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Daily Fluctuation in Negative Affect for Family Caregivers of Individuals With Dementia

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Abstract

Objective—The study examined associations of intrinsic fluctuation in daily negative affect (i.e., depression and anger) with adult day service (ADS) use, daily experiences, and other caregiving characteristics.

Methods—This was an 8-day diary of 173 family caregivers of individuals with dementia. Multilevel models with common within-person variance were fit first to show average associations between daily stressors and mean level of daily affect. Then multilevel models with heterogeneous within-person variance were fit to test the hypotheses on associations between ADS use, daily experiences, and intrinsic fluctuation in daily affect.

Results—The study showed that, when the sum of ADS days was greater than average, there was a stabilizing effect of ADS use on caregivers' within-person fluctuation in negative affect. Moreover, fewer daily stressors and greater-than-average daily care-related stressors, more positive events, not being a spouse, greater-than-average duration of caregiving, and less-than-average dependency of individuals with dementia on activities of daily living were associated with less fluctuation. Better sleep quality was associated with less intrinsic fluctuation in anger; and younger age and more years of education were associated with less intrinsic fluctuation in daily depression.

Conclusions—Because emotional stability has been argued as an aspect of emotional well-being in the general populations, intrinsic fluctuation of emotional experience was suggested as an outcome of evidence-based interventions for family caregivers.

Keywords

adult day service (ADS); daily stressors; intrinsic fluctuation; daily negative affect

Chronic stress in the context of family caregiving can be detrimental to caregivers' emotional well-being and physical health, particularly when care is being given to an individual with dementia (IWD; Aneshensel, Pearlin, Mullan, Zarit, & Whitlatch, 1995). The caregiving experience can be physically and emotionally demanding, especially when the IWD engages in disturbing behavior problems along with other daily stressors. Guided by the stress process model, most research on caregiving has made between-person comparisons of the effects of stressors on the level of affect. Recent studies on affect in noncaregiving and caregiving samples have used daily diary designs, which create new opportunities for examining the association of stressors and affect. In a series of groundbreaking studies, Charles, Piazza, Luong, and Almeida (2009) used daily diary designs to identify affective reactivity, which they defined as between-person differences in the amount of increase in negative affect on days when there are stressors compared to nonstressor days. People with greater increases in negative affect on stressor days were said to have heightened affective reactivity. Heightened affective reactivity, in turn, was associated with poorer long-term health outcomes (Piazza, Charles, Sliwinski, Mogle, & Almeida, 2013).

Both the level and fluctuation of affect constitute the core components of individuals' emotional experience. In the context of daily emotions, within-person fluctuation can be considered an indicator of emotional lability. Lower emotional lability may indicate better emotional experience over time, which is in turn associated with better survival rates (Carstensen et al., 2011; Röcke, Li, & Smith, 2009). In the caregiving literature, however, although it is clear that caregiving under distress is associated with higher depression and more anger, caregivers' affective fluctuation in response to their daily experiences or other factors associated with such fluctuation have not been examined. Consequently, most caregiver interventions usually focus on reducing the mean levels of affective outcomes (i.e., lower depression and less anger). However, they pay little attention to reducing caregivers' negative affective lability, and they have not targeted affective fluctuation as an active measure of positive intervention effects. This is problematic, given that caregivers' affective fluctuation may represent an important dimension of their own well-being and may be associated in a similar way as their levels of affect to health. The current study, therefore, examines questions related to the magnitude of caregivers' affective fluctuation and whether such fluctuation are associated with caregivers' daily experiences, with an intervention, adult day service (ADS) use, that affects daily experiences by lowering exposure to care-related stressors, and with other caregiving characteristics.

Using daily diaries, an individual's daily fluctuation in affect is often operationalized by the magnitude of variation across observation days and studied with a two-step procedure. First, fluctuation is measured by individual standard deviation (*iSD*; Carstensen, Pasupathi, Mayr, & Nesselroade, 2000; Eid & Diener, 1999), which captures the raw amount of within-person affect variation. Then, these *iSD* measures are used in subsequent between-person analyses

to examine predictors or covariates of individual differences in the magnitude of within-person variation. Another procedure, multilevel models with heterogeneous variance (also called dispersion models; Hoffman, 2007; Raudenbush & Bryk, 2002) provide a parsimonious and powerful within-person approach to modeling affective fluctuation, taking into account individuals' general level of affect. In this procedure, within-person variation is operationalized using the Level 1 model residual of daily affect, after considering the associations between the average level of affect and the potential within-person covariates. The resulting value, which was named "intrinsic fluctuation," represents the amount of variance that is left unexplained by all the Level 1 covariates of the multilevel models. Although intrinsic fluctuation and within-person variance are conceptually similar, intrinsic fluctuation is model-based. It differs from the usual within-person variance as measured by *iSD*, which is conceptually a "raw" observed score describing an individual's magnitude of fluctuation from her or his personal mean. In common multilevel models, these within-person residuals have largely been considered a statistical nuisance, neglected, and assumed to be homogeneous across time (Hoffman, 2007). They may, however, represent a fundamental characteristic of each caregiver's reactivity to the daily flow of events, to behavioral interventions, and even to physiological processes that also influence affect. By allowing intrinsic fluctuation to differ on covariates, these models also provide a better fit of the data than in common multilevel models, which assume intrinsic fluctuation to be homogeneous (i.e., the same across people) and treat them as errors around the average level.

Focusing on a sample of caregivers of IWDs, the current study examines caregivers' intrinsic fluctuation in negative affect in relation to ADS use, daily stressors, and positive events over a period of 8 consecutive days. Figure 1 illustrates the conceptual model of the current study. Caregivers' daily affect is conceptually partitioned into two components: (a) the between-person or level of affect and (b) the within-person or intrinsic fluctuation of an individual's daily affect. As in prior studies, the modeling starts by estimating the between-person effects of ADS use and stressors on daily level of affect. Following approaches suggested by Hedeker and Mermelstein (2007) and Hoffman (2007), within-person intrinsic fluctuation of daily affect is then modeled and related to ADS use, stressors, and other caregiving characteristics. In addition to a focus on the role of daily stressors on intrinsic fluctuation, the model is expanded in three ways. First, the effects of an intervention is considered, use of ADS program, which decreases exposure to care-related stressors for caregivers on days when the IWD attends an ADS program (Zarit, Kim, Femia, Almeida, & Klein, 2014; Zarit et al., 2011). Across the 8 days of the study, IWDs attended ADS on some days and on the remaining days spent most of their time with their caregivers, thus allowing for a comparison of the effects of high and low stressor exposure days on intrinsic fluctuation in daily affect. The increased variability in stressor exposure across days due to the intervention may help better establish the linkages between stressors and intrinsic fluctuation in affect than when there are relatively smaller quotidian differences in stressor exposure, as well as identifying whether an intervention that modifies stressor exposure influences both between-person daily affect and within-person affective lability. Second, the effects of two daily measures of caregiver stressors, positive events, and quality of sleep were considered, which are known to influence their daily affect (Totterdell, Reynolds, Parkinson, & Briner, 1994;

Zarit et al., 2014). Third, in contrast to most studies of caregivers that have focused only on a single type of affect, two emotions are examined, depression and anger, which differ in terms of their likely reactivity to daily events.

Negative Affect: Anger and Depression

In the caregiving literature, negative affect is usually operationalized as a single dimension, consisting of either depressive symptoms or composite scales of negative symptoms. One dimension of affect that is potentially very important for caregiving is anger (Gallagher-Thompson & Coon, 2007; Zarit, Todd, & Zarit, 1986). Researchers usually distinguish between trait and state anger. Trait anger is a more stable personality characteristic, whereas state anger reflects fluctuation in feelings that are reactive to daily happenings (Spielberger, Jacobs, Russell, & Crane, 1983). Because of our interest in daily fluctuation in affect, state anger was measured in the current study. Anger is more of a “hot” emotion, with high reactivity to daily events (Watson & Tellegen, 1985). In contrast to state anger, depression is a more stable emotion with slower responses (Suls & Bunde, 2005). Anger and depression also differ on dimensions of activation and arousal, which are used to conceptualize the continuity among mood states (Watson & Tellegen, 1985). Anger is categorized as a high-activation/arousal negative affect, and depression is considered a low-activation/arousal negative affect. Thus, in the current study, anger and depression were compared for their associations with stressors and intrinsic fluctuation.

ADS Use and Caregiver Well-Being

ADS programs and other types of respite services have long been considered an essential part of services to assist family caregivers. Prior research has shown that caregivers who enroll an IWD into ADS experience lower subjective stress, lower depressive symptoms, and anger at 3 months as well as at 1 year (Zarit, Stephens, Townsend, & Greene, 1998). One reason for these effects is that, in turning their relative over to an ADS program, caregivers experience significant reductions in exposure to care-related stressors (Zarit et al., 2011). Just as ADS is associated with improved levels of well-being, it may lead to reduced intrinsic fluctuation by decreasing overall stressor exposures.

Stressor Exposure, Positive Events, and Affective States

Stressor exposures may exert their effects on the level of an individual's affect and fluctuation of affect within individuals. Recent studies of emotional development in adulthood and old age have found that older adults had significantly less fluctuation in negative affect after controlling for personality factors (Röcke et al., 2009). This smaller amount of fluctuation is consistent with notions of improved emotional control in later life (Carstensen et al., 2011). In contrast, Charles and colleagues (2009) have argued that although older people are more likely to avoid daily stressors of conflict or problematic situations, they have similar affective reactivity when they encounter stressors as do younger people.

In caregiving studies, much of the focus has been on care-related stressors, particularly IWD's behavioral symptoms of dementia and the general level of caregiver well-being. Caregivers may also experience daily stressors not directly related to the care they are providing (Aneshensel et al., 1995). These noncare stressors have an impact on caregivers' levels of affect (Zarit et al., 2014) and may also affect their intrinsic fluctuation.

In addition to stressors, caregivers may also have positive experiences. Positive events have been defined in various ways in prior studies, broadly as anything pleasant, any experienced life events that have a positive impact, or specifically as the enjoyment of certain leisure activities like having meals with friends or families (Cohen & Hoberman, 1983; Mausbach, Harmell, Moore, & Chattillion, 2011; Röcke et al., 2009). In daily diary studies, positive events have been found consistently to benefit individuals' daily affective states both in the general population and in family caregivers of IWDs specifically (e.g., Mausbach et al., 2011; Röcke et al., 2009). Little is known, however, about how positive events might contribute to intrinsic fluctuation in affect.

Sleep Quality and Daily Affect

Another factor that contributes to daily affect is sleep quality the night before. Caregivers' sleep is often disrupted if their relative has difficulty falling asleep or has frequent awakenings during the night (McCurry, Gibbons, Logsdon, Vitiello, & Teri, 2005). Sleep disturbances were found to be related to higher levels of trait anger even after adjusting for other potential risk factors (Shin et al., 2005). Results from a daily diary study by Totterdell and colleagues (1994) indicate that changes in sleep behaviors were more strongly related to well-being on subsequent days, with early onset of sleep being associated with better mood and social interaction experiences the next day.

Caregivers' Characteristics and Associations With Affective Well-Being

Although the caregiving process is driven by care-related stressors, caregivers' personal and social characteristics also influence their responses to specific daily challenges. Characteristics such as age, gender, education, spouse status, duration of care, and the IWD's severity of disability are relevant to caregivers' affective well-being in the level and the fluctuation (Aneshensel et al., 1995; Covinsky et al., 2003). These characteristics were considered as covariates in our models.

The Present Study

In the present study, caregivers' daily intrinsic fluctuation in both depression and anger were considered, as well as predictors thereof, including ADS use, daily stressors and positive events, daily quality of sleep, and other caregiving characteristics.

The following hypotheses on intrinsic fluctuation in negative affect were tested: Caregivers who have more ADS days (Hypothesis 1) and who have more daily positive events (Hypothesis 2) over an 8-day period of observation will have less intrinsic fluctuation of daily negative affect in the context of other daily experiences; caregivers who have more daily care-related stressors (Hypothesis 3) and who have more daily noncare (Hypothesis 4)

stressors over an 8-day period of observation will have greater intrinsic fluctuation of daily negative affect in the context of other daily experiences.

For the above hypotheses, caregiver demographic indicators and other covariates that are likely to influence their intrinsic fluctuation in daily affect were considered. Based on the literature, younger, female, spouse, recent caregivers, caregivers with poorer sleep quality, caregivers with lower education, and IWDs with a higher level of disability in activities of daily living (ADL) were expected to be associated with greater intrinsic fluctuation in caregivers' daily negative affect.

Method

Participants and Procedures

Participants were 173 family caregivers who were (a) providing primary care to IWDs who lived in the same household, (b) reporting the IWD having a type of dementia such as Alzheimer's disease that was diagnosed by a physician, and (c) using ADS programs at least 2 days a week, and who participated in an 8-day diary study as part of the Daily Stress and Health study (Zarit et al., 2014). In total, the 173 caregivers provided 1,359 valid daily interviews (on average 7.86 of 8 interview days, 98% compliance). Of these 1,359 days, 707 days in total (52%) and 4.09 days on average ($SD = 1.46$) were days the IWDs participated in an ADS program, and on 652 days in total and 3.77 days on average ($SD = 1.43$), IWDs were at home with their family caregivers.

ADS programs were identified through regional and state associations. Programs that agreed to participate were provided with detailed information about the study, recruitment brochures, and announcements that could be included in the newsletters. Over a 3-year period, family caregivers from 57 ADS programs expressed interest in study participation. These caregivers were phoned by the research coordinator, given additional information about the study, and screened for eligibility. Subsequently, an initial face-to-face interview was conducted at the caregiver's home, during which they signed consent forms and completed a set of questionnaires. After the initial meeting and baseline assessment, caregivers participated in daily interviews for 8 consecutive days via evening phone calls (conducted by the staff at the Penn State Survey Research Center). Caregivers received \$150 for completing the entire study protocol.

Among the 241 people who initially screened for participation, 41 people were not eligible. The most frequent reasons were that the care receiver did not have eligible dementia diagnosis ($n = 16$), did not coreside with the IWD ($n = 5$), or was not using ADS at least two times a week ($n = 11$). Among the 200 eligible participants, 27 (13.5%) were not part of the final sample for the following reasons: decided not to participate ($n = 6$), did not complete the in-home interview ($n = 10$), and did not complete the daily interview ($n = 2$). Given the comparative nature of our hypotheses (i.e., ADS vs. non-ADS days), caregivers ($n = 9$) who only provided a homogeneous set of interviews (i.e., all ADS or all non-ADS days) were not included in the analysis, either. Table 1 presents demographic characteristics of caregivers and the IWD they were caring for.

Measures

Daily negative affect—Daily negative affect was measured using an inventory of emotions adapted from the Nonspecific Psychological Distress Scale (Kessler et al., 2002). During each evening's telephone interview, caregivers were asked how frequently (5-point scale; 1 = *none of the day* to 5 = *all day*) they felt each of the 24 items over the past day. As confirmed through factor analysis, the full scale assesses four affective domains relevant to caregivers: anxiety, anger, depression, and positive affect. For the current study, the Anger (four items, $\alpha = .83$) and Depression (four items, $\alpha = .84$) subscales were used, coded so that higher scores indicated higher levels of anger or depression.

Daily ADS use—In each daily interview the caregivers indicated whether they had made use of ADS that day. From these reports, both time-varying and time-invariant variables were derived. The time-varying ADS use measure was a binary variable indicating use (= 1) or nonuse (= 0) that day. A time-invariant ADS variable was computed as the sum of ADS days across the daily interview period.

Daily stressors—Two types of daily stressors were distinguished: care-related stressors and noncare stressors. *Care-related stressors* were considered in relation to the IWD's daily behavior problems and were measured using the daily record of behavior. The daily record of behavior, designed specifically for use in daily diaries, assesses the frequency with which 19 behaviors occurred over a 24-hr time frame (see Femia, Zarit, Stephens, & Greene, 2007 for psychometric properties). To assist caregivers in reporting, the day is broken up into four time-blocks that correspond to the modal periods during which caregivers use ADS: (a) waking to 9:00 a.m., (b) 9:00 a.m. to 4:00 p.m. (typical ADS attendance hours), (c) 4:00 p.m. to bedtime, and (d) overnight. For each period of the day, caregivers were asked whether each behavior had occurred (yes/no). From these reports, both time-varying and time-invariant variables were derived. The time-varying care-related stressors were the sum of behavior occurrences that were reported that day, excluding the overnight period; the time-invariant care-related stressors were the average level of daily behavior occurrences reported across the interview period.

Noncare stressors were measured using the Daily Inventory of Stressful Events (Almeida, Wethington, & Kessler, 2002). Each evening, caregivers reported on the occurrence (yes/no) of eight events over the previous 24-hr period: arguments with other people, whether they avoided an argument with someone, incidents concerning their friends or family, health-related issues or incidents, money or finance-related issues, work-related issues, and other stressful issues or incidents. Separating care-related and noncare stressors, caregivers were specifically instructed to report events they found stressful other than those encountered when assisting their relative. Both time-varying and time-invariant variables were derived based on the daily reports. The time-varying noncare stressors were the sum of stressors reported across all eight categories that day; the time-invariant noncare stressors were the average level of daily stressors reported across the interview period.

Daily positive events—Using five items drawn from the Daily Inventory of Stressful Events (Almeida et al., 2002), caregivers reported occurrences of positive experiences during

the past 24 hr: sharing a laugh with someone, having an experience at home, with a close friend or relative, or at work that others would consider positive, and any other positive experience. Both time-varying and time-invariant variables based on the daily reports were derived. The time-varying variable was the sum of positive events reported across all five categories that day; the time-invariant variable was the average level of daily positive events across the interview period.

Covariates—Additional variables that are often associated with caregivers' emotional well-being were considered as covariates. Caregivers' chronological age, gender (1 = *female* and 0 = *male*), spouse status (1 = *spouse* and 0 = *other relationship types*), duration of care provision (in months), education level (6-point scale: 1 = *less than high school* to 6 = *post college degree*), IWD ADL dependency (mean of 13 items, coded on a 4-point scale: 1 = *does not need help* to 4 = *cannot do without help*; higher scores indicated greater dependency; $\alpha = .83$), and caregivers' sleep quality, assessed each day as the response to the item: "Rate the quality of your sleep last night" (5-point scale; 1 = *poor* to 5 = *excellent*). Caregivers' daily sleep quality was used as a time-varying covariate and caregivers' mean sleep quality across days was used as a time-invariant covariate.

Analytical Strategy

The analysis was conducted in a series of steps to explore caregivers' intrinsic fluctuation in anger and depression. First, unconditional models without any covariates were examined to (a) explore the nature of nesting and (b) estimate variance components and compute the intraclass correlations (ICCs). Initially, three-level unconditional multilevel models were fit to explore whether all three levels of nesting were needed, where days nested within participants and participants nested within ADS programs. The ICCs of ADS programs were small, and the variance components were nonsignificant for both anger (ICC = .002) and depression (ICC = .004). Therefore, two-level multilevel models, where days nested within participants were considered in subsequent analysis. These models indicate that there was substantial within-person variation in anger (ICC = .49; 49% variance between-persons, 51% within-persons) and less so in depression (ICC = .73; 73% variance between-persons, 27% within-persons). Second, a day of the week effect and a linear time trend for day in the study was evaluated for both depression and anger to determine if they needed to be included in models as fixed effects. Because these factors did not have any significant fixed effects, they were dropped from subsequent analyses. Third, unconditional models of daily affect were carefully examined for best model fit using different error structures in the G matrix and R matrix (i.e., lowest Akaike information criterion [AIC] and Bayesian information criterion [BIC] for nonnested models and restricted maximum likelihood [REML] deviance test for nested models). For the depression model with common variance, the random intercept +ARH(1) model had the lowest AIC and BIC values; for the anger model, the random intercept +AR(1) model had the lowest AIC and BIC values. The extent to which these error structures were still appropriate was re-evaluated after adding covariates, with similar findings.

Last, individual differences in the magnitude of within-person variation across days were tested based on procedures described in Hoffman (2007, p. 619), using 5 days as the

minimum cut-off degrees of freedom for Level 2 units (i.e., caregivers). The purpose was to see whether homogeneity of the Level 1 residual was a plausible assumption. These tests showed significant heterogeneity of within-person variance for both depression, $H(87) = 469.21$, $p < .001$, and anger, $H(137) = 586.86$, $p < .001$. Based on these findings, it is justifiable to examine what between-person characteristics are associated with within-person variability. In the models with heterogeneous variance, a scale parameter that is conceptually the random intercept of the Level 1 residual variance (i.e., individual differences in fluctuation) was not estimated. Such models are generally specified as mixed effects location-scale models (Cleveland, Denby, & Liu, 2002; Hedeker, Mermelstein, & Demirtas, 2008), which permits individual characteristics to be associated with the mean (i.e., location) and variation (i.e., scale) of individual affective outcomes. As the random scale effect is the model-based test of heterogeneity, the location-scale models were initially attempted in Proc NLMIXED. However, these models did not converge. Empirical studies using multilevel models with heterogeneous variance have not been uniformly tested with such random scale effect in the models (Hedeker & Mermelstein, 2007; Hoffman, 2007), and it is not clear whether such an effect necessitates the model building process in the previous literature. Least-squares-based tests of heterogeneity were adopted instead.

Multilevel models of negative affect with common within-person variance were developed, separately for anger and depression outcomes (Model 1). Specifically,

$$\begin{aligned} \text{Negative affect}_{id} = & \pi_{i0} + \pi_{i1}(\text{ADS use}_{id}) + \pi_{i2}(\text{Sleep quality}_{id}) \\ & + \pi_{i3}(\text{Care-related stressors}_{id}) + \pi_{i4}(\text{Noncare stressors}_{id}) \\ & + \pi_{i5}(\text{Positive events}_{id}) + \varepsilon_{id} \end{aligned} \quad (1)$$

where daily reports of negative affect (anger or depression) for person i on day d is modeled as a function of a person-specific intercept (π_{i0} , the average affect on non-ADS days, holding daily stressors, positive events, and sleep quality at that individual's average), ADS use on that particular day (π_{i1} , within-person association between ADS use and daily affect, holding daily stressors, positive events, and sleep quality at that individual's average), sleep quality of the previous night (π_{i2} , within-person association between daily sleep quality and daily affect on non-ADS days), care-related stressors on that day (π_{i3} , within-person association between daily care-related stressors and daily affect on non-ADS days), noncare stressors on that day (π_{i4} , within-person association between daily noncare stressors and daily affect on non-ADS days), positive events on that day (π_{i5} , within-person association between daily positive events and daily affect on non-ADS days), and the within-person residual, ε_{id} , whose variance was σ_{η}^2 . All within-person covariates were person-mean centered; the binary variable of daily ADS use ($1 = \text{use}$, $0 = \text{nonuse}$) was left as such. Person-specific coefficients were then modeled (Model 1) as

$$\begin{aligned}
\pi_{i0} = & \beta_{00} + \beta_{10}(\text{Sum of days}_i) \\
& + \beta_{20}(\text{Average sleep quality}_i) + \beta_{30}(\text{Average care-related stressors}_i) + \beta_{40}(\text{Average noncare stressors}_i) \\
& + \beta_{50}(\text{Average positive events}_i) + \beta_{60}(\text{CG age}_i) \\
& + \beta_{70}(\text{CG female}_i) + \beta_{80}(\text{CG spouse}_i) \\
& + \beta_{90}(\text{CG education}_i) + \beta_{100}(\text{Duration of care}_i) \\
& + \beta_{110}(\text{IWD ADL dependency}_i) + \nu_{i0} \\
\pi_{i1} = & \beta_{01} \\
& \vdots \\
\pi_{i5} = & \beta_{05}
\end{aligned}$$

(2)

where β s are population-level parameters and ν_{i0} are unexplained between-person differences in the intercept with a variance, σ_v^2 (note that CG = caregiver). All between-person covariates were grand-mean centered. The corresponding parameter estimates and significance tests were reported in Table 2.

Then, the common models were extended with heterogeneous within-person variance (Model 2) to test the key hypotheses (Hedeker & Mermelstein, 2007; Hoffman, 2007). The hypothesized effects of ADS use (Hypothesis 1), positive events (Hypothesis 2), and daily stressors (Hypotheses 3 and 4) were tested on caregivers' affective fluctuation in both anger and depression. Both linear and quadratic effects of hypothesized predictors and other caregiving characteristics on intrinsic affective fluctuation were examined. The assumptions on within-person intrinsic fluctuation were relaxed in Model 2 to allow it to differ across caregivers depending on their total ADS use, average stressor experiences, and other caregiving characteristics. Specifically, the within-person (Level 1) variance, σ_{in}^2 was allowed to vary across caregivers as a function of aforementioned between-person characteristics,

$$\begin{aligned}
\sigma_{in}^2 = & \alpha_0 * \exp(\alpha_1 * \text{Caregiving characteristics}_i) \\
& + \alpha_2 * \text{Caregiving characteristics}_i^2
\end{aligned} \quad (3)$$

where α_0 indicates the expected intrinsic fluctuation for the prototypical individual, multiplied by the exponentiated difference in the residual variance as a function of the linear (α_1) and quadratic (α_2) effects of caregiving characteristics. The log (exponential) structure of the model accommodates the bounded nature of intrinsic fluctuation (i.e., variation cannot go below zero, see Hoffman, 2007). Due to the complexity of the model, effects of predictors on heterogeneous intrinsic fluctuation were tested one at a time with separate models (Hedeker & Mermelstein, 2007). Because an ARH(1) and AR(1) structure was needed for the Level 1 residuals in addition to the random intercept in the homogeneous variance models for depression and anger, respectively, these residual structures were modeled in the heterogeneous variance models to control for the time effect on within-

person variance heterogeneity. Specifically, the ARH(1) structure was modeled in each of the residual variance equations for depression by adding dummy-coded predictors for day in addition to the key predictor; the AR(1) structure was modeled in each of the residual variance equations for anger by adding linear and quadratic time effects in addition to the key predictor. Nonsignificant effects were trimmed from the final model, and estimates are presented in Table 2.

REML deviance tests were used to compare model fit between the common models with random intercepts and each of the within-person heterogeneous models with common between-person random intercepts, and the reported models all showed improved fit compared to the common between-person models. For example, by adding heterogeneous variance for sum of ADS days, model fit improved for both depression, REML χ^2 difference (1) = 27.9, $p < .05$, and anger, REML χ^2 difference (2) = 7.4, $p < .05$.

Results

Model estimates with common within-person variance (Model 1) are presented in Table 2. In general, ADS use and sleep quality of the previous night did not have significant fixed effects, whereas average daily stressors and positive events had significant between-person associations with both types of affect. Specifically, more stressors and less positive events were associated with greater depression and anger. At the within-person level, caregivers' better sleep was marginally associated with less anger on that day ($\beta = -0.029$, $p = .081$), whereas less daily noncare stressors were associated with more depression on that day ($\beta = -0.118$, $p = .007$).

Because the fixed effects and common between-person variance were very similar for the separate heterogeneous models, only linear effects and significant quadratic effects for the heterogeneous models were presented in the lower part of Table 2. Although daily ADS use and sleep quality were not significant for the levels of daily negative affect (Model 1), sum of ADS days had negative effects on the residual variance (Hypothesis 1) for depression ($\alpha_1 = -1.563$, $p < .001$; $\alpha_2 = -10.124$, $p < .001$) and anger ($\alpha_1 = 0.562$, $p = .016$); average sleep quality had a negative linear effect on the residual variance only for anger ($\alpha_1 = -0.213$, $p < .001$). The linear association between sum of ADS days and heterogeneous within-person variance in negative affect was significant in the hypothesized direction for anger only, as shown in Figure 2. For depression, the presence of a quadratic effect meant that the linear effect needed to be qualified. Specifically, the negative coefficient for linear effect was referring to the sum of ADS days at the average (= 4.09 days). As shown in Figure 2, when the sum of ADS days was greater than average, more ADS days were associated with less intrinsic fluctuation in depression; when the sum of ADS days was lower than average, however, more ADS days were associated with greater intrinsic fluctuation in depression.

Further, caregivers' average daily experiences across the 8-day period had significant effects on intrinsic fluctuation in negative affect (Hypotheses 2, 3, and 4). There was a negative linear effect of average positive events on the intrinsic fluctuation (Hypothesis 2) for both depression ($\alpha_1 = -0.122$, $p = .001$) and anger ($\alpha_1 = -0.115$, $p < .001$). Hypothesis 3 was partially supported, as average care-related stressors had a linear effect on intrinsic

fluctuation for depression only ($\alpha_1 = -0.047, p < .001$). For anger, there were significant linear and quadratic effects ($\alpha_1 = 0.066, p .001$; $\alpha_2 = -0.002, p < .001$). Specifically, when average care-related stressors were below the sample mean, more stressors were associated with greater intrinsic fluctuation in anger; at greater levels of stressor, more stressors were associated with less anger fluctuation. As hypothesized, there was also a positive linear effect of average noncare stressors on the intrinsic fluctuation (Hypothesis 4) for both depression ($\alpha_1 = 0.282, p < .001$) and anger ($\alpha_1 = 0.225, p < .001$).

Additionally, the extent to which caregivers' demographic and other caregiving characteristics were associated with their own intrinsic affective fluctuation was also explored in separate models, controlling for their average associations with daily affect, and the heterogeneity of residual variance across days. Although these covariates did not have significant fixed effects in Model 1, some of them showed significant effects on residual variance in Model 2. Caregiver gender did not have any significant effect on intrinsic fluctuation; being a spouse caregiver or not was a significant predictor, with spouse caregivers having greater intrinsic fluctuation in depression ($\alpha_1 = 0.545, p < .001$). Similarly, caregiver education had a negative linear effect on the intrinsic fluctuation in depression only ($\alpha_1 = -0.189, p < .001$). Caregiver age had an accelerating positive effect on intrinsic fluctuation in depression ($\alpha_1 = 0.017, p < .001$; $\alpha_1 = 0.001, p = .001$) at older ages. Duration of care had a significant quadratic effect on caregivers' intrinsic fluctuation in depression ($\alpha_2 = -0.000, p < .001$); IWD ADL dependency showed a negative linear and positive quadratic effect on caregivers' intrinsic fluctuation in depression only ($\alpha_1 = -0.447, p < .001$; $\alpha_2 = 0.452, p = .010$). Specifically, when duration of care was below average, it had positive associations with intrinsic fluctuation in depression, whereas when duration of care was above average, the association was negative. When IWD ADL dependency was less than average (better functioning), its association with intrinsic fluctuation in depression was negative; when the dependency was greater than average (worse functioning), its association with intrinsic fluctuation in depression was positive.

Discussion

To date, most research on caregivers' daily affect has examined average daily scores across days or the relation of daily scores to daily events. This study demonstrated that intrinsic fluctuation in affect across a series of days provide additional and meaningful information about the effects of caregivers' ADS use and daily experience on their affective functioning. The degree of intrinsic fluctuation (i.e., within-person variation) that occurs in affect from day-to-day indicates the extent of a caregiver's emotional highs and lows beyond the influence attributable to daily events and constitutes an important dimension of their emotional well-being. Specifically, lower emotional lability is a critical part of emotional well-being and is associated with improved health and greater life expectations (Carstensen et al., 2011). As the present study demonstrates, it can also contribute to family caregivers' well-being similarly and perhaps also to health in the long run.

The present study illustrates the value of moving beyond usual computational approaches in common multilevel models in which within-person residuals have largely been considered a statistical nuisance and assumed to be homogeneous across time (Hoffman, 2007). Doing so

eases computation, but veils important mechanisms to further study such fluctuation. Multilevel models with heterogeneous variance are a useful tool to capture more fully how personal characteristics and behavioral interventions such as ADS influence emotional outcomes. The study demonstrated that the sum of ADS days was negatively associated with caregivers' intrinsic fluctuation of anger across observation days; its association with intrinsic fluctuation in depression was negative only when ADS days were greater than average. Caregivers having greater-than-average ADS days experienced less intrinsic fluctuation in both daily anger and depression, controlling for their average associations with daily experiences and other caregiving characteristics. For caregiver depression, however, ADS use was positively associated with fluctuation in daily depression when the sum of ADS day was below average. Some explanations could be that preparing IWDs to attend ADS centers can be stressful especially when it is accompanied by resistance and may be more common in lower-than-average use. Alternatively, lower use may be associated with limited financial resources, which can contribute to lowered caregiver well-being (Aneshensel et al., 1995). These findings suggest that greater-than-average ADS use is advantageous as they provide a stability effect on caregivers' daily affective processes. Therefore, ADS is most beneficial with regular and substantial use as suggested by prior literature (Zarit et al., 1998).

Additionally, prior findings from the Daily Stress and Health study indicated that, not controlling for other daily experiences, ADS use had direct effects on daily levels of anger; controlling for other daily experiences, ADS use had a buffering effect on daily levels of depression (Zarit et al., 2014). Thus, ADS use can potentially reduce both the average level of daily distress and the extent of intrinsic fluctuation, although findings from the current study are preliminary and need to be verified in other studies. Both levels of affect and emotional volatility have been associated with negative health outcomes (i.e., Piazza et al., 2013), and so interventions that address both dimensions of affect may be more protective for health.

Caregiving Characteristics and Intrinsic Fluctuation in Negative Affect

Findings from the study confirmed that caregiver characteristics (i.e., spouse status, age, and education) and caregiving situations (i.e., duration of care and IWD ADL dependency) are closely associated with caregivers' within-person affective fluctuation in well-being. These associations had diverse patterns, with fluctuation in anger being associated more prominently with some characteristics and fluctuation in depression being associated more strongly with others. Caregiver–patient *relationship* type has been linked to caregiver well-being. Pinquart and Sörensen (2011) found that spouse caregivers provided more care, had greater financial and physical burden, were more depressed, and had lower psychological well-being. Spouse caregivers in the current study also showed greater fluctuation in daily depression, complementing prior findings. One explanation for heightened distress in spouse caregivers is that spouses have the closest relationships to the patients, and the closer relationships are often associated with more caregiving distress (Cantor, 1983). Further, older age was associated with greater fluctuation in caregivers' daily depression, which contradicts findings from prior studies on older people having less within-person fluctuation and better emotion regulation (Birditt, Fingerma, & Almeida, 2005; Röcke et al., 2009).

This increased emotional lability accelerating at older ages indicates compromised well-being and, potentially, a breakdown in the mental and physical system in family caregivers (Eizenman, Nesselroade, Featherman, & Rowe, 1997). Compared with non-caregiving population of similar age, caregivers of IWDs have increased exposures to daily stressors, which explain their increased vulnerability to emotional reactions. Although older people tend to have lower affective reactivity to stressors due to emotional regulation strategies like avoidance, they are equally likely to react strongly to an actual stressor occurrence (Charles et al., 2009).

It is known that individuals with lower socioeconomic status (SES) are in general more emotionally vulnerable to stressors and tend to have compromised affective functioning compared to people with higher SES; dementia caregivers of lower SES are especially at risk for psychiatric morbidity. The findings on caregivers' lower education and associations with greater intrinsic fluctuation in depression add to our understanding on SES factors, stress, and affective manifestation of stressors: caregivers with lower education and probably lower SES also tend to have greater intrinsic fluctuation in depression, which put them at heightened risk for lowered well-being and, potentially, poor physical health over time.

Longer duration of care and lower IWD ADL dependency were associated with less daily fluctuation in depression, whereas shorter duration of care and greater IWD ADL dependency were associated with greater daily fluctuation in depression. For long-term versus recent caregivers, there are two possible mechanisms: adaptation and mastery in caregiving. Long-term caregivers may have better adapted to the caregiving role among their other life roles and know what to expect and strategically respond to behavioral problems that might otherwise seem most disturbing for novice caregivers (Gaugler, Davey, Pearlin, & Zarit, 2000; Zainuddin, Arokiasamy, & Poi, 2003). Long-term caregivers may also have derived a meaning in caregiving and associated positive feelings (Noonan & Tennstedt, 1997). Although caregivers' global sense of mastery can erode over time, long-term caregivers can still have a better sense of mastery than the more recent caregivers, thus attenuating the negative impact of stressors on affective well-being (Infurna, Gerstorf, & Zarit, 2013). Additionally, ADL dependency has been reported as a covariate for longitudinal caregiver burden and overload (Pinquart & Sörensen, 2003), and the current study complemented such findings by demonstrating that higher IWD ADL dependency was associated with greater daily fluctuation in depression.

The findings on better sleep quality associated with less intrinsic fluctuation in daily anger, but not depression showed support to poor sleep being an important stressor for caregivers and the conceptualization of anger and depression as being different in levels of affective arousal (Russell, 1980). Poor sleep quality among caregivers is often directly due to IWD sleep problems. IWDs can have difficulty falling asleep or wake up in the middle of the night. Whatever the cause, caregivers' poor quality of sleep can reduce emotional control the next day and lead to more frequent and stronger angry outbursts. Treatment that reduces sleep problems in IWDs and addresses other sources of caregivers' sleep difficulties may be a useful strategy for stabilizing caregiver's affect (McCurry et al., 2005).

Caregiver depression and anger may be the consequence of multiple processes such as patient behavior problems, their own health conditions, or other factors that are not directly related to caregiving, such as financial resources (Covinsky et al., 2003). Caregiver depression can be a catalyst for feelings of anger and vice versa, and caregivers' poor mental health has been associated with their own poor quality of life, declining functionality, and mortality. Moreover, such negative affect may also put caregivers at risk for engaging in abusive behaviors against IWDs and developing unhealthy caregiving relationships (MacNeil et al., 2010). From the perspective of intrinsic affective fluctuation, more studies on whether caregivers' greater fluctuation may act in similar detrimental ways for themselves and the IWDs are warranted. Longitudinal studies using intrinsic affective fluctuation to predict both caregiving dyads' health and well-being can help test such hypotheses.

Further, current findings may also have practical significance for future caregiver intervention designs: They need to address different caregiver populations and needs. For example, because spouse caregivers may have greater affective fluctuation in depression, interventions can focus more on educating them to keep a little emotional distance with regard to daily caregiving tasks and to have realistic expectations for their loved ones. Such education component showed promising effects in prior caregiver interventions (Hepburn, Tornatore, Center, & Ostwald, 2001). Similarly, intervention efforts need to target at recent caregivers of older age who have lower education and are assisting IWDs with greater ADL dependency, as this group of caregivers may have greater intrinsic fluctuation in daily depression.

ADS Use in the Context of Daily Experiences

Both effects of ADS use and other daily experiences on caregivers' daily affective fluctuation were considered at the within-and between-person levels. For family caregivers of IWDs who are under chronic stress, their level and fluctuation of daily affect can be driven to a large extent by daily fluctuation in stressor exposures and positive events (Zarit et al., 2014). ADS use changes the structure and routines of daily caregiving experiences by providing temporary yet predictable time away from caregiving responsibilities and relieving caregivers' exposure to potentially stressful behavior problems. This brief recess thus prevents possible accumulation of daily negative affective reactions in both depression and anger.

The associations between caregivers' daily stressors and intrinsic fluctuation further extended findings on the complex links between daily stressor exposures and reactivity. Compared with their noncaregiving counterparts, caregivers of IWDs experience a relatively high amount of daily stressors. Although some stressors can be strategically managed with minimal reactions, others can still cause strong affective arousal (Charles et al., 2009). The study showed that the average daily care-related stressor had a positive association with fluctuation in depression, but its association with anger fluctuation was conditional. When the average daily care-related stressor was below average, its association with intrinsic fluctuation in anger was positive; when the average care-related stressor was above average, however, its association with fluctuation in anger was negative, such that more stressors

were associated with less fluctuation. This could be due to an adaptation effect in caregiving, such that caregivers experiencing care-related stressors like disturbing behaviors are desensitized once a threshold is past. Also, the current findings suggested that although caregivers having more care-related stressors tended to show less anger fluctuation, they still demonstrated greater fluctuation in depression. The possible association and mechanism between the occurrence and magnitude of emotional reactions in family caregivers to specific events across days is worth further examination to better depict caregivers' emotional well-being, considering the potential long-term relation of emotional reactivity and caregivers' physical well-being and other caregiving outcomes (Piazza et al., 2013).

The current findings also suggest that ADS use may benefit caregivers in different ways depending on their characteristics and specific caregiving situations. It may help older caregivers by bringing down their fluctuation in depression; it may benefit spouse caregivers by reducing fluctuation in depression; it may help caregivers with lower education, and possibly lower SES, have less fluctuation in depression; and it may benefit recent caregivers who are providing care to IWDs with lower functioning and greater dependency by reducing their fluctuation in depression. To what extent these hypothesized ADS benefits are practically significant needs to be reexamined and verified in future studies.

Limitations and Conclusions

There are limitations in this study. Personality traits like neuroticism, as well as daily experiences, are associated with both the general level of affect and its daily fluctuation, although the association can be minimal (Miller, Vachon, & Lynam, 2009). The current findings on extent of daily affective fluctuation and associations would be strengthened if such variables were included as covariates in the model. Also, multilevel models with heterogeneous variance were applied to data collected of 8 days under the assumption that 8 days of data provide a full representation of people's lives and caregiving experiences. Although there were some identified associations, the availability of longer time series would increase the precision with which differences in intrinsic affect fluctuation and associations could be examined (Hoffman, 2007). Further, heterogeneity of the quality of ADS programs and their support to caregivers could be associated with both level and fluctuation of caregivers' daily emotional well-being, which could be tested given a larger sample size per program. A more representative sample of caregivers using ADS programs across the country would also be useful to cross-validate the current findings. Last, although both homogeneous and heterogeneous models showed that average daily stressors and positive events were significantly related to the mean level and fluctuation of caregivers' daily negative affect, it is not clear whether these associations were practically significant. For example, care-related stressors and positive events seemed to have a relatively small magnitude of association with both mean level and fluctuation of negative affect, as suggested by the coefficients; ADS use did not have any significant fixed effects, but its association with intrinsic fluctuation in daily depression seemed substantial. To what extent these significant fixed and random effects are meaningful for caregivers in the long run can be addressed by linking daily experience to longitudinal outcomes of health and well-being in future studies.

In conclusion, the construct of intrinsic fluctuation adds to our understanding of the associations between ADS use, daily experiences, and affect of family caregivers. Just as affective reactivity to stressors has been found to have long-term consequences for health (Charles et al., 2009), intrinsic daily fluctuation in affect may also increase these risks. Furthermore, lowering the fluctuation may be as important an outcome of interventions for people under high levels of stress as modifying mean affect levels. Despite the unrelenting challenges associated with care of people with dementia, experiencing fewer “bad” days may go a long way toward making the caregiving role more manageable.

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Figure 1.

The conceptual model showing a decomposition of daily negative affect into the within-person (WP) and between-person (BP) effects and hypotheses of the intervention and daily experience. ADS = adult day service.

Figure 2. Model predicted intrinsic fluctuation for daily anger and depression by sum of adult day service (ADS) days. Patterns of association were shown for the first day in the study. The pattern across days was similar.

Table 1

Descriptive Statistics of Caregivers and IWDs

	<i>M</i>	(<i>SD</i>)	Range
Caregivers' characteristics			
Age (in years)	61.97	(10.66)	39–89
Education ^a	4.46	(1.20)	1–6
Income ^b	6.68	(3.10)	1–11
Female, %	87		
Race (White), %	73		
Employed, %	42		
Relationship to IWD			
Spouse, %	38		
Daughter/in-law, %	58		
Other, %	4		
Duration of care (in months)	61.12	(45.55)	3–264
Less than 1 year, %	9		
1 to 5 years, %	57		
More than 5 years, %	34		
IWDs' characteristics			
Age (in years)	82.02	(8.34)	57–100
Female, %	60		
ADL dependency	3.06	(0.49)	2–4

Note. *N* = 173. IWD = individual with dementia; *SD* = standard deviation; ADL = activities of daily living.

^aMeasured on a 6-point scale ranging from 1 (*less than high school*) to 6 (*post college degree*).

^bMeasured on a 11-point scale ranging from 1 (*less than \$10,000*) to 11 (*\$100,000 or more*).

Table 2
Multilevel Models With Common and Heterogeneous Within-Person Variance for Negative Affect of Caregivers

	Depression		Anger	
	Model 1 ^a Estimate (SE)	Model 2 ^b Estimate (SE)	Model 1 ^a Estimate (SE)	Model 2 ^b Estimate (SE)
Fixed effects				
Intercept	1.320 *** (0.128)		1.812 *** (0.133)	
Within-person predictors				
ADS use (yes = 1)		(0.014)	−0.042 (0.027)	
Sleep quality		(0.008)	−0.029 † (0.016)	
Care-related stressors		(0.007)	−0.005 (0.009)	
Noncare stressors	−0.118 ** (0.044)		−0.010 (0.047)	
Positive events	0.040 (0.037)		0.039 (0.040)	
Between-person predictors				
Sum of ADS days	−0.057 (0.184)		−0.166 (0.192)	
Average sleep quality	0.062 (0.047)		−0.037 (0.051)	
Average care-related stressors	0.024 *** (0.007)		0.041 *** (0.007)	
Average noncare stressors	0.152 *** (0.043)		0.181 *** (0.045)	
Average positive events	−0.071 * (0.037)		−0.120 ** (0.038)	
CG age	0.005 (0.004)		−0.003 (0.004)	
CG gender	0.059 (0.097)		−0.023 (0.101)	
CG spouse	0.060 (0.088)		0.083 (0.091)	
CG education	−0.036 (0.028)		−0.014 (0.029)	
Duration of care	−0.001 (0.001)		−0.001 (0.001)	
IWD ADLs dependency	−0.070 (0.067)		−0.111 (0.070)	
Random effects				
Intercept variance	0.163 *** (0.020)		0.153 *** (0.021)	
ARH(1)	0.223 *** (0.035)		—	
AR(1)	—		0.110 ** (0.034)	

	Depression			Anger		
	Model 1 ^a		Model 2 ^b	Model 1 ^a		Model 2 ^b
	Estimate	(SE)		Estimate	(SE)	
Residual variance	—			0.216 ^{***}	(0.010)	
Linear effects of between-person predictors ^c						
Sum of ADS days			−1.563 ^{***}			−0.562 [*]
Average sleep quality			0.028			−0.213 ^{***}
Average care-related stressors			0.047 ^{***}			0.066 ^{***}
Average noncare stressors			0.282 ^{***}			0.225 ^{***}
Average positive events			−0.122 ^{***}			−0.115 ^{***}
CG gender			−0.050			0.132
CG spouse			0.545 ^{***}			0.043
CG education			−0.189 ^{***}			0.050
CG age			0.017 ^{***}			−0.006
Duration of care			0.000			−0.002 [†]
IWD ADLs dependency			−0.447 ^{***}			−0.143 [†]
Quadratic effects of between-person predictors						
Sum of ADS days			−10.124 ^{***}			—
Average daily care-related stressors			—			−0.002 ^{***}
CG age			0.001 ^{***}			—
Duration of care			−0.000 ^{***}			—
IWD ADLs dependency			0.452 ^{**}			—
REML deviance ^d	622.0			2137.4		
AIC, BIC ^d	642.0, 673.5			2143.4, 2152.9		

Note.

Caregiver $N = 173$; Day $N = 1,359$. SE = standard error; ADS = adult day service; CG = caregiver; IWD = individual with dementia; ADL = activities of daily living; AR(1) = first-order autoregressive covariance structure; ARH(1) = heterogeneous AR(1) = heterogeneous structure; REML = restricted maximum likelihood; AIC = Akaike information criterion; BIC = Bayesian information criterion. REML = estimation was used for these models.

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^bModel 1 is multilevel models with common within-person variance. For depression, we specified random intercept + ARH(1) as the error structure for best model fit (all ARH parameter estimates are not reported due to the space limitation); for anger, we specified random intercept + AR(1) as the error structure for best model fit.

^cModel 2 is multilevel models with heterogeneous within-person variance. Models included random intercepts as the between-person error structure (effects not reported due to the space limitation).

^dThe linear effects on heterogeneous within-person variance were tested one at a time. Models controlled for the day of the week effect for depression and day in study effects for anger (time effects not reported due to the space limitation).

^eThe model fit indices for models with heterogeneous variance are not reported due to the space limitation.

^f $p < .10$.

^{*} $p < .05$.

^{**} $p < .01$.

^{***} $p < .001$.