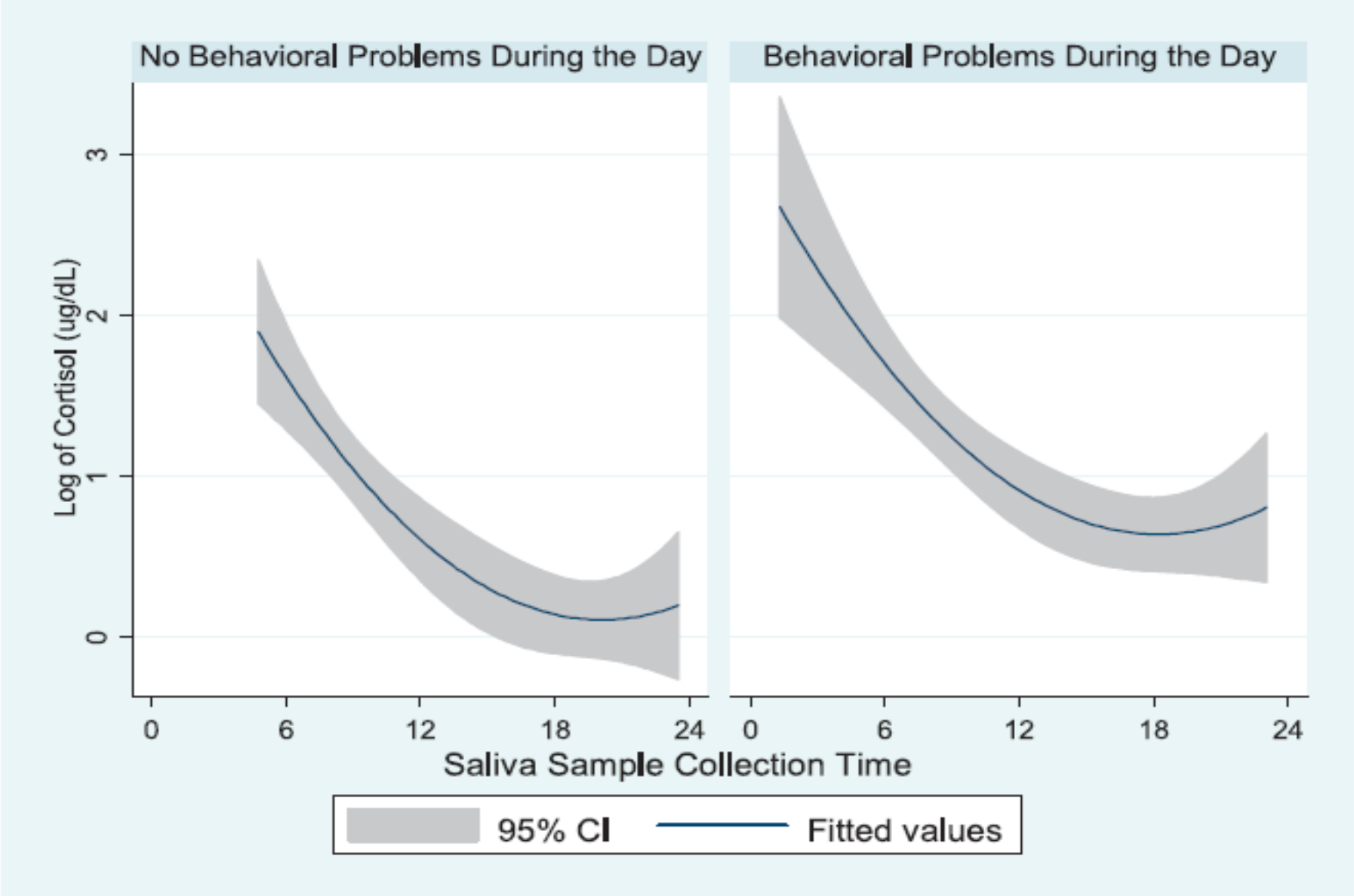
Salivary Alpha-Amylase Among Care Partners Reporting Memory Related Problems

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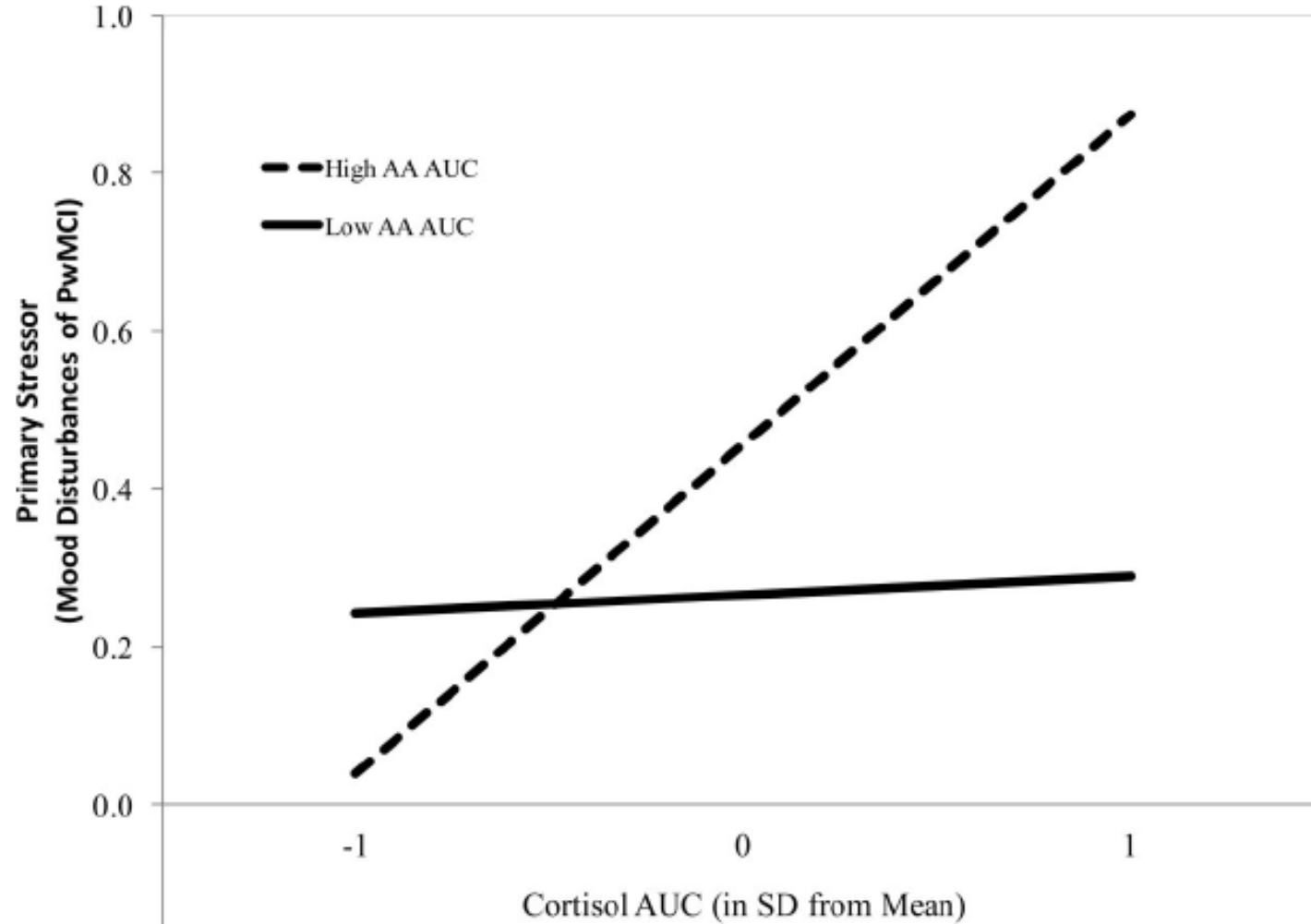
Figure 3. Cortisol AUC is more strongly associated with primary objective stressor in presence of higher sAA AUC ($p < .05$).

- **Hyper**arousal in both systems associated with highest stressor appraisals
- **Hypo**arousal in both systems associated with lower stressor appraisal
- But, hyperarousal in HPA activity, and hypoactivity in ANS – were not associated with stressor appraisals.
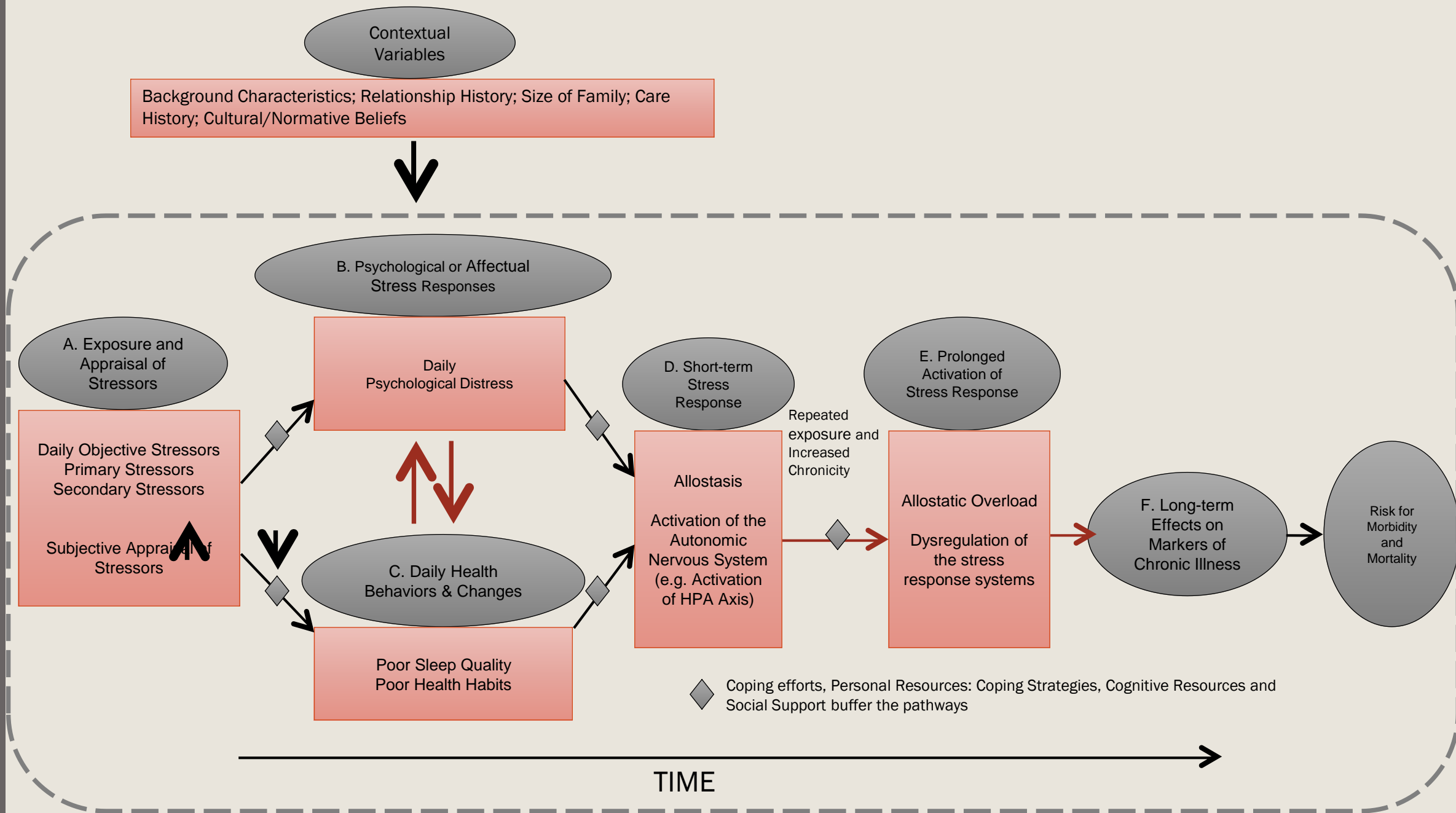- Buffering role of ANS – that may regulate effect of systemic stressors

Figure 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

N =158; 3553 Saliva Samples

| 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 |

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.
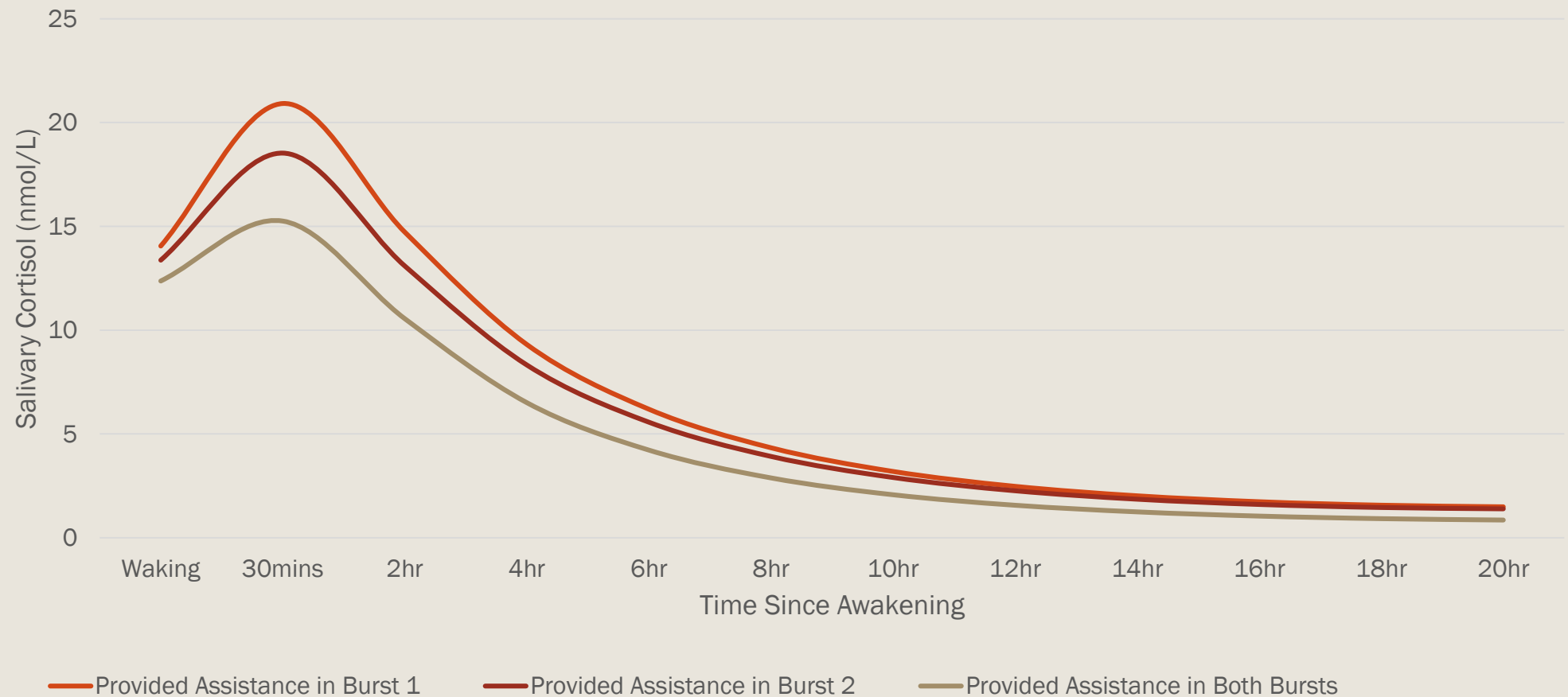
Limitations & Next Steps

■ 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*

54

Current Directions: Individual Differences

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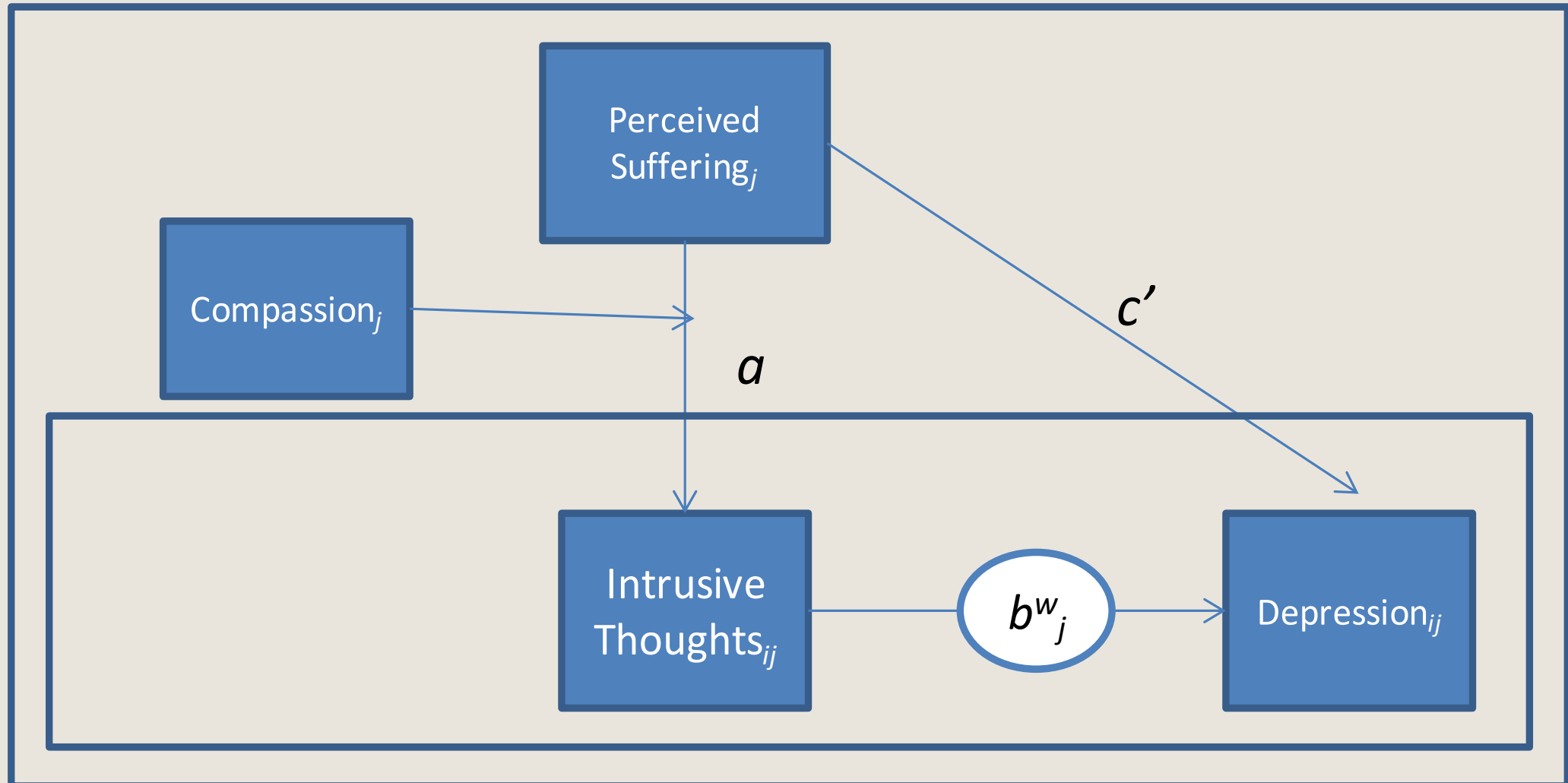 - *Caregivers of Nonnormative Children* (Children with Mental or Developmental Disability)
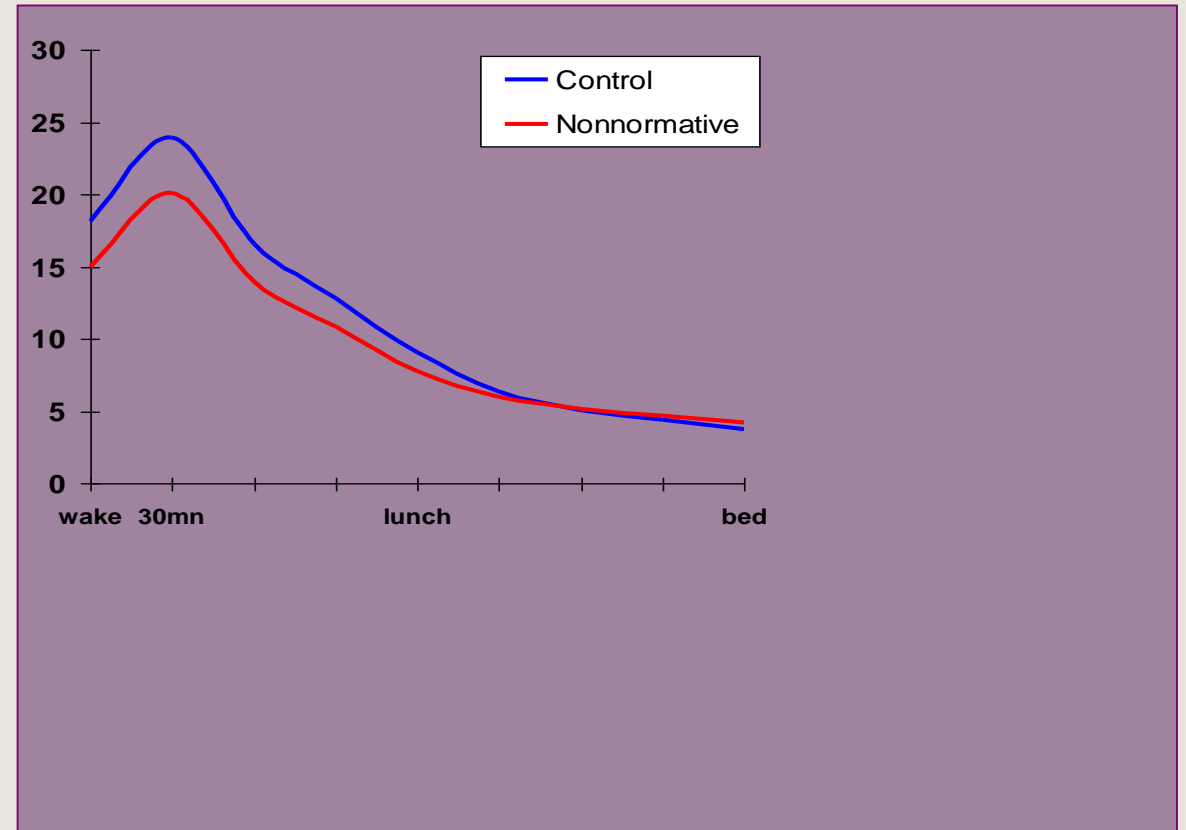
Current Directions:
Collaborative Attempts at Coping with Stressors

Electrodermal Activity Monitor

ROLE OF INTRUSIVE THOUGHTS AND COMPASSION ON DEPRESSIVE SYMPTOMS
(Schulz, Savla, Czaja & Monin, in press)

Thank you for your attention!