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Age Differences in Everyday Stressor-Related Negative Affect: A Coordinated Analysis

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Abstract

Advancing age is often characterized by preserved or even enhanced emotion regulation, which is thought to manifest in terms of age-related reductions in the within-person association between stressors and negative affect. Existing research from ecological momentary assessment and end-of-day daily diary studies examining such age-related benefits have yielded mixed results, potentially due to differences in samples, design and measurement of everyday stressors and negative affect. We conducted a coordinated analysis of five ecological momentary assessment and two end-of-day daily diary studies to examine adult age differences in the within-person association between everyday stressors and negative affect. Reported stressor occurrences are robustly associated with higher negative affect, regardless of study design and sample characteristics. Across studies, interactions between age and everyday stressors predicting negative affect revealed a pattern of

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age-related decreases in the stressor-negative affect association, but this interaction was only significant for two studies. Further, examination of statistical power of the included studies suggests that, despite differences in the number of repeated assessments, power to detect within-person stressor-negative affect associations is quite good. In contrast, despite possessing wider age ranges, observed age differences were relatively small in magnitude, and studies are potentially underpowered to detect age differences in these within-person associations. We discuss the importance of study design, interval of repeated assessments and number of participants for examining age differences in everyday stressors and negative affect, as well as the virtue of coordinated analyses for detecting consistent direction of associations, but inconsistent patterns of statistical significance.

Keywords

stress; negative affect; ecological momentary assessment; daily diary; aging

Research on everyday stress documents individuals' stressful experiences that naturally occur in daily life, and how those experiences relate to affect and health (Almeida, 2005; Smyth, Sliwinski, et al., 2018). Adult age is an important source of individual differences in daily stress processes due to purported age-related benefits in emotion regulation (e.g., Carstensen, Isaacowitz & Charles, 1999; Schilling & Diehl, 2015). Results from extant studies, however, provide mixed support for age-related benefits, potentially due to differences in sampling, methodological and analytic factors. We examined adult age differences in everyday stressors and negative affect, drawing on data from five ecological momentary assessment (EMA) and two end-of-day (EOD) daily diary studies. Employing a coordinated analysis approach (Hofer & Piccinin, 2009), we applied common operational definitions and analytic approaches across independent studies differing in sample, design and measurement characteristics. With this coordinated analysis, we aimed to provide a systematic examination of adult age differences in affective responses to everyday stressors by evaluating the concordance of results across studies.

Everyday Stress and Affect

Our conceptualization of everyday stress processes (Smyth et al., 2018) led us to delineate two primary constructs to explore age-related associations. First, *exposure*, which refers to the reported occurrence of stressors – experiences with the potential to elicit emotional responses (e.g., having had an argument with someone). Second, *reactivity*, which represents *changes* in affect thought to be associated with stressor exposure (Almeida, 2005, Bolger & Zuckerman, 1995). Reactivity, in everyday stress research, is often defined as the time-varying statistical association between various dimensions of stressor reports (e.g., the presence, number or severity of self-reported stressors) and (negative) affect. Both EMA and EOD designs have been employed to examine everyday stressor-affect associations, however reactivity indexed as the relation between stressor and affect potentially means something different for EMA and EOD designs. EMA designs compare differences in negative affect that manifest over the course of minutes and hours in relation to associated stressor reports, whereas EOD designs compare overall levels of negative affect on days with and without reported stressors.

Further, reactivity, classically in stress research, connotes a time-dependent, stimulus-response-type process, with a stressor preceding a change in negative affect. Time-varying stressor-affect associations most-oft examined in EMA and EOD-type studies differentiate types of moments or days (e.g., the mean of non-stressor vs. stressor days/moments), ignoring a specific temporal ordering (cf. Scott, Ram, Smyth, Almeida & Sliwinski, 2017). Thus, previously documented associations demonstrate time-varying stressor-affect associations, but not that stressors necessarily (or immediately) preceded reported affect. As such, recent work in this area questions the appropriateness of the term "reactivity" as the research designs and statistical approaches applied do not reflect a temporal sequencing where self-reports of stressors necessarily preceded self-reports of affect (see Scott et al., 2017; Smyth, Sliwinski, et al., 2018). Henceforth, we opt to use the term *stressor-related negative affect (SRNA)*, as this language is more causally neutral and, we believe, more accurately describes what is reflected by approaches employed in extant research than the term "reactivity."

Adult Age and Stressor-Related Negative Affect

Psychological theories contend that there are age-related improvements in emotion regulation abilities, (e.g., Socioemotional Selectivity Theory: Carstensen et al., 1999; Strength and Vulnerability Integration: Charles, 2010). This has led to adult age differences in SRNA receiving considerable empirical attention as one lens for considering such age-related benefits. If increasing age is associated with improved emotion regulation abilities, this could be evidenced by age-related reductions in SRNA - weaker within-person association between stressors and negative affect for older compared to younger adults. Results from research on age-related differences in SRNA has been mixed (Schilling & Diehl, 2015), at times showing the age-related decreases (Birditt, 2014, Charles, Piazza, Luong & Almeida, 2009; Scott, Ram, Smyth, Almeida & Sliwinski, 2017; Scott, Sliwinski & Blanchard, Fields, 2013; Uchino et al., 2006), no significant age-related differences (Diehl & Hay, 2010; Schilling & Diehl, 2014; Stawski et al., 2008), and even in some cases age-related increases in SRNA (Mroczek & Almeida, 2004; Sliwinski, Almeida, Smyth & Stawski, 2009; Wrzus, Luong, Wagner, Riediger, 2015; Wrzus, Muller, Wagner, Lindenberger & Riediger, 2013).

There are several potential reasons for discrepancies in the pattern of results from these studies. First, studies differ in how stressors are measured and quantified. Some assess multiple types of stressors and obtain subjective severity ratings (e.g., Almeida Wethington & Kessler, 2002), and operationally define stressors as any stressors reported (e.g., Stawski et al., 2008), total number of events reported (e.g., Diehl & Hay, 2010), a severity-weighted composite of stressors reported (e.g., Mroczek & Almeida, 2004), or select specific types of stressors (e.g., interpersonal tensions, Charles et al., 2009), Hofer and Piccinin (2009) have argued that meaningful comparison across studies is optimized when identical, or at least similar, operational definitions of key constructs are employed. Thus, without consistent quantification of everyday stressors, comparison and reconciliation across studies is difficult.

Second, differences in study design could contribute to mixed findings. EMA and EOD studies reflect stressor-affect associations over different time scales (moments and days, respectively), and age-related differences in stressor-related negative affect may be systematically influenced by such temporal design features (e.g., Scott et al., 2017). If adult age differences in SRNA are more pronounced as more time since the stressor has elapsed (e.g., Charles, 2010), then patterns of age differences in SRNA may not be comparable for EMA and EOD studies. Age differences may be less evident with EMA designs as the temporal resolution of stressor-affect associations (i.e., moment-to-moment) is much finer, reflecting influences that are more proximal. In contrast, with EOD studies where assessments are comparatively distal (e.g., reporting about the occurrence of stressors that occurred late-morning and affect at the end of the day) may reflect something more enduring about stressors (e.g., Charles, Mogle, Urban & Almeida, 2016).

Third, the number of assessments and the sample size influence the statistical power to detect SRNA and associated age-related differences. Given that SRNA is defined as the time varying association between stressor and affect reports, the statistical power to detect SRNA is influenced by the number of assessments – moments in EMA studies and days in EOD studies – per person. Previous EMA studies have included as few as 5 (e.g., Scott et al., 2013; 2017) and as many as 10 (Uchino et al., 2006) assessments per day, whereas previous EOD studies have included as few as 6 (Stawski et al., 2008) and as many as 30 (Diehl & Hay 2010, Schilling & Diehl, 2014) days of assessment. Given that the number of assessments is critical for the detection and reliability of within-person associations (Mejía, Hooker, Ram, Pham & Metoyer, 2014), it is unclear whether studies are adequate for reliably detecting SRNA and potential sources of individual differences (Hertzog, von Oertzen, Ghisletta & Lindenberger, 2008; Rast & Hofer, 2014).

Similarly, detection of adult age (or any other individual characteristic) as a moderator of SRNA is operationally defined as an interaction between the individual characteristic and the momentary or daily stressor (i.e., a cross-level interaction) in predicting affect. As such, detecting age differences in SRNA depends on the magnitude of the age differences in SRNA and the number of individuals assessed (Bolger & Laurenceau, 2013). Previous studies observing age-related increases in SRNA have employed samples of between 116 (Sliwinski et al., 2009), and 1,012 (Mroczek & Almeida, 2004) participants, whereas studies observing age-related decreases have employed samples of between 110 (Birditt, 2014) and 1,031 (Charles, et al. 2009). Studies revealing no age differences employed samples of between 116 (Stawski et al., 2008) and 289 (Schilling & Diehl, 2014). Thus, examining the power of study designs, both in terms of the number of assessments per person and number of persons, for detecting SRNA and age differences therein is necessary for evaluating such associations.

Finally, in addition to age, numerous factors have been linked to SRNA including sex (Almeida & Kessler, 1998), education (Almeida, Neupert, Banks & Serido, 2005), race (Cichy, Stawski & Almeida, 2012), employment status (Davis, Goodman, Pirretti & Almeida, 2008), and day of week (Stone, Schneider & Harter, 2012). Thus, studies varying in the inclusion of characteristics other than age as covariates can be difficult to compare in terms of the robustness of age differences (or lack thereof).

The Present Study

To evaluate evidence for age-related differences in SRNA, we conducted a coordinated analysis (Hofer & Piccinin, 2009) of five EMA studies (two of which also included EOD assessments, which we refer to as hybrid studies) and two EOD studies. By leveraging multiple studies of everyday stressors and negative affect among adults spanning a wide age range, and standardizing the operational definition and statistical analysis, we will better understand whether age-related differences in SRNA are present and replicable across studies.

As results from any single study may be attributable to that study's design, sample, measurement and quantification of key constructs, we conducted coordinated analyses to evaluate the consistency in findings across studies (Hofer & Piccinin, 2009). Coordinated analysis allows for analyzing multiple independent datasets, differing in samples and measures, but assessing similar constructs, and conducting parallel statistical analyses to evaluate a specific question. Thus, the virtue of the coordinated analysis approach stems from utilizing common quantitative operational definitions and analytic procedures across studies, thereby strengthening the fidelity, robustness and generalizability of results.

This coordinated analysis was based on seven intensive repeated measures studies for which we had access to raw data: five EMA studies (two of which were hybrid studies), and two EOD daily diary studies. This work was conducted as part of the National Institutes of Health Common Fund's Science of Behavior Change program (Nielsen et al., 2018). Studies were selected as they were EMA and EOD designs containing measures sufficient to evaluate everyday stress responses, as well as indices of physical activity and sleep behaviors in daily life, across diverse populations, which were central to the aims of the parent project for this study – applying an experimental medicine (mechanisms focused) approach to the study of everyday stress processes and their influence on enacting health behaviors in daily life (see Smyth et al., 2018). Thus, the current coordinated analysis draws on strengths of these datasets, including the requirement of granular assessment of stress and affect central to this analysis, as a sub-study of the parent project.

The present study utilized this coordinated analysis approach to achieve three goals. First, we evaluated the presence of adult age differences in SRNA, defined as the within-person association (across moments in EMA studies and days in EOD studies) between stressor occurrence and negative affect. Furthermore, we examined if such age differences were consistent across studies and robust to covariate adjustment, utilizing samples differing in age, social and demographic composition. Second, we evaluated the nature of such age differences in SRNA by considering linear and quadratic age trends. Third, we examined the post-hoc statistical power of the employed studies for detecting age-related differences in SRNA as a source of heterogeneity in results across individual studies.

Method

This coordinated analysis utilized data from intensive repeated measures studies: five EMA studies (two of which were hybrid studies), and two EOD daily diary studies. Studies were selected as they were EMA and EOD designs containing measures of physical activity and/or sleep behaviors in daily life, across diverse populations, which were central to the aims of the parent project for this study – examining everyday stress processes and their influence on health outcomes (see Smyth et al., 2018), as part of the National Institutes of Health Common Fund's Science of Behavior Change program. Thus, the current coordinated analysis draws on the datasets as a sub-study of the parent project. We present brief descriptions of the samples, measures and procedures below, with more detailed sample descriptions shown in Table 1 and plots of the age distributions of each study shown in Figure 1. All studies were approved by relevant Institutional Review Boards; the coordinated analysis of anonymized secondary data was deemed exempt by the Institutional Review Board at the Pennsylvania State University.

It is important to note that age differences in SRNA have been previously (albeit infrequently) included in individual studies listed below but were considered in the interest of statistical covariation – not necessarily a/the focus of primary inquiry (Neubauer, Smyth & Sliwinski, 2018; Scott et al., 2017; Scott, Kim, Smyth, Almeida & Sliwinski, 2018; Scott, Munoz, Mogle, Gamaldo, Smyth, Almeida & Sliwinski, 2018; Stawski et al., 2010). Scott et al. (2017) is the lone exception, however, the authors focused on age differences in the timing of SRNA post-stressor, addressing a different question than the current study. Thus, these analyses represent novel use of the data from near all studies, for explicit and primary focus on age differences in SRNA.

Ecological Momentary Assessment Studies: Momentary Reports.

Stress, Health, and Daily Experiences (SHADE).

Participants.: Individuals (n = 128) with a physician confirmed diagnosis of rheumatoid arthritis (RA; n = 97) or asthma (n = 31) completed the study examining how daily experiences relate to health and well-being for adults with asthma and RA (see Smyth, Zawadzki, Santuzzi, & Filipkowski, 2014 for additional details). Of the total sample, 117 participants provided EMA data and are the analytic sample for the current study.

Measures.: Stressor occurrence was assessed with the following item: Has anything stressful occurred?. Moments were coded dichotomously (1 = *Yes*; 0 = *No*). Negative affect was measured using 9 Likert-type items (0 = *Not at all*; 6 = *Very much*; see Supplemental Table 1 for affect items by study) of how participants felt *right now*. A negative affect score was obtained by taking the average across items. For this, and all subsequent studies, we computed within- and between-person reliability estimates for negative affect (Cranford et al., 2006; Scott, Sliwinski et al., 2018). Specifically, within-person reliability reflects the reliability of a measure of differences in the negative affect scale score between occasions within the same person, whereas between-person reliability reflects the reliability of a measure of stable between-person differences. Within- and between-person reliabilities for negative affect were .85 and .99, respectively.

Procedures.: Participants initially came to the laboratory and completed baseline measurements not relevant to the present study and were subsequently trained on how to use a provided palmtop computer. With 117 participants, 7 days, and 5 momentary assessments daily, the maximum number of momentary observations would be 4,095; 3,384 momentary observations were collected (82.6%).

North Texas Heart (NTH).

Participants.: A community sample (*n* = 300), stratified by gender within age and race/ethnicity from North Texas, was recruited to examine social vigilance as a predictor of cardiovascular disease (see Ruiz et al., 2017, for additional details).

Measures.: Stressor occurrence was assessed with the following question: Since the previous cuff inflation, has anything stressful occurred?. Moments were coded dichotomously (1 = *Yes*;0 = *No*). Negative affect was measured with 8 Likert-type items (1 = *Not at all*; 7 = *Extremely*) of how participants felt *right now* (Watson, Clark & Tellegen, 1988). A negative affect score was created by taking the average score across all items. Within- and between-person reliabilities for negative affect were .78 and .99, respectively.

Procedures.: Participants underwent a brief physical exam, completed a personal and family medical history, gave a fasting blood draw, and completed a battery of surveys at a community vascular medicine clinic on a Thursday morning. Participants were then fitted with an ambulatory blood pressure monitor and given a cellular phone to complete the EMA protocol. On two consecutive days, participants completed an EMA assessment after each blood pressure measurement which occurred at random times within 45-minute intervals. Due to different start times to the study, wake and sleep times, and blood pressure functions, participants varied in the number of observations they completed (Mean, 27.2, SD = 8.7, Median = 28; Range = 1 to 49). A total of 7,872 observations were collected.

Work & Daily Life (WDL).

Participants.: Participants (*n* = 122) from the greater metropolitan area of a mid-sized northeastern city were recruited to examine how workplace stress affects health and well-being among a sample of full-time employed workers (see Damaske, Smyth, & Zawadzki, 2014 for additional details).

Measures.: Stressor occurrence was assessed with the following item: Since the last prompt, did you experience any of these:? (with the following options presented: Argument; Work stress; Traffic jam; Deadline trouble; Paying bills; Running late; Other; None). Participants were asked to check all that apply. Moments were coded dichotomously (1 = Any stressors endorsed;0 = No stressors endorsed). Negative affect was measured with a single Likert-type item (0 = *Not at all*; 6 = *Very much*) of how sad participants felt *right now* (Diener & Emmons, 1984).

Procedures.: Participants were trained on how to use a provided palmtop computer and signaled participants to complete momentary surveys 6 times each day for 3 days. With 112 participants, 3 days and 6 momentary assessments per day, the maximum observations would be 2,016; 1,580 were collected (74.8%).

Hybrid Studies: Momentary and End-of-Day Reports.

Effects of Stress on Cognitive Aging, Physiology, and Emotions (ESCAPE).

Participants.: Participants (*n* = 241) were recruited using systematic probability sampling of New York City Registered Voter Lists for the zip code 10475, an area of Bronx, NY (see Scott et al., 2015 for additional details).

Measures.: Stressor occurrence was measured using the following question: Did anything stressful occur since the last survey?. A stressful event is any event, even a minor one, which negatively affected you. For the EMA protocol, moments were coded dichotomously (1 = Yes; 0 = No). As a hybrid study, days were coded dichotomously (1 = Stressor indicated at any EMA moments during the day; 0 = No stressors indicated at any EMA moment during the day). Negative affect was measured using 4 items on a visual analog scale (0 = *Not at all*; 100 = *Extremely*). For the momentary EMA assessments, participants indicated how they were feeling *right now*. For the EOD assessment, participants completed the same 4 items, but indicated how they had been feeling *today*. A negative affect score was created by taking the average across items (Diener & Emmons, 1984), doing so separately for EMA and EOD assessments. Within- and between-person reliabilities for the EMA assessments of negative affect were .82 and 1.00 respectively, and .85 and .99, respectively for the EOD assessments.

Procedures.: Participants received training on how to use the smartphone collection devices by coming to a laboratory session. Participants then carried the specially-programmed study smartphones for 14 days. For *momentary data collection*, beeps occurred 5 times each day during the 14-day study period prompting participants to complete momentary surveys. Beeps were programmed based on participant’s self-reported typical waking time. Based on the number of participants (*n* = 241), days (*n* = 14), and momentary assessments (*n* = 5 daily), the maximum number of momentary observations would be 16,870; 13,966 momentary observations were collected. For *end-of-day data collection*, participants self-initiated a daily diary survey on the smartphone prior to bedtime each day. Based on the number of participants (*n* = 241) and study days (*n* = 14), the maximum number of daily observations would be 3,374; 2,753 daily observations were collected (81.6%).

Stress and Working Memory (SAWM).

Participants.: Participants (*n* = 172) were recruited from advertisements and flyers in a city in the Northeast U.S. (see Mogle, Muñoz, Hill, Smyth, & Sliwinski, 2017 for additional details).

Measures.: Stressor occurrence was measured using the following question: Did anything stressful occur since the last assessment? As with the ESCAPE study, for the EMA protocol, moments were coded dichotomously (1 = Yes; 0 = No). As a hybrid study, days were coded dichotomously (1 = Stressor indicated at any EMA moments during the day; 0 = No stressors indicated at any EMA moment during the day). Negative affect was measured using four Likert-type items (1=*Not at all*; 4=*Moderately*; 7=*Extremely*). For the EMA protocol participants indicated how they were feeling *right now*. For the EOD protocol, participants indicated how they have been feeling *today*. A scale score was created by taking the average across items (Russell, 1980; Watson & Clark, 1999), doing so separately for

EMA and EOD assessments. Within- and between-person reliabilities for the EMA assessments of negative affect were .84 and .99 respectively, and .85 and .98, respectively for the EOD assessments.

Procedures.: Participants attended a training session on the protocol and how to operate the palm-top computers to complete affect surveys. For *momentary data collection*, Palm-top computers were programmed to beep 5 times daily based on participants' self-reported wake time. Participants were instructed to complete a momentary survey after each beep. Based on the number of participants (n = 172), days (n = 7), and momentary assessments (n = 5 daily), the maximum number of momentary observations would be 6,020; 5,241 momentary observations were collected. For *end-of-day data collection, participants* completed a self-initiated daily diary survey on the palm-pilot before bed each night. Based on the number of participants (n = 172) and study days (n = 7), the maximum number of daily observations would be 1,204; 1,062 daily observations were collected (88.2%).

Daily Diary Studies: End-of-Day Reports.

National Study of Daily Experiences (NSDE).

Participants.: Participants were 2,022 individuals who participated in the larger Midlife in the United States study (MIDUS; n = 4,963), and completed the second wave of the National Study of Daily Experiences (NSDE; see Almeida, McGonagle, & King, 2009 for additional details). Of the 2,022 NSDE respondents, 1,079 were from the random digit dialing (RDD) sample, 185 siblings of individuals in the RDD sample, 516 from the twin RDD subsample, 62 from the city oversamples, and 180 from the Milwaukee-specific African-American subsample.

Measures.: Stressor occurrence was measured using the Daily Inventory of Stressful Events (Almeida, Wethington & Kessler, 2002), with participants responding to each of seven stem questions pertaining to the experience of arguments, avoided arguments, work- and home-related stressors, stressors emanating from the respondent's social network, and other self-identified stressors. Days were coded dichotomously (1 = Any stressors endorsed; 0 = No stressors endorsed).

Negative affect was measured using 14 Likert-type items (0 = *None of the time*; 1 = *A little of the time*; 2 = *Some of the time*; 3 = *Most of the time*; 4 = *All of the time*) assessing how participants felt *over the past day*. A negative affect score was calculated by taking the average across items (Kessler et al., 2002; Mroczek & Kolarz, 1998). Within- and between-person reliabilities were .77 and .97, respectively.

Procedures.: On each of 8 consecutive evenings, participants completed telephone interviews (~20 minutes). The interview protocol consisted of separate "flights" of 30 participants with the start day staggered across the day of the week to control for the possible confounding between day of study and day of week. Based on the number of participants (n = 2022) and study days (n = 8), the maximum number of person-days possible was 16,176; 14,912 days of observation were collected (92.2%).

Work, Family, & Health (WFH).

Participants.: The sample was comprised of 313 adults from a multisite workplace intervention conducted in both Information Technology and Assisted Care contexts (Bray et al., 2013). A daily diary study was conducted using a subsample of study participants from a larger work-place intervention study. For the purposes of the current study we use data from the baseline (pre-intervention) daily diary assessment.

Measures.: Stressor occurrence was measured using the Daily Inventory of Stressful Events (Almeida, Wethington & Kessler, 2002), with participants responding to each of 7 stem questions pertaining to the experience of arguments, avoided arguments, work- and home-related stressors, stressors emanating from the respondent's social network, and other self-identified stressors. Days were coded dichotomously (1 = Any stressors endorsed; 0 = No stressors endorsed).

Negative affect was measured using 10 Likert-type items (0 = *None of the time*; 1 = *A little of the time*; 2 = *Some of the time*; 3 = *Most of the time*; 4 = *All of the time*) of how participants felt *over the past day*. A negative affect score was calculated by taking the average across items (Watson, Clark & Tellegen, 1998). Within- and between-person reliabilities for negative affect were .73 and .95, respectively.

Procedures.: Participants completed telephone interviews on 8 consecutive evenings following a protocol similar to that of NSDE described above. Based on the number of participants (n = 313) and study days (n = 8), the maximum number of daily observations would be 2,504; 2,311 daily observations were collected (92.3%).

Quantification of Everyday Stressors and Negative Affect Across Studies—To standardize quantification of stressors across studies, assessments were coded dichotomously (1 = Any stressors reported; 0 = No stressors reported). Thus, moments in EMA models reflect whether any stressor(s) were reported since the previous assessment, whereas days in EOD models reflect whether any stressor(s) had been reported today. The decision to dichotomize this variable as opposed to using a count variable was made for consistency, as some of the EMA studies only allowed respondents to endorse one stressor per assessment.

Each study used a different scale for negative affect, with different items, numbers of items, and response scales. So that negative affect scores were scaled comparably across studies, we employed a modified proportion of maximum score calculation. For each study, negative affect scores were modified in the following three steps: 1) subtract the minimum value of scale, 2) divide resulting scores from step 1 by the maximum score of scale, and 3) multiply values from step 2 by 10. Thus, despite differences across scales, and to facilitate comparison across studies, affect scores were rescaled to have a range from 0 (the complete absence of NA) to 10 (the maximum NA score).

Analytic Strategy

Models for adult age differences in SRNA.: Linear multilevel models were employed to predict negative affect in each study. Three-level models were used for the EMA studies (moments nested within days nested within persons), whereas two-level models were used for the EOD studies (days nested within persons). All models were estimated using SAS PROC MIXED (v9.4). For these predictive models, the dichotomous stressor variable was included as a level-1 (moment for EMA studies, day for EOD studies) within-person predictor. Person-mean frequency of stressors across the study period, centered at the sample average, was included as a person-level variable to account for the contextual effect of 'person' or individual differences (Hoffman & Stawski, 2009). Thus, the level-1 stressor effect reflects the within-person effect of stressors, for a participant with the sample average frequency of stressors, holding person-mean stressor effect constant. Importantly, this parameterization yields intercepts that reflect level of negative affect on non-stressor moments/days, with the within-person stressor effect reflecting the difference between stressor and non-stressor moments (EMA) or days (EOD). EMA and EOD in hybrid studies assessed intensity of negative affect, whereas EOD studies assessed frequency of negative affect. Thus, for EMA and EOD in hybrid studies, the within-person stressor effect reflects variation in the intensity of negative affect, while for EOD models, it reflects the frequency of negative affect associated with the reported occurrence of any stressors. The main effect of age and momentary-/day-level stressor by age cross-level interaction were included to examine age differences in levels of negative affect on non-stressor days and stressor-related differences in negative affect, respectively. The intercepts and within-person stressor slopes were included as day- and person-level random effects for EMA studies and person-level random effects for EOD studies in all models to allow for individual differences in stressor-negative affect association[1].

Quantifying adult age differences.: Age was coded in two ways: as a continuous and as a categorical variable. This was done to examine robustness to quantification, as well as examine potential non-linear age associations. For models treating age as a continuous predictor, age was centered at 46, the average age across all studies, with both linear and quadratic effects of age considered. For models treating adult age as a categorical predictor, five age categories (<25, 25–39, 40–59, 60–74, 75+) were created and applied across all models. Thus, age groups are standardized across studies, even though each age band is not necessarily represented in each study. Continuous and categorial quantifications of age were considered as a sensitivity analysis to ensure that results were not an artifact of variation in sample size or age distribution. Study-specific distributions of the age variables are shown in Table 1 and Figure 1.

Inclusion of covariates in predictive models and model specification.: For all models, both within-person and person-mean stressor variables, age, and the within-person stressor by age interaction were included as predictors of negative affect. Four models were estimated for each study. In Model 1, age differences in the within-person stressor effect

[1]The random within-person stressor slope was not statistical significant for the WFH EOD study, and its inclusion resulted in a model convergence error. As such all analyses of the WFH EOD study data included the within-person stressor variable as a fixed effect only.

were examined using the continuous age variable. In Model 2, the following covariates were added: sex (female; male), education (high school General Equivalency Diploma or less; Bachelor's Degree or some college; coursework/degree beyond Bachelor's Degree), race (Caucasian vs. other), employment status (working; other), marital status (married; other), day of week (weekday[M-F]; weekend[Sa-Su]). Covariates were included both as main effects, as well as moderators of the within-person stressor effect, ensuring age differences in SRNA were robust to other potential modifiers of SRNA. Further, assessment occasion was included as a level-1 covariate to account for linear trends potentially contributing to spurious within-person associations (e.g., Sliwinski et al., 2006). Models 3 and 4, were identical to Models 1 and 2, respectively, except age was included as a categorical variable. All models were estimated using maximum likelihood estimation. Residuals were allowed to be correlated over time and were modeled using a spatial power covariance structure to account for the unequal interval between assessments for EMA studies, and a first-order autoregressive structure for EOD studies.

Simulations for power analyses.: To evaluate the statistical power of each study for detecting SRNA and age differences in SRNA, we conducted Monte Carlo simulations following methods outlined by Bolger, Stadler and Laurenceau (2011). For these simulations, study-specific parameter estimates (i.e., point estimates for slopes of fixed effects, variance components) from our multilevel analyses were employed as our expected effects for the within-person stressor effect and age by within-person stressor interaction. Further, study-specific design parameters including the number of participants, days and moments (for EMA studies only) were used for these simulations. One thousand simulations were conducted for each study. The resulting simulations provide the proportion of simulations (out of 1000) for which the estimates were significant at α=.05, serving as the post-hoc power of each study to detect SRNA and age-related differences in SRNA.

Results

Descriptive Statistics – Stressor Frequency and Negative Affect

Table 2 displays the frequency of self-reported stressors across the different studies and study types. The mean frequencies of reported stressors ranged from 15 to 32% of assessments across the EMA studies. Aggregating momentary reports across the day for these studies, stressors were reported on 40% to 76% of days. For EOD and EOD from hybrid studies, stressors were reported on between 39% and 51% of days across studies. Negative affect scores were, on average, low, ranging from 0.83 to 2.38 for EMA, 1.91 to 2.68 for hybrid EOD and 0.60 to 0.99 for EOD studies.

With respect to correlations, individuals' frequency of stressors and average levels of negative affect were significantly positively correlated across all studies (*r*s = .23 to .58, all *p*s<.01), indicating that individuals who reported stressors more frequently also reported higher average levels of negative affect. Similarly, individual differences in negative affect and age were negatively correlated across all studies, indicating older age is associated with lower average negative affect; however, correlations were only statistically significant for studies that included participants aged 80 years or older: two EMA studies (SAWM, SHADE) and two EOD studies (SAWM, NSDE). Correlations between individual differences in stressor frequency and age were more mixed in direction and statistical significance. Older age was significantly associated with higher stressor frequency for both EMA (ESCAPE, WDL) and EOD (ESCAPE, WFH) studies where most participants were working, but with lower stressor frequency for one EMA study (SHADE) and one EOD study (NSDE) with samples that included people aged 80 and older.

Adult Age Differences in Non-Stressor and Stressor-Related Negative Affect

Table 3 displays the results from models with age predicting non-stressor and SRNA (see Supplemental Table 2 for results using study-specific negative affect scale scores). Specifically, to examine the association between age and SRNA, we modeled negative affect as a function of age, stressor, and their interaction. The intercept at the top portion of Table 3 (Model 1) shows that, across all studies, negative affect scores (on the 0–10 scale) for adults aged 46 years were low on non-stressor moments in EMA studies (.255 to 1.842), and days in EOD studies (.135 to 1.810). The second row in Table 3 shows that, across all EMA and EOD studies, each year increase in age was associated with lower levels of non-stressor negative affect, although this association was only significant for two EMA models (SAWM and WDL) and three EOD models (WFH, ESCAPE and SAWM). The third row in Table 3 shows that, across all studies, the within-person stressor effect among adults aged 46 years, at the sample average frequency of stressors, was positive and significant indicating participants reported significantly higher levels of negative affect at moments (.675 to 1.968 units higher in EMA studies) and on days (.367 to 2.232 units higher in EOD studies) they also reported stressors[2]. The fourth row indicates that age differences in SRNA trended negative across studies, suggesting that older age may be associated with relatively less negative affect on stressor compared to non-stressor observations. These age differences were not statistically robust as this interaction was significant for only two of the nine studies (ESCAPE EMA and NSDE EOD). Importantly, however, across eight of the nine studies, the pattern indicated lower SRNA with age. A two-tailed test of binomial proportions revealed that our observed proportion of results (eight of nine analyses) exhibiting lower SRNA with older age was significantly different from chance ($p = .019$).

Considering the magnitude of the estimates of the age difference in SRNA relative to the estimate of SRNA (at age 46), age-related decreases in SRNA range from 0.10% to 1.02% reduction in SRNA per year for EMA studies, and 0.21% to 1.76% reductions in SRNA per year for EOD studies. We also calculated Pseudo-R^2 values (see Table 2 – Row 5), indicating the percent of variance in SRNA was explained by age, relative to a model where the within-person stressor slope was unconditional. Age explained between −.11% and 3.87% of the variance in SRNA across EMA studies, and between 1.36% and 3.09% of the variance in SRNA across EOD studies[3].

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[2]It is important to reiterate that the EMA and hybrid studies assessed intensity of negative affect, whereas EOD studies assessed frequency of negative affect. As such, the within-person stressor effect reflects stressors-related increases in the intensity of negative affect for EMA and hybrid studies, and stressor-related increases in the frequency of negative affect for EOD studies.

[3]Pseudo-R^2 should be interpreted with caution as it is influenced by the accuracy and reliability of the estimates of the random slopes (the parameter of variance to-be-explained), and covariances among random effects, which can result in negative values (e.g., NTH EMA study results).

In covariate-adjusted models, shown in the bottom portion of Table 3, the intercepts show that age differences in negative affect on stressor free occasions remained negative. With respect to age differences in SRNA, the broad pattern of age-associated decreases remained. The direction of association, however, changed for three studies. Estimates for the SAWM and SHADE EMA studies emerged as positive, while the estimate for the WDL EMA study became negative. None of these associations was significance before or after covariate adjustment. The age-related reductions in SRNA maintained significance for the ESCAPE EMA study (−.019, SE = .008) and NSDE EOD study (−.008, SE = .001). While the direction of age differences in SRNA was negative across seven of the nine studies from these covariate-adjusted models, re-analysis of the test of binomial proportions indicated that the proportion of observed results was no longer significantly different from chance ($p = .096$).

Evaluating the Pattern of Adult Age Differences in Stressor-Related Negative Affect

Given these initial results, we sought to explore whether the pattern of age differences in SRNA was complicated by non-linear age-SRNA associations and evaluated this possibility two ways. First, we extended to the previous analyses to include a quadratic age effect. Across all studies, the quadratic age by within-person stressor interaction failed to reach statistical significance (all *p*s > .30) suggesting that a non-linear (i.e., quadratic) association was not statistically reliable. Second, we estimated the models employing the age categories shown in Table 1. Figure 2 displays the within-person stressor effect for each study and age category (see Supplemental Table 3 for estimates). Despite inconsistent patterns of SRNA between the <25 and 25–39 age categories, age differences in SRNA across the last 4 age categories appears notably minimal with perhaps a trend toward reduced SRNA with age, which is consistent with the results presented for continuous linear age effects. Note that the categorical age by within-person stressor interaction was significant for the ESCAPE EMA, $F(3,13000) = 3.86$, $p = .021$, and NSDE EOD, $F(3,11000) = 9.88$, $p < .001$ studies, which is consistent with results from the continuous linear age models shown in Table 3.

Statistical Power to Detect Age Differences in Stressor-Related Negative Affect

Given the consistency in direction of age differences in SRNA, but inconsistency in statistical significance across studies, we conducted simulations to determine the post-hoc statistical power for: a) detecting the within-person effect of stressors on negative affect (i.e., SRNA) and b) the linear age by within-person stressor interaction (i.e., age difference in SRNA). Supplemental Table 4 displays results from these simulations. Power to detect SRNA was very high (>.90) across all studies, while power for detecting age differences in SRNA was mixed. The two studies exhibiting significant age differences in SRNA had the highest statistical power, NSDE EOD (.999) and ESCAPE EMA (.752), whereas all other studies exhibited comparatively lower statistical power (.079 to .436).

Discussion

Previous research has yielded mixed findings regarding age differences in SRNA. The purpose of this study was to conduct a coordinated analysis of EMA and EOD studies to examine the presence and shape of age-related differences in SRNA, utilizing a coordinated analysis approach and standardizing operational definitions and statistical analysis. The results of this investigation yielded several findings. First, negative affect is consistently higher when stressors are reported, regardless of differences in study designs and measurement of negative affect and everyday stressors. Second, there was a reasonably consistent pattern in the direction of association, age-related decreases in SRNA, across studies. This effect, however, was statistically significant in only two studies, one EMA (ESCAPE) and one EOD (NSDE). Third, age-related reductions in SRNA appear to be linear in shape, particularly from age 25 on, and small in size. Finally, most of these studies appear to be underpowered to detect relatively small age differences in SRNA, suggesting a primary reason for inconsistent findings across studies.

The Value of a Coordinated Analysis Approach

The coordinated analysis approach has several strengths for examining age differences in SRNA. Importantly, this approach helps to overcome shortcomings of previous research by using common operational definitions across studies varying in sampling and design to define our primary constructs of everyday stressors, negative affect, and SRNA. We provided a rigorous evaluation of within-person stressor-negative affect associations, applying centering techniques to isolate within-person variation and covariation (Hoffman & Stawski, 2009), and were broad and systematic in our inclusion of covariates across studies for evaluating age differences in SRNA despite differences in sample characteristics. Thus, the results of the current study provide evidence consistent with age-related decreases in SRNA, at the level of constructs.

Although eight of nine studies suggested age-related reductions in SRNA (seven of nine after covariate adjustment), this interaction was only significant for two of the studies. For some studies, the standard error for the age by SRNA interaction was large suggesting influences due to measurement differences, unmeasured moderators, among other potential sources, which complicates interpretation and sole reliance on statistical significance. A test of binomial proportions was significant, albeit only marginally so after covariate adjustment, qualifying the direction of age-related differences (i.e., decrease) in SRNA was reasonably consistent across studies; underscoring the value of the coordinated analysis approach. If, assuming adequate statistical power, statistical significance was used as the benchmark for drawing strong inference regarding age differences in SRNA, the results of this coordinated analysis would suggest there is weak evidence of age differences. Results of our post-hoc power analyses, however, indicated that the power of many of our studies to detect an age difference in SRNA was poor; undermining reliance on, and potential utility of, statistical significance. On the other hand, if, despite the statistical power of any individual study, consistency in the direction of association is considered, there is comparatively consistent evidence for reduced SRNA with older age. These effects, however, are small in size and appear sensitive to particular design, measurement and sampling considerations. Thus, the coordinated analysis approach provided a very powerful tool for examining the generalizability in pattern of age differences in SRNA.

Adult Age Differences and SRNA in EMA and EOD Studies: Design, Measurement and Sampling Considerations

Although previous research examined age differences in SRNA as one potential approach for examining age-related strengths in emotion regulation, the empirical support for such associations, both in terms of direction and statistical significance, has been mixed. As noted in the Introduction, differences in study designs, samples, measurement, operational definition and analytic approach can all contribute to heterogeneity in findings. Our coordinated analysis approach, employing common quantitative operational definitions and analytic procedures across multiple independent studies, revealed a consistent pattern of age-related reductions in SRNA, but that these effects are small. This pattern, in terms of direction of association, is broadly consistent with psychological theories positing age-related strengths in emotion regulation (Carstensen et al., 1999; Charles, 2010). Despite the consistency in pattern of age-related differences in SRNA, there are important nuances across designs and studies to consider with respect to the current results.

According to Charles (2010), age differences in SRNA are potentially negligible when a stressor initially occurs, and increase in favor of older adults as time post-stressor elapses, evidencing their superior emotion regulation capabilities. Thus, age differences in SRNA may be less evident in EMA studies where the stressor occurrence and affect reports occur close in time, reflecting a more proximal influence of stressors on affect. In contrast, age differences may be more evident in EOD studies where retrospective reports of stressor occurrence throughout the day (in EOD studies) and the amalgam of momentary reports across the day (in hybrid studies) are linked to retrospective reports of affect across the entire day, reflecting a more durable impact of stressors on affect. Results from the current study provided partial support for both suppositions. Although stressor-negative affect associations weakened with age and did so in a relatively linear fashion, particularly from age 25 on, this age difference was only significant in two studies – the ESCAPE EMA study and the NSDE EOD study.

The presence of a significant age difference in SRNA in the ESCAPE EMA study stands out compared to the other four EMA studies. The ESCAPE study used a visual analog scale for assessing negative affect, whereas the other studies employed Likert-type scales. Visual analog scales may provide for more sensitive detection of (subtle) variations in negative affect. This, combined with a comparatively larger sample size for detecting small individual differences attributable to age, potentially explains why a significant age difference was observed in the ESCAPE, but not other EMA studies. Inconsistency in results across studies could also be due to differences in the types of stressors the sample-specific participants experienced and their impact on negative affect. Regardless, visual analog scales may be particularly beneficial for evaluating predictors of within-person stressor effects, particularly when moderating effects are potentially small.

Similarly, the presence of a significant age difference in the NSDE EOD study stands out compared to the other EOD study, and EOD assessments from the hybrid studies. Again, the superior statistical power of the NSDE for detecting the age differences is a likely reason for this difference. Alternative explanations for the difference in results include that the NSDE has a comparatively preferential distribution (and number) of individuals 75 and older. If age-related benefits become more evident at such older ages, the other studies utilized are not as well poised to detect such an effect (e.g., 1% of the WFH sample was aged 60 or older).

The discrepancy in results between the NSDE EOD study and the ESCAPE and SAWM hybrid studies could be that frequency of negative affect was assessed in the NSDE study whereas intensity of negative affect was assessed in the ESCAPE and SAWM studies. The magnitude of age differences in the frequency and intensity of SRNA may not be identical, nor reflect equivalent constructs in the context of stress processes (e.g., Diener, Larsen, Levine & Emmons, 1985). Another reason for the discrepancy could be that EOD retrospective reports of stressors and the aggregation of momentary assessments of stressors from EMA studies do not reflect identical constructs. Previous research has shown that individuals rely on different information when making current versus retrospective self-reports (Robinson & Clore, 2002). Similarly, the aggregation of health (Wolff, Brose, Lovden, Tesch-Romer, Lindenberger & Schmiedek, 2012) and affect (Charles et al., 2016) assessments over different temporal and sampling dimensions (e.g., moments, days, people) do not necessarily reflect the same theoretical variation (Hoffman & Stawski, 2009), or relate to age in consistent and symmetric ways (Charles et al., 2016). As such, additional research comparing EMA and EOD approaches, measurement and construct equivalence, and the complementary strengths of each for everyday stress research is warranted.

Statistical Power to Detect the Moderation of Stressor-Related Negative Affect by Age

Both the number of observations per person and number of persons are important when considering the design and statistical power to detect focal associations in EMA and EOD studies, but these decisions will influence key questions differently. The number of observations per person and number of persons are critical to the detection of within-person (e.g., stressor-negative affect) associations, whereas the power to detect individual differences in within-person associations (e.g., age differences in SRNA) is largely determined by the number of persons. This can be problematic for intensive longitudinal designs which, although obtaining many repeated assessments, may have more modest numbers of participants. Results of our post-hoc power analysis across studies revealed that power to detect within-person stressor-negative affect associations was very high, across both EMA and EOD studies, despite differences in samples, number of assessments and measures of stressors and negative affect. In contrast, power to detect age differences in SRNA exceeded the conventional threshold for ‘acceptable’ power (i.e., $\geq$.80) for the NSDE EOD study only, which included over 2000 participants. Thus, differences in the statistical power of each study to detect age differences in SRNA contribute to inconsistency in the significance in results observed across studies, with the number of persons, not the number of observations per person representing the liability (Bolger & Laurenceau, 2013).

In areas where the extant findings are mixed, explicit consideration of sampling and design features is critical for conducting new studies and yielding a high degree of confidence in the results. Although 2000 individuals measured repeatedly over a short period of time may not be feasible for most studies, the current results demonstrate that consideration of the number of moments (for EMA) and days (for EMA and EOD), and, especially, the number of individuals assessed are important for considering adult age, or any other individual/group difference predictor of SRNA. If resources are limited, strategic sampling (e.g., extreme groups designs) could also be employed to maximize power, despite potential loss of generalizability.

Limitations and Future Directions

Various approaches have been employed to quantify everyday stressors and their impact on negative affect, including whether any events occurred, subjective severity ratings, severity-weighted event occurrence, number of stressors reported, and specific types of stressors (e.g., arguments or work-related stressors). Our quantification (i.e., were any stressors reported) is reductionist, obfuscating potential contribution of other quantifications of stress (e.g., number or type of stressors reported). Further, our focal within-person stressor-NA associations are correlational, precluding delineation of directionality and causation. To be certain, this study is an initial step in a longer stream of work that will explore the nuances of design dimensions (e.g., instructions for types of experiences to report on, the timing of experiences, recall duration), and everyday stress processes (e.g., the influence of events versus affective responses to events, components of responses including magnitude of reaction, duration and degree of recovery; Smyth et al., 2018), not a final answer.

If age differences in SRNA are specific to other dimension of the stressor characteristics (e.g., subjective severity, type or number of events), our approach would not reveal such nuances. For example, if the severity of stressors decreases with age, this could contribute to age-related reductions in SRNA. Subjective severity ratings of everyday stressors do vary across both events and people (Almeida, Stawski & Cichy, 2010). Recent research has shown within-person associations among daily perceived stress and negative affect decrease with age (Blaxton, Bergeman & Wang, 2018), however it is unclear whether subjective perceptions of stress, discrete experiences, the severity of these experiences, or some combination contribute to this pattern. Thus, future research examining whether the nuances of severity (and other characteristics) contribute to explain age-related reductions in SRNA, or have an interactive association such that SRNA might exhibit a dose-response association with severity that may further interact with age.

Similarly, although negative affect was a common construct across studies, each study differed in the scale employed, discrete emotions represented, number of items included, and whether responses were made with respect to the frequency or intensity of negative affect. If stressors vary in the specific emotions, and the frequency and/or intensity of the emotions they catalyze, and adult age differences in SRNA are specific to particular stressor-emotion combinations (e.g., Wrzus et al., 2015), such differences would be difficult to detect using study-specific scale scores. Furthermore, the EMA and EOD based on hybrid studies employed assessments of intensity of negative affect, whereas the EOD studies employed assessments of frequency. Given that intensity and frequency are confounded by study design, it is unclear whether similar results would be observed if intensity ratings were employed in EOD studies or frequency ratings were employed in EMA studies. Additional research considering alternative quantification of everyday stress and taking a more granular approach to considering age differences in specific stressor-related emotions would be a worthwhile effort for understanding potentially specific conditions under which age differences in SRNA are present and robust (e.g., Charles et al., 2009).

We employed an approach to examining age differences in SRNA that focused on concurrent within-person associations between self-reported experiences and negative affect, an approach frequently employed in research on everyday stress that has largely been synonymized with the construct of emotional reactivity (e.g., Almeida, 2005). Recent research has called for more nuanced considerations of the role of time since event to differentiate reactivity and recovery processes (Scott et al. 2017), as well as how stressors pile up to impact negative affect (Schilling & Diehl, 2014; Smyth et al., 2018), and age differences therein. Given that stress is a multifaceted construct (Smyth, Zawadzki & Gerin, 2013), an important endeavor for future research will be to design studies to adequately capture these different dimensions of everyday stress processes and whether doing so helps to better articulate age differences in stress-affect associations (Smyth et al., 2018). Careful analysis of timing and lagged effect in EMA and EOD studies (e.g., Scott et al., 2017) will also be essential to fleshing out such nuances.

The power analyses we conducted were post-hoc, which researchers have criticized because of reliance on observed effects resulting from specific study and design features (Hoenig & Heisey, 2001). As such, our reported power estimates are not, summarily, an indictment of these types of EMA and EOD designs for detecting age differences in SRNA. As with many secondary analyses, data come from studies that can be used to, but were not necessarily designed to, answer a particular research question. These results should serve as a cautionary note that the magnitude of age differences in SRNA are relatively small, but heterogeneous, and future research in this area needs to consider such information to optimize study designs in an a priori fashion.

Despite multiple studies that included samples ranging from early adulthood, through midlife and into old age, only three of the studies had individuals age 75 and older, with this age strata comprising a small minority of each sample. If age-related resilience to everyday stressors is the province of more advanced old age, our analysis only employed one sample with participants 80 or older (NSDE), and is unable to adequately account for SRNA in these later years and decades of life. Previous studies in this area, despite impressive age ranges (e.g., 12–88, Wrzus et al., 2015; 18–89, Diehl & Hay, 2010; 36–76, Uchino et al., 2006), similarly possessed a paucity of individuals in their 70s and older. Only 7 to 8% of the near 400 participants in Wrzus and colleagues studies were 70 or older, whereas only 32% of the 239 participants in Diehl and Hay's studies (Diehl & Hay, 2010; Hay & Diehl, 2010) were 60 or older, and 12.6% of Uchino and colleagues 310 participants were between 66 and 75 years old. Birditt (2014) is one notable exception with better representation of adults in advanced old age with 34% of the 110-person sample ages 60 to 79 and 33% ages 80 to 95. Thus, future studies with greater representations of adults in their 70s and beyond would provide a more comprehensive account of SRNA in advanced old age.

Lastly, we employed a coordinated analysis approach to a set of studies selected because of their properties for a different, but related scientific purpose. It is unclear whether one should favor heterogeneity in samples/designs (as we have done here; favoring external validity and generalizability) versus studies designed for aging that are often more homogenous (e.g., typically healthy people, less socioeconomic and demographic diversity, etc…; favoring greater sensitivity and precision) when conducting a coordinated analysis for examining a focal research question. Further, coordinated analysis allows for evaluating consistency in patterns across studies, both in terms of direction of association and statistical significance. Coordinated analysis, however, cannot speak to ‘population’ estimates of age differences in SRNA or explicate specific sources of variation in estimates across studies as other forms of integrated data analysis can (e.g., pooled analysis; Curran & Hussong, 2009). Such a pooled analysis, however, relies on the same measures across studies or at least some common items to anchor measurement across the pooled datasets (Curran & Hussong, 2009), which the current studies do not possess (see Supplemental Table 1). As such, the value of the coordinated analysis comes from the ability to evaluate the consistency in pattern of results at the level of construct, standardizing operational definition and employing parallel analysis across studies, despite study-specific idiosyncrasies. Future research employing pooled analysis on a broader corpus of datasets satisfying criteria for such an approach would certainly be a valuable contribution to this literature.

Conclusion

Overall, and in line with theoretical accounts of age and emotion regulation, the results from this coordinated analysis of EMA and EOD studies suggests that there is evidence consistent with age-related reductions in SRNA. This effect, however, is small in size and studies are potentially underpowered to detect it. While the findings of this coordinated analysis do not offer definitive conclusions regarding the presence, direction and/or magnitude of age differences in SRNA, they do provide a systematic account of these across diverse study designs and samples of adults. Taken together, the current study highlights the need for continued research, carefully considering study design, sampling and measurement, to better understand the circumstances under which older adults may exhibit greater resilience in the context of stressors in their everyday lives.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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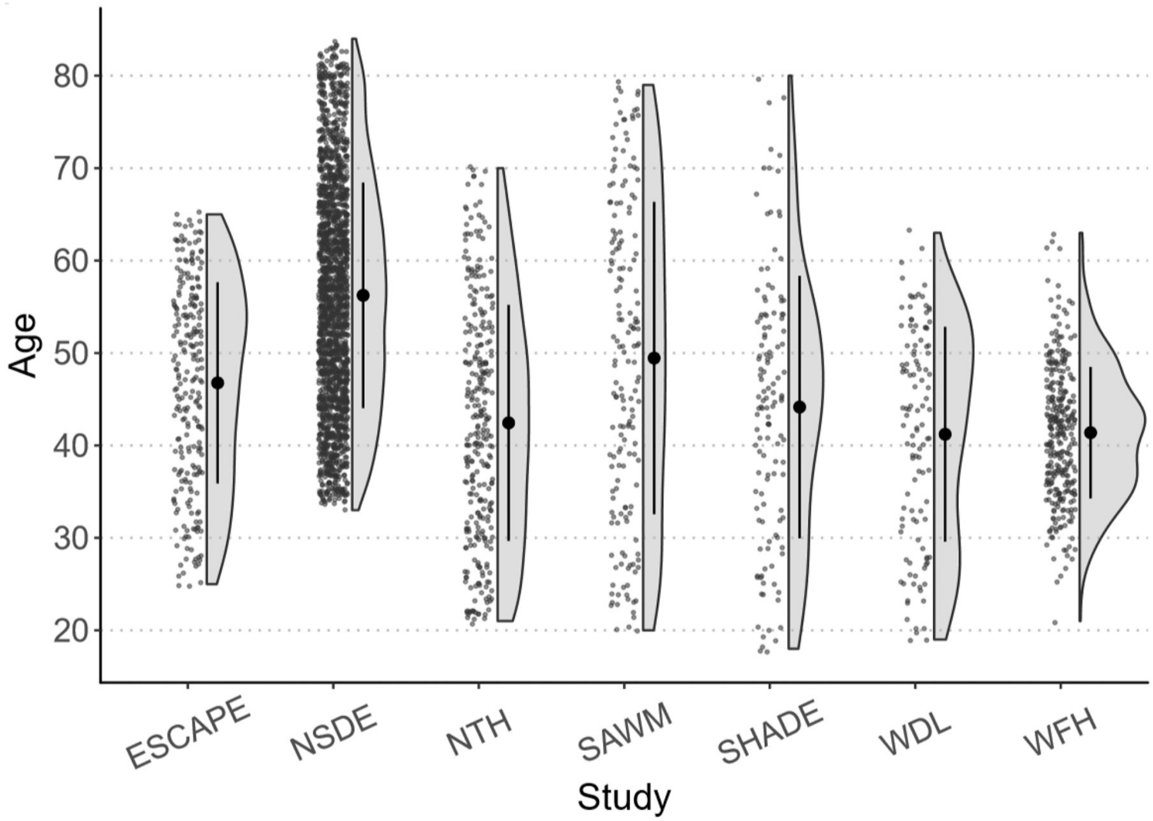

Figure 1.

Age Distributions by Study illustrated in a flipped raincloud plot. Black dots represent age observations (jittered horizontally). The black circles with vertical lines represent mean age ± 1 *SD*. The grey figures are halved Violin plots based on Kernel density estimations of age.

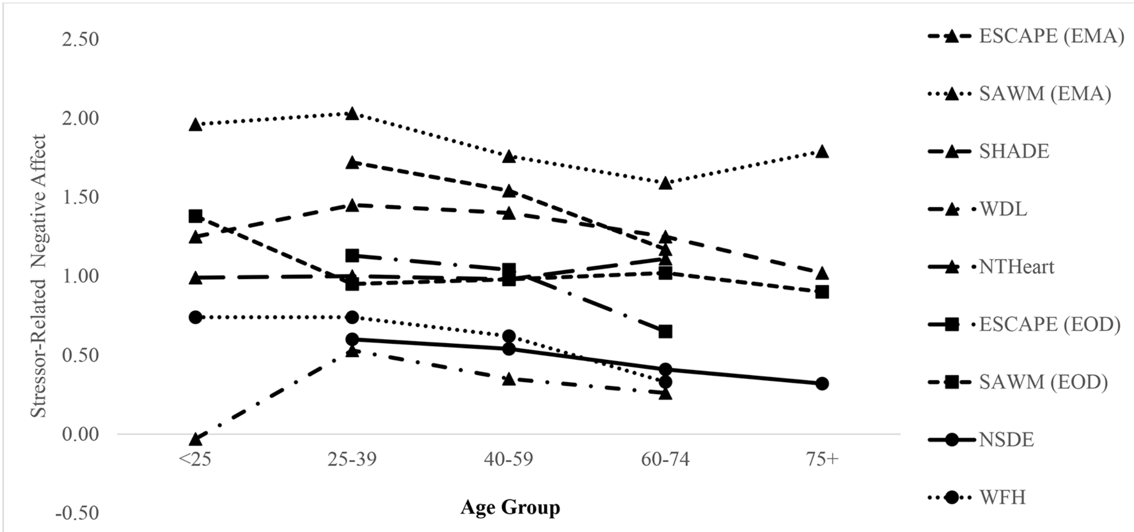

Figure 2.

Stressor-Related Negative Affect by Age Category and Study. Ecological Momentary Assessment studies indicated by triangles, End-of-Day Assessment studies indicated by circles, End-of-Day Assessment from hybrid studies indicated by squares. Age category significantly associated with SRNA for ESCAPE EMA and NSDE EOD only.

Table 1.

Sample Demographics by Study

	EMA				EOD		
	ESCAPE[a]	SAWM[a]	SHADE	WDL	NTH	NSDE	WFH
N of Participants	240	170	117	122	300	2022	311
Mean Age (SD)	46.77	46.81	44.64	41.21	42.44	56.24	41.38
	(10.88)	(16.94)	(13.46)	(11.62)	(12.76)	(12.20)	(7.11)
Range of Age	25–65	20–80	18–80	19–64	21–70	33–84	21–63
<25	0%	8.14%	7.63%	8.70%	8.39%	0%	0.32%
25–39	29.17%	23.84%	26.27%	31.30%	33.89%	8.70%	41.16%
40–59	57.67%	35.47%	54.24%	57.39%	47.99%	51.93%	57.23%
60–74	14.17%	23.84%	10.17%	2.61%	9.73%	30.76%	1.29%
75+	0%	8.72%	1.69%	0%	0%	8.61%	0%
Sex (%Female)	67%	52%	73%	67%	50%	56%	74%
Education							
High School Diploma/GED or Less	22%	44%	25%	27%	12%	36%	22%
Bachelor's Degree or Some College	60%	46%	48%	56%	68%	18%	40%
Coursework/Degree Beyond Bachelors	18%	10%	27%	17%	20%	46%	38%
Race (% Caucasian)	10%	59%	84%	67%	76%	84%	66%
Employment Status (% Working)	51%	42%	58%	100%	81%	50%	100%
Marital Status (% Married)	31%	29%	33%	51%	63%	72%	63%

Note. SD: Standard Deviation. GED: General Equivalency Diploma. EMA: Ecological Momentary Assessment. EOD: End-of-Day.

[a]Hybrid studies providing both EMA and EOD assessments.

Table 2.

Descriptive Statistics and Correlations among Stressor Frequency and Negative Affect by Study

	EMA					EOD			
	ESCAPE[a]	SAWM[a]	SHADE	WDL	NTH	ESCAPE[a]	SAWM[a]	NSDE	WFH
Frequency of Stressors									
% of Moments	18%	15%	23%	32%	15%	-	-	-	-
% of Days	43%	40%	57%	76%	73%	-	-	39%	51%
[b]Mean Negative	2.34	1.61	1.75	2.38	0.83	2.68	1.91	0.60	0.99
Affect (SD)	(1.59)	(1.38)	(1.31)	(1.38)	(1.07)	(1.59)	(1.67)	(0.80)	(0.91)
Correlations									
[c]Frequency of Stressors and	.23**	.33**	.26**	.36**	.58**	.26**	.34**	.44**	.40**
[b]Negative Affect									
[c]Frequency of Stressors and Age	.16**	.08	−.24**	.23**	−.07	.17**	.14	−.23**	.16**
[b]Negative Affect and Age	−.07	−.21**	−.21*	−.11	−.10	−.07	−.28**	−.16**	−.12*

Note:

* $p<.05$,

** $p<.01$. SD: Standard Deviation. EMA: Ecological Momentary Assessment. EOD: End-of-Day.

[a]Hybrid studies providing both EMA and EOD assessments.

[b]Person-mean negative affect across assessments.

[c]Person-mean frequency of stressors across assessments.

Table 3.

Linear Multilevel Models of Age Predicting Non-Stressor and Stressor-Related Negative Affect

	EMA					EOD			
	ESCAPE[a]	SAWM[a]	SHADE	WDL	NTH	ESCAPE[a]	SAWM[a]	NSDE	WFH
Model 1	**Estimate (SE)**	**Estimate (SE)**	**Estimate (SE)**	**Estimate (SE)**	**Estimate (SE)**	**Estimate (SE)**	**Estimate (SE)**	**Estimate (SE)**	**Estimate (SE)**
Intercept	1.859	1.420	1.187	1.968	0.675	2.232	1.026	0.367	0.566
	(0.141)**	(0.098)**	(0.207)**	(0.144)**	(0.052)**	(0.111)**	(0.191)**	(0.016)**	(0.061)**
Age	−0.013	−0.019	−0.014	−0.023	−0.004	−.0.021	−0.030	−0.001	−0.019
	(0.009)	(0.006)**	(0.009)	(0.011)*	(0.004)	(0.010)*	(0.007)**	(0.001)	(0.007)*
WP Stressor	1.552	1.821	1.350	0.307	.938	0.978	0.998	0.518	0.595
	(0.080)**	(0.124)**	(0.104)**	(0.102)**	(0.059)**	(0.086)**	(0.146)**	(0.020)**	(0.052)**
WP	−0.016	−0.006	−0.002	0.004	−0.002	−0.011	−0.003	−0.006	−0.010
Stressor*Age	(0.007)*	(0.007)	(0.008)	(0.008)	(0.004)	(0.008)	(0.008)	(0.001)**	(0.006)
Pseudo R^2	3.13%	3.87%	0.41%	0.03%	−0.11%	3.09%	1.36%	2.52%	-†
Model 2									
Intercept	1.736	1.146	1.011	2.067	0.747	2.205	1.339	0.496	0.925
	(0.220)**	(0.324)*	(0.370)**	(0.343)**	(0.153)*	(0.220)**	(0.402)**	(0.028)**	(0.084)**
Age	−0.012	−0.022	−0.010	−0.017	−0.005	−0.023	−0.030	−0.003	−0.011
	(0.010)	(0.007)**	(0.009)	(0.012)	(0.005)	(0.011)*	(0.008)**	(0.001)*	(0.008)
WP Stressor	1.657	3.063	1.239	0.710	1.086	0.955	0.947	0.512	0.568
	(0.140)**	(0.335)**	(0.276)**	(0.275)**	(0.160)**	(0.155)**	(0.406)*	(0.034)**	(0.071)**
WP	−0.019	0.011	0.001	−0.008	−0.008	−0.010	−0.006	−0.007	−0.005
Stressor*Age	(0.008)**	(0.008)	(0.008)	(0.010)	(0.005)	(0.008)	(0.009)	(0.001)**	(0.007)

Note. WP: Within-Person. EMA: Ecological Momentary Assessment. EOD: End-of-Day. SE: Standard Error.

* $p<.05$,

** $p<.01$. Age was centered at 46 years old in each study. Model 1: Age only. Model 2: Model 1 plus covariates (sex, education, race, employment status, marital status, and day of week).

[a] Hybrid studies providing both EMA and EOD assessments.

† Pseudo-R^2 could not be calculated for the WFH EOD study as the random slope was not statistically significant and its inclusion resulted in model a model convergence error (see Footnote 2).