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Research Article

Poor Disgust Suppression Is Associated with Increased Anxiety in Caregivers of People with Neurodegenerative Disease

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Abstract

Objectives: Caregivers of persons with neurodegenerative disease have high rates of mental health problems compared to noncaregiving adults. Emotion regulation may play an important role in preserving caregivers' mental health. We examined the associations between caregivers' emotion regulation measured in several ways (ability, habitual use, and self-ratings) and their mental health symptoms.

Method: Ninety-one caregivers of persons with neurodegenerative disease participated in a laboratory-based assessment of emotion regulation. In two series of tasks, caregivers were given different instructions (no instruction, suppress) regarding altering their emotional behavioral responses to disgusting films and acoustic startle stimuli. Caregivers' emotional behavior was measured via behavioral coding and caregivers rated "how much emotion" they showed during each task. Anxiety, depression, and habitual use of expressive suppression were measured via questionnaires.

Results: Poor emotion regulation in the disgust suppression condition (i.e., greater emotional behavior) was associated with greater anxiety. Associations were not found for the startle suppression condition, depression, or self-report measures of emotion regulation.

Discussion: Findings suggest that caregivers who are unable to suppress emotional behavior in response to disgusting stimuli may be at greater risk for anxiety. Given high levels of anxiety in caregivers, it may be useful to evaluate interventions that improve ability to downregulate emotional behavior.

Keywords: Dementia, Depression, Emotion/emotion regulation, Mental health

Although there are many positive aspects of caregiving for a loved one with dementia (e.g., increased sense of self-efficacy, meaning; Carbonneau, Caron, & Desrosiers, 2010), a great deal of evidence has documented adverse effects (Schulz & Beach, 1999; Vitaliano, Zhang, & Scanlan, 2003). Caregivers of persons with dementia or neurodegenerative disease (PWD) have fourfold increases in rates of depression and threefold increases in seeking treatment for anxiety compared to noncaregiving adults (Cooper, Balamurali, & Livingston, 2007; Schulz, O'Brien, Bookwala, & Fleissner, 1995). Even compared to caregivers of individuals with other diseases (e.g., cancer, stroke), dementia caregivers experience higher levels of strain, spend more hours caregiving, and exhibit higher rates of physical and mental health problems (Ory, Hoffman, Yee, Tennstedt, & Schulz, 1999). Over 35 million adults worldwide have been diagnosed with dementia and other neurodegenerative diseases, and this number is projected to more than triple by 2050 (Prince et al., 2013). Thus, caregiving and its adverse effects are destined to

become a salient issue for many families and an increasingly important public health concern.

Individual Differences in Caregiver Outcomes

Substantial individual differences exist in the extent to which dementia caregivers experience adverse outcomes. It is crucial to improve understanding of the factors accounting for these differences in order to identify caregivers who are most vulnerable and identify targets for preventative interventions. A major focus of existing research has been on contextual and dispositional factors associated with adverse caregiver outcomes. For example, low financial resources, social support, and self-esteem are related to worse well-being in caregivers (Brodaty & Donkin, 2009; Schulz et al., 1995). Epidemiological research has also highlighted important demographic differences, such that being the spouse of a PWD, female, or younger are associated with greater strain and psychological morbidity in caregivers (Brodaty & Donkin, 2009; Schulz et al., 1995).

Another theme in existing research has been the association between PWDs' impairments and caregivers' psychological and physical morbidity (see Ornstein & Gaugler, 2012). A recurrent finding from this research has been that PWDs' behavioral and psychological problems (e.g., disinhibition, aggression) are especially difficult for caregivers, even more so than cognitive or functional impairments (Schulz et al., 1995). Our own work has focused on the impact that impairments in PWDs' emotional functioning has on caregivers, finding that impairments in PWDs' emotional reactivity (Chen et al., 2017), recognition (Brown et al., 2018), and regulation (Otero & Levenson, 2017) are associated with poor psychological outcomes in caregivers. PWDs' emotional functioning impairments often become most salient in interpersonal contexts, such as their interactions with caregivers (Lwi et al., 2019), which further contributes to caregivers' poor psychological health.

Taken together, the existing research underscores the influences that environmental, dispositional, and PWD factors have on caregivers' health and well-being. Ironically, the relationship between individual differences in caregivers' own emotional functioning and their health has not received as much attention (e.g., Wells et al., 2019). Moreover, when such studies have been conducted, they have frequently relied on self-report measures of emotional functioning. For example, an experience sampling study found that caregivers who reported frequently used the coping strategies "seeking distraction," "seeking social support," and "fostering reassuring thoughts" also reported less negative emotional reactivity to daily stressors (van Knippenberg, de Vugt, Ponds, Verhey, & Myin-Germeys, 2018). Studies of caregiver emotional functioning using laboratory-based assessments have been essentially nonexistent.

Emotion Regulation

Caregivers' ability to regulate their emotions may play a key role in preserving their mental health in the face of the stress associated with caregiving. Gross' (1998) process model of emotion regulation describes five types of strategies that may be used at different times during the process of generating an emotion (situation selection, situation modification, attention modification, cognitive change, and response modulation). Expressive suppression (a type of response modulation) could be used at the end of the emotion generative process in order to inhibit one's emotion-expressive behavior. Early research in this area often focused on the relative benefits of specific regulatory strategies over others (e.g., John & Gross, 2004), with some strategies broadly labeled as beneficial (e.g., reappraisal, or thinking about the emotion-eliciting situation in a different way) or maladaptive (e.g., suppression, or reducing the outward manifestations of emotion). However, a more nuanced view of the adaptive value of different emotion regulation strategies has emerged, which stresses the importance of selecting and implementing the appropriate regulation strategy for a given context (Bonanno & Burton, 2013).

In the field of affective science, studies of emotion regulation often utilize self-report measures (e.g., Gross & John, 2003). However, it is not clear to what extent individuals can accurately report on their emotion regulation given the vulnerabilities of these reports to current mood states, social desirability, and other factors. Although self-report may be suitable for measuring certain aspects of emotion regulation (e.g., how capable an individual feels about using a particular strategy; Goldin et al., 2012), it may not be as appropriate for measuring other aspects (e.g., ability to implement a particular strategy; Troy, Wilhelm, Shallcross, & Mauss, 2010).

An alternative to self-report is to observe emotion regulation directly under controlled laboratory conditions. In such studies, participants are typically instructed to regulate in particular ways (e.g., suppress or amplify; Gross & Levenson, 1997; Gyurak, Goodkind, Kramer, Miller, & Levenson, 2012), but may also be placed in situations where regulation is likely to occur spontaneously (e.g., warning participants about an upcoming stressor; Hagemann, Levenson, & Gross, 2006). Past research has shown that disgusting films and acoustic startle stimuli elicit strong emotional responses, so they are often utilized in studies of emotion regulation ability (Côté, Gyurak, & Levenson, 2010). However, laboratory studies do not necessarily map onto how people choose to regulate their emotions in their daily lives (Hay, Sheppes, Gross, & Gruber, 2015). It is therefore useful to measure multiple aspects of emotion regulation. Additionally, given individual differences in affect intensity (Larsen & Diener, 1987), it is important when assessing emotion regulation to account for differences in emotional responding (i.e., downregulating emotion may be more difficult for a person who has relatively large

emotional responses than for a person who has relatively small emotional responses).

Although there are a number of studies of coping in dementia caregivers (e.g., greater use of avoidance coping strategies and lower use of problem-focused coping are associated with greater levels of anxiety and burden; Cooper, Balamurali, & Livingston, 2007), these are not specific to emotion regulation. Indeed, studies of emotion regulation among dementia caregivers are quite rare. A study of professional caregivers of PWDs measured habitual use of emotion regulation strategies via self-report questionnaire, finding that caregivers who reported frequently using expressive suppression and experiencing less positive emotion at work had higher levels of emotional exhaustion (Bassal, Czellar, Kaiser, & Dan-Glauser, 2016). Emotion regulation has also been studied in interventions, such as those designed to increase positive emotion in caregivers of PWDs (Moskowitz et al., 2019). To our knowledge, there have been no prior studies in dementia caregivers that used laboratory assessments of emotion regulation. Clearly, additional work is needed to understand the associations between dementia caregivers' emotion regulation and their mental health.

The Present Study

The present study examined the association between caregivers' mental health and three aspects of their emotion regulation: (a) self-reported *habitual use* of expressive suppression, (b) self-reported *estimates* of emotion regulation performance, and (c) laboratory-based assessments of emotion regulation *ability* (i.e., success at complying with instructions to suppress visible emotional behavior). Our primary hypothesis was that caregivers with lower emotion regulation *ability* (i.e., expressing *more* emotional behavior during instructed suppression conditions) would have worse mental health. Based on the prior work in professional caregivers of PWDs, we expected that greater self-reported use of expressive suppression in daily life would be associated with worse mental health. Although these hypotheses may appear contradictory, we are referring to two different aspects of emotion regulation: ability and habitual use (e.g., one might have excellent ability to regulate emotion but does so rarely). We did not have hypotheses regarding self-reported estimates of emotion regulation performance. Advantages of this study design include accounting for individual differences in emotional reactivity (i.e., emotional behavior without instructions to regulate), assessing two types of emotion-eliciting stimuli (disgusting films and loud noises), and (c) evaluating multiple aspects of emotion regulation (behavior and self-report).

Method

Participants

Caregivers of PWDs (N = 91) were recruited from the Memory and Aging Center at the University of California, San Francisco (UCSF). PWDs were evaluated at UCSF and diagnosed based on current consensus criteria, including Alzheimer's disease (AD; McKhann et al., 2011), frontotemporal dementia (FTD; Gorno-Tempini et al., 2011; Rascovsky et al., 2011), and other neurodegenerative diseases that impact motor functioning (e.g., corticobasal syndrome, amyotrophic lateral sclerosis; Armstrong et al., 2013; Litvan et al., 1996; Wijesekera & Leigh, 2009). PWDs and caregivers were invited to participate in an additional study at the University of California, Berkeley (UCB) conducted within 4 months of the initial assessment. All participants provided informed consent. Research procedures were approved by the UCB Institutional Review Board. Caregivers were compensated $120 for their participation.

There was considerable heterogeneity in the types of PWDs, including the three clinical subtypes of FTD (n = 41; 20 behavioral variant FTD, 10 nonfluent variant primary progressive aphasia, 11 semantic variant primary progressive aphasia); AD (n = 18); and other neurodegenerative diseases (n = 32). Caregivers were predominantly spouses/significant others (91%). Demographic characteristics of caregivers are presented in Table 1.

Procedure

At UCB, caregivers completed questionnaires and participated in a comprehensive assessment of their emotional functioning (Levenson et al., 2008). PWDs also completed a similar assessment of emotional functioning. Given our interest in caregivers' emotional functioning, only data from their assessments were used in the present study.

Caregivers reviewed and completed consent forms upon arrival. They were then seated in an experimental room where noninvasive physiological sensors were attached (e.g., heart rate, skin conductance; physiological data were not used in the present study). For all trials, caregivers were seated in front of a television screen and told to relax and watch the screen. After a brief period, an "X" appeared for a 60-s pretrial baseline period along with the instructions to "watch the X, please." After 60 s, a stimulus was presented. Then, the "X" was displayed for another 60 s. Each of the stimuli are described below. Facial behavior was recorded using partially concealed cameras. After each trial, caregivers were asked questions about their subjective emotional experience (data not used in the present study) and, after the emotion regulation conditions, asked to rate their performance.

Disgust Films

Both disgust film clips depicted a person engaged in an unpleasant eating activity, a prototypical elicitor of disgust (Rozin & Fallon, 1987). (The study included a disgust amplification condition, where caregivers were told, "This time, SHOW your reaction so that someone watching you would know exactly how you feel while watching the film." Measures from this condition were not associated with

Table 1. Sociodemographic Characteristics of Sample ($N = 91$)

Means and *SD* provided, unless otherwise noted		
Caregiver Age		65.91 (7.27)
Caregiver Sex (% Female)		59.3
Caregiver Race (%)		
	American Indian/Alaska Native	3.3
	Asian/Asian American/South Asian	5.5
	Black/African American/Afro-Caribbean	2.2
	Latino/Chicano/Hispanic	4.4
	Multiracial/Other	3.3
	Native Hawaiian/Pacific Islander	1.1
	White/Caucasian/European American	80.2
Caregiver Relationship to the PWD (%)		
	Spouse or significant other	91.2
	Other family member	4.4
	Friend	4.4
PWD Diagnosis (n =)		
	FTD	41
	AD	18
	Other neurodegenerative disease	32
PWD CDR Total		0.78 (0.47)

Note: AD = Alzheimer's disease; CDR = Clinical Dementia Rating scale (PWD dementia severity); FTD = frontotemporal dementia; PWD = person with dementia or neurodegenerative disease.

any outcomes; these results are not reported here.) In our sample, these films elicited similar levels of self-reported disgust, $M(90) = .02$, $t = .33$, $p = .74$. Film lengths were between 84 and 105 s.

Disgust reactivity film

Prior to the baseline period, caregivers were told, "In the next task you will see a short film. First, watch the X for 1 minute. Please try to relax and clear your mind until the film starts." After the baseline period, they were shown a clip from the television show *Fear Factor* depicting a person sucking fluid out of cow intestines.

Disgust suppression film

Prior to the baseline period, caregivers were told, "HIDE your reaction so that no one would know how you feel while watching the film." Caregivers indicated they understood the instructions. After the baseline period, they were shown a clip from the film *Pink Flamingos* depicting a person eating dog feces.

Acoustic Startle Stimuli

The acoustic startle stimulus was a 115-dB, 100-ms burst of white noise (akin to a gunshot) presented using hidden speakers located directly behind the caregiver.

Startle reactivity stimulus

Prior to the baseline period, caregivers were told, "For this next task, please just watch the screen. You will hear some background noise come on in a moment." After the baseline period, the startle stimulus was presented without warning.

Startle suppression stimulus

After completing the startle reactivity trial, caregivers were informed that they would repeat the same task with a countdown, so that they would know exactly when the "loud noise" was going to come and to, "HIDE your reaction so that no one would know how you feel when you hear the noise." Caregivers indicated they understood the instructions. At the end of the baseline period, they viewed a 20-s countdown (10 to 1) and then the startle was presented.

Measures

Emotion regulation measures

Caregiver emotional behavior

Caregivers' emotional facial behavior during each trial was coded by trained research assistants using the Emotional Expressive Behavior Coding System (Gross & Levenson, 1993). Ten emotions (i.e., happiness/amusement, interest, embarrassment, surprise, disgust, anger, fear, contempt, confusion, sadness) were coded second-by-second on a 0–3 intensity scale. For the disgust films, a predetermined 30-s "hot spot" (i.e., period of maximal emotional intensity) was selected to code. For the startle conditions, a 16-s period beginning when the startle stimulus was presented was selected to code. Emotional intensity scores/durations were summed across all 10 emotions for each trial. Interrater

reliability between 2–4 coders was high (intraclass correlation coefficient for all trials > .83).

Caregiver self-reported estimates of performance
After the instructed suppression conditions, caregivers were also asked to rate how successful they were at complying with the instructions during the trial. Caregivers responded to the questions, "how good were you at hiding your feelings?" on a 5-point scale from "very bad" to "very good," and "how much emotion did you show on your face?" on a scale from "none" to "a lot." (Caregivers did not rate "how much" emotion they showed on their faces during the startle suppression condition.)

Caregiver habitual expressive suppression
Habitual use of expressive suppression was assessed using the Emotion Regulation Questionnaire (Gross & John, 2003). Caregivers rated themselves on four items (e.g., "I control my emotions by not expressing them") on a scale from 1 (strongly disagree) to 7 (strongly agree). Items were averaged. Higher scores indicate greater use of expressive suppression.

Clinical measures

Caregiver anxiety
Anxiety symptoms were assessed using the Beck Anxiety Inventory (Beck, Epstein, Brown, & Steer, 1988). For each of the 21 items (e.g., "Unable to relax") caregivers rated themselves on a scale from 0 (not at all) to 3 (severely). Scores were summed. Higher scores indicate greater anxiety.

Caregiver depression
Depressive symptoms were assessed using the Center for Epidemiological Studies scale (Radloff, 1977). For each of 20 items (e.g., "Nothing made me happy"), caregivers rated themselves on a 4-point scale from 0 (not at all) to 3 (a lot). Four items were reverse scored, then all items were summed. Higher scores indicate greater depression.

PWD dementia severity
Clinicians at UCSF assessed PWDs' dementia severity using the Clinical Dementia Rating scale (CDR; Morris, 1993). The CDR total ranges from 0 to 3. Higher scores indicate greater dementia severity.

Sensitivity Power Analysis

To address whether our study was adequately powered, we conducted post-hoc sensitivity power analyses. For the disgust suppression condition, with a maximum of seven predictors, $N = 85$, $\alpha = .05$, and power = .80, we were able to detect an effect size of $f^2 = 0.18$. For our startle tasks, with two predictors (startle reactivity emotional behavior and startle suppression emotional behavior), $N = 58$, $\alpha = .05$, and power = .80, we were able to detect an effect size of $f^2 = 0.18$. Thus, in all tasks, our sample size was adequate to detect medium effect sizes (Cohen, 1998).

Results

Descriptive statistics, intercorrelations, and sample sizes of study variables are reported in Table 2. All analyses were conducted in R Studio Version 1.2.1335.

Association Between Mental Health Measures

First, we examined the association between the two measures of caregivers' mental health (anxiety and depression), given expected multicollinearity among these constructs (Clark & Watson, 1991). A Pearson correlation revealed that caregivers' anxiety and depression were significantly related ($r(82) = .66$, $t = 7.92$, $p < .001$). Given the clinical utility of understanding the unique relationships between caregivers' mental health outcomes and emotion regulation abilities, we proceeded with analyzing anxiety and depression in separate statistical models.

Associations Between Behavioral Measures of Emotion Regulation and Anxiety

We conducted a series of regression analyses to examine associations between behavioral measures of caregivers' emotion regulation abilities (emotional behavior during the disgust suppression and startle suppression conditions) and their mental health (anxiety and depression). In these analyses, we controlled for the amount of emotional behavior that occurred in response to each stimulus when presented without emotion regulation instructions (disgust reactivity film and startle reactivity stimulus).

Disgust Suppression

We conducted a linear regression with emotional behavior during the disgust suppression condition predicting anxiety, controlling for emotional behavior during the disgust reactivity condition. Caregivers' emotional behavior during the disgust suppression condition ($\beta = .21$, $t(88) = 2.07$, $p = .041$) and disgust reactivity condition ($\beta = .25$, $t(88) = 2.42$, $p = .017$) were positively associated with their anxiety.

We conducted further regression analyses accounting for caregivers' demographic and PWD dementia characteristics known to influence caregivers' mental health (Brodaty & Donkin, 2009; Schulz et al., 1995): caregiver age, caregiver sex (0 = female, 1 = male), PWD dementia severity, and PWD diagnosis (FTD [0 = no, 1 = yes] and AD [0 = no, 1 = yes]). Emotional behavior during the disgust suppression condition remained significantly positively associated with anxiety ($\beta = .21$, $t(77) = 2.02$, $p = .047$). Among the

Table 2. Summary of Descriptive Statistics and Intercorrelations for Key Study Variables

Measure	1	2	3	4	5	6	7	8	9	*M*	*SD*	*n*
1. Disgust reactivity emotional behavior										36.29	26.28	91
2. Disgust suppression emotional behavior	.16									9.85	15.79	91
3. Startle reactivity emotional behavior	.10	−.14								6.54	6.29	67[a]
4. Startle suppression emotional behavior	−.18	.03	.14							1.12	3.87	65[b]
5. Disgust suppression "how good"	−.03	−.07	.16	−.13						3.52	0.83	91
6. Disgust suppression "how much"	.14	.18	−.15	.21	−.45***					1.47	0.86	91
7. Startle suppression "how good"	.10	.01	−.02	−.41***	.25*	−.16				3.36	0.96	91
8. Expressive suppression (ERQ)	−.30**	−.07	−.25	−.20	−.01	.04	−.13			3.41	1.07	82[c]
9. Anxiety symptoms (BAI)	.28**	.25*	.07	−.08	−.08	.13	−.12	−.07		6.25	6.71	91
10. Depression symptoms (CES-D)	.08	.09	−.13	−.04	−.02	.15	−.15	.05	.66***	12.56	8.83	84[c]

Note: BAI = Beck Anxiety Inventory; CES-D = Center for Epidemiologic Studies scale; Emotional behavior = Emotional Expressive Behavior; ERQ = Emotion Regulation Questionnaire.

[a]Behavioral data not available (n = 6); trial not completed due to insufficient time (n = 18). [b]Behavioral data not available (n = 5); caregiver declined to participate (n = 3); trial not completed due to insufficient time (n = 18). [c]Caregiver did not complete full battery of self-report questionnaires (n = 9 for ERQ; n = 7 for CES-D).
*p < .05; **p < .01; ***p < .001.

covariates, being female was significantly associated with greater anxiety (β = .23, $t(77)$ = 2.17, p = .033).

Startle Suppression

We conducted a linear regression with emotional behavior during the startle suppression condition predicting anxiety, controlling for emotional behavior during the startle reactivity condition. Neither emotional behavior during the startle suppression condition (β = −.10, $t(61)$ = .71, p = .48) nor startle reactivity condition (β = .05, $t(61)$ = .34, p = .74) was associated with anxiety.

Associations Between Behavioral Measures of Emotion Regulation and Depression

Disgust suppression

We conducted a linear regression with emotional behavior during the disgust suppression condition predicting depression, controlling for emotional behavior during the disgust reactivity condition. Neither caregivers' emotional behavior during the disgust suppression condition (β = .08, $t(81)$ = .71, p = .48) nor disgust reactivity condition (β = .07, $t(81)$ = .58, p = .56) were associated with their depression.

Startle suppression

We conducted a linear regression with emotional behavior during the startle suppression condition predicting depression, controlling for emotional behavior during the disgust reactivity condition. Neither caregivers' emotional behavior during the startle suppression condition (β = −.01, $t(55)$ = −.08, p = .94) nor startle reactivity condition (β = −.16, $t(55)$ = −1.18, p = .24) were associated with their depression.

Associations Between Behavioral and Self-Report Measures of Disgust Suppression

Given findings that poor disgust suppression was associated with greater anxiety, we further examined the associations between emotional behavior during the disgust suppression condition and: (a) self-reported estimates of their performance and (b) self-reported habitual use of expressive suppression (i.e., the ERQ subscale).

Self-reported estimates of performance

Pearson correlations revealed that neither caregivers' estimates of "how good" they were at hiding their feelings ($r(89)$ = −.07, t = −.63, p = .53) nor "how much" emotion they showed ($r(89)$ = .18, t = 1.76, p = .082) during the disgust suppression condition were associated with their emotional behavior during this trial.

Self-reported habitual use of expressive suppression

Pearson correlations revealed that caregivers' habitual use of expressive suppression was not associated with their

emotional behavior during the disgust suppression condition ($r(89) = .07$, $t = -.63$, $p = .53$).

Strength of Associations Between Different Measures of Disgust Suppression (emotional behavior, self-reported estimates, habitual use of expressive suppression) and Anxiety

We explored the relative value of the three types of measures (i.e., objectively coded emotional behavior, self-reported estimates of performance, and self-report habitual use of expressive suppression) in predicting caregivers' mental health by entering them in the same regression model, controlling for emotional behavior during the disgust reactivity condition. Only emotional behavior during the disgust suppression condition was significantly associated with anxiety ($\beta = .25$, $t(76) = 2.15$, $p = .035$).

Discussion

We examined whether caregivers' emotion regulation was associated with their mental health. Results revealed that caregivers who were worse at suppressing emotional behavior in response to a disgusting film had greater levels of anxiety. This association was robust when accounting for the amount of emotional behavior that occurred in response to the disgust reactivity film (presented without instructions) and other demographic and environmental covariates. Being female was the only covariate associated with greater anxiety, consistent with the literature on predisposing factors for psychological distress in caregivers (Brodaty & Donkin, 2009). The relationship between expressive suppression ability and mental health was specific to disgusting films (not found for the startle stimuli) and anxiety (not found for depression). We did not find any associations between caregivers' self-reported estimates of their performance nor their self-reported habitual use of expressive suppression and their anxiety levels. To our knowledge, this is the first study to use laboratory assessment of emotion regulation in caregivers of PWDs and the first to include this kind of comprehensive comparison of behavioral and self-report measures of emotion regulation using multiple emotional stimuli.

Disgust, Not Startle

Greater emotional reactivity and poor expressive suppression during a disgusting film were independently associated with greater anxiety. These relationships were not found with the acoustic startle stimulus, which elicits a range of emotions (e.g., surprise, embarrassment; Sturm, Rosen, Allison, Miller, & Levenson, 2006). One possible explanation for this discrepancy might be that disgust is a particularly relevant emotion to the caregiving experience. For example, persons with the behavioral variant of FTD show impairments in disgust responding (i.e., low reactivity to films depicting filth and contamination; Eckart, Sturm, Miller, & Levenson, 2012) and symptoms of disinhibition and hyperorality (Rascovsky et al., 2011), which leads them to engage in behaviors that others find disgusting (e.g., eating contaminated food). Additionally, the act of caring for an older adult often involves responsibilities, such as assisting with toileting and hygiene (Ory et al., 1999) that can elicit disgust. Thus, lower disgust reactivity and greater ability to downregulate disgust may both be adaptive in caring for a PWD.

It is important to highlight a key difference in methodologies between the disgust and startle suppression conditions. Whereas caregivers were not warned about the content of disgust suppression condition, they knew precisely what and when to expect during the startle suppression condition. The disgust suppression condition was thus a more unpredictable experience, arguably closer to that of caregiving itself (van Wijngaarden, van der Wedden, Henning, Komen, & The, 2018), which involves heterogeneity in PWD symptoms and uncertainty regarding rate of progression (Erkkinen, Kim, & Geschwind, 2018). It is also possible that differences in the nature of these tasks influenced our observed findings. The disgust suppression condition utilized a dynamic, visual stimulus, whereas the startle suppression condition utilized a static, auditory stimulus. Finally, we could not address whether the relationship between disgust suppression and anxiety *only* emerges in the context of dementia caregiving. For example, it is possible that an individual who is unable to hide or disguise their disgust may also feel anxiety about constantly offending their romantic partner. Nevertheless, these results suggest two potentially important areas of the caregiving experience, responding to disgusting and unpredictable stimuli that may play a role in caregivers' increased anxiety levels.

Anxiety, Not Depression

The results suggest that greater disgust reactivity and lower ability to downregulate disgust are associated with greater anxiety, but not depression. However, we note that the directions of the associations between emotional behavior during the disgusting films and depression, though nonsignificant, were in the same (positive) direction as with anxiety. It may be that a small association exists, but we did not have sufficient power to detect the effect. Additionally, we did not measure the ability to upregulate positive emotion. Evidence for the tripartite model of depression and anxiety (Clark & Watson, 1991) suggests that while increased negative affect is relevant to both depression and anxiety, decreased positive affect is more related to depression than anxiety. It is plausible that the ability to upregulate positive emotion may be associated with depression in caregivers of PWDs.

Value of Behavioral Assessment of Emotion Regulation

The association between disgust suppression and anxiety was specific to emotional behavior and was not found for self-report measures. Contrary to our hypothesis, we did not find associations between self-reported habitual expressive suppression and either of our mental health measures. Previous studies of emotion regulation in dementia caregivers have utilized similar self-report measures, finding that habitual use of suppression moderates the association between low levels of positive emotion and greater levels of emotional exhaustion (e.g., Bassal et al., 2016). Notably, that study differed from the present one in that their sample included professional, rather than informal caregivers. Familial caregivers are under a considerable amount of stress and may not be accurate reporters, particularly those who are in poor psychological health (Schulz et al., 2013). More generally, self-report measures can be subject to biases, such as low self-awareness or social desirability (Van de Mortel, 2008).

Indeed, the association between self-reported anxiety and objectively measured emotional behavior is even more striking given that these measures do not share common-method variance. Self-report measures are widely used and certainly useful. In comparison, laboratory assessments of emotional behaviors are less commonly used, very time consuming, and make additional demands on caregivers. However, in this case, laboratory assessment and behavioral coding revealed a potentially important risk factor in caregivers. Thus, relying solely on self-report measures of emotion regulation may not be the most useful approach when examining emotional functioning and mental health in caregivers.

Implications

This work has important implications for both dementia caregiving and for broader issues in clinical and affective science. Our findings contribute to the growing literature relating emotion regulation to mental health outcomes (e.g., Goldin et al., 2012; Troy et al., 2010). Decades of research have illustrated the link between expressive suppression and a host of negative consequences, including increased sympathetic arousal, reduced rapport, disrupted communication, and decreased well-being (Butler et al., 2003; Gross & John, 2003; Gross & Levenson, 1993). A more nuanced examination of expressive suppression, however, indicates that it may be an appropriate, adaptive strategy in particular contexts. For example, in the caregiving context, expressive suppression could be useful when caregivers wish to conceal their negative emotions from the PWDs in their care and from other family members.

These results highlight potential avenues for clinical intervention. There are a number of existing treatments related to emotion regulation (e.g., altering stress mindsets, reappraising anxiety as excitement; Brooks, 2014; Crum, Salovey, & Achor, 2013), including some that are specific to caregivers (Moskowitz et al., 2019). New treatments could be developed to teach caregivers to employ expressive suppression and to identify the situations where this strategy would be most effective. Given high rates of anxiety in caregivers of PWDs (Cooper, Balamurali, & Livingston, 2007) and lack of successful interventions to reduce anxiety (Cooper, Balamurali, Selwood, & Livingston, 2007), treatment development in this area is critical. Further, early identification of caregivers at risk (e.g., those with low ability to downregulate disgust) could enable them to access supportive resources early in caregiving that could mitigate future increases in anxiety. In light of evidence linking poor mental health in caregivers to shorter survival in PWDs (Lwi, Ford, Casey, Miller, & Levenson, 2017), interventions aimed at improving caregivers' anxiety could have benefits for both caregivers and PWDs alike.

Strengths and Limitations

The present study had several strengths, including evaluating multiple aspects of emotion regulation (ability to downregulate, habitual use of emotion regulation strategies, estimates of performance), measured in different ways (behavioral coding, self-report), and using different kinds of emotional stimuli (disgusting films and acoustic startle). In addition, analyses controlled for "baseline" emotional reactivity and a number of other demographic and environmental factors known to relate to caregiver health.

The study also had a number of limitations. Although the initial presentation of emotional stimuli without instructions on how to react was our best proxy for baseline emotional reactivity, we cannot rule out the possibility that caregivers may have spontaneously regulated their emotional behavior during these trials. Due to sample size constraints, we were unable to counterbalance the order in which the stimuli were presented; thus, we cannot know whether findings were influenced by order effects. Smaller sample sizes for particular tasks (e.g., startle suppression) may also have influenced the results by reducing statistical power. We did not have a comparison group in order to evaluate whether these results extend to noncaregiving relationships. Given the cross-sectional study design, we cannot determine the direction of causality. While it is plausible that caregivers' poor emotion regulation leads to their experiencing greater anxiety (e.g., Linehan, 1993), it may also be that anxiety interferes with caregivers' ability to regulate their emotions. Longitudinal studies are needed to test the causal link between caregivers' poor expressive suppression and high levels of anxiety. Given the limited literature on emotion regulation in caregivers, it will be important to replicate these findings in an independent sample. Evaluating additional emotional stimuli (e.g., sadness, anger) and emotion regulation conditions (e.g., reappraisal, acceptance, positive emotion upregulation) would deepen understanding of the boundary conditions of these findings.

Conclusions

Given the increasing prevalence of neurodegenerative diseases worldwide, and the corresponding increase in the number of caregivers providing critically needed assistance to PWDs, there is an urgent need to identify risk factors that are associated with greater caregiver vulnerability to adverse health outcomes. The present study suggests that greater reactivity to disgusting stimuli as well as lower ability to downregulate disgust emotional behavior in caregivers are associated with higher levels of anxiety. This finding has clear implications both for the early detection of caregivers at risk and for developing interventions aimed at improving emotion regulatory abilities.

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Limited, deidentified data and analytic materials will be made available upon e-mail request to jennawells7@berkeley.edu. This study was not preregistered. All authors are from Berkeley Psychophysiology Laboratory, Department of Psychology, University of California, Berkeley.

Conflict of Interest

None reported.

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