Published in final edited form as:
Behav Ther. 2008 December ; 39(4): 366–374. doi:10.1016/j.beth.2007.10.002.

Engagement in Activities is Associated with Affective Arousal in Alzheimer's Caregivers: A Preliminary Examination of the Temporal Relations Between Activity and Affect

Brent T. Mausbach, Ph.D.[1,2], **David W. Coon, Ph.D.**[3], **Thomas L. Patterson, Ph.D.**[1], and **Igor Grant, M.D.**[1]

1 *Department of Psychiatry, University of California, San Diego*

2 *Veterans Affairs Center for Excellence on Stress and Mental Health (CESAMH)*

3 *Department of Social & Behavioral Sciences, Arizona State University*

Abstract

The primary purpose of this study was to examine the synchronous and temporal relations between engagement in activities and the two primary dimensions of affect, namely positive and negative affect, using an intensive time-series design called concomitant time series analysis (CTSA). Twenty-four dementia caregivers completed 56 diary measures (4 times per day for 2 weeks) assessing their experience of positive and negative affect as well as engagement in a variety of activities. Total number of activities was significantly correlated with positive affect (r = .40), but not negative affect (r = −.12). Obtained pleasure from activities was significantly correlated with both positive (r = .42) and negative affect (r = −.17). These results may help further develop behavioral models of depression by suggesting that behavioral or self-reinforcing activities are associated primarily (or more saliently) with one's experience of positive affect. Future research examining the effect of behavioral interventions on both positive and negative affect is suggested, as is the examination of factors that may be more strongly associated with negative affect.

Keywords

Affect; Depression; Activity; Time-Series; Dementia; Caregiving

Those who provide care for a loved one with dementia are at increased risk for suffering both mental and physical health consequences (Schulz, O'Brien, Bookwala, & Fleissner, 1995). Perhaps the most notable consequence of caregiving is an increased risk for experiencing depressive symptoms. Indeed, compared to non-caregivers, caregivers are at approximately twice the risk for depression (Baumgarten et al., 1992), with studies placing caregivers' risk for depression between 28% and 33% (Cohen et al., 1990; Williamson & Schulz, 1993). Although research examining depressive symptoms among caregivers is quite common, little research has examined both positive and negative affect as individual constructs.

Research over the past decades has established two basic, independent dimensions of affect termed positive and negative affect. Positive affect reflects one's level of excitement, interest, and enthusiasm, whereby negative affect reflects one's level of distress, fear, and relaxation (Watson, Wiese, Vaidya, & Tellegen, 1999). According to Watson, Clark, and Carey (1988),

Corresponding Author: Brent T. Mausbach, Ph.D., Department of Psychiatry (0680), University of California San Diego, 9500 Gilman Drive, La Jolla, CA 92093-0680 Tel: (858) 822-5925 E-mail: bmausbach@ucsd.edu.

depressive disorders result from a combination of low positive affect and high negative affect. This *tripartite model* of depression (Clark & Watson, 1991) further identifies high negative affect as a common factor underlying both depression and anxiety, whereas low positive affect is a primary distinguishing feature of depression as compared to other negative mood states (i.e., anxiety). This theory has been supported in multiple studies (Brown, Chorpita, & Barlow, 1998; Chorpita, Albano, & Barlow, 1998; Joiner, Catanzaro, & Laurent, 1996; Watson et al., 1995). For example, Watson and colleagues (1999) demonstrated that positive and negative affect each contributed unique variance to the prediction of a diagnosis of major depression, with the number of depressive symptoms highly correlated with positive affect ($r = -.40$) and negative affect ($r = .57$). Similarly, others have found that Hamilton Depression Scale scores are highly correlated with positive affect ($r = -.52$) and negative affect ($r = .44$), respectively, within a non-clinical sample (Crawford & Henry, 2004). Furthermore, these findings appear stable into later life. In a sample of mothers caregiving for adult children with disabilities, positive and negative affect have been independently related to depressive symptoms (Pruchno & Meeks, 2004). Another study of older adults found positive affect to be inversely correlated with depressive symptoms (i.e., Beck Depression Inventory scores); greater endorsement of negative affect was associated with more depressive symptoms (Cook, Orvaschel, Simco, Hersen, & Joiner, 2004). Given that depressive symptoms appear to consist of both positive and negative dimensions, researchers and practitioners should identify behavioral and coping strategies which simultaneously increase positive and decrease negative affect to effectively and efficiently combat depressive symptoms.

A key line of research has examined the role of reduced engagement in self-reinforcing activity (Lewinsohn, 1974; 1975), or activity restriction (Williamson & Shaffer, 2000), in the development of emotional distress. These approaches posit the dynamic interplay between engagement in activities and mental health outcomes. For example, the *Activity Restriction Model* posits that restriction of normal activities mediates the relationship between life stressors and psychological adjustment (Williamson & Shaffer, 2000). To date, research testing this model has been promising, particularly with regard to the relationship between activity restriction and negative affect. For example, activity restriction has been associated with depressed affect in community dwelling older adults (Benyamini & Lomranz, 2004; Williamson & Schulz, 1992) and among geriatric outpatients suffering from cancer (Williamson & Schulz, 1995). Other studies have found that activity restriction is associated with depressed affect among limb amputees (Williamson, Schulz, Bridges, & Behan, 1994), caregivers of cancer patients (Williamson, Shaffer, & Schulz, 1998), and dementia family caregivers (Thompson et al., 2002).

Only a few studies have explored the relations between activity and *positive* affective states, with preliminary evidence suggesting that increased activity may be associated with affective well-being. For example, a recent study of community-dwelling middle-aged and older adults found that those who engaged in more activities reported greater affective well-being and life satisfaction (Warr, Butcher, & Robertson, 2004). Another study found that individuals with major depressive disorder experienced a significant increase in positive affective states (i.e., positive well-being and vigor) following 30 minutes of aerobic physical exercise (Bartholomew, Morrison, & Ciccolo, 2005). Using a time-series design, Vittengl and Holt (1998) found significant synchronous correlations between active social interaction and positive affect. However, these studies are typically limited to one domain of activity (i.e., physical exercise and social interaction, respectively) rather than a variety of activities encompassing mental, physical, and social engagement.

Although separate studies have demonstrated relationships between activity and both positive and negative affective states, the existing research is not without limitations. For example, it remains unclear how activity relates to both positive and negative affect in the same individuals.

It could be, for example, that behavioral activation works entirely on positive affect, whereas other mechanisms, such as cognitions, more strongly relate to fluctuations in negative affect. This conceptualization would be consistent with Beck's “Cognitive Triad” (Beck, Rush, Shaw, & Emery, 1979), whereby individuals establish negative cognitions about themselves, their experiences, and their future, which in turn are believed to increase negative affect. One goal of the present study is to take a first step toward aligning the independent research findings on the relationship between activity and affect by examining the intra-individual relationships between activity levels and both positive and negative affect.

Another notable limitation of the existing research is its limited use of different types of research designs. With the exception of the study conducted by Vittengl and Holt (1998), the existing research has focused on either cross-sectional or longitudinal designs, both of which have their share of weaknesses. For example, cross-sectional designs do not allow for the examination of intra-individual fluctuations in activity and affect over time and do not allow for the examination of temporal relations between variables of interest (Barnett & Gotlib, 1988). Alternately, whereas longitudinal designs attempt to take temporal precedence into account, many longitudinal studies assume that the constructs being measured are trait-like and remain stable over time. Specifically, participants are typically asked to recall their activity levels and affective states over an extended period of time prior to each assessment point (e.g., the previous month). Further, many investigations of change assume linear change in variables over time. This type of assessment may be problematic because individuals might experience daily (or even hourly) fluctuations in their activity levels and their affect, and these intra-individual fluctuations may be concomitantly and temporally related to one another. To address these concerns, idiographic fluctuations in constructs of interest and their covariation over time need thorough investigation.

The present study takes a novel approach by using time series analysis to help address the methodological issues just raised. Specifically, we examined idiographic fluctuation in both positive and negative affect as well as several activities over time in a sample of dementia caregivers. Because they have significant caregiving responsibilities which frequently (although not completely) interfere with their ability to engage in self-reinforcing activities (Ory, Hoffman, Yee, Tennstedt, & Schulz, 1999), dementia caregivers provide an excellent source in which to examine these fluctuations and their temporal relations.

The usefulness of time series analysis for analyzing behavior has been reported in the literature (Birditt, Fingerman, & Almeida, 2005; Mroczek & Almeida, 2004; Tryon, 1982). One approach to examining time-series data is concomitant time-series analysis (CTSA). In CTSA, data are collected over extended periods of time (e.g., weeks) through the use of a regular and frequent assessment schedule (e.g., daily). This design has several advantages over traditional research designs (Nasby & Read, 1997; Stader & Hokanson, 1998; West & Hepworth, 1991). First, CTSA, because of its longitudinal nature, can reveal trends and cycles in data that by themselves might divulge important information to both investigators and participants. Second, CTSA reveals details of the variation among variables over time that most traditional analyses obscure. Third, CTSA can explicitly represent finite causal lag times and help establish causal inferences that traditional cross-sectional designs cannot. Fourth, CTSA can be used to examine not only the correlations between time-series at the same point in time but also the relations of prior values of one variable with current values of another. Finally, CTSA detects and models serial dependencies of repeated observations over time to ensure valid statistical inference. Therefore, CTSA is an idiographic approach to determining not only a description of day-to-day fluctuations in constructs of interest but also the covariation of these constructs over time (Stader & Hokanson, 1998).

The current study had two aims: 1) to test the synchronous and temporal relationships between activity and affective states, and 2) to demonstrate the usefulness of a unique research design (i.e., CTSA) for examining these relationships. In doing so, we employed an intensive time-series design in which 24 individuals completed a 2-week diary assessing general activity, obtained pleasure from these activities, and positive and negative affect. These assessments were made at multiple time-points each day, allowing us to examine both synchronous (at the same time-point) and lagged correlations (correlations between variables at different points during the day). Based on behavioral theories of depression (Lewinsohn, 1975; Williamson & Shaffer, 2000), we hypothesized that greater engagement in self-reinforcing activities would be positively associated with positive affect and inversely related to negative affect.

Method

Participants

A total of 24 dementia caregivers participated in this study. They were recruited through a variety of means, including community support groups, local senior centers and medical clinics, and senior service professionals. Criteria for inclusion in the study included: a) being age 21 or older, b) providing 8 or more hours of care per week to an individual with a physician-diagnosis of Alzheimer's disease (AD), c) being in generally good health, and d) reporting 3 or more symptoms of depression over the past month per DSM-IV criteria. In addition, patients with AD must have required assistance with at least 2 instrumental activities of daily living (IADLs) (e.g., shopping, using the telephone) or 1 activity of daily living (ADL) (e.g., dressing, toileting). Individuals were excluded if they: a) did not speak English or b) reported having a serious medical condition (e.g., cancer).

Measures

Demographic and Baseline Characteristics—At baseline, all participants were administered demographic questionnaires assessing their age, gender, relationship to their care recipient, ethnicity, years of caregiving, yearly income, and hours of care provided per week. Caregivers were also administered the Activities of Daily Living scale (ADL; Katz, Ford, Moscowitz, Jackson, & Jaffee, 1963) and the Instrumental Activities of Daily Living scale (IADL; Lawton & Brody, 1969), which assess the level of care required by the care recipient for performing basic daily living tasks.

Problem behaviors exhibited by the care recipient (e.g., asking the same question over and over; trouble remembering recent or past events; appearing sad or depressed) were assessed using the Revised Memory and Behavior Problem Checklist (RMBPC; Teri et al., 1992). For this scale, caregivers report on whether or not their care recipient exhibited each of 24 problem behaviors over the past week, with a total score consisting of the sum of the 24 responses (range = 0-24). For each problem behavior endorsed, caregivers are asked to rate the extent to which they were bothered or upset by the problem behavior. Responses to these follow-up questions are on a Likert scale ranging from 1 = “not at all” to 5 = “extremely”. The cross-products (occurrence × upset) for the 24 behaviors is are summed to create an overall Distress score (range = 0-120).

Affective Experience—The Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988) was used to assess affective experience. This scale consists of 20 mood adjectives. Ten items comprise the Positive Affect (PA) subscale, including adjectives such as “interested”, “excited”, and “enthusiastic.” The remaining ten items comprise the Negative Affect (NA) subscale, which consists of adjectives such as “distressed”, “scared”, and “irritable.” The participant responded to each adjective by rating how much she felt that

way during the past 4 hours. Response options were: 1 = Very slightly or not at all, 2 = A little, 3 = Moderately, 4 = Quite a bit, 5 = Extremely.

Activity Levels—The Pleasant Events Schedule-AD (PES-AD; Logsdon & Teri, 1997) was used to assess each caregiver's engagement in activities. The scale consists of 20 activities in which individuals engage during the course of a typical day (e.g., listening to music, having meals with friends or family, exercising, etc.). At each assessment point, the participant rated the frequency with which he/she engaged in each activity over the past 4 hours. Response options were as follows: 0 = Not at all, 1 = 1 time, and 2 = 2 or more times. A *total activity* score (TA) was calculated for each assessment by summing the 20 items (range = 0-40).

In addition, for each activity engaged, the participant was asked to report how enjoyable the activity was on a scale ranging from 0 = “Not at all” to 2 = “A great deal”. For each of the 20 activities, a cross-product of the frequency and pleasure scores was calculated (range = 0-4 for each item). The sum of these cross products was used to create an *Obtained Pleasure* (OP) score (range = 0-80).

Procedures

All participants volunteered and provided written consent to participate in the Pleasant Events Project (PEP), which was approved by the Institutional Review Board at the University of California, San Diego. The participant was given a ‘diary’ of research forms mentioned above and was instructed to complete these measures at the following times each day for a period of 2 weeks: a) early morning, b) noon, c) late afternoon, and d) prior to retiring in the evening. Therefore, for the current study, each participant completed a total of 56 diary entries for each time-series construct. This schedule was chosen because the literature suggests a minimum of 50 observations when using a time-series design (West & Hepworth, 1991). The forms were counterbalanced to eliminate potential bias due to the order in which forms were completed.

Data Analysis

For the current study, 4 time-series were examined: a) *positive affect* (PA), b) *negative affect* (NA), c) *total activity level* (TA), and *Obtained Pleasure* from activities (OP). Prior to conducting cross-correlations, CTSA requires that each variable be described separately and that threats to the validity of a time-series be removed. The most conservative approach to removing threats involves *prewhitening* each time series one participant at a time, a process that reduces each variable to white noise residuals. Prewhitening first entails detecting, estimating, and removing long-term trends as well as cycles from each series (Nasby & Read, 1997; West & Hepworth, 1991).

An assumption of time series analysis is stationarity, which requires, among other criteria, that the mean of the repeated measures not vary systematically over time (Nasby & Read, 1997; West & Hepworth, 1991). Sources of nonstationarity are modeled and removed according to the following decomposition model:

$$Y(t) = T(t) + C(t) + D(t)$$

Where T(t), C(t), and D(t) refer to the components of long-term trend, cyclic patterns (superimposed about the long-term trend), and daily variations (superimposed about the long-term trend and cycles), respectively (Nasby & Read, 1997). The components T(t) and C(t) delineate the variation of the mean of Y over time, and require estimation and removal to isolate the daily component and prevent distortion of the cross-correlations between “daily” variations in two series (Nasby & Read, 1997; West & Hepworth, 1991). Once trends and cycles are removed, the daily component of the series is isolated.

Another assumption of CTSA is that each observation is independent of the others. Serial dependencies, which may exist in the daily component, violate this assumption. That is, if the correlation of the residuals from adjacent time-points is "non-zero," the result would be that one would conduct regression analyses that violate the assumption that observations are independent of one another. West and Hepworth (1991) indicate that the result of conducting analyses with correlated residual error terms would be to "bias the standard error of the regression coefficients so that inferential statistical tests based on the data will be incorrect" (p. 619). These analyses become particularly problematic when non-zero correlations of the residuals exist in two time-series to be cross-correlated. Serial dependencies must therefore be modeled using the Autoregressive Integrated Moving Average (ARIMA) technique (Box & Jenkins, 1976). This was accomplished using autocorrelograms. After serial dependencies were modeled for each series, the Box-Ljung Q statistic indicated that all series were equivalent to white noise residuals. For each participant, all four time series in this study were reduced to their white noise residuals using this prewhitening process.

Once prewhitening was completed and each time series had been decomposed to its white noise residuals, cross-correlations were calculated between variables of interest. In the present study, cross correlations consisted of both synchronous and lagged correlations. Synchronous correlations reveal the relations between variables during the same time frame ("lag" 0). In addition to synchronous correlations, each variable was alternately placed as the lead variable (e.g., TA preceding PA by one or more time intervals) and the lag variable (e.g., PA preceding TA by one or more time intervals), and the pair of variables was examined for significant lagged correlations. In the present analyses, each variable was placed as the lead variable by 4 time-points (i.e., "lag" 4), as this would indicate one full day of data collection. It is these lagged correlations that help establish temporal inferences between the variables of interest. In all, we conducted cross-correlations between the following variables: a) TA and PA, b) TA and NA, c) OP and PA, and d) OP and NA.

Using the methods described by Vittengl and Holt (1998), we calculated the number of participants with significant correlations ($p < .05$, two-tailed) as an indication of the prevalence of the effect. As reported by Vittengl and Holt, a binomial distribution was used to calculate the minimum number of significant effects needed to deviate from chance given a two-tailed alpha of .05. Using a Bonferroni correction, we determined that the probability of significance in each direction was .0007 (p-value of .025 divided by 36 total cross-correlations). In this case, 5 or more participants with significant effects indicated a departure from chance. Finally, effect-sizes were calculated using Fisher's z transformation and weighting participants' values by the number of diaries (out of 56 total) they completed. As per Cohen's (1988) guidelines, mean effect sizes for correlational data of .10, .30, and .50 were considered small, medium, and large, respectively.

Results

Baseline characteristics of the sample are presented in Table 1. On average, participants were approximately 62 years of age and had been caregiving for 3.8 years. Most caregivers were spouses (63%) and of Caucasian ethnicity (83%).

Participants were highly compliant in completing their diaries. Specifically, participants completed an average of 51.6 consecutive PES-AD forms and 51.0 consecutive PANAS forms. The total number of diary observations across participants was approximately 1,200 for each of our time series studied (i.e., PA, NA, TA, and OP). One participant did not adequately complete the pleasure scale of the PES-AD. Therefore, cross-correlations between obtained pleasure and affective outcomes were conducted for 23 of the 24 participants. Table 2 presents a summary of the trends, cycles, and autoregressive parameters used to prewhiten diary data.

As can be seen, daily cycles were relatively common, most notably for the frequency and obtained pleasure variables. For PA and NA, an autoregressive parameter was fairly common, indicating that a given diary record for these constructs was correlated with adjacent diary records.

Cross-Correlation Results

Results for selected cross-correlations are presented in Table 3. As can be seen, Total Activity (TA) was positively related with positive affect (PA), demonstrating a medium to large effect (r = .40) at lag 0 (synchronous correlation). Of 24 participants, 18 demonstrated a significant positive correlation between TA and PA, which exceeded the number expected by chance. When TA followed PA by one diary period (lag-1), there was a small effect (mean r = .09). However, only 2 participants demonstrated significant correlations, which did not reach our pre-defined number of participants needed to deviate from chance (i.e., 5 participants).

Similarly, obtained pleasure (OP) was positively associated with PA, also demonstrating a medium to large effect (r = .42) at lag 0. Of 23 participants, 18 demonstrated a significant correlation between these constructs ($p < .05$). When PA preceded OP by one diary period, there was a small effect (r = .11), with 3 of 23 participants reaching statistical significance.

The relationship between TA and negative affect (NA) appeared weaker than that between TA and PA. Specifically, a small effect was observed between TA and NA ($r = -.12$), with 4 participants demonstrating a significant negative correlation. When TA preceded NA by one diary period, the average effect was −.07, with no significant correlations.

Finally, the number of participants with significant negative correlations between obtained pleasure (OP) and negative affect (NA) at lag 0 exceeded that expected by chance (n = 7). The mean effect for this relationship was small to medium ($r = -.17$).

Discussion

The purpose of this study was to examine the synchronous and lagged correlations between activity and affect in a sample of dementia family caregivers. Our results suggest that alterations in caregivers' experience of positive and negative affect were associated with their level of activity, particularly engagement in activities deemed to be pleasurable. That is, greater experience of positive affect and reduced experience of negative affect were associated with obtained pleasure from activities. These results, which encompass over 1,200 observations, provide a first-look at the relations between behavioral activation, particularly self-reinforcing activity, and one's positive and negative affective states over time.

Although previous research has focused on the relations between activity and depressive symptoms, this study expands upon this research by demonstrating that engagement in self-reinforcing activities (i.e., obtained pleasure) is associated with each of the two central domains of affect (i.e., positive and negative affect) known to be associated with depressive symptoms (Crawford & Henry, 2004; Watson, Clark, & Carey, 1988). Interestingly, self-reinforcing activities appeared to be much more strongly related to positive affect than negative affect, an effect that behavioral researchers may wish to investigate more thoroughly in future studies. Indeed, these results are preliminary and correlational, and caution should be exercised in determining the causality of these findings. Although CTSA is a unique method of establishing concomitant and temporal correlations among longitudinal data, it remains a correlational analysis that is open to alternative explanations (e.g., the impact of important confounding variables not included in the analyses). Further, among correlational data such as presented in this study, causal inferences are developed through thoughtful deliberations on the nature of the statistical association (e.g., if patterns were predicted *a priori*, if potentially confounding

covariates have been modeled and ruled out). Nonetheless, this study lays early groundwork for using traditional experimental methods of testing whether behavioral activation produces affective change, particularly change in positive affect. The most salient means of establishing this would be to conduct a randomized trial comparing a behavioral and control intervention for producing change in positive and negative affect. Although others (Coon, Thompson, Steffen, Sorocco, & Gallagher-Thompson, 2003; Gallagher-Thompson et al., 2000) have conducted randomized clinical trials that successfully demonstrated the benefit of behaviorally-based interventions in the reduction of depressive symptoms among dementia caregivers, these authors did not examined the impact of these strategies on positive affect or the mediating role of pleasurable activities on these outcomes. It may be particularly interesting to utilize daily diary approaches during the course of a behavior therapy trial, thereby allowing researchers to incorporate analyses such as CTSA to tease out daily time-lag effects while simultaneously examining the causal effects of the intervention via the RCT.

It should be noted that the participants in this study were not necessarily clinically depressed, which may have limited the correlation between participants' activity ratings and negative affect. Future research among participants experiencing significant symptoms of depression may reveal a unique pattern from the one presented in this study. Nonetheless, activity levels, particularly engagement in self-reinforcing activities, were significantly associated with both positive and negative affect in this sample, thus providing preliminary evidence to be replicated in future studies.

Interestingly, there was a lack of evidence supporting lagged correlations between constructs assessed in this study, thereby making it unclear as to whether activity or affect preceded change in the other construct. No significant lagged correlations were found when activities (TA) preceded positive affect. These data suggest a weak effect of positive affect on one's engagement in self-reinforcing activities, whereby individuals engaged in slightly more activities during diary periods immediately following elevations in PA, or fewer activities during diary periods immediately following reductions in PA. As an example, it seems highly plausible that if individuals are feeling fatigued, disinterested, or unenthusiastic during the afternoon, they would forego engaging in activities during the evening hours. Although we did not test this effect, the lack of significant lagged correlations when activity preceded affect might also be explained by a “burnout” period following periods of “exceptionally” high levels of activity. That is, individuals who engaged in high levels of activity during the afternoon may have become ‘fatigued’ by the stimulation and elected to rest or conserve energy during the evening, which would be reflected as lower levels of positive affect. Similarly, from a caregiving context, a caregiver who engaged in activities apart from her care recipient may experience a concomitant increase in positive affect, but a return to caregiving duties later that day, in turn, reduces both activity and positive affect. However, these conclusions are speculative and beyond the scope of the current study. Verification is therefore needed using greater diary data and/or a more advanced analytic framework than used in this study.

It should be noted that an important feature of the design used in this study was that our correlations were obtained after removal of trends, cycles, and serial dependencies. This ‘prewhitening’ process served to reduce otherwise spuriously high correlations between activity and affect. Indeed, cycles of 2 and 4-diary periods were common in these data, as were autocorrelations within the time series. Specifically, cycles of 4 diary periods appeared quite frequently for our total activity and obtained pleasure domains, which may suggest that for some individuals, activities are scripted, or planned, for specific times of the day (e.g., a walk in the evening or late afternoon, a favorite television show before bed, etc.). This may be particularly true for dementia caregivers who need to keep a specific schedule to help manage their caregiving responsibilities and have less flexibility in their schedules. Also, autoregressive parameters were common for positive and negative affect, indicating that reports of these

affective states were correlated at nearby diary points (e.g., those reporting high positive affect at noon also reported high levels of positive affect at dinner). If behavioral activation does indeed produce changes in positive affect, as Bartholemew et al. indicated (2005), these increases in positive affect may not only carry over to future time-periods, but they may cycle back to one's engagement in activities. Specifically, an individual may engage in pleasurable activities and experience an immediate increase in positive affect, which in turn increases one's engagement in future activities, and so on over time. Indeed, this can be conceptualized as a reversal of the “downward spiral” or “vicious cycle” effect wherein a lack of engagement leads to a cycle of depressive symptoms reinforcing disengagement and greater mood disturbance. This familiar cycle is a noted feature of behavioral models of depression, although its effect can be difficult to observe statistically given the complex intercorrelations occurring over time. Nonetheless, we do observe in this study that affect and pleasurable activities appear correlated during the same time period, and that affective experiences appear to carry over to future time periods, which in turn appear positively correlated with activity levels.

Overall, this study provides a preliminary examination of the synchronous and temporal relations between activity and affect in a sample of Alzheimer's caregivers. We find that although both positive and negative affect are associated with engagement in pleasurable activities, the association between positive affect and pleasurable activities is stronger than that of negative affect. Noted strengths of this study are: a) our examination of the two core aspects of depressed affect, i.e., positive and negative affect, and their unique correlations with activity, and b) utilization of a powerful longitudinal design (i.e., concomitant time-series analysis), which allowed for the examination of fluctuations in activity and affect and analysis of the synchronous and temporal relations between these constructs over time. Future investigations should examine: a) the impact of behavioral activation interventions on participants' engagement in activities and both positive and negative affect and b) whether mechanisms other than engagement in activities (e.g., changes in cognitions) more strongly influence negative affect.

Acknowledgements

This research was supported by awards 23989 and 15301 from the National Institute on Aging.

References

Barnett PA, Gotlib IH. Psychosocial functioning and depression: Distinguishing among antecedents, concomitants, and consequences. Psychological Bulletin 1988;104:97–126. [PubMed: 3043529]

Bartholomew JB, Morrison D, Ciccolo JT. Effects of acute exercise on mood and well-being in patients with major depressive disorder. Medicine and Science in Sports and Exercise 2005;37:2032–2037. [PubMed: 16331126]

Baumgarten M, Battista RN, Infante-Rivard C, Hanley JA, Becker R, Gauthier S. The psychological and physical health of family members caring for an elderly person with dementia. Journal of Clinical Epidemiology 1992;45:61–70. [PubMed: 1738013]

Beck, AT.; Rush, AJ.; Shaw, BF.; Emery, G. Cognitive therapy of depression. Guilford Press; New York: 1979.

Benyamini Y, Lomranz J. The relationship of activity restriction and replacement with depressive symptoms among older adults. Psychology and aging 2004;19:362–366. [PubMed: 15222831]

Birditt KS, Fingerman KL, Almeida DM. Age differences in exposure and reactions to interpersonal tensions: A daily diary study. Psychology and Aging 2005;20:330–340. [PubMed: 16029096]

Box, GEP.; Jenkins, GM. Time series analysis: Forecasting and control. Holden-Day; San Francisco: 1976. Rev. ed.

Brown TA, Chorpita BF, Barlow DH. Structural relationships among dimensions of the DSM-IV anxiety and mood disorders and dimensions of negative affect, positive affect, and autonomic arousal. Journal of Abnormal Psychology 1998;107:179–192. [PubMed: 9604548]

Chorpita BF, Albano AM, Barlow DH. The structure of negative emotions in a clinical sample of children and adolescents. Journal of Abnormal Psychology 1998;107:74–85. [PubMed: 9505040]

Clark LA, Watson D. Tripartite model of anxiety and depression: Psychometric evidence and taxonomic implications. Journal of Abnormal Psychology 1991;100:316–336. [PubMed: 1918611]

Cohen D, Luchins D, Eisdorfer C, Paveza GJ, Ashford JW, Gorelick P, et al. Caring for relatives with Alzheimer's disease: The mental health risks to spouses, adult children, and other family caregivers. Behavior, Health, and Aging 1990;1:171–182.

Cohen, J. Statistical power analysis for the behavioral sciences. Lawrence Erlbaum Associates; Hillsdale, NJ: 1988.

Cook JM, Orvaschel H, Simco E, Hersen M, Joiner T. A test of the tripartite model of depression and anxiety in older adult psychiatric outpatients. Psychology and Aging 2004;19:444–451. [PubMed: 15382995]

Coon DW, Thompson L, Steffen A, Sorocco K, Gallagher-Thompson D. Anger and depression management: Psychoeducational skill training interventions for women caregivers of a relative with dementia. The Gerontologist 2003;43:678–689. [PubMed: 14570964]

Crawford JR, Henry JD. The Positive and Negative Affect Schedule (PANAS): Construct validity, measurement properties and normative data in a large non-clinical sample. British Journal of Clinical Psychology 2004;43:245–265. [PubMed: 15333231]

Gallagher-Thompson D, Lovett S, Rose J, McKibbin C, Coon D, Futterman A, et al. Impact of psychoeducational interventions on distressed family caregivers. Journal of Clinical Geropsychology 2000;6:91–110.

Joiner TE Jr. Catanzaro SJ, Laurent J. Tripartite structure of positive and negative affect, depression, and anxiety in child and adolescent psychiatric inpatients. Journal of Abnormal Psychology 1996;105:401–409. [PubMed: 8772010]

Katz S, Ford AB, Moscowitz RW, Jackson BA, Jaffee MW. Studies of illness in the aged. The index of ADL: A standardized measure of biological and psychosocial function. Journal of the American Medical Association 1963;185:914–919. [PubMed: 14044222]

Lawton MP, Brody EM. Assessment of older people: self-maintaining and instrumental activities of daily living. The Gerontologist 1969;9(3):179–186. [PubMed: 5349366]

Lewinsohn, PM. A behavioral approach to depression. In: Friedman, RJ.; Katz, MM., editors. The psychology of depression: Contemporary theory and research. John Wiley & Sons; New York: 1974. p. 157-178.

Lewinsohn PM. Engagement in pleasant activities and depression level. Journal of Abnormal Psychology 1975;84:729–731. [PubMed: 1194539]

Logsdon RG, Teri L. The Pleasant Events Schedule-AD: Psychometric properties and relationship to depression and cognition in Alzheimer's disease patients. The Gerontologist 1997;37:40–45. [PubMed: 9046704]

Mroczek DK, Almeida DM. The effect of daily stress, personality, and age on daily negative affect. Journal of Personality 2004;72:355–378. [PubMed: 15016068]

Nasby W, Read NW. The life voyage of a solo circumnavigator: Integrating theoretical and methodological perspectives. Journal of Personality 1997;65:785–1068. [PubMed: 9483818]

Ory MG, Hoffman RR 3rd, Yee JL, Tennstedt S, Schulz R. Prevalence and impact of caregiving: A detailed comparison between dementia and nondementia caregivers. The Gerontologist 1999;39:177–185. [PubMed: 10224714]

Pruchno RA, Meeks S. Health-related stress, affect, and depressive symptoms experienced by caregiving mothers of adults with a developmental disability. Psychology and Aging 2004;19:394–401. [PubMed: 15382990]

Schulz R, O'Brien AT, Bookwala J, Fleissner K. Psychiatric and physical morbidity effects of dementia caregiving: Prevalence, correlates, and causes. The Gerontologist 1995;35:771–791. [PubMed: 8557205]

Stader SR, Hokanson JE. Psychosocial antecedents of depressive symptoms: An evaluation using daily experiences methodology. Journal of Abnormal Psychology 1998;107:17–26. [PubMed: 9505035]

Teri L, Truax P, Logsdon R, Uomoto J, Zarit S, Vitaliano PP. Assessment of behavioral problems in dementia: the revised memory and behavior problems checklist. Psychology and aging 1992;7(4): 622–631. [PubMed: 1466831]

Thompson LW, Solano N, Kinoshita L, Coon DW, Mausbach B, Gallagher-Thompson D. Pleasurable activities and mood: Differences between Latina and Caucasian dementia family caregivers. Journal of Mental Health and Aging 2002;8:211–224.

Tryon WW. A simplified time-series analysis for evaluating treatment interventions. Journal of Applied Behavior Analysis 1982;15:423–429. [PubMed: 7142062]

Vittengl JR, Holt CS. A time-series diary study of mood and social interaction. Motivation and Emotion 1998;22:255–275.

Warr P, Butcher V, Robertson I. Activity and psychological well-being in older people. Aging and Mental Health 2004;8:172–183. [PubMed: 14982722]

Watson D, Clark LA, Carey G. Positive and negative affectivity and their relation to anxiety and depressive disorders. Journal of Abnormal Psychology 1988;97:346–353. [PubMed: 3192830]

Watson D, Clark LA, Tellegen A. Development and validation of brief measures of positive and negative affect: The PANAS scales. Journal of Personality and Social Psychology 1988;54:1063–1070. [PubMed: 3397865]

Watson D, Weber K, Assenheimer JS, Clark LA, Strauss ME, McCormick RA. Testing a tripartite model: I. Evaluating the convergent and discriminant validity of anxiety and depression symptom scales. Journal of Abnormal Psychology 1995;104:3–14. [PubMed: 7897050]

Watson D, Wiese D, Vaidya J, Tellegen A. The two general activation systems of affect: Structural findings, evolutionary considerations, and psychobiological evidence. Journal of Personality and Social Psychology 1999;76:820–838.

West SG, Hepworth JT. Statistical issues in the study of temporal data: Daily experiences. Journal of Personality 1991;59:609–662. [PubMed: 1960644]

Williamson GM, Schulz R. Pain, activity restriction, and symptoms of depression among community-residing elderly adults. Journal of Gerontology 1992;47:367–372.

Williamson GM, Schulz R. Coping with specific stressors in Alzheimer's disease caregiving. The Gerontologist 1993;33:747–755. [PubMed: 8314101]

Williamson GM, Schulz R. Activity restriction mediates the association between pain and depressed affect: A study of younger and older adult cancer patients. Psychology and Aging 1995;10:369–378. [PubMed: 8527058]

Williamson GM, Schulz R, Bridges MW, Behan AM. Social and psychological factors in adjustment to limb amputation. Journal of Social Behavior and Personality 1994;9:249–268.

Williamson, GM.; Shaffer, DR. The activity restriction model of depressed affect: Antecedents and consequences of restricted normal activities. In: Williamson, GM.; Shaffer, DR.; Parmelee, PA., editors. Physical illness and depression in older adults: A handbook of theory, research, and practice. Kluwer Academic/Plenum; New York: 2000. p. 173-200.

Williamson GM, Shaffer DR, Schulz R. Activity restriction and prior relationship history as contributors to mental health outcomes among middle-aged and older spousal caregivers. Health Psychology 1998;17:152–162. [PubMed: 9548706]

Table 1

Characteristics of the Sample

Variable		
Caregiver Age, *M (SD)*		62.71 (11.33)
Gender, *n* (%)		
	Male	1 (4)
	Female	23 (96)
Relationship, *n* (%)		
	Spouse	15 (63)
	Non-spouse	9 (37)
Ethnicity, *n* (%)		
	Caucasian	20 (83)
	Latina/Hispanic	4 (17)
Years Caregiving, *M (SD)*		3.88 (2.59)
Income*, *n* (%)		
	< $50,000	12 (52)
	≥ $50,000	11 (48)
Hours of Care/Week, *M (SD)*		58.61 (52.04)
Patient Age, *M (SD)*		76.71 (8.26)
Activities of Daily Living, *M (SD)*		2.71 (2.37)
Instrumental Activities of Daily Living, *M (SD)*		7.05 (1.60)
RMBPC Total Behaviors, *M (SD)*		11.06 (3.47)
RMBPC Distress, *M (SD)*		1.55 (0.74)

* One participant did not provide income data. RMBPC = Revised Memory and Behavior Problem Checklist.

Table 2

Models Used to Prewhiten Diary Variables

	Transformation		Trend			Cycle		Autoregressive Parameter				
Variable	**Sqrt**	**Log10**	**(+)**	**(−)**	**(Par)**	**2**	**4**	**1**	**2**	**3**	**4**	**5**
Frequency	3	1	4	4	5	2	13	5	1	4	0	1
Obtained Pleasure	0	0	4	2	5	1	10	5	1	3	0	0
Positive Affect	1	1	6	5	5	0	8	7	1	0	1	1
Negative Affect	1	1	4	4	4	0	3	8	5	0	0	0

Note. Numbers inside cells correspond to the number of participants' models that required the specific time-series parameter for prewhitening, with a maximum cell value of 24. Sqrt = Square root; (+) and (−) correspond to positive and negative linear trends, respectively; (Par) corresponds to a parabolic trend; Cycles of 2 and 4 correspond to 2 (half-day) and 4 (1 day) diary periods, respectively. For each cell, a maximum of 24 participants was possible except for obtained pleasure, in which a maximum of 23 was possible.

Table 3

Cross-Correlations between Affect and Activity Variables

Lag 0 Cross-Correlations	**Minimum**	**Maximum**	**S (−)**	**S (+)**	**M**
Frequency with					
Positive Affect	.12	.67	0	18	.40
Negative Affect	−.43	.10	4	0	−.12
Obtained Pleasure with					
Positive Affect	.17	.81	0	18[a]	.42
Negative Affect	−.36	.21	7	0	−.17
Lag -1 Cross-Correlation					
Positive Affect with					
Frequency	−.19	.38	0	2	.09
Obtained Pleasure	−.21	.44	0	3	.11
Negative Affect with					
Frequency	−.33	.11	0	0	−.07
Obtained Pleasure	−.21	.09	0	0	−.07

Note. N = 24

[a]N = 23 for Obtained Pleasure. S(−) = Number of participants with significant negative correlations. S(+) = Number of participants with significant positive correlations. M = Mean correlation.

Behav Ther. Author manuscript; available in PMC 2009 January 27.