

ATTACHMENT SECURITY MODERATES THE LINK BETWEEN ADVERSE  
CHILDHOOD EXPERIENCES AND CELLULAR AGING

by

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## ABSTRACT

Exposure to childhood adversity has been linked to accelerated telomere shortening, a marker of cellular aging and an indicator of physical health risk. However, some individuals show remarkable resilience in spite of such early traumatic events. A number of studies suggest that parental sensitivity may buffer children from the allostatic costs associated with chronic stress exposure. Thus, in the current study, we examined whether adult attachment representation moderated the association between childhood adversity and telomere length. Participants included 78 young adults (Mean age = 20.46,  $SD = 1.57$ ), who reported on their exposure to adverse childhood experiences (ACE) on a questionnaire and were administered the Adult Attachment Interview (AAI), which was coded for attachment “state of mind”. Relative telomere length was assayed from buccal cells. Multiple regression analyses revealed a significant interaction between attachment state of mind and ACE in predicting telomere length. Whereas the association between number of ACE and telomere length was non-significant for secure-autonomous and insecure-preoccupied young adults, there was a strong negative association between number of ACE and telomere length for insecure-dismissing young adults. This study is novel in demonstrating that particular attachment patterns promote biological resilience following childhood adversity, offering clinical implications and contributing to the growing literature about the role of the quality of early caregiving experiences and their representations in shaping biological processes and physical health.

*Keywords:* Attachment, telomeres, adverse childhood experiences, resilience

## CHAPTER 1: INTRODUCTION

Exposure to childhood adversity threatens physical well-being across the lifespan (Matthews & Gallo, 2011; Repetti, Taylor, & Seeman, 2002). The accumulation of adverse childhood experiences (ACE), such as being the victim of physical abuse, growing up with a parent who suffers from psychopathology, and witnessing domestic violence, leads to poor physical health outcomes (Monnat & Chandler, 2015; Repetti et al., 2002; Shonkoff, Boyce, & McEwen, 2009; Taylor, 2010). More specifically, Felitti and colleagues (1998) found that the risk for several age-related diseases, such as stroke, liver diseases, and diabetes, increases with the number of ACE experienced in the first 18 years of life.

One biological mechanism that may explain, in part, the association between exposure to childhood adversity and poor health outcomes is accelerated cellular aging, measured via telomere length (Price, Kao, Burgers, Carpenter, & Tyrka, 2013; Shalev, 2013). Telomeres are repetitive sequences of DNA that protect chromosomes from damage. Telomere shortening is an important indicator of physical health risk independent of chronological health, as it is associated with an array of age-related diseases, including cardiovascular diseases and metabolic disorders (Yang et al., 2009), cancer (Ma et al., 2011; Willeit et al., 2010; Zhang et al., 2015), dementia (Honig, Kang, Schupf, Lee, & Mayeux, 2012; von Zglinicki et al., 2000), type 2 diabetes (Salpea et al., 2010; Zee, Castonguay, Barton, Germer, & Martin, 2010; Zhao et al., 2014), as well as earlier mortality (Bakaysa et al., 2007; Cawthon, Smith, O'Brien, Sivatchenko, & Kerber, 2003; Kimura et al., 2008).

A number of studies have found that adults with histories of child maltreatment have shorter telomeres than those without such histories (Donovan et al., 2012; Kananen et al., 2010; Kiecolt-Glaser et al., 2011; Tyrka et al., 2010). Collectively, studies suggest that the association

between early life stress and reduced telomere length follows a dose-response relationship, with greater severity, number, or chronicity of exposures associated with greater telomere attrition (Kiecolt-Glaser et al., 2011; Price et al., 2013; Puterman et al., 2016).

Despite exposure to trauma and adversity, some individuals show remarkable resilience. A number of studies suggest that parent sensitivity may buffer children from the allostatic costs associated with chronic stress exposure (Gunnar & Fisher, 2006; McEwen, 2000). For example, Evans and colleagues (2007) found that maternal responsiveness moderated the association between early life cumulative exposure to psychosocial (e.g., family turmoil) and physical (e.g., substandard housing) stressors, and levels of allostatic load. More specifically, the link between early life adversities and allostatic overload, indicated in heightened secretion of stress hormones, resting blood pressure, and an index of fat deposition (i.e., BMI), was only apparent among adolescents who experienced low maternal responsiveness. A similar buffering effect of maternal responsiveness was reported by Asok and colleagues (2013); high-risk children involved with child protective services showed reduced telomere length relative to low-risk peers, but not if they had sensitive parenting. Overall, these studies and others (Afifi & MacMillan, 2016; Laucht, Esser, & Schmidt, 2001) suggest that responsive parenting may have protective benefits on cellular aging for children exposed to early life stress.

Few studies have investigated the potential buffering effect of supportive parental care on the link between childhood adversity and *adulthood* physical health at the molecular level. In one study of African American young adults, elevated levels of life-long non-supportive parenting predicted reduced telomere length at age 22 (Brody, Yu, Beach, & Philibert, 2015). However, participating in a six-week program designed to increase parental emotional support during late adolescence mitigated the negative impact of non-supportive parenting on accelerated

telomere shortening at age 22. In another study, Chen and colleagues (2011) examined healthy adults who were raised in low socioeconomic households in early life. Compared to adults who retrospectively reported experiencing high maternal warmth in childhood, those who reported low maternal warmth showed indications of excess immune and pro-inflammatory activity, which may contribute to accelerated telomere shortening (Shalev et al., 2012).

Taken together, these studies suggest that attachment theory may offer an important framework for examining moderators of the association between childhood adversity and cellular markers of physical well-being. According to attachment theory (Bowlby, 1982), individuals with secure attachments derive a sense of safety from physical or perceived proximity to caregivers when facing distress. Thus, a secure attachment may provide one with an internal psychological resource that helps regulate anxiety and promote resilience in the face of trauma (Charuvastra & Cloitre, 2009; Pierrehumbert, Torrisi, Ansermet, Borghini, & Halfon, 2012). In the absence of a secure attachment, then, individuals may be especially vulnerable to stressors. When children experience inattentive, hostile, or punitive responses from caregivers in response to their distress, they are likely to develop an insecure-avoidant attachment, characterized by turning away from one's caregiver in times of need, or an insecure-resistant attachment, characterized by expressing anger or resistance towards one's caregiving simultaneously with proximity-seeking (Main, 2000). In adulthood, these behavioral attachment patterns are evident in individuals' attachment "state of mind," as assessed using the Adult Attachment Interview (AAI; George, Kaplan, & Main, 1984), a semi-structured interview that asks one to reflect on attachment-related experiences with primary caregivers. Similar to the insecure-avoidant behavioral pattern observed in children, adults classified as "insecure-dismissing" on the AAI tend to fix their attention *away from* past attachment relationships and the influences of those

relationships on the self, minimizing the importance of or idealizing attachment figures (Hesse, 2016). Likewise, similar to the insecure-resistant behavioral pattern observed in children, adults classified as “insecure-preoccupied” tend to fix their attention strongly *towards* past and present attachment relationships, exhibiting over-involvement and anger when describing attachment figures and attachment-related experiences (Hesse, 2016). Given that insecure-dismissing and insecure-preoccupied attachment states of mind both reflect histories of insensitive caregiving that have led to ineffective and inflexible strategies for regulating distress, individuals with these insecure attachment patterns may experience chronic, dysregulated physiological stress responses (Cassidy, Jones, & Shaver, 2013), which may ultimately lead to shorter telomeres (Lin, Epel, & Blackburn, 2012).

In the current study, we examined whether adult attachment state of mind moderated the association between early adversity and telomere length among young adults. As the gold-standard measure of adult attachment, the AAI offers a number of strengths not afforded by measures of parent sensitivity (observed or parent-report) used in previous studies. First, although AAI classifications are correlated with parental sensitivity (Haydon, Roisman, Owen, Booth-Laforce, & Cox, 2014), they reflect consolidated attachment patterns based on relational experiences across development (Treboux, Crowell, & Waters, 2004). Thus, the AAI offers a relatively stable and generalized measure of attachment (Ammaniti, van IJzendoorn, Speranza, & Tambelli, 2000; Haydon et al., 2014; Hesse, 2016; Steele et al., 2014). Second, the different insecure classifications, dismissing and preoccupied, allow for more nuanced examination of the attentional strategies (i.e., deactivating versus hyperactivating) that may guide individuals’ responses to distress in the context of activation of the attachment system (Main, 2000; Ravitz, Maunder, Hunter, Sthankiya, & Lancee, 2010). Lastly, given that attachment classifications are

assessed by independent coders based on an individuals' responses during the AAI, biases associated with retrospective reporting or self-report are reduced (Jacobvitz, Curran, & Moller, 2002).

In line with previous research, we examined the following hypotheses. First, we predicted that the number of ACE would be negatively associated with telomere length, with increased exposure to ACE associated with reduced telomere length. Second, we predicted that attachment classification would moderate the association between the number of ACE and telomere length. Specifically, we predicted that, among individuals with insecure attachment (dismissing or preoccupied), the association between number of ACE and telomere length would be stronger than among individuals with secure-autonomous attachment. These results would suggest that secure-autonomous attachment serves to buffer against the effects of exposure to childhood adversity on cellular aging.



## CHAPTER 2: METHOD

### 2.1 Participants

Participants included 85 young adults recruited through undergraduate subject pools at two universities. Of the original sample, 78 participants were included in analyses, with 3 excluded due to outlying telomere values (as described below) and 4 excluded because samples were lost due to storage problems. Participants (80% female) ranged in age from 18 to 23.75 years ( $M = 20.46$ ,  $SD = 1.57$ ). The majority of the sample was Caucasian (47%), with 26% Asian-Americans, 12% Hispanics, and 4.5% African-Americans. Participants were distributed across income levels with the majority (45%) reporting an annual household income of between \$40,000 to \$99,999, 29.5% reporting an annual household income of less than \$40,000, and 25.5% reporting an annual household income of more than \$100,000. See Table 1 for additional sample demographic information per adult attachment classification group.

### 2.2 Procedure

After obtaining informed consent, participants completed questionnaires electronically that assessed for demographic information, health-related covariates, and exposure to ACE. Then, they were administered the Adult Attachment Interview (AAI), which was audio-recorded for later verbatim transcription and coding. Following the interview, participants brushed the inside of both of their cheeks (about 30 seconds on each side) using SK-1 buccal swabs (Boca Scientific, Boca Raton, FL). Samples were stored short-term at  $-20^{\circ}\text{C}$ , and long-term at  $-80^{\circ}\text{C}$  until assay.

### 2.3 Measures

**Attachment state of mind.** The AAI (George et al., 1984) is a 20-question semi-structured interview, which asks participants to describe their relationships with primary

caregivers in childhood, recall specific memories about their relationships in childhood and memories of distress, describe experiences of trauma and loss, and evaluate how their childhood relationships and experiences might have influenced who they are today. Each interview was classified as secure-autonomous (F), insecure-dismissing (Ds), or insecure-preoccupied (E). A fourth category, unresolved/disorganized (U) with respect to trauma or loss, could have been assigned in conjunction with one of the three other classifications, but was not used in our analyses as hypotheses concerned organized attachment classifications. In our sample, 50 participants (64%) were classified as secure-autonomous, characterized by a collaborative, balanced, and coherent description of attachment-related experiences with primary caregivers; 19 (24%) as insecure-dismissing, characterized by a tendency to minimize the importance of or idealize attachment figures; and 9 (12%) as insecure-preoccupied, marked by over-involvement with past or current attachment experiences. The distribution of AAI classifications in our low-risk sample resembles normative rates reported in a recent meta-analysis (Bakermans-Kranenburg & van IJzendoorn, 2009). All transcripts were coded by the first author, with approximately 25% ( $n = 20$ ) double-coded by the last author. Both coders are certified reliable coders who were trained by the developers of the AAI, Drs. Mary Main and Eric Hesse. The agreement between the two raters was high (90%;  $k = .81$ ) for three-way classifications (secure-autonomous, insecure-dismissing, insecure-preoccupied). Disagreements between the raters were resolved by discussion and conferenced classifications were used in analyses.

**Adverse childhood experiences (ACE).** Adverse childhood experiences in the first 18 years of life were assessed using the ACE Study questionnaire (Dube et al., 2003; Felitti et al., 1998). The ACE instrument assesses for 10 ACE, including 5 that reflect experiences of maltreatment (i.e., physical abuse, physical neglect, emotional abuse, emotional neglect, sexual

abuse) and 5 that reflect experiences of household dysfunction (i.e., parent with psychopathology, incarcerated parent, parent with substance abuse problems, parental divorce/separation, domestic violence). Each item was scored dichotomously (as present or absent) and items were totaled to yield an ACE score ranging from 0 (no exposure) to 10 (exposure in all categories). Number of ACE in our sample ranged from 0 to 7 ( $M = 2.05$ ,  $SD = 1.88$ ).

**Telomere length.** Following procedures used previously (i.e., Asok et al., 2013), participants' DNA was purified from buccal swabs using the Gentra Puregene Buccal Cell Kit (Qiagen, Valencia, CA) and measured in triplicate via quantitative PCR on a Bio-rad CFX96 real-time PCR system (Bio-rad, Hercules, CA). Relative telomere length was calculated by comparing telomere (T) amplification to the single copy gene (S) acidic ribosomal phosphoprotein P0 (36B4) using the formula  $T/S = (2^{\Delta Ct_{tel}})/(2^{\Delta Ct_{36B4}})$  and the following primer sets: Tel<sub>F</sub> 5'-CGGTTTGTGGTTGGGTTGGGTTGGGTTGGGTTGGGTT-3', Tel<sub>R</sub> 5'-GGCTTGCCTTACCCTTACCCTTACCCTTACCCTTACCCT-3') and 36B4 (36B4<sub>F</sub> 5'-CAGCAAGTGGGAAGGTGTAATCC-3', 36B4<sub>R</sub> 5'-CCCATTCTATCATCAACGGG-TACAA-3'). Any triplicate (~ 1.44 % of all triplicates) that deviated by more than 1 cycle threshold (Ct) was excluded from the calculation of the sample average and the remaining replicates were used. The inter- and intra-assay coefficients of variation were 0.67% and 0.99%, respectively, for telomeres and 0.59% and 0.73%, respectively, for 36B4. Three samples were excluded from analyses: one because it amplified beyond the range of standards, and two because values were beyond 3 *SD* of the sample mean.

**Covariates.** We also collected information on demographic and health-related factors in order to control for potential confounds. Demographic variables included age at the time of

buccal swab collection, gender, ethnicity, and current income. Health-related factors, also assessed via self-report, included smoking history (currently smoking, smoked but not currently, never smoked), current physical activity level (heavy activity, moderate activity, low activity, and inactive), and BMI (computed from participant report of current height and weight).

## CHAPTER 3: RESULTS

**3.1 Preliminary Analyses: Links between variables of interest**

First, we examined bivariate associations between primary variables of interest (i.e., AAI classification, ACE, telomere length), demographic characteristics, and health-related factors. With regard to preliminary analyses for AAI classification, gender was significantly associated with AAI classification,  $\chi^2(N = 78, df = 2) = 6.5, p = .039$ , with a higher percentage of males in the insecure-preoccupied group than in the secure-autonomous group. AAI classification was also significantly associated with ACE,  $F(2,75) = 6.89, p = .002$ , with participants classified as insecure-dismissing reporting fewer ACE than participants classified as either insecure-preoccupied or secure-autonomous. Associations between AAI classification and telomere length, age, ethnicity, income level, smoking history, level of current physical activity, and BMI were non-significant (all p-values  $> 0.05$ ). Preliminary analyses for ACE revealed no significant associations with demographic or health-related variables; further, in contrast to our prediction, number of ACE was not correlated with telomere length. Finally, telomere length was not associated with demographic or health-related variables (all p-values  $> 0.05$ ); despite these non-significant associations, we included demographic and health-related covariates in primary analyses, given associations reported in previous studies.(Puterman & Epel, 2012) Bi-variate correlations are presented in Table 2.

**3.2 Primary Analyses: Moderating Role of Attachment Security in the Link between ACE and telomere length**

We conducted a hierarchical multiple regression, with telomere length as the dependent variable. In Model 1, we entered demographic covariates of age, gender (entered as 0 for male, 1 for female), ethnicity (entered as 0 for non-minority, 1 for minority), and income level. In Model

2, we added health-related covariates, including smoking status (entered as a categorical variable, with never smoked [0] vs. past/current smoking [1]), current physical activity level (entered as a continuous variable from inactivity [0] to heavy activity [3]), and BMI. In Model 3, we added number of ACE and dummy-coded indicators of adult attachment state of mind (for secure-autonomous versus insecure-dismissing and secure-autonomous versus insecure-preoccupied), with secure-autonomous as the reference group. Finally, in Model 4, we added in ACE X attachment state of mind interaction terms (for both insecure-dismissing and insecure-preoccupied variables) to examine whether attachment state of mind moderated the link between ACE and telomere length.

The hierarchical multiple regression (see Table 3 for results) revealed that Model 1 (demographic variables) accounted for significant variation in telomere length,  $R^2 = .13$ . Model 2 (adding health-related variables) did not significantly increase the amount of variance explained. Introducing the attachment state of mind and ACE variables without their interactions (Model 3) did not contribute significantly to the explained variance in telomere length. However, there was a main effect of insecure-dismissing (vs. secure-autonomous) on telomere length,  $b = -.17, p = .028$ . Adding the ACE X attachment state of mind interaction terms (Model 4) resulted in a significant increase in the total variance explained in telomere length (36%). The interaction between insecure-dismissing (vs. secure-autonomous) attachment and number of ACE significantly predicted telomere length,  $b = -.17, p = .002$ , suggesting that attachment state of mind moderated the association between childhood adversity and telomere length. To probe this interaction effect, we examined the correlation between ACE and telomere length separately for each AAI classification group. There was a significant negative correlation between ACE and telomere length in the insecure-dismissing group,  $r(19) = -.59, p = .007$ , but not for either the

secure-autonomous group,  $r(50) = -.15, p = .31$ , or the insecure-preoccupied group,  $r(9) = -.15, p = .71$  (See Figure 1).

Given that the insecure-dismissing group reported a more limited range of ACE scores than the secure-autonomous group (0-3 and 0-7, respectively), we confirmed that the moderation effect held when reducing analyses to autonomous-secure and insecure-dismissing adults who reported between 0 and 3 ACE (See Figure 2). Indeed, the insecure-dismissing X ACE interaction effect remained significant,  $b = -.16, p = .01$ , and Model 4 still explained a similar amount of variance in telomere length,  $R^2 = .48, F(10,47) = 4.32, p < .001$ .

## CHAPTER 4: DISCUSSION

Our findings showed that attachment representation moderated the association between exposure to childhood adversity and telomere length in young adulthood. Specifically, controlling for demographic and health-related variables, increased exposure to ACE was associated with reduced telomere length among young adults classified as insecure-dismissing. In contrast, there was no association between childhood adversity and telomere length among young adults classified as secure-autonomous and insecure-preoccupied. These findings highlight the key role of attachment in potentially exacerbating (in the case of insecure-dismissing attachment) or mitigating (in the case of secure-autonomous and insecure-preoccupied attachment) the effects of early life stress and trauma on cellular aging, adding to the growing body of evidence suggesting that parenting can shape pathways towards physical well-being in the face of adversity (Cicchetti & Blender, 2006; Gunnar & Quevedo, 2007).

Given that individuals with secure-autonomous attachments were essentially protected from the negative effects of childhood adversity on telomere erosion, it is critical to consider mechanisms that may be involved. Attachment patterns influence individuals' expectations, interpretations, and memories of relationship experiences (Dykas & Cassidy, 2011); thus, stressors encountered across the life span, including adverse childhood experiences, may be perceived as less overwhelming for secure-autonomous adults (Coan, Schaefer, & Davidson, 2006; Eisenberger et al., 2011). Furthermore, secure-autonomous attachment state of mind, entailing an ongoing perception of a secure base that one can reliably count on as a haven of safety for comfort and support when stressed (Waters & Cummings, 2000), may allow for greater flexibility of problem solving and openness to social support. In the long run, these cognitions and stress regulation capacities may reduce systematic inflammation (Erlich, Miller,



Jones, & Cassidy, 2016), and consequently lead to lower levels of cumulative physiological wear and tear.

Whereas ACE were associated with reduced telomere length among insecure-dismissing young adults, there was no significant association between ACE and telomere length among insecure-preoccupied individuals. It is possible that the null finding among insecure-preoccupied individuals was due to a relatively small sample size; however, the specificity of the effect to insecure-dismissing individuals complements findings from the broader literature. For example, studies show that insecure-dismissing individuals, but not insecure-preoccupied or secure-autonomous individuals, exhibit significantly higher physiological reactivity, assessed via electrodermal activity, when responding to AAI questions about separation, rejection, and other potentially threatening childhood experiences (Dozier & Kobak, 1992; Roisman, Tsai, & Chiang, 2004), and when directly interacting with their mothers in the context of a conflict issue (Beijersbergen, Bakermans-Kranenburg, Van Ijzendoorn, & Juffer, 2008).

These differences in physiological responses between insecure-dismissing and insecure-preoccupied individuals may reflect differences in their distress regulation coping strategies. During stressful times, insecure-dismissing adults tend to engage in greater avoidance behavior and less support-seeking from close partners than insecure-preoccupied adults (Collins & Feeney, 2000; Simpson, Rholes, & Nelligan, 1992). Conversely, insecure-preoccupied adults may overemphasize the need for support and heighten affective expression, sometimes manifesting in elevated anger and hostility during conflicts with partners (Simpson, Collins, Tran, & Haydon, 2007). Thus, unlike insecure-dismissing, but similar to secure-autonomous adults, insecure-preoccupied adults are prompted to engage in social interaction, though aggressive or excessive in nature, in order to *attenuate or eliminate their distress*. In contrast,

insecure-dismissing adults tend to turn away from feelings of distress, appear distant, and are less willing to rely on others (Miga, Hare, Allen, & Manning, 2010). These avoidance strategies may prevent the restoration of felt security via *maintenance of their distress*. Over time, insecure-dismissing stress regulation strategies may harm one's ability to develop and sustain close relationships (Miga et al., 2010), which may perpetuate the lack of perceived or actual warmth and support (Barger & Cribbet, 2016). This lack of support, in turn, may contribute to chronic activation of physiological stress response systems (Cassidy et al., 2013), specifically more pronounced and prolonged neuroendocrine (i.e., cortisol) stress responses (Scheidt et al., 2000). Altered cortisol reactivity to stress is linked to accelerated telomere shortening, thereby providing support for how disrupted patterns of attachment may mechanistically influence cellular aging across the lifespan (Gotlib et al., 2014; Tomiyama et al., 2012).

We should note several limitations of the current study. First, the sample size was relatively small; it will be important to replicate the findings with a larger sample, particularly with more participants in the insecure sub-groups. Second, and perhaps as a result of a relatively small sample size, our AAI sub-groups differed in the mean and range in number of ACE, with insecure-dismissing participants reporting relatively fewer ACE than other groups; although results remained significant when limiting analyses to the reduced range of ACE, it is possible that including insecure-dismissing individuals with high numbers of ACE (4 or more) could lead to different results. Third, our sample was limited to young adults in college. In future studies, it will be important to extend findings to older individuals as well as individuals facing higher levels of risk. Fourth, our study was cross-sectional. Our cross-sectional design limits our understanding of whether the attachment-related differences that we observed in telomere length reflect lasting consequences of early life adverse experiences (which may have emerged decades

before our assessment) or more recent alterations due to cumulative effects, or some combination. Relatedly, in this study we did not assess participants' current life stressors, which may have contributed to current telomere length. Finally, our assessment of childhood adversity took into account only the number of different exposures from a list of commonly-studied types, but did not take into account the severity, frequency, chronicity, or developmental timing of these exposures. A more nuanced approach to measuring childhood adversity will be informative in future studies.

In conclusion, this study adds to our understanding of the potential mechanisms (i.e., cellular aging) that link childhood adversity to negative health outcomes, as well as factors in social environment (i.e., early attachment experiences and their adult representations) that may promote resilience to childhood adversity. In future research, it will be important to understand what specifically about different attachment patterns (e.g., perception of stressful events, flexible/adaptive coping strategies) exacerbates risk and promotes resilience, and specifically how attachment patterns influence biological processes that lead to negative health outcomes. Such advances in understanding these social and biological mechanisms may offer critical steps toward changing our current health care system from an acute "sick-care" to a preventative "well-care" model (Shonkoff et al., 2012).

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**Table 1.** Characteristics of participants per adult attachment classification group.

Variable	Autonomous ( <i>n</i> = 50)		Dismissing ( <i>n</i> = 19)		Preoccupied ( <i>n</i> = 9)	
	<i>M</i>	( <i>SD</i> )	<i>M</i>	( <i>SD</i> )	<i>M</i>	( <i>SD</i> )
Age (in years)	20.26	(1.54)	20.69	(1.67)	21.12	(1.41)
BMI	23.24	(4.42)	22.14	(2.79)	22.97	(4.27)
Telomere length	1.02	(.26)	.90	(.33)	1.12	(.18)
ACE	2.18	(1.87)	1.00	(1.15)	3.56	(2.07)
	N	(%)	N	(%)	N	(%)
Gender						
Female	43	(86.0)	15	(78.9)	4	(44.4)
Male	7	(14.0)	4	(21.1)	5	(55.6)
Ethnicity						
Caucasian	26	(52.0)	6	(31.6)	3	(33.3)
Asian-American	10	(20.0)	8	(42.1)	3	(33.3)
Hispanic	5	(10.0)	3	(15.8)	1	(11.1)
African-American	2	(4.0)	0	(0.0)	2	(22.2)
Other	7	(14.0)	2	(10.5)	0	(0.0)
Household income						
Less than \$40,000	16	(32)	3	(15.8)	4	(44.4)
\$40,000 – 99,999	23	(46)	8	(42.1)	4	(44.4)
More than \$100,000	11	(22)	8	(42.1)	1	(11.1)
Smoking history						
Currently smoke	5	(10.0)	5	(26.3)	2	(22.2)
Smoked, not currently	7	(14.0)	0	(0.0)	1	(11.1)
Never smoked	38	(76.0)	14	(73.7)	6	(66.7)
Activity level						
Inactive	26	(52)	10	(52.6)	4	(44.4)
Light/Moderate activity	17	(34)	7	(36.9)	1	(11.1)
Heavy activity	7	(14)	2	(10.5)	4	(44.4)

*Note.* BMI = Body Mass Index; ACE = Adverse Childhood Experiences

**Table 2.** Bivariate correlations between demographic, behavioral-health, and cellular aging variables.

Variable	1	2	3	4	5
1. ACE	-				
2. Telomere length	-.11	-			
3. Age (in years)	.19	-.21	-		
4. BMI	-.02	.02	-.11	-	
5. Income level	-.21	-.12	.05	.05	-
6. Activity level	-.09	-.10	-.28*	.17	.10

*Note.* BMI = Body Mass Index; ACE = Adverse Childhood Experiences. \* $p < .05$

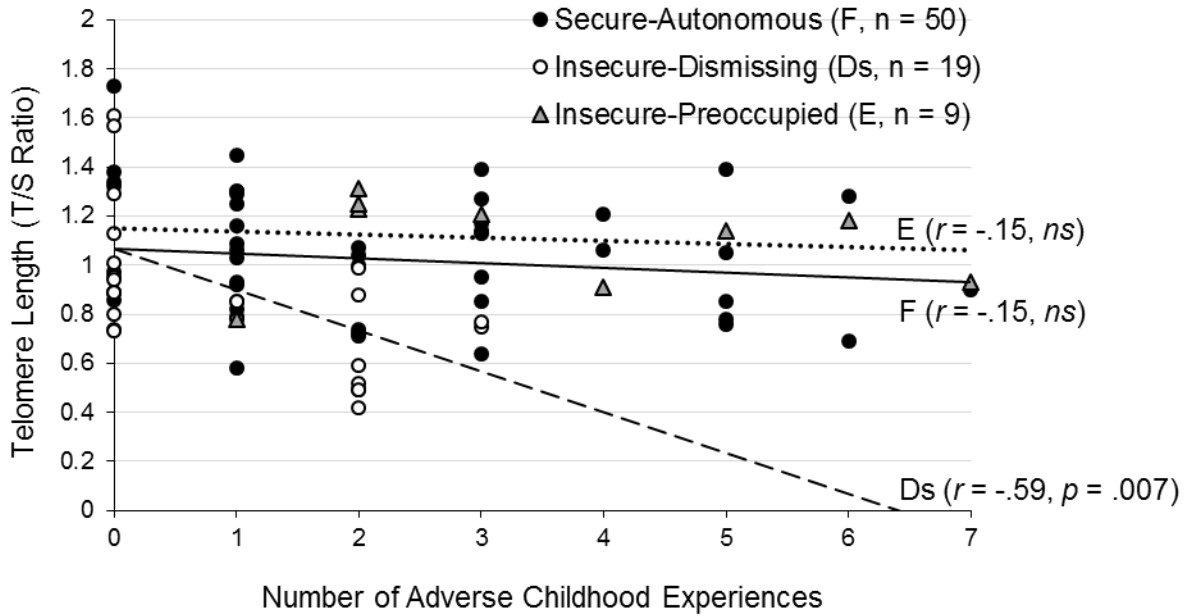


**Table 3.** Summary of Hierarchical Regression Analysis for Covariates, Adverse Childhood Experiences (ACE), and Adult Attachment State of Mind as Predictors of Telomere Length (N = 78).

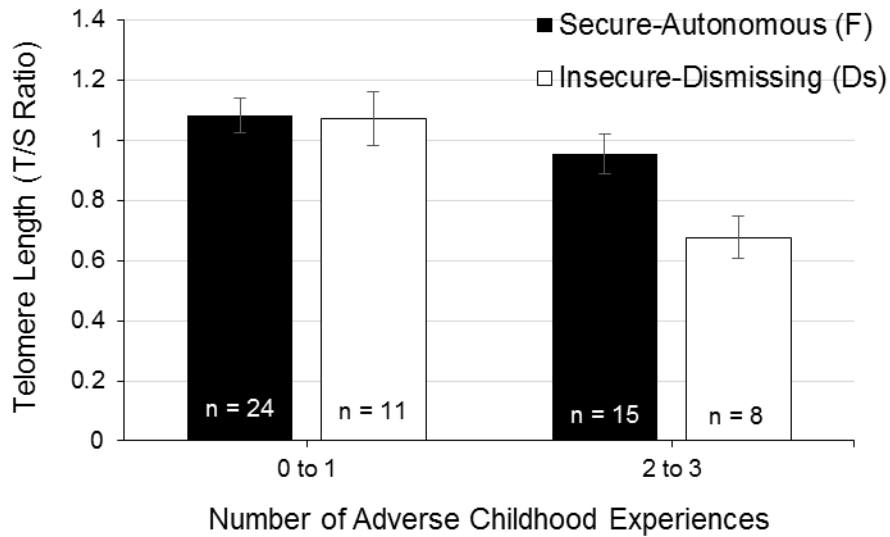
Variable	Model 1			Model 2			Model 3			Model 4		
	<i>B</i>	<i>SE</i>	$\beta$	<i>B</i>	<i>SE</i>	$\beta$	<i>B</i>	<i>SE</i>	$\beta$	<i>B</i>	<i>SE</i>	$\beta$
<b>Demographic</b>												
Age	-.04 <sup>†</sup>	.02	-.21	-.05*	.02	-.26	-.04 <sup>†</sup>	.02	-.20	-.04*	.02	-.22
Ethnicity	.15*	.06	.27	.14*	.06	.26	.17*	.06	.30	.20**	.06	.37
Gender	-.01	.08	-.01	-.01	.08	-.02	.01	.08	.02	.03	.07	.04
Income level	-.01	.01	-.06	.00	.01	-.04	.00	.01	-.04	-.01	.01	-.07
<b>Health-related</b>												
BMI				.00	.01	-.01	.00	.01	-.05	-.01	.01	-.11
Smoking Status				.02	.07	.04	.03	.07	.05	.03	.06	.04
Activity Level				.04	.03	.15	.02	.03	.09	.02	.03	.08
<b>Attachment, ACE</b>												
Total ACE							-.03 <sup>†</sup>	.02	-.21	-.02	.02	-.15
Dismissing							-.17*	.08	-.27	.00	.09	.00
Preoccupied							.11	.10	.13	-.10	.19	-.15
<b>Attachment X ACE</b>												
Dismissing X ACE										-.17**	.05	-.43
Preoccupied X ACE										.06	.05	.28
<i>R</i> <sup>2</sup>		.13			.15			.24			.36	
<i>F</i> for change in <i>R</i> <sup>2</sup>		2.65*			.61			2.56 <sup>†</sup>			6.27**	

*Note.* BMI = Body Mass Index. ACE = Adverse Childhood Experiences. Insecure-dismissing and insecure-preoccupied are dummy-coded variables with secure-autonomous (coded as 0 for both variables) as the reference group. Insecure-dismissing/preoccupied X ACE are interaction terms between dummy-coded attachment variables and total ACE score. <sup>†</sup>*p* < .10 \**p* < .05 \*\**p* < .01

**Figure 1.** Moderating effect of attachment state of mind on the association between number of adverse childhood experiences (ACE) and telomere length, graphed using the continuous measure of ACE, as used in multiple regression analyses.



**Figure 2.** Moderating effect of attachment state of mind on the association between number of adverse childhood experiences (ACE) and telomere length, graphed categorizing ACE data as 0 to 1 versus 2 to 3, for reduced sample (ACE < 4). Error bars represent +/- 1 SE of the mean.



## APPENDICES

## A. Adverse Childhood Experience (ACE) Questionnaire

**Adverse Childhood Experiences Study Questionnaires**

(short version adapted from web site of United States Centers for Disease Control and Prevention (CDC) at <http://www.cdc.gov/nccdphp/ace/>)

(Murphy, A, personal communication Shanta Dube, 2007)

(Prepared by Jordan Bate, Research Manager, Center for Attachment Research/Center for Babies, Toddlers, and Families, Albert Einstein College of Medicine)

This scale is to be used as a screening measure and interpreted in the context of the ACE study which suggests a score >4 increases risk of physical and mental health problems in adulthood. It should be interpreted to describe the adverse effects of early child maltreatment.

Scoring is done based on a “Presence/Absence” basis, with 1 indicating presence of the **bolded items** (ACEs). Score “1” for each bolded item if for any of the questions the responses match those listed. For some questions (e.g. mother treated violently) there are multiple questions. Endorsement of more than one still results in a score of “1” for that ACE. Similarly endorsement of only one question (and not the others) results in a score of “1” for that ACE.

The total possible number of ACEs is 10.

\_\_\_\_\_ **Emotional abuse**

1. often/very often
2. sometimes/often/very often

\_\_\_\_\_ **Physical abuse**

3. sometimes/often/very often
4. once,twice/sometimes/often/very often

\_\_\_\_\_ **Sexual Abuse**

5. yes

6. yes

7. yes

8. yes

\_\_\_\_\_ **Parental/Household substance abuse**

9. yes

10. yes

\_\_\_\_\_ **Parental/Household mental illness**

11. yes

12. yes

\_\_\_\_\_ **Mother Treated Violently**

13. sometimes /often/very often

14. sometimes/often/very often

15. once,twice/sometimes/often/very often

16. once,twice/sometimes/often/very often

\_\_\_\_\_ **Incarcerated Parental/Household Member**

17. once,twice/sometimes/often/very often

\_\_\_\_\_ **Parental Divorce or Separation**

18. yes (score "never together" as "yes")

\_\_\_\_\_ **Physical Neglect**

19. sometimes/often/very often

20. sometimes /often/very often

21. never/once,twice/sometimes

22. sometimes /often/very often

**\_\_\_\_\_ Emotional Neglect**

23. never/once,twice/sometimes
24. never/once,twice/sometimes
25. never/once,twice/sometimes

**\_\_\_\_\_ TOTAL NUMBER OF ADVERSE CHILDHOOD EXPERIENCES BY CATEGORY**

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Beyond the presence of ACEs, a score for Positive Experiences in childhood can be derived from the following questions. Each response is assigned a numeric value, and the total score is a sum of those values. Scores for Positive Experiences range from 0-9.

**\_\_\_\_\_ Positive Experiences - Sum Score Based on Item Values Below**

- |     |               |           |                |
|-----|---------------|-----------|----------------|
| 23. | sometimes (1) | often (2) | very often (3) |
| 24. | sometimes (1) | often (2) | very often (3) |
| 25. | sometimes (1) | often (2) | very often (3) |

**\_\_\_\_\_ TOTAL NUMBER OF POSITIVE EXPERIENCES**

## B. Adult Attachment Interview (AAI) protocol

*[The following instructions are adapted from: George, C., Kaplan, N., & Main, M. (1984). Adult attachment interview. Unpublished Manuscript. Regents of the University of California, Berkeley, CA]*

*Start by saying: I'm going to be interviewing you about your childhood experiences, and how those experiences may have affected your adult personality. We'll focus mainly on your childhood, but later we'll get on to your adolescence and then to what's going on right now. Many parents like this interview even though we ask very personal questions. Some people find it nosy, though. You should feel free to say if there are questions that you're not comfortable answering. You should also let me know afterwards (either today or another day) if you'd like to get help in talking through any of the issues raised more. In our project, part of what we're looking at is how parents' experiences when they were kids affect how they parent. Please remember that everything we ask about will be kept confidential. This interview usually takes about an hour.*

*Then ask the following Main Questions:*

Theme	Main Questions	Subquestions	Notes
Early Family Situation	1. <i>Could you start by filling me in on your family when you were little: where you lived, whether you moved around much, what your parents did for a living, brothers &amp; sisters, that sort of thing? (verbatim)</i>  <i>** If raised by several persons ask: Who would you say raised you?</i>	a. <i>Did you see much of your grandparents when you were little?</i>  b. <i>Did you have brothers, sisters living in the house, or anybody besides your parents? Are they living nearby now or do they live elsewhere?</i>	This should take no longer than 5 minutes: Not used for coding
Relationship with Parents	2. <i>I'd like you to try to describe your relationship with your parents as a young child...if you could start from as far back as you can remember?</i>		This should be relatively brief. Just sets the stage.
5 Adjectives-Mother	3. <i>Now I'd like you to choose five adjectives or words that reflect your relationship with your mother starting from as far back as you can remember in early childhood—as early as you can</i>	<i>You said your relationship with her was _____ (or that she was ____). Can you think of a specific memory that fits with</i>	<b>3-Time Rule to Get Specific Memories for this and for upset, separated, and</b>

	<p><i>go—but say, age 5 to 12. This may take a bit of time so go ahead and think for a minute..then I'll ask you why you chose them. I'll write each one of them down as you give them to me.</i></p>	<p><i>her being_____?</i></p> <p>If Response is general memory or redefinition:  <i>Ask for memory, then specific memory</i>  <i>Can you think of a particular time when she was _____?</i></p>	<p>rejected</p>
5 Adjectives- Father	4. SAME AS MOTHER		
Closest Parent	5. <i>Now I wonder if you could tell me to which parent did you feel the closest, and why? Why isn't there this feeling with your other parent?</i>	OK remark: <i>You've already discussed this a bit, but...</i>	
Upset as Child	<p>6. <i>When you were upset as a child, what would you do?</i></p> <p><i>When you were <u>upset emotionally</u> when you were little, what would you do?</i></p> <p><i>Can you remember what would happen when you were <u>hurt physically</u>... like maybe when you fell down skating or fell off your bike?</i></p> <p><i>Can you remember a time when you were <u>sick</u> as a child?</i></p>	<p>For each, (what is needed are specific memories)</p> <p>If the participant hasn't mentioned being held by parent in incidents, ask: <i>I was just wondering, do you remember being held by either of your parents at any of these times—I mean, when you were upset, or hurt, or ill?</i></p>	<p>With 1<sup>st</sup> question allow participant to interpret <i>upset</i>. Probe to understand what participant means.</p>
1 <sup>st</sup> Separation from Parents	7. <i>What is the first time you remember being separated from your parents?</i>	a. <i>How did you respond? Do you remember how your parents responded?</i>	



		(Specific memories)  b. Are there any other separations that stand out in your mind?	
Rejection by Parents	8. Did you ever feel rejected as a young child? Looking back on it now, you may realize it wasn't really rejection, but what I'm trying to ask about here is whether you remember ever having <u>felt</u> rejected in childhood?  8a. Were you ever frightened or worried as a child? How did your parents respond?	a. How old were you when you first felt this way?  b. Why do you think your parent did those things—do you think she realized she was rejecting you?  c. If no examples are forthcoming, Probe: Did you ever feel pushed away or ignored	
Parents Threatening	9 Were your parents ever threatening with you in any way—maybe for discipline, or even jokingly?  Some people have said, for example, that their parents would threaten to leave them or send them away from home.  Some people have memories of threats or of some kind of behavior that was abusive. Did anything like this ever happen to you, or in your family?	How old were you at the time i. Did it happen often? ii. Do you feel this experience affects you now as an adult? iii. Does it influence your approach to your own child?  2. Did you have any such experiences involving people outside your family? i. How old were you at the time	Be clinically sensitive but try to ascertain specific details: e.g., What did getting the belt mean? To code abuse, there must be marks, for example.  In cases of sexual abuse( as opposed to battering), the interviewer, seldom needs to press for details (unless there is real ambiguity) & must follow participant's lead.

		<ul style="list-style-type: none"> <li>ii. <i>Did it happen often?</i></li> <li>iii. <i>Do you feel this experience affects you now as an adult?</i></li> <li>iv. <i>Does it influence your approach to your own child?</i></li> </ul>	
Effect of Overall Experience	<p>10. <i>In general, how do you think your overall experiences with your parents have affected your adult personality?</i></p> <p><i>Are there any early experiences you feel were a setback in your development?</i></p>	<p>a. <i>If none named, ask: Is there <u>anything</u> about your early experiences that you think might have been a setback, or had a negative effect on the way you turned out?</i></p>	
"Why?" Parents' Behavior	<p>11. <i>Why do you think your parents behaved as they did during your childhood?</i></p>		
Other Close Adults	<p>12. <i>Were there any other adults with whom you were close, like parents, as a child?</i></p>	<p>a. <i>Or any other adults who were especially important to you, even though they weren't parental?</i></p> <ul style="list-style-type: none"> <li>1. <i>At what age were you close?</i></li> <li>2. <i>Did they live with your family?</i></li> <li>3. <i>Did they have any caregiving</i></li> </ul>	Not Terribly Important.

		responsibilities?	
Loss	<p>13. <i>Did you ever experience the loss of a parent or other close loved one when you were a young child? Someone like a sibling or close family member?</i></p> <p>13a. <i>Did you lose other important persons during your childhood?</i></p> <p>13b. <i>Have you lost other close persons, in adult years?</i></p>	<p>a. <i>Could you tell me about the circumstances, and how old you were at the time?</i></p> <p>b. <i>How did you respond at the time?</i></p> <p>c. <i>Was this death sudden or was it expected?</i></p> <p>d. <i>Can you recall your feelings at the time?</i></p> <p>e. <i>Have your feelings regarding this death changed much over time?</i></p> <p>f. <i>If not volunteered earlier, ask: Did you attend the funeral? What was this like for you?</i></p> <p>g. <i>If loss of a parent or sibling, ask: What would you say was the effect on your other parent &amp; household, and how did this change over the years?</i></p>	<p>Very Important. Probe for details of how they found out, circumstances, funeral.</p> <p>Probe at max, 4-5 losses.</p> <p>W/ older adults, probe loss of parents, spouse, children, and "any other loss which you feel may have been especially important to you."</p>

		<p>h. <i>Would you say this loss had an effect on your adult personality?</i></p> <p>i. <i>How does it affect your approach to your own child?</i></p>	
Other Trauma	<p>14. <i>Other than any difficult experiences you've already described, have you had any other experiences that you would regard as potentially traumatic?</i></p>	<p>a. Clarify if necessary: <i>I mean any experience that was overwhelmingly and immediately terrifying?</i></p>	
Changes in Relationship w/ Parents	<p>15. <i>Now I'd like to ask you a few more questions about your relationship with your parents. Were there many changes in your relationship with your parents (or remaining parent) after childhood? We'll get to the present in a few minutes, but right now I mean changes occurring roughly between your childhood and your adulthood?</i></p>		
Current Relationship w/ Parents	<p>16. <i>Now, I'd like to ask you what your relationship with your parents (or remaining parent) is like for you now that you're an adult? Here I'm asking about your current relationship.</i></p>	<p>a. <i>Do you have much contact with your parents at present?</i></p> <p>b. <i>What would you say the relationship with your parents is like currently?</i></p> <p>c. <i>Could you tell me about any (or any other) sources of dissatisfaction in your current relationship with your parents? Any special sources of satisfaction?</i></p>	

Current Relationship w/ Child	17. <i>I'd like to move on now to a different sort of question—it's not about your relationship with your parents. Instead, it's about an aspect of your relationship with <u>specific child/all participant's children</u>. How do you respond, in terms of feelings, when you separate from your child/children?</i>	a. <i>Do you ever feel worried about <u>child</u>?</i>	
3 Wishes/20 Years for Child	18. <i>If you had three wishes for your child twenty years from now, what would they be? I'm thinking partly of the kind of future you would like to see for your child. I'll give you a minute or two to think about this one?</i>	a. <i>For participants w/o children, ask: ^Now, I'd like you to continue to imagine that you have a one-year-old for just another minute. This time, I'd like to ask, if you had three wishes for your child .....</i>	
Things Learned from Childhood	19. <i>Is there any particular thing that you feel you learned above all else from your own childhood experiences? I'm thinking here of something you feel you might have gained from the kind of childhood you had.</i>		
Future: Hope for Child	20. <i>We've been focusing a lot on the past in this interview, but I'd like to end up looking a ways off into the future. We've just talked about what you think you may have learned from your own childhood experiences. I'd like to end by asking you what would you hope your child (or your imagined child) might have learned from his/her experiences of being parented by you?</i>		