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Emotional Behavior in Couples with bvFTD:
Implications for Caregiver Relationship Satisfaction and Psychological Well-being

By

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requirements for the degree of

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Abstract

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Doctor of Philosophy in Psychology

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Emotions are an important part of marital life. Prior research indicates that patients with behavioral variant frontotemporal dementia (bvFTD) experience significant impairments in socioemotional functioning, including emotional blunting, inappropriate behavior and decreased empathy (Levenson & Miller 2007, Neary et al., 1998). These changes in patients often strain marriages and can lead to a decline in marital satisfaction, as well as increase the risk of depression in the healthy spouse (Ascher et al., 2010, Braun et al., 2010). However, few studies have explored the emotional dynamics of couples living with bvFTD in a systematic way (Braun et al., 2009). The goal of this study was twofold. First, it sought to extend our understanding of the emotional dynamics of couples where one spouse has bvFTD. Second, it sought to understand the relationship between the couple's emotional behavior during a marital interaction and the caregiving spouse's marital satisfaction as well as psychological well-being, looking specifically at depression.

This study examined emotional behavior and emotional reciprocity of couples where one spouse is diagnosed with either bvFTD (N=30) or Alzheimer's disease (N=30), in comparison to healthy controls (N=29), in the context of a 10-minute naturalistic marital interaction. Emotional behavior was coded using the Specific Affect Coding System (SPAFF), which consists of five positive emotional behavior codes, ten negative emotional behavior codes, and a neutral code. Emotional reciprocity between spouses was calculated using the Allison and Liker (1982) statistic. The study also examined the relationship between positive and negative emotional behavior as well as escalating and de-escalating patterns of emotional reciprocity and the caregiving spouse's self-reported marital satisfaction and levels of depression.

The current findings reveal that couples with bvFTD show a reduction in humor and positive emotion reciprocity but an exacerbation in negative emotion (e.g., criticism, sadness) and conflict escalation during a marital interaction. Furthermore, decreased marital satisfaction in the spousal caregiver is associated with low positive emotion, high negative emotion and conflict escalation. Self-reported depression in the spousal caregiver is associated with high negative emotion.

Introduction

Emotions are an essential part of life. They communicate our needs and wants, our pleasures and displeasures and regulate our sense of closeness with others. The expression and reciprocity of emotion serves important interpersonal functions and is at the heart of human relationships. For many adults, particularly in older age, marriage is the most important stage for emotional interaction (Carstensen et al., 1996). Marital interactions can range from the mundane to the highly charged but always reflect the intricate dynamic between each spouse's thoughts, emotions, and behaviors (Noller & Feeney, 2002). Observational studies of emotional behavior in physically healthy couples suggest that the emotional climate of marriages becomes increasingly positive and less negative with age (Carstensen et al., 1995).

With the growth in life expectancy, dementia-related diseases have been on the rise, and consequently, caregiving for a loved one with dementia is playing an increasingly prominent role in the marriages of older adults (Torti et al., 2004). Two of the most prevalent and devastating dementias are frontotemporal dementia (FTD) and Alzheimer's disease (AD). FTD is the most common early onset dementia, typically emerging between the mid 50s and 60s, and makes up approximately 10-20% of all diagnosed dementia cases (Miller et al., 1998). This disease targets areas of the brain responsible for maintaining social and emotional functioning. Consequently, FTD patients are described as presenting with significant changes in emotional behavior, personality, and social conduct (Neary et al., 1998). AD, on the other hand, is by far the most common type of dementia and constitutes nearly 75% of all dementia cases in individuals 65 years and older (Ganguli et al., 2000). AD targets memory and cognitive function (Dickerson et al., 2009) but presents with relatively preserved emotional functioning in the early stages of the disease.

The onset of dementia, with its characteristic changes in cognition, memory, and especially changes in emotion and behavior, can disrupt interpersonal relationships, and more specifically marital dynamics, in profound ways. Longstanding emotional and communication patterns can become unfulfilling and unpredictable, partners become patients, and a loved one's gradual decline drives the healthy spouse more and more to become a caregiver. Whereas healthy older couples enjoy increased positivity and decreased negativity with age, the physical and emotional changes that accompany the onset of dementia can drain marriages of their emotional color and lead to a profound sense of loss, isolation, burden and dissatisfaction (Ascher et al., 2010, de Vugt et al., 2006, Mioshi et al., 2013, Zarit, Reever, & Bach-Peterson, 1980). Remarkably, few studies have explored the emotional dynamics of couples living with dementia in a systematic way (Braun et al., 2009).

The aim of this study is to extend our understanding of the emotional dynamics of couples with dementia with a particular focus on couples where the spouse has FTD. Furthermore, the study aims to understand the association between emotional behavior during the marital interaction and the caregiving spouse's relationship satisfaction and psychological well-being, looking specifically at depression. This type of research sits at the intersection of several conceptual and empirical domains, including aging, dementia, marriage and caregiving, all of which are bound together with the common thread of emotion. Although the focus of this research is on emotional functioning in couples

where one spouse is diagnosed with dementia, to introduce the proposed research, the following sections will review the literature on: (1) emotion and aging (2) emotion and dementia, specifically focusing on emotional functioning in patients with FTD and AD (3) emotion and marriage (4) dementia caregiving and marriage, and (5) emotional behavior in FTD and AD marriages.

Emotion and Aging

Because dementias occur in late life, research that focuses on the emotional lives of couples where one spouse has dementia is inevitably concerned with older adults. Thus, it is important to consider emotional functioning in the healthy older adult population before delving into emotional functioning in a dementia population. Early theories of aging postulated that old age brought with it a general dulling of emotionality and that people in older age were divested from emotional concerns (Banham, 1951, Looft, 1972). However, this theory has not been empirically supported (Malatesta and Kalnok, 1984). In fact, current theories suggest that as we age, we continue to refine our emotional selves and that our emotional lives become more rich and nuanced (Levenson, 2000; Carstensen, 1992; Labouvie-Vief & Chandler, 1978). This conclusion is based on a number of empirical studies that have documented a complex picture of emotional functioning in older age, with some areas of decreased emotion, many areas of emotional preservation, and even some areas of emotional heightening.

For instance, Tsai et al., (1999) used two emotion-eliciting films (sadness and amusement) to assess self-reported and observable expression of emotion in older and younger adults. There were no differences between older and younger adults as measured by continuous rating of emotional experience (positive, neutral and negative) while watching either film. Furthermore, a more detailed retrospective report of emotional experience during the sad film revealed no differences between groups in their emotional experience. However, a more detailed retrospective report of feeling during the amusement film revealed that older adults experienced less amusement, contentment and happiness than younger adults. A similar pattern was found when examining facial expressions. While there were no age related differences in emotional facial behavior during the sad film, during the amusement film, older adults were observed to smile less.

Using a relived-emotions task, Levenson et al., (1991) asked participants to remember a time in their lives when they felt a specific emotion very strongly then asked them to 'relive' that memory in the laboratory. Result of that study found no differences between young and old age participants in the intensity of reported experience or in the frequency of spontaneously occurring facial expressions during the task. These findings suggest that recalling personally meaningful emotional events brings about a similar emotional expression and experience in older age as it does in younger age. Evidence also suggests that emotionality, and in particular positive emotion, may increase with age. These findings are most evident in the context of meaningful interpersonal interactions. Examining long-term marriages, Levenson et al., (1994) found that older adults report experiencing more positive affect than middle aged adults during positive, neutral, and negative conversations. Furthermore, older couples report more pleasure and less conflict across a broad range of marital concerns than younger couples (Carstensen, 1992; Isaacowitz et al., 2006; Levenson et al., 1993; Verstaen et al., in prep).

An important theory that helps explain this age-related increase in positive emotion, particularly within the interpersonal context, is socioemotional selectivity theory (Carstensen, 1992). This theory stipulates that with age we become progressively more aware of the limited time left in life. This perceptual change alters the salience of a variety of life goals, which shifts our motivation toward pursuing emotionally meaningful goals (e.g., emotional regulation, interpersonal closeness) and away from other goals, such as information seeking. Older adults are believed to ‘mold’ their social environment in a way that maximizes the potential for positive affect and minimizes the potential for negative affect, with the ultimate goal of preserving important social relationships (Carstensen, 1995). Indeed, as the social networks of older adults shrink, intimate social connections gain more prominent importance (Fredrickson & Carstensen, 1990) and the marital relationship becomes the most central to influencing overall quality of life (Clements and Swensen, 2000).

Emotional Functioning in FTD and AD patients

Although emotional functioning remains mostly preserved or even heightened in older age, the onset of dementia can alter this positive trajectory in profound ways. The majority of what we know about emotional functioning in patients with FTD and AD has been, historically, the product of caregiver report and clinician observation. Although these insights can paint the broad strokes of emotional functioning in patients with dementia, studying these individuals in controlled laboratory settings can provide a more discriminating understanding of patterns of emotional preservation and loss by allowing us to examine emotional functioning with precision and specificity (Levenson et al., 2008). The following sections will discuss, wherever possible, laboratory findings of emotional functioning in patients with FTD and AD, and where laboratory findings are not available, will consider caregiver or clinician reports.

Emotional functioning in patients with FTD

FTD affects core elements of personhood such as emotion, personality, language and self-awareness and can lead to devastating changes in interpersonal relationships (Levenson & Miller 2007). Clinician and caregiver reports suggest a profound decline in warmth, empathy and socially appropriate behavior in these patients (Sollberger et al., 2011, Boxer and Miller, 2005). Empirical studies have identified more specific elements of dysfunction. Laboratory experiments consistently show that patients with FTD have significant impairment in the ability to understand the emotions of others. For instance, when asked to identify the emotions displayed in static faces, patients with FTD were significantly worse at correctly identifying the expression of negative emotions, such as anger, sadness, and disgust than both AD patients and controls (Lavenex et al., 1999). In these early studies, FTD patient’s ability to recognize positive emotions appeared to be preserved, however these studies typically assessed only a single positive emotion (e.g., happy). In a more recent study using dynamic film clips, patients were shown eleven video clips; four clips depicting negative emotions (anger, fear, disgust, and sadness), four depicting positive emotions (affection, amusement, calm, and enthusiasm), and three depicting self-conscious emotions (embarrassment, pride, and shame) (Goodkind et al., in press). The authors found that patients with FTD demonstrated a significantly reduced

ability to recognize emotions than AD patients and controls, across all three types of emotions. The capacity for accurate recognition of others' emotions underlies the sense of connectedness between people and is integral to effective and satisfying social and interpersonal interactions. The lack of this ability in patients with FTD may underlie some of the reported coldness and lack of empathy observed in this population.

In addition to changes in emotional recognition, patients with FTD show changes in emotional reactivity. For example, a study examining FTD patients' emotional reactivity in response to a disgust-eliciting film clip found a significant reduction in their self-reported experience of disgust, as well as related physiological and facial expressions, when compared to participants without dementia (Eckart et al., 2012). Additionally, two laboratory studies have found that patients with FTD have a significantly reduced self-conscious response in situations that typically generate embarrassment in healthy adults. The first study (Sturm et al., 2006), examined expression of embarrassment in the context of an acoustic startle, a stimulus known to elicit a twofold emotional response; first a defensive, negative emotional response, followed by a secondary self-conscious response (embarrassment and amusement) that parallels the process of becoming aware of and responding to one's own startle (Ekman et al., 1985). The authors found that although patients with FTD had a preserved initial reflexive response to the startle, they expressed significantly less embarrassment on their face than controls during the secondary response period. This finding was replicated in a subsequent study (Sturm et al., 2008) using a 'karaoke' singing paradigm, a task that reliably evokes a self-conscious response. Self-conscious emotions (e.g., embarrassment, shame) are considered higher-level emotions because they require an awareness of the self in the context of a social situation (Tangney, 1999). FTD patients' lack of self-conscious emotion may underlie some of their interpersonal deficits.

In contrast to these findings of deficits in emotional reactivity, there is evidence that some aspects of basic emotional responding (i.e., emotion not involving a self referential or social evaluation) are preserved. For example, one study examined emotional reactivity in patients with FTD by using dynamic film clips selected to elicit three different emotions: happiness, sadness and fear (Werner et al., 2007). Examination of three measures of emotion reactivity, including self-report, facial expressive behavior and physiological activity, revealed no differences between patients with FTD and healthy controls.

Emotion functioning in patients with AD

Unlike patients with FTD, patients with AD present with relatively preserved socio-emotional functioning in the early stages of the disease. The patients are reported to maintain interpersonal warmth despite illness progression (Sollberger et al., 2011) and have no difficulty identifying the emotions of others in either static images or short videos (Lavenu et al., 1999, Goodkind et al., in press). Emotional reactivity also remains intact in these patients. For instance, when viewing static emotion eliciting images from the International Affective Picture System (IAPS), patients with AD did not differ from healthy controls in their self-reported or electrodermal reactions to the stimuli (Hamann, Monach & Goldstein, 2000) and did not differ in facial reactivity in response to emotion eliciting films (Mograbi, Brown & Morris, 2012). Interestingly, according to caregiver report, AD patients may even undergo a modest increase in their level of self-conscious

emotion reactivity (Chatterjee et al., 1992). Self-conscious emotion, particularly embarrassment, is vital in the context of interpersonal relationships because it is thought to increase emotional cohesion between individuals by way of increasing trust and smoothing out transgressions (Keltner & Anderson, 2000). Lastly, recent work has suggested that AD patients may respond with greater emotional contagion in response to others. When caregivers were asked to rate AD patients on the Interpersonal Reactivity Index, AD patients scored higher than controls and individuals with mild cognitive impairment on the Personal Distress index, a proxy measure of emotional contagion (Sturm et al., 2013).

In sum, patients with FTD show considerable deficits in the domains of emotional recognition and emotional responding, particularly in the context of disgust and self-conscious emotions. These patients are often described as cold and uncaring and have difficulty with social interaction. Emotional functioning in patients with AD appears to be relatively intact. Caregivers describe them as warm and as somewhat more self-conscious than before illness onset. Moreover, despite relatively little change in emotional reactivity in response to static images or emotional eliciting film clips, in the social context, these patients report greater emotional contagion and sharing in the affect of others than healthy older adults. Despite considerable advances in our understanding of emotional functioning in FTD and AD patients derived from laboratory studies, very little is known about the emotional functioning of these patients in the context of more naturalistic settings such as when interacting with their spouse.

Emotion and Marriage

Before discussing emotional behavior in couples where one spouse has dementia, it is important to consider what is known about emotional behavior in healthy adult couples. Although a full review of the literature is beyond the scope of this thesis, marital research in healthy adults sets the stage for examining and interpreting emotional behavior in other types of populations. Marital research has typically used objective coding of emotional behavior within a dyadic interaction. In this approach, trained coders identify a variety of emotional behaviors in both spouses. Moreover, emotional behavior is quantified both in terms of the amount of emotion expressed as well as the reciprocity of emotion between spouses (i.e., the likelihood that partner A expresses positive emotion in response to partner B's positive emotion) (Carstensen et al., 1995). This type of research has served a critical role in understanding important marital outcomes, such as marital satisfaction and divorce (Gottman, 1994).

Empirical studies consistently show that emotions expressed during intimate marital interactions are a barometer for marital satisfaction. Overall, the expression of negative emotions is associated with dissatisfied marriages, whereas the expression of positive emotions is associated with satisfied marriages (Gottman & Krokoff, 1989). Research suggests that specific negative emotional behaviors such as anger, contempt, criticism, belligerence, defensiveness, domineering and sadness are associated with marital dissatisfaction; and specific positive emotions such as humor, affection and validation are associated with marital satisfaction (Gottman 1994; Carstensen et al., 1995). Some theories have identified anger as the 'dangerous' emotion, the expression of which is hypothesized to be destructive to marriages (Hendrix, 1988; Parrot & Parrott,

1995). However, empirical studies of marital dissolution found that although anger is indeed associated with marital distress, over time it may actually predict an increase in marital satisfaction (Gottman & Krokoff, 1989). Similar longitudinal studies have confirmed that anger is not predictive of divorce. Furthermore, these studies identified that emotional behaviors dubbed “The Four Horsemen of the Apocalypse” - criticism, contempt, defensiveness, and stonewalling (listener withdrawal) - are reliably predictive of marital dissolution. Belligerence was later found to also be predictive of divorce, and together these 5 emotional behaviors are considered uniquely corrosive to relationships (Gottman, 1994; Gottman et al., 1998). The expression of sadness in marriage is less clearly predictive of marital dissolution. Sadness may reflect dissatisfaction and disappointment with an unchangeable situation and may signal emotional disengagement, which is highly detrimental for relationships (Gottman, 1994). However, sadness is theorized to reflect a bid for closeness and support (Lazarus, 1991), which, if met empathically, may lead to increased intimacy and satisfaction.

In addition to examining the relationship that positive and negative emotions in general and particular discrete emotion have with marital satisfaction as outlined above, studies have also examined the relationship of emotion reciprocity, or how emotions are volleyed back and forth between partners, and marital satisfaction. Research on emotional reciprocity has found that dissatisfied marriages are uniquely characterized by the presence of negative emotion reciprocity (Carstensen et al., 1995). In these couples, negative emotion becomes an ‘absorbing state’ and they become caught up in an escalating cycle of negativity. These couples lack the ability to de-escalate conflict, for instance, by responding to negative emotion with neutral or positive emotion, or by engaging in what Weiss (1980) termed “positive sentiment override”. Indeed, the concept of the Sound Marital House details how emotional expression and reciprocity not only influence marital satisfaction, but also actively construct the basic building blocks of what makes marriages ‘work’. This theory proposes that two ‘staples’ of marriage are (1) an overall level of positive affect (in both conflict as well as non-conflict contexts) and (2) the ability to reduce negative affect during conflict resolution (Gottman, 1999 pg. 105). It is stipulated that these two core elements give rise to other important factors that make marriages last, including the ability to make ‘cognitive room’ for your partner, turning toward instead of turning away from your partner in everyday situations, solving solvable problems, as well as creating shared meaning within the relationship (e.g., conjoined life dreams, goals, roles and narratives) (Gottman, 1999).

Dementia Caregiving and Marriage

Spouses provide the majority of caregiving for patients with dementia (Torti et al., 2004). Couples where one spouse has dementia face many changes to their established life routines and challenges to their marriage. In addition to the increased need to monitor their spouse and attend to their health and daily needs, the healthy spouse must often absorb their spouse’s household chores and responsibilities. Additionally, the healthy spouse is acutely aware of the slow deterioration and loss of their partner. These changing roles can lead to feelings of depression, resentment and entrapment in the caregiving spouse. Caregiver burden, or the sense that caregiving demands outweigh available emotional, physical, social and financial resources, can lead to significant

psychological and physical illness (Zarit, Reever, & Bach-Peterson, 1980). Indeed, caregiving has been shown to predict higher rates of depression than in the general population (22% in caregivers compared to 11% in the population) (Schultz et al., 1995). Furthermore, structured diagnostic interviews reveal that 18% of caregivers meet diagnostic criteria for current depression, in contrast to 0% of non caregivers (Dura et al., 1991) and caregivers are more likely to use psychotropic medication than non-caregivers, suggesting that difficulties in mental health are a major concern (Grafstrom et al., 1992). Additionally, caregivers have been demonstrated to have higher levels of stress hormones and lower level of antibodies than non-caregivers, making them more susceptible to physical illness (Vitaliano, Zhang & Scanlan, 2003). Together, these findings suggest that caregiving can compromise emotional and physical health.

The impact of caregiver burden has been well established in caregivers for patients with dementia. Interestingly, though Alzheimer's disease is more prevalent and more frequently studied, research suggests that FTD caregivers report a greater sense of subjective burden than caregivers of patients with AD (Riedijk et al., 2006, de Vugt et al., 2006; Wong et al., 2012). Several factors are believed to contribute to caregiver burden, including dementia severity, problematic behaviors, (e.g., apathy, aggression, disinhibition) as well as a decline in the capacity for empathy (Guevara et al., 2015; Mioshi et al., 2012; Perren, Schmid, & Wettstein 2006).

Although patient symptoms play an important role in predicting spousal caregiver burden, characteristics of the marital relationship play an integral role as well. Several studies have explored the protective value of relationship quality on caregiver burden. Premorbid relationship satisfaction with the dementia patient appears to be crucial in predicting post illness caregiver burden. Steadman, Tremont and Davis (2007) found that caregivers with high premorbid relationship satisfaction reported significantly less burden and less distress over loved ones' behavioral and cognitive difficulties than caregivers with low premorbid relationship satisfaction. These results were independent of disease severity or length of caregiving. Another study examined the impact of marital idealization, the tendency to discount or reframe negative interpersonal events in favor of preserving a positive outlook on the marriage, on the subjective burden of caring for a spouse with AD over the course of one year (O'Rourke et al., 2011). This longitudinal exploration found that high baseline levels of marital idealization predicted lower levels of caregiver burden one year later. Moreover, an increase in marital idealization over the course of the year similarly predicted a decrease in caregiver burden (O'Rourke et al., 2011). These findings underscore the role of positive attribution and outlook, particularly before illness onset, in mitigating the impact of caregiving.

Although it is evident that premorbid relationship quality is an important factor in caregiver burden and marital well-being, relationship satisfaction once dementia sets in exerts a similar influence on the experience of caregiver burden and relationship satisfaction. Iecovich (2011) examined not only the impact of relationship quality on caregiver burden but also specific caregiver characteristics, such as caregiver health and economic status, at the time when the patient was already ill. The findings suggest that high quality of the relationship is the strongest predictor of low caregiver burden. Similarly, Lawrence and colleagues (1998) found that higher relationship quality predicted lower levels of depression and a reduced sense of captivity, both elements of caregiver burden.

A number of theories try to explain the impact of caregiving on the healthy spouse as well as on the marital relationship more generally. The construct of family adaptability suggests that greater capacity of the healthy spouse to adapt to changing situational demands (e.g., flexibility in relationship leadership, rules and roles) is associated with less subjective experience of stress and depression (Olson, 2000; Majerovitz, 1995). With an eye toward the emotional functioning of the couple, Coyne and Smith (1991) developed the concept of relationship-focused coping. They identified two forms of dyadic coping: (1) active engagement and (2) protective buffering. The first form involves one partner engaging the other in discussion and problem solving; the second form involves one partner attempting to minimize the emotional impact of a problem by suppressing anger and accepting influence. The hypothesis is that both active engagement and protective buffering lead to less caregiver stress. Another useful theory for examining marital relationships in the context of caregiving is the Equity Theory (Hatfield et al., 1978; Braun et al., 2009; Braun et al., 2010). The basic tenant of this theory suggests that members of the couple are motivated to have balance, if not in the moment, then over time, in what is contributed to and what is received from the relationship. Indeed, research suggests that equality in contribution is associated with a more satisfied relationship and that inequality is associated with relationship distress (Hatfield et al., 1978). The onset of dementia in one spouse skews what each partner is able to provide and what each partner derives from the relationship. This theory helps make sense of the changes in marital satisfaction and caregiver burden observed in couples where one spouse has dementia.

Emotional Behavior in FTD and AD marriages

The majority of research on emotional functioning in patients with dementia has been conducted exclusively at the level of the individual. This is unfortunate given that emotions play an integral role in interpersonal dynamics and that dementia can lead to significant disruptions in intimate relationships (Perren et al., 2006). Therefore, examining emotion at the level of the dyad can shed light not only on new areas of patient functioning but also on how patients and their spouses interact with one another. As described in the above section, there is a rich tradition of studying emotion in marriage in healthy adults because this is often a powerful context for emotional experience in people's lives (Levenson & Gottman, 1983; Gottman & Levenson 1992). Although effective strategies to observe couple interactions have existed for some time, only a handful of studies have applied this methodology to study couples with dementia.

Emotional behavior in couples with FTD

Only two studies to date, both from our research group, have directly observed the marital interaction and emotional communication in couples where one spouse has FTD. In the first study, Ascher and colleagues (Ascher et al., 2010) used text analysis to examine positive and negative emotional language used by bvFTD, AD and healthy couples when discussing an area of disagreement in their relationship. The findings revealed no differences between the diagnostic groups in the use of positive emotion words, either within or between couples. However, there were significant differences in the use of negative emotion words; bvFTD spouses used more negative words during the

conflict conversation than the patients. Furthermore, both bvFTD and AD spouses used more negative words than control spouses. There were no differences in negative language use among bvFTD patients, AD patients and controls. The results of this study show that spouses of bvFTD patients express more negative affect, as measured by greater use of negative language, than control and AD spouses. One limitation of this study is that the examination of language alone does not capture the full spectrum of emotional interaction, which requires a more comprehensive analysis of emotional behavior as well.

The second study examined mutual gaze, or the amount of time partners spend looking at one another, during a conflict conversation among bvFTD, AD and healthy control couples (Sturm et al., 2011). The authors found that bvFTD patients exhibited significantly reduced mutual gaze with their spouses than patients with AD and controls, suggesting a loss of one critical 'building block' of social interaction. This finding may help explain some of the emotional disengagement observed in bvFTD patients.

Emotional behavior in couples with AD

Couples where one spouse has AD have received considerably more attention than FTD couples. Gallagher-Thomson and colleagues (Gallagher-Thomson et al., 1997) were one of the first groups to observe AD spouse caregivers interact with AD patients in a naturalistic setting. They developed two paradigms for observing couples in their home: 'unplanned mealtime' where couples engaged in conversation during a meal, and 'structured planning task' where couples were asked to plan an activity together. Gallagher-Thomson and colleagues (Gallagher-Thomson et al., 2001) used these paradigms to assess how communication patterns differ between healthy couples and couples where one spouse has AD. Interactions were coded using the Marital Interaction Coding System (MICS-IV) and the codes were reduced into three interaction factors: 'Supportive' factor (e.g., paraphrasing, agreement), 'Facilitative' factor (e.g., clarifying statement, positive mind reading, propose positive solutions), and 'Rapport' (e.g., smiling, laughing, interest). Several key differences between the couples were identified. As expected, healthy couples were much more engaged and communicative with one another both during the structured and the unstructured interaction. Caregiving wives were much less likely to use supportive communication during the meal, and much more likely to use facilitative communication during the planning task with their AD spouses than wives of healthy spouses. AD husbands were less supportive during the meal but not during the planning task, and less facilitative during both tasks. However, AD spouses expressed more rapport building behavior, particularly during the planning task, than healthy spouses.

More recently, Braun and colleagues (Braun et al., 2010) studied marital interaction in couples with dementia in a laboratory setting. Using the same paradigm as Gallagher-Thomson and colleagues (Gallagher-Thomson et al., 2001), the authors asked couples to 'plan a future event together' while being videotaped. Using the Rapid Marital Interaction Coding System (RMICS), they created three communication variables: positive (e.g., humor), negative (e.g., hostility) and neutral (e.g., problem discussion). The authors were interested in examining how the couples communicate and if the caregiving wives differ in communication style from their AD husbands. They examined not only the amount of positive, negative and neutral codes, but also the

sequential analyses of the positive codes (i.e., positive code in partner 1 is followed by a positive code in partner 2) to determine how the reciprocity of positive communication impacts well-being in the couple. Overall, the caregiving wives expressed more neutral and negative communication patterns than their AD husbands, and AD husbands exhibited more positive communication than their wives. Additionally, wives who had more positive communication reciprocity during their interaction reported lower levels of depression. Unfortunately, they were not able to evaluate the reciprocity of negative communications due to low base rates of negative sequences.

In sum, these studies suggest that it is possible to capture and quantify the dynamic emotional and behavioral changes taking place between spousal caregivers and patients with dementia. Findings suggest that although AD husbands are no longer able to engage supportively with their spouses, they appear to compensate for this with greater positive affect and rapport building behavior. Both bvFTD and AD spouses appear to use more negative language than patients, although bvFTD spousal caregivers tend to do this more than either AD spousal caregivers and controls. There appear to be no differences in the use of negative language among the patients with bvFTD, AD or healthy controls. Furthermore, patients with AD exhibit preserved mutual gaze, whereas patients with bvFTD appear to lack this rapport building ability.

Given the many emotional changes that take place within marriages where one spouse has dementia, it is important to learn more about the specific areas of emotional loss and emotional preservation in these relationships. Ideally, research in this area would examine both the quality of emotion expressed as well as the nature of emotional reciprocity within these couples.

The Present Study

The present study examined emotional behavior during a discussion about an area of disagreement in three groups of married couples: (a) couples in which one spouse has bvFTD, (b) couples in which one spouse has AD, and (c) couples in which both spouses are neurologically healthy. FTD is a syndrome that has three distinct subtypes, behavioral variant FTD (bvFTD), semantic dementia (SD) and progressive nonfluent aphasia (PNFA). In this study, we focused on the behavioral variant of FTD because language problems in the other two variants interfere with the ability to carry out the marital interaction task.

The study had three aims. The first aim was to examine positive and negative emotional behavior in couples where one spouse is diagnosed with bvFTD or AD in comparison to neurologically healthy couples. The second aim was to compare emotion reciprocity, or the probability of different emotional sequences (i.e., the probability that spouse A expresses positive emotion in response to partner B's positive affect, or the probability that spouse A expresses negative emotion in response to partner B's neutral affect) among the three types of couples. The third aim was to explore the relationship between bvFTD, AD and control couple's expression and reciprocity of emotion during the conversation and the caregiving spouse's marital satisfaction and depression.

To address aims one and two, we compared the emotional behavior and emotion reciprocity among bvFTD, AD, and healthy control couples during a conflict conversation. Emotional behavior was measured using the Specific Affect Coding

System (SPAFF), a system that captures 5 positive emotional speaker behaviors, 10 negative emotional speaker behaviors, 1 neutral speaker behavior and four listener behaviors. Emotion reciprocity was measured by sequential analysis of the positive, negative and neutral SPAFF codes (determining the probability that each category of emotion will be followed by the others). To address the third aim, we examined the relationship between the couple's emotion expression and reciprocity and the caregiving spouse's self-reported (1) marital satisfaction and (2) depression.

Hypotheses

Aim 1: To investigate expression of positive and negative emotion in bvFTD, AD and control couples.

Hypothesis 1a. BvFTD couples will show less positive emotion than AD and control couples, specifically; they will show less affection, interest, enthusiasm, humor and validation than AD and control couples.

Rationale: There is evidence from clinician report that bvFTD patients present with significant emotional blunting, decreased social reciprocity and increased coldness (Neary et al., 1998, Sollberger et al., 2011), and although previous research has not found a reduction in positive emotions in spouses of bvFTD patients (Ascher et al., 2010), we believe that the well documented increased burden and frustration felt by these spousal caregivers in response to their partner's emotional changes (de Vugt et al., 2006, Mioshi et al., 2013) will manifest in decreased levels of positive emotion in these couples overall.

Hypothesis 1b. BvFTD and AD spouse caregivers will show more negative emotion than control spouses and AD patients will show more negative emotion than control and bvFTD patients. Specifically, they will show more anger, belligerence, contempt, criticism, defensiveness, disgust, domineering, fear/tension, sadness and whining.

Rationale: Previous research shows that spouses of patients with bvFTD and AD use more negative language than spouses of healthy controls (Ascher et al., 2010). Furthermore, there is evidence that patients with AD show an increase in negative emotion including anxiety and sadness (Feretti et al., 2001, Spalletta et al., 2010).

Aim 2: To investigate emotion reciprocity in bvFTD, AD and control couples by comparing the probability of nine emotional sequences (a) positive – positive, (b) positive – negative (c) positive – neutral, (d) negative – positive, (e) negative – negative, (f) negative – neutral (g) neutral – positive, (h) neutral – negative and (i) neutral - neutral.

Hypothesis 2a. Couples with bvFTD will show lower probability of positive-positive sequences and stronger probability of positive-negative and positive-neutral sequences than AD and control couples.

Rationale: Given the documented emotional blunting, inappropriate behavior and coldness in patients with bvFTD (Neary et al., 1998), we expect to see less positive emotion reciprocity and more negative and neutral emotion in response to positive emotion in these couples than in AD and control couples.

Hypothesis 2b. Couples with bvFTD will show lower probability of negative-negative sequences and stronger probability of negative-neutral sequences than AD and control couples. AD couples will show higher probability of negative-negative sequences than bvFTD and control couples.

Rationale: Given the documented emotional blunting, coldness and inappropriate behavior in patients with bvFTD (Neary et al., 1998), we expect to see less negative emotion reciprocity and more neutral emotion in response to negative emotion in these couples than in AD and Control couples. Given the previous report of enhanced emotional contagion in patients with AD (Sturm et al., 2013), we expect greater negative emotion reciprocity in these couples than bvFTD and Controls.

Hypothesis 2c. Couples with bvFTD will show stronger probability of neutral-neutral and neutral-negative sequences and weaker probability of neutral-positive sequences than AD and control couples.

Rationale: Given the documented emotional blunting, coldness, and inappropriate behavior in patients with bvFTD (Neary et al., 1998) as well as greater use of negative language by bvFTD spouses (Ascher et al., 2010) we expect to see more negative emotion in response to neutral emotion and more neutral emotion reciprocity in these couples than in AD and control couples.

Aim 3: To investigate the relationship between bvFTD, AD and control couple's emotional expression and reciprocity and the caregiving spouse's self-reported marital satisfaction and depression.

Hypothesis 3a. Total positive emotional expression, specifically, affection, interest, enthusiasm, humor, as well as positive-positive, neutral-positive and negative-positive emotion reciprocity will be associated with greater marital satisfaction and total negative emotional expression, specifically, anger, belligerence, contempt, criticism, defensiveness, disgust, domineering, fear/tension, sadness and whining, as well as negative-negative, neutral-negative and positive-negative emotion reciprocity will be associated with lower marital satisfaction.

Rationale: Prior research indicates that positive emotion and positive sentiment override and de-escalation of conflict are associated with greater marital

satisfaction and negative emotion, negative sentiment override and escalation of conflict are associated with lower marital satisfaction (Gottman, 1999).

Hypothesis 3b. Total positive emotional expression, specifically, affection, interest, enthusiasm, humor, as well as positive-positive, neutral-positive and negative-positive emotion reciprocity will be associated with lower levels of depression and total negative emotional expression, specifically, anger, belligerence, contempt, criticism, defensiveness, disgust, domineering, fear/tension, sadness and whining, as well as negative-negative, neutral-negative and positive-negative emotion reciprocity will be associated with higher levels of depression.

Rationale: Prior research indicates that positive emotional expression and positive emotion reciprocity are associated with lower levels of depression in spousal caregivers (Braun et al., 2010) and negative emotional expression is associated with higher levels of depression (Gallagher-Thomson et al., 1997).

Methods

Participants

Patients diagnosed with bvFTD (N=30) and AD (N=30) and age matched neurologically healthy controls (N=29) as well as their spouses (89 couples total) were recruited through the Memory and Aging Center (MAC) in the Department of Neurology at the University of California, San Francisco (UCSF). bvFTD was diagnosed based on the Neary clinical criteria (Neary et al., 1998) and AD was diagnosed based on standard research criteria (McKhann et al., 1984) by a group of neurologists, neuropsychiatrists, and nurses at UCSF using MRI imaging, neuropsychological testing, and clinical interviews. Patients and their spouses were recruited as part of a larger collaborative study conducted by the MAC and the Berkeley Psychophysiology Laboratory. If the diagnostic team at the MAC determined that the patient was functioning at a sufficiently high level to be able to participate in the Berkeley assessment procedures (e.g, could attend to simple instructions, answer simple verbal questions, remain seated for one or more hours), then they and their spouse were invited to participate in the study. The couple was informed that laboratory procedures would help the research teams learn more about emotional functioning in people with dementia. They were also offered general feedback about their performance on the laboratory tasks at the end of the laboratory session. The majority of couples who were invited and who did not have scheduling conflicts participated in the study.

Control couples were recruited from the local community via advertisements and word-of-mouth and were neurologically and psychiatrically healthy as determined by a complete evaluation at the MAC. All patients underwent a thorough clinical and neuropsychological examination and completed a brief overall cognitive assessment using the Mini-Mental Status Exam (MMSE; Folstein et al., 1975). Because both spouses of the control couple were neurologically healthy, one spouse was randomly assigned 'caregiver' status and the other 'patient' status. The control 'patient' spouse underwent the same assessment as the clinical patients.

Procedure

Participants came in to the Berkeley Psychophysiology Laboratory for a 6-hour laboratory procedure. Upon arrival, participants signed consent forms, approved by the Committee for the Protection of Human Subjects at the University of California, Berkeley, and learned about the experimental procedures for the day. The laboratory procedures included a series of tasks designed to assess various aspects of emotional functioning (Levenson et al., 2008). In this study, we focus on the conflict conversation, which was designed to study emotional behavior in an interpersonal context, as well as the empathy task, which was designed to study the ability to recognize emotions in others. Patients and their spouses were seated in chairs across from one another, in a well-lit 3 x 6 m room. Their faces and torsos were recorded throughout the study session using remotely controlled, high-resolution video cameras embedded in a bookshelf and partially concealed behind darkened glass. A split-screen video recording was produced that enabled both patient and spouse to appear on the same video image. Both participants had recording devices attached that enabled continuous recording of peripheral physiological activity. These physiological measures were not included in this study. In addition to the laboratory procedure, all participants were asked to fill out a set of questionnaires. All participants received \$30 for their participation.

Conflict Conversation. A trained experimenter briefly interviewed the couple to help identify an area of conflict or disagreement in their relationship. The experimenter explained to the couple that they should discuss this area of conflict, taking turns expressing their point of view, and work toward a resolution during their conversation. The experimenter then left the room and the couple sat quietly for five minutes for a pre-conversation rest period. Afterward, they were instructed to begin their conversation and then engage in a 10-minute unrehearsed discussion about the area of conflict.

Questionnaires: Each participant completed a set of questionnaires while still in the Berkeley laboratory. The questionnaires assessed general demographics, psychological health and marital satisfaction. For the present study, only the caregiving spouse's marital satisfaction and psychological health data were used.

Measures

Emotional Behavior. A team of trained coders, who were blind to diagnosis, rated video recordings of the conflict conversation using the Specific Affect Coding System (SPAFF, Gottman, 1989, Coan & Gottman, 2007). The SPAFF system relies on a combination of verbal content, body posture, facial expression, verbal tone and conversational context to continuously (second by second) assign codes to the speaker and the listener. SPAFF consists of 16 speaker codes; five positive speaker codes (affection, interest, enthusiasm, humor, validation), ten negative speaker codes (anger, belligerence, contempt, criticism, defensiveness, disgust, domineering, fear/tension, sadness, whining), a neutral speaker code (indicating an absence of specific emotional behavior), and four listener codes; neutral, positive, negative and stonewalling – which communicates an unwillingness to listen or respond to the partner. During the 10-minute conversation, a total of 600 individual codes (one of 16 speaker codes or four listener codes per second) were assigned to each partner.

To allow for assessment of inter-rater reliability, 47% of all conversations were coded by two coders. If inter-rater reliability was low for a particular couple, a third rater

re-coded the conflict interaction. Cohen's kappa was computed for each partner of each couple to control for agreement by chance alone. The overall kappa for second by second SPAFF coding was moderate, at 0.66 (Carstensen et al., 1995) and overall agreement was high, 78% (Coan & Gottman, 2007).

Conflict Conversation Topic. A team of trained coders watched video recordings of the conflict conversation and coded the content of the conversation as predominantly falling into one of the following content areas: Social Issues (e.g., religion, politics), Communication (e.g., complaining too much, not discussing problems enough), Household (e.g., laundry, pets, garden), Money (e.g., savings, debt), Health/Well-Being (e.g., medication, exercise, physical safety), Family (e.g., raising children, parents), Free Time (e.g., planning vacations, seeing friends) and Inappropriate Behavior (e.g., crude jokes, touching strangers).

Marital Satisfaction. Both members of the couple completed the Locke-Wallace Marital Adjustment Scale (Locke & Wallace, 1959), a well-established self-report measure of marital satisfaction that consists of 15 items, e.g., "Do you and your mate engage in outside interests together?" "Do you confide in your mate?" "Do you ever wish you had not married?" (2 bvFTD spouses, 4 AD spouses and 3 control spouses did not complete the questionnaire for unknown reasons). Scores range from 2-158, with higher scores indicating greater marital satisfaction. Scores of 100 or above are generally considered to indicate satisfied couples, and scores below 100 indicating dissatisfied couples. Only the caregiving spouse's scores were used in this study.

Psychological Well-being. Only the caregiver spouses completed the Symptom Checklist – 90 (SCL-90) (Derogatis et al., 1973), a well-validated self-report measure of a broad range of psychological problems and symptoms of psychopathology. The SCL-90 yields 9 symptom categories (e.g., somatization, obsessive-compulsive, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, psychoticism and paranoid ideation) and one category of 'additional items' that assess other aspects of health (e.g., poor appetite). For this study, only the depression subscale was used because of substantial evidence linking caregiving with depression (Schultz et al., 1995). The depression scale consists of 13 items and higher scores indicate greater level of depression symptoms. (1 bvFTD spouse and 2 AD spouses did not complete the questionnaire for unknown reasons. 14 control spouses did not completed the questionnaire because they participated in an earlier version of the study which did not implement the SCL-90).

Emotion Recognition. Patients viewed 11 film clips, 37 seconds in length, in which a character strongly displayed a discrete emotion. Patients watched 4 clips depicting negative emotions (anger, disgust, fear and sadness), 4 clips depicting positive emotions (affection, amusement, calmness, enthusiasm), and 3 clips depicting self-conscious emotions (embarrassment, shame and pride). After viewing each film clip, patients were asked to indicate which one of 11 emotions (affectionate, afraid, amused, angry, ashamed, calm, disgusted, embarrassed, enthusiastic, proud, or sad) the character in the film felt most strongly. A total score of emotion recognition was calculated by summing correct answers across all films and dividing by the total number of films.

Dementia severity. The Clinical Dementia Rating Scale (CDR) (Morris, 1993) was administered by trained MAC staff. The CDR is a widely used measure of dementia severity, as reported by caregivers, across six domains of daily functioning. Higher

scores indicate greater impairment. The scores can range from 0 to 3.

Data Reduction

Emotion Behavior. In addition to examining each of the SPAFF codes separately, we also created composite scores for positive and negative emotion by averaging the 5 positive speaker codes together and the 10 negative speaker codes together. Additionally, a total emotional behavior code was created by averaging all 15 emotional speaker codes (listener codes were not included).

Emotion Reciprocity. To control for Type 1 error and reduce the number of dependent measures, we collapsed the 16 speaker codes into positive, negative and neutral averages. We analyzed the reciprocity of nine possible emotional sequences; (a) positive – positive, (b) positive – neutral (c) positive – negative, (d) negative – positive, (e) negative – negative, (f) negative – neutral (g) neutral – positive, (h) neutral – negative and (i) neutral – neutral. Using R statistical software (R Core Team, 2013), we created syntax that identified emotional sequences in two steps. First, we identified an antecedent positive, negative or neutral event (an antecedent event is defined as a run of SPAFF code of interest of any duration that is preceded and followed by a SPAFF code not of interest). Second, every time an antecedent event was identified in the first partner, a consequent positive, negative or neutral event was identified in the second partner (a consequent event is defined as a run of SPAFF code of interest of any duration that began within five seconds after the end of the antecedent event).

Emotion reciprocity z -scores were calculated as sequential probability in two steps. First, we calculated the difference between the conditional probability of a given consequent code following a given antecedent code (i.e., the probability that patient's neutral emotion will follow a spouse's negative affect) and the unconditional probability of the consequent code (e.g., patient's neutral affect). Second, the difference was divided by an estimate of the standard deviation, calculated using the Allison and Liker's formula (1982) and as described in previous research (Levenson & Gottman, 1985, Carstensen et al., 1995). This process was completed for consequents occurring within 1, 2, 3, 4 and 5 seconds of the antecedent, and then averaged across all 5 seconds. Positive z -scores indicate that the consequent emotion was expressed in the 5-seconds following the antecedent emotion at rates higher than the expected base rate. Zero indicates that the consequent emotion was displayed at the base rate rates regardless of the antecedent emotion. Negative z -scores indicate that the consequent emotion was expressed in the 5 seconds following the antecedent emotion at rates lower than the expected base rate.

Analytic Strategy

General analytic approach. The present study had three primary aims: (1) to examine emotional behavior in patients with bvFTD, AD, as well as healthy controls and their respective spouses, (2) to compare the probability of reciprocity of nine emotional sequences in couples with bvFTD, AD and healthy controls and (3) to investigate the relationship between bvFTD, AD and control couple's emotional expression and reciprocity and the caregiving spouse's self-reported marital satisfaction and depression. In order to achieve the first two aims, repeated measures analyses of variance (ANOVAs) were conducted to compare emotional behavior during the conflict conversation between

bvFTD, AD and neurologically healthy couples. Diagnosis (FTD, AD, or control) was treated as a between-subjects factor and partner (caregiver or patient) was treated as a within-subjects factor. The repeated measures approach is appropriate for this kind of dyadic analysis because it takes into account the interpersonal association between the two members of the same dyad by creating the appropriate covariance matrix (see Gonzalez and Griffin 2012). Furthermore, a repeated measures design fits our dyadic data well because the within-subject variable (caregiver or patient) is independent (i.e., it varies from person to person within a dyad but the dyad average is the same across all dyads, in contrast to nonindependent variables where the average differs across dyads) (see Kenny, Kashy and Cook 2006). A similar analytic approach was used in our previous research (Ascher et al., 2010). For the sake of consistency and simplicity, spouses of patients with dementia will be called ‘caregivers’ in the discussion of results. A set of separate repeated measures analyses of covariance (ANCOVAs) were conducted including age, sex, CDR, emotion recognition and total caregiver and patient emotional behavior as covariates (see below). Significant main effects and interactions were followed up with Bonferroni-adjusted pair-wise comparisons.

In order to achieve the third aim, relationships between bvFTD, AD and control couple’s emotional behavior and the caregiving spouse’s marital satisfaction and depression were examined using a series of linear multiple regressions. In each regression, either the marital satisfaction or the SCL-90 depression score was designated as the dependent variable and the emotional behavior variable was treated as the primary predictor variable. Total caregiver and patient emotional behavior as well as sex, CDR, emotion recognition, and diagnosis were treated as covariates.

Results

Age, Sex, CDR: Table 1 shows demographic information and statistics. An analysis of variance revealed no significant age differences between the three groups of patients ($F(2,84) = .92, p = .40$) or between the three groups of caregivers ($F(2,77) = .51, p = .60$).

A chi-square analysis revealed that the three groups of couples differed in terms of distribution of sex in the patient and the caregiver role ($\chi^2(2, N = 89) = 6.21, p = .045$). Couples where the patient was diagnosed with bvFTD had a significantly greater proportion of male patients and female caregivers than control couples or couples where the patient was diagnosed with AD.

Only the patients of each couple completed the Clinical Dementia Rating scale (CDR; Morris, 1993) in order to assess general cognitive functioning and dementia severity. One member of the control couple was randomly assigned ‘patient’ status, and only that spouse completed the CDR. As expected, there were significant differences in CDR scores between the three diagnostic groups ($F(2, 86) = 66.17, p < .001$). Follow-up with Bonferroni simple effects tests revealed that patients with bvFTD and patients with AD had greater dementia severity (as indicated by higher scores) than controls ($p < .001$). There were no differences in CDR scores between bvFTD and AD patients ($p = .50$).

Emotion Recognition: Only the patients of each couple completed the emotion recognition task in order to assess their ability to understand emotions in others. An analysis of variance revealed a significant difference in Emotion Recognition between the

three groups of patients ($F(2,86) = 17.51, p < .001$) and follow-up with Bonferroni simple effects tests revealed that patients with bvFTD and patients with AD scored lower than control participants ($p < .01$) and patients with bvFTD scored lower than patients with AD, approaching significance ($p = .062$).

Total Emotional Behavior: An analysis of variance revealed significant differences in total emotion expressed (positive and negative emotion combined) between the three groups of patients ($F(2,86) = 5.09, p = .008$). Follow-up with Bonferroni simple effects tests revealed that patients with AD showed significantly more emotion than patients with bvFTD ($p < .01$). There were no differences in total emotion between bvFTD and controls or AD and controls ($p = .28$). There was no significant difference between the three groups of caregivers in the total amount of emotion expressed ($F(2,86) = 2.38, p = .098$).

Conflict Conversation Topic: A chi-square analysis revealed that the three groups of couples (Ctrl, AD, bvFTD) differed in terms of distribution of conflict conversation topics ($\chi^2(16, N = 89) = 39.47, p = .001$). Table 2 shows conflict conversation topic distribution across the three couple groups. Couples where the spouse was diagnosed with either bvFTD or AD were less likely to discuss topics related to interpersonal and social issues (e.g., communication, religion, politics) and more likely to discuss topics related to practical and functional issues (e.g., household, money, free time, health) than control couples. Of the three sets of couples, bvFTD couples were the only ones to discuss issues related to inappropriate behavior (e.g., crude jokes, touching strangers).

Depression: Only the caregiving spouse completed the SCL-90. An analysis of variance revealed a significant difference in depressive symptoms among the three groups of spouses ($F(2,80) = 9.61, p < .001$) and follow-up with Bonferroni simple effects tests revealed that bvFTD spouses reported higher levels of depressive symptoms than AD spouses ($p = .016$) and control spouses ($p < .001$). There were no differences between AD and control spouses ($p = .20$).

Correlations were computed between SCL-90 depression scores and emotion recognition, CDR, as well as the caregiving spouse's age and sex (see Table 2). Higher levels of depression were associated with women and lower patient scores on the emotion recognition task.

Marital Satisfaction: Only the caregiving spouse's measure of marital satisfaction was used. An analysis of variance revealed a significant difference in marital satisfaction among the three groups of spouses ($F(2,80) = 9.64, p < .001$) and follow-up with Bonferroni simple effects tests revealed that bvFTD spouses reported lower marital satisfaction than AD spouses ($p = .034$) and control spouses ($p < .001$). There were no differences between AD and control spouses ($p = .26$).

Correlations were computed between marital satisfaction scores and emotion recognition, CDR, as well as the caregiving spouse's age and sex and marital satisfaction (see Table 2). Lower levels of marital satisfaction were associated with women and higher patient scores on the CDR.

Emotional Behavior in bvFTD, AD and Control Couples

Analytic Approach:

To examine emotional expression of couples during the conflict conversation, a series of 3x2 repeated measures analysis of variance were used with emotional behavior as the dependent measure. Total positive and total negative emotional behaviors were analyzed. In addition, each of the 5 positive emotions (affection, enthusiasm, humor, interest, validation) and 10 negative emotions (anger, belligerence, contempt, criticism, defensiveness, disgust, domineering, fear/tension, sadness, whining) were analyzed individually. Diagnosis (bvFTD, AD, or control) was the between-subject variable and partner (caregiver or patient) was the within-subject variable. A similar analytic approach was used in our previous research (Ascher et al., 2010).

Analyses were first conducted without covariates and then again with CDR, emotion recognition, sex, and patient and caregiver total emotional behavior as covariates. Significant main effects and interactions were followed up using post hoc Bonferroni analysis.

A few of the emotional behaviors had skewed distribution, as indicated by a kurtosis statistic greater than seven (West, et al., 1995). To correct for the skewness, a natural log transformation was applied. Analyses were conducted first with non-transformed values and then again with the log transformed values. See Appendix A for kurtosis statistics.

Positive Emotional Behavior

Examining the total positive emotional behavior as well as each of the 5 positive emotional behaviors independently revealed significant effects for Humor and Validation (see Table 4 for non-adjusted means and standard deviation for all positive emotional behaviors for both partners in each diagnostic group).

Humor: There was a significant main effect for diagnosis when examining expression of humor, $F(1,86) = 4.87, p = .01, \eta_p^2 = .10$. The main effect for partner ($F(1,86) = 1.11, p = .30$) and the diagnosis by partner interaction ($F(2,86) = .13, p = .88$) were not significant. Follow-up Bonferroni pair-wise comparisons revealed that bvFTD couples expressed significantly less humor than control couples ($p = .007$). There were no differences between AD and control couples ($p = .32$) or AD and bvFTD couples ($p = .40$).

Validation: There was a significant main effect for partner expression of validation, $F(1,86) = 4.15, p = .045, \eta_p^2 = .046$ such that patients expressed more validation than caregivers. The main effect for diagnosis ($F(2,86) = 2.23, p = .11$) and diagnosis by partner interaction ($F(2,86) = 1.28, p = .29$) were not significant.

There were no significant main effects for partner or diagnosis or partner by diagnosis interaction when examining expression of total positive emotional behavior ($F(1,86) = .048, p = .83; F(2,86) = .96, p = .39; F(2,86) = .66, p = .52$), affection ($F(1,86) = 1.03, p = .31; F(2,86) = .47, p = .63; F(2,86) = .08, p = .92$), interest ($F(1,86) = 1.03, p = .31; F(2,86) = .47, p = .63; F(2,86) = .08, p = .92$) or enthusiasm ($F(1,86) = .02, p = .88; F(2,86) = 2.7, p = .07; F(2,86) = .25, p = .78$).

The overall pattern of results for humor and validation remained the same after including CDR, emotion recognition, sex, and patient and caregiver total emotional behavior as covariates. However, the main effect for diagnosis on the expression of humor no longer reached significance $F(1,81) = 1.46, p=.32$, and the main effect for partner on the expression of validation approached significance $F(1,81) = 3.69, p = .058$.

The main effect for diagnosis on the expression of humor remained significant after conducting the analyses using the log transformed values. The main effect for partner on the expression of validation was no longer significant after conducting the analyses using the log transformed values.

Negative Emotional Behavior

Examining total negative emotional behavior as well, each of the 10 negative emotional behaviors independently revealed significant effects for Total Negative affect, Anger, Criticism, Belligerence, Domineering and Sadness. (See Table 4 for non-adjusted means and standard deviations for all negative emotional behaviors for both partners in each diagnostic group.)

Total Negative Behavior: There was a significant main effect for partner expression of total negative affect, $F(1,86) = 24.65, p = .000, \eta_p^2 = .22$ and a significant interaction between diagnosis and partner, $F(2,86) = 6.94, p=.002, \eta_p^2 = .14$. The main effect for diagnosis ($F(2,86) = .63, p=.53$) was not significant. The diagnosis by partner interaction was follow-up with Bonferroni simple effects tests. Examining the three diagnoses within each partner revealed trending differences among caregivers ($F(2,86) = 2.75, p=.070, \eta_p^2 = .06$), such that bvFTD caregivers showed more total negative emotion than control spouses at a trend level ($p=.084$), and a significant difference among patients, $F(2,86) = 3.38, p=.038, \eta_p^2 = .07$, such that AD patients showed more total negative emotion than bvFTD patients ($p=.033$). Examining each partner within each diagnostic group, bvFTD caregivers expressed more total negative emotion than bvFTD patients $F(1,58) = 23.58, p=.000, \eta_p^2 = .29$. There were no differences between AD caregivers and AD patients $F(1,58) = 1.04, p=.31$. There were no differences between Control spouses $F(1,56) = .44, p=.51$.

Anger: There was a significant main effect for partner expression of anger, $F(1,86) = 6.0, p = .016, \eta_p^2 = .065$ such that caregivers expressed more anger than patients. The main effect for diagnosis ($F(2,86) = .67, p=.51$) and diagnosis by partner interaction ($F(2,86) = 1.4, p=.26$) were not significant.

Criticism: There was a significant main effect for partner expression of criticism, $F(1,86) = 4.51, p = .037, \eta_p^2 = .05$, such that caregivers expressed more criticism than patients. The main effect for diagnosis, $F(2,86) = .48, p=.62$ and diagnosis by partner interaction, $F(2,86) = 1.57, p=.21$ were not significant.

Belligerence: There was a significant main effect for diagnosis for belligerence, $F(1,86) = 3.36, p = .04, \eta_p^2 = .072$. The main effect for partner, $F(1,86) = .50, p=.48$ and

diagnosis by partner interaction, $F(2,86) = .43, p=.66$ were not significant. Follow-up Bonferroni pair-wise comparisons revealed that bvFTD couples expressed more belligerence at a trending level than control couples ($p=.055$). There were no differences between AD and Control couples ($p=1.0$) or AD and bvFTD couples ($p=.14$).

Domineering: There was a significant main effect for partner expression of domineering, $F(2,86) = 26.05, p < .001, \eta_p^2 = .23$, and a significant interaction between partner and diagnosis $F(2,86) = 3.77, p = .027, \eta_p^2 = .081$. The main effect for diagnosis was not significant, $F(2,86) = 1.7, p = .32$. The diagnosis by partner interaction was follow-up with Bonferroni simple effects tests. Examining the three diagnoses within each partner revealed a trending difference among caregivers ($F(2,86) = 2.47, p=.091$), such that bvFTD caregivers showed more domineering behavior than control spouses, and a trending difference among patients ($F(2,86) = 2.97, p=.056$), such that AD patients showed more domineering behavior than bvFTD patients. Examining each partner within each diagnostic group, bvFTD caregivers expressed more domineering behavior than bvFTD patients $F(1,58) = 29.14, p < .001, \eta_p^2 = .33$. AD caregivers expressed more domineering behavior than AD patients $F(1,58) = 4.88, p = .031, \eta_p^2 = .078$. There were no differences between Control caregivers and Control patients $F(1,56) = .72, p = .40$.

Sadness: There was a significant interaction between partner and diagnosis for sadness $F(2,86) = 3.3, p = .040, \eta_p^2 = .072$. The main effect for partner $F(1,86) = .49, p = .48$ and main effect for diagnosis $F(1,86) = 1.37, p = .26$ were not significant. The diagnosis by partner interaction was follow-up with Bonferroni simple effects tests. Examining the three diagnoses within each partner revealed a trending difference among caregivers $F(2,86) = 2.92, p=.059$ such that bvFTD caregivers showed more sadness than AD and control spouses, but the pairwise comparisons failed to reach significance ($p=.10$ and $p=.14$ respectively). There were no differences among patients $F(2,86) = .70, p=.49$. Examining each partner within each diagnostic group, bvFTD caregivers expressed more sadness behavior than bvFTD patients at a trend level $F(1,55) = 3.01, p = .09$. AD patients expressed more sadness behavior than AD caregivers at a trend level $F(1,55) = 3.18, p = .079$. There were no differences between Control caregivers and Control patients $F(1,51) = .14, p = .79$.

There were no significant main effects for partner or diagnosis or partner by diagnosis interaction when examining expression of contempt ($F(1,86) = .075, p = .79; F(2,86) = .60, p = .51; F(2,86) = 1.06, p=.34$), defensiveness ($F(1,86) = 1.52, p = .22; F(2,86) = 2.97, p = .056; F(2,86) = 1.28, p=.28$), disgust ($F(1,86) = .59, p = .45; F(2,86) = .39, p = .67; F(2,86) = .62, p=.54$), fear/tension ($F(1,86) = 2.85, p = .095; F(2,86) = .91, p = .41; F(2,86) = .38, p=.69$) or whining ($F(1,86) = 1.91, p = .17; F(2,86) = .41, p = .67; F(2,86) = 1.43, p=.25$).

The overall pattern of results for total negative emotional behavior, anger, criticism, belligerence and sadness remained the same after including CDR, emotion recognition, sex, and patient and caregiver total emotional behavior as covariates. The interaction of partner and diagnosis in the expression of total negative emotion remained significant ($F(1,81) = 4.16, p = .019$) and the main effect for partner on the expression of anger

($F(1,81) = 3.33, p = .052$) approached significance. The main effect of partner on the expression of criticism ($F(1,81) = .39, p = .53$), the main effect of diagnosis on the expression of belligerence ($F(2,81) = 2.02, p = .14$), and the interaction of partner and diagnosis on the expression of sadness ($F(2,81) = .59, p = .56$) no longer reached significance. The overall pattern of results for domineering behavior changed with the inclusion of covariates, such that the effect of partner became more prominent and the interaction of partner and diagnosis receded. The main effect for partner on the expression of domineering behavior ($F(2,81) = 1.41, p = .23$) no longer reached significance.

The overall pattern of results remained the same after conducting the analyses using the log-transformed values, however the main effect of diagnosis for the expression of belligerence and the partner by diagnosis interaction for the expression of domineering behavior no longer reached significance.

Summary of Findings

There were differences in emotional behavior during the conflict conversation within and between the three sets of couples. In general, the findings were less straightforward than hypothesized, but overall, revealed that dementia caregiving spouses showed more negative emotion and less positive emotion than controls. Additionally, bvFTD patients expressed less total negative emotion than AD patients.

The hypothesis that bvFTD couples would show less positive emotion than AD and control couples, and that specifically they would show less affection, interest, enthusiasm, humor and validation was only partially supported. There were no differences among couples in the total expression of positive emotion. Humor was the only specific emotion that differentiated the couples in the predicted direction such that bvFTD couples expressed less humor than control couples. Contrary to the hypothesis, patients expressed more validation than their spouses. This finding appears to be driven by AD and bvFTD patient's expression of validation, though not at a statistically significant level.

The hypothesis that bvFTD and AD caregiver spouses would show more negative emotion than controls and that AD patients would show more negative emotion than bvFTD patients and controls, specifically that they would show more anger, belligerence, contempt, criticism, defensiveness, disgust, domineering, fear/tension, sadness and whining was partially supported. bvFTD couples expressed more belligerence than control couples and bvFTD caregiving spouses expressed more sadness than controls. Both bvFTD and AD spouse caregivers expressed more domineering behavior than their patient spouses. Overall, caregiving spouses expressed more anger and criticism than patients. This finding appears to be driven by bvFTD spouse caregiver's expression of anger and criticism, though not at a statistically significant level. As predicted, AD patients expressed more total negative emotion than bvFTD patients.

The overall findings remained the same after controlling for CDR, emotion recognition, sex, and patient and caregiver total emotional behavior as covariates; however, no longer at the level of statistical significance.

Emotion Reciprocity in bvFTD, AD and Control Couples

Analytic Approach:

To examine emotion reciprocity in couples during the conflict conversation, a 3x2 repeated measures analysis of variance was used with emotional reciprocity sequences as the dependent measure. Each of the nine emotional behavior sequences, (a) positive – positive, (b) positive – negative (c) positive – neutral, (d) negative – positive, (e) negative – negative, (f) negative – neutral, (g) neutral – positive, (h) neutral – negative and (i) neutral - neutral), were analyzed individually. Diagnosis (bvFTD, AD, or control) was the between-subject variable and partner (caregiver or patient) was the within-subject variable. A similar analytic approach was used in our previous research (Ascher et al., 2010, Carstensen et al., 1995).

Analyses were first conducted without covariates and then again with CDR, emotion recognition and sex as covariates. Total patient and caregiver behavior was not included as a covariate because this value was accounted for in the Allison-Liker z -statistic calculation. Significant main effects and interactions were followed up using post hoc Bonferroni analysis.

None of the emotional sequences had skewed distribution, as indicated by a kurtosis statistic greater than seven (West, et al., 1995). No correction was applied to the values. See Appendix B for kurtosis statistics.

Positive Antecedents

All of the three sequences starting with a positive antecedent revealed significant effects. (Table 5 shows non-adjusted means and standard deviations for both partners in each diagnostic group).

Positive-Positive: There was a significant main effect for diagnosis when looking at the likelihood of the positive-positive sequence, $F(2,81) = 4.22$, $p = .017$, $\eta_p^2 = .095$. The main effect for partner, ($F(1,81) = .013$, $p=.91$) and diagnosis by partner interaction, ($F(2,81) = .11$, $p=.89$) were not significant. Follow-up Bonferroni pair-wise comparisons revealed that bvFTD couples were less likely to exhibit engage in positive emotion reciprocity than control couples ($p=.014$). There were no differences between AD and control couples ($p=.34$) or AD and bvFTD couples ($p=.54$).

Positive-Negative: There was also a significant main effect for diagnosis when looking at the likelihood of the positive-negative sequence, $F(2,78) = 4.75$, $p = .011$, $\eta_p^2 = .11$. The main effect for partner, ($F(1,78) = 2.91$, $p=.092$) and diagnosis by partner interaction, ($F(2,78) = .24$, $p=.79$) were not significant. Follow-up Bonferroni pair-wise comparisons revealed that bvFTD couples were more likely to exhibit negative emotion in response to positive emotion than control couples ($p=.014$). There were no differences between AD and control couples ($p=.074$) or AD and bvFTD couples ($p=1.0$).

Positive-Neutral: There was a significant partner by diagnosis interaction when examining the likelihood of the positive-neutral sequence, $F(2,81) = 5.67$, $p = .005$, $\eta_p^2 = .12$. The main effect for partner, ($F(1,81) = .53$, $p=.47$) and diagnosis, ($F(2,81) = 1.37$,

$p=.26$) were not significant. The diagnosis by partner interaction was follow-up with Bonferroni simple effects tests. Examining the three diagnoses within each partner initiated sequence revealed a significant difference in the strength of the positive-neutral sequence when initiated by caregivers, $F(2,82) = 3.2, p=.045$ such that bvFTD patients were more likely to show neutral emotion in response to their caregiver's positive emotion than control patients ($p=.039$). There were no significant difference between control and AD or bvFTD and AD patients. There was also a significant difference in the strength of the positive-neutral sequence when initiated by patients, $F(2,82) = 3.2, p=.045$ such that bvFTD caregivers were less likely to show neutral emotion in response to their patient's positive emotion than AD caregivers ($p=.043$). There were no significant difference between AD and control or bvFTD and control caregivers. Examining each partner initiated sequence within each diagnostic group revealed that bvFTD patients were more likely to express neutral emotion in response to their spouse caregiver's positive emotion than caregivers were to express neutral emotion in response to the patient's positive affect, reaching near significance, $F(1,54) = 3.5, p=.068$. There were no differences between AD caregiver and patient initiated sequences, $F(1,58) = 1.2, p=.28$ or between Control caregiver and patient initiated sequences, $F(1,54) = 2.2, p=.15$.

Negative Antecedents

There were no significant main effects for diagnosis, partner, or partner by diagnosis interactions when looking at the likelihood of the negative-positive, ($F(1,78) = .22, p = .64; F(2,78) = 2.4, p = .09; F(2,78) = .23, p=.79$), negative-neutral, ($F(1,80) = 1.32, p = .25; F(2,80) = 1.9, p = .15; F(2,80) = 1.44, p=.84$), or negative-negative, ($F(1,80) = .64, p = .43; F(2,80) = 1.21, p = .28; F(2,80) = .07, p=.94$) sequences. Table 5 shows non-adjusted means and standard deviations for both partners in each diagnostic group.

Neutral Antecedents

Two of the three sequences starting with a neutral antecedent revealed significant effects. Table 5 shows non-adjusted means and standard deviations for both partners in each diagnostic group.

Neutral-Positive: The interaction between diagnosis and partner for neutral-positive sequence approached significance, $F(2,81) = 3.0, p = .054, \eta_p^2 = .07$. The main effects for partner, ($F(1,81) = .37, p=.55$) and diagnosis, ($F(2,81) = .91, p=.41$) were not significant. Examining the three diagnoses within each partner initiated sequence revealed no difference in the strength of the neutral-positive sequence when initiated by caregivers, $F(2,81) = 1.35, p=.27$. However, there was a significant difference in the strength of the neutral-positive sequence when initiated by patients, $F(2,82) = 3.45, p = .034, \eta_p^2 = .077$, such that bvFTD caregivers were more likely to show positive emotion in response to their patient's neutral emotion than control spouses ($p=.045$). There was no difference between AD and Control ($p=1.0$) or bvFTD and control ($p=.12$) caregivers. Examining each partner initiated sequence within each diagnostic group revealed no differences between bvFTD patients and bvFTD caregiver initiated neutral-positive sequences, $F(1,54) = 2.38, p=.13$. There were also no differences between AD caregiver and patient

initiated sequences, $F(1,58) = 1.72, p = .20$ or between control caregiver and patient initiated sequences, $F(1,54) = .99, p = .32$.

Neutral-Negative: There were no significant effects for diagnosis, partner, or partner by diagnosis interaction when looking at the likelihood of the neutral-negative sequence, ($F(1,80) = 1.14, p = .29$; $F(2,80) = 2.4, p = .09$; $F(2,80) = .06, p = .94$).

Neutral-Neutral: There was a significant main effect for diagnosis when looking at the likelihood of the neutral-neutral sequence, $F(2,84) = 3.75, p = .027$. The main effect for partner, ($F(1,84) = .57, p = .45$) and diagnosis by partner interaction, ($F(2,84) = 1.84, p = .16$) were not significant. Follow-up Bonferroni pair-wise comparisons revealed that bvFTD couples were more likely to exhibit neutral emotion in response to neutral emotion than control couples ($p = .025$). There were no differences between AD and control couples ($p = .26$) or AD and bvFTD couples ($p = .95$).

The overall pattern of results for positive-positive, positive-negative, positive-neutral, neutral-positive and neutral-neutral sequences remained the same after including CDR, emotion recognition and sex as covariates. However, the main effect for diagnosis on the positive-positive sequence, ($F(2,78) = 1.13, p = .33$), positive-negative sequence, ($F(2,75) = .32, p = .73$) and neutral-neutral sequence, ($F(2,81) = .24, p = .79$) no longer reached significance. The interaction of partner and diagnosis for the positive-neutral sequence remained significant, ($F(2,78) = 3.84, p = .026, \eta_p^2 = .09$) and the interaction between partner and diagnosis for neutral-positive sequence remained approaching significance, ($F(2,78) = 2.64, p = .078$).

Summary of Findings

There were differences in emotion reciprocity during the conflict conversation within and between the three sets of couples. With one exception, in general, the results indicated that bvFTD couples engaged in less positive emotion reciprocity and in more neutral and negative emotion reciprocity than control couples. In the context of bvFTD patient's neutral affect, bvFTD spouses engaged in more positive emotional behavior than controls.

The hypothesis that couples with bvFTD would show lower probability of positive-positive sequences and stronger probability of positive-negative and positive-neutral sequences was largely supported. bvFTD couples were less likely to display positive emotion in response to positive emotion and more likely to exhibit negative emotion in response to positive emotion than control couples. bvFTD patients were more likely to respond with neutral emotion to their spouse's positive emotion. In contrast to the hypothesis, bvFTD caregivers were less likely to respond with neutral emotion to their spouse's positive emotion than controls.

The hypothesis that couples with bvFTD would show lower probability of negative-negative sequences and stronger probability of negative-neutral sequences than AD and control couples was not supported. There were no differences among couples in their likelihood of responding to negative emotion with positive, neutral or negative emotion.

The hypothesis that couples with bvFTD would show stronger probability of neutral-neutral and neutral-negative sequences and weaker probability of neutral-positive sequences than AD and control couples was partially supported. Although bvFTD couples were more likely to respond with neutral emotion to one another than control couples, there were no differences among couples in their likelihood of responding to neutral emotion with negative emotion. Surprisingly, bvFTD spouse caregivers were more likely to show positive emotion in response to their patient's neutral emotion than control spouses. The overall findings remained the same after controlling for CDR, emotion recognition and sex; however, no longer at the level of significance.

Emotional Behavior in bvFTD, AD and Control Couples and Caregiver Spouse's Marital Satisfaction and Depression

Analytic Approach:

In order to examine the relationship between couple's emotional behavior during the conflict conversation and the caregiver spouse's marital satisfaction and depression, two sets of multiple regression analyses were performed. Marital satisfaction was the dependent variable in the first set of analyses and depression was the dependent variable in the second set of analyses.

The aim of each regression analysis was to determine if emotional behavior was significantly predictive of either marital satisfaction or depression above and beyond variables that might explain a significant portion of the variance (e.g., CDR, emotion recognition, sex, total couple emotional behavior and patient diagnosis). In the first step of each regression analysis, CDR, emotion recognition, sex, total couple emotional behavior and patient diagnosis was entered. Total couple emotional behavior was not added in the first step for analyses involving emotional reciprocity. The emotional variable(s) of interest were entered in the second step of each regression,

Two sets of six regression analyses were completed looking at the relationship between one of the two dependent variables (e.g., marital satisfaction or depression) and six groups of emotion variables of interest¹ – (1) total positive emotion, (2) affection, enthusiasm, humor, interest, validation (entered together into one regression), (3) total negative emotion, (4) anger, belligerence, contempt, criticism, defensiveness, disgust, domineering, fear/tension, sadness, whining (entered together into one regression), (5) positive and de-escalating sequences: positive-positive, negative-positive, neutral-positive, negative-neutral (entered together into one regression) and (6) negative or escalating sequences: negative-negative, positive-negative, neutral-negative (entered together into one regression).

Marital Satisfaction

Positive Emotional Behavior: Total positive emotional behavior during the conversation did not predict the caregiving spouse's marital satisfaction (standardized $\beta = .14$, R^2 change = .36, $p = .18$). Looking at all five positive emotions together revealed that

¹ All emotion variables of interest for this set of analyses represent emotional behavior for the couple as a whole and were calculated by creating a sum score of patient and spouse values. Braun et al., 2010 had used a similar method.

expression of humor (standardized $\beta = .21$ R^2 change = .49, $p = .05$) and validation (standardized $\beta = .24$, R^2 change = .49, $p = .037$) positively predicted marital satisfaction.

Positive/De-escalating Emotion Reciprocity: Looking at the four positive/de-escalating sequences together revealed that the positive start-up sequence (neutral-positive) negatively predicted marital satisfaction (standardized $\beta = -.27$ R^2 change = .36, $p = .043$), contrary to the hypothesis. None of the other sequences were significantly predictive of marital satisfaction.

Negative Emotional Behavior: As hypothesized, total negative emotional behavior negatively predicted the caregiving spouse's marital satisfaction (standardized $\beta = -.24$, R^2 change = .38, $p = .058$). Looking at all ten negative emotions together revealed that expression of criticism (standardized $\beta = -.39$ R^2 change = .42, $p = .006$) predicted lower marital satisfaction.

Negative/Escalating Emotion Reciprocity: Looking at the three negative/escalating sequences together revealed that the positive-negative escalating sequence negatively predicted marital satisfaction (standardized $\beta = -.23$ R^2 change = .32, $p = .037$). None of the other sequences were significantly predictive.

Psychological Well-being: Depression

Positive Emotional Behavior: Total positive emotional behavior during the conversation did not predict the caregiving spouse's level of depression (standardized $\beta = -.18$, R^2 change = .24, $p = .11$). None of the five positive emotions predicted spousal levels of depression.

Positive/De-escalating Emotion Reciprocity: None of the four positive/de-escalating sequences predicted spousal levels of depression.

Negative Emotional Behavior: As hypothesized, total negative emotional behavior during the conversation positively predicted caregiving spouse's level of depression (standardized $\beta = .46$, R^2 change = .42, $p < .001$). Looking at all ten negative emotions together revealed that expression of sadness (standardized $\beta = .34$ R^2 change = .45, $p < .001$) and domineering (standardized $\beta = .29$ R^2 change = .45, $p = .011$) positively predicted spouse's level of depression.

Negative/Escalating Emotion Reciprocity: None of the three negative/escalating sequences predicted spousal levels of depression.

Summary of Findings

With the exception of one result, the findings were consistent with the hypotheses and overall, revealed that positive emotion expression is associated with greater marital satisfaction and negative emotion expression and reciprocity is associated with lower

marital satisfaction. Furthermore, the finding revealed that negative emotional expression predicted greater levels of depression in the caregiving spouse.

The hypothesis that total positive emotional expression would predict greater marital satisfaction was not supported. However, the hypothesis that specific positive emotions (e.g., affection, interest, enthusiasm, humor and validation) would predict greater marital satisfaction was partially supported. Humor and validation both positively predicted the caregiving spouses' marital satisfaction. The hypothesis that total negative emotional expression would predict lower marital satisfaction was supported. Furthermore, the hypothesis that specific negative emotions (e.g., anger, belligerence, contempt, criticism, defensiveness, disgust, domineering, fear/tension, sadness and whining) would predict lower marital satisfaction was partially supported. Expression of criticism negatively predicted marital satisfaction. The hypothesis that positive/de-escalating sequences would positively predict marital satisfaction was not supported. Surprisingly, the opposite was found for the positive start up (positive-neutral) sequence such that it predicted lower marital satisfaction. The hypothesis negative/escalating sequences would negatively predict marital satisfaction was partially supported such that the positive-negative sequence negatively predicted marital satisfaction.

The hypothesis that total positive emotional expression would predict lower depression in the caregiving spouse was not supported and neither was the hypothesis that specific positive emotions (e.g., affection, interest, enthusiasm, humor and validation) would predict lower depression. The hypothesis that total negative emotional expression would predict higher levels of depression was supported. Furthermore, the hypothesis that specific negative emotions (e.g., anger, belligerence, contempt, criticism, defensiveness, disgust, domineering, fear/tension, sadness and whining) would predict higher levels of depression was partially supported. Expression of sadness and domineering positively predicted depression levels. The hypothesis that positive/de-escalating sequences would negatively predict depression in the spouse was not supported and neither was the hypothesis that negative/escalating sequences would positively predict depression.

Discussion

The goal of this study was twofold. The first was to examine the emotional dynamics of couples with dementia, with a special focus on couples where one spouse is diagnosed with bvFTD. The second was to explore the relationship between couple's expression and reciprocity of emotion and the caregiving spouse's marital satisfaction and depression. Committed relationships such as marriage are arguably the most important relationships in late life and many spouses continue to care for their loved ones with dementia. While many older adults enjoy an increase in positive emotion and a decrease in negative emotion in late life, spouses of patient's dementia are forced to take on the new role of caregiving, which leaves them vulnerable to depression, caregiver burden and a decline in marital satisfaction. Although the emotional lives of healthy adult marriages have been well characterized, little is known about the emotional dynamics of couples living with bvFTD and AD and how those dynamics impact the caregiving spouse.

This study aimed to characterize the emotional behavior of couples where one spouse is diagnosed with either bvFTD or AD in the context of a naturalistic marital interaction in comparison to healthy controls. This was achieved in two separate sets of analyses. The first set of analyses examined the expression of total positive emotional behavior, in addition to 5 discreet positive behaviors (affection, interest, enthusiasm, humor, validation). It also examined the expression of total negative emotional behavior, in addition to 10 discreet negative behaviors (anger, belligerence, contempt, criticism, defensiveness, disgust, domineering, fear/tension, sadness, whining). The second set of analyses examined the reciprocity of 9 emotion sequences (positive – positive, positive – negative, positive – neutral, negative – positive, negative – negative, negative – neutral, neutral – positive, neutral – negative, and neutral – neutral). The study also aimed to understand the relationship between positive and negative emotional behavior; escalating and de-escalating sequences of interaction; and the caregiving spouse's marital satisfaction and levels of depression. These behaviors were of interest because previous research has identified that, while expression and reciprocity of negative emotional behavior is related to marital distress, the expression of positive emotion and the de-escalation of negative emotion is related to marital satisfaction (Gottman, 1994; Gottman et al., 1998, Carstensen et al., 1995). Furthermore, research on marriage in the context of dementia suggests that the presence of negative emotion as well as a lack of positive emotion during couple interactions is related to negative caregiver outcomes (Braun et al., 2009).

Consistent with our hypothesis, findings revealed that couples where one spouse has bvFTD were less likely to engage in positive emotion reciprocity than control couples. This is noteworthy in light of the finding that bvFTD couples expressed a similar overall level of positive emotion as did AD and control couples, which was not in line with our hypothesis but consistent with previous research (Ascher et al., 2010). Together, this set of findings suggest that even though bvFTD couples express positive emotion to one another, they do so in a less interpersonally contingent way than healthy older adult couples. Similarly, we found that bvFTD couples expressed less humor during the conversation than control couples. This finding is both expected and unfortunate because in healthy couples humor is thought to help maintain relationships and mitigate conflict (Bippus, 2003). Indeed, our findings also suggest that the expression of humor during the conflict conversation is positively related to marital satisfaction. Furthermore, research on couples where one spouse has dementia suggests that positive emotion reciprocity can buffer against negative emotional consequences, such as depression (Braun et al., 2010). However, our data did not find this association. Because the behavioral coding of humor in our sample relied on the mutual expression of positively motivated amusement, the finding that bvFTD couples share less humor further supports the idea that these couples show a decline in interpersonally contingent expression of positive emotion.

Despite this decrease in shared positive emotion, spouses of patients with bvFTD were actually more likely to engage in positive start-up behavior. This finding was not consistent with our original hypothesis, but can be interpreted in several different ways. From a more optimistic perspective, this behavior on behalf of bvFTD spouse caregivers can be seen as an attempt to inject positive emotion into the conversation, or at least as an attempt for the caregiver to put his or her best emotional foot forward. From a more

cynical perspective, this behavior may suggest that a lack of emotion in bvFTD patients is what potentiates the expression of positive emotion in their spouse. Taken a step further, this may reflect the bvFTD spouse's relative sense of relief at the fact that their ill spouse is not expressing negative or inappropriate emotion. Indeed, we also found that the neutral-positive sequence is associated with lower marital satisfaction, which was contrary to the hypothesis. Although surprising at first, this finding can potentially give additional credence to the idea that, in the context of a dissatisfied marriage, partners are giving a last ditch effort in order to try to improve their marital dynamics by engaging in more positive start up behavior.

Of interest, patients also appear to play a part in trying to generate positive emotion during the marital interaction. Findings revealed that patients expressed more validation than their spouses. The function of validation is to communicate understanding and acceptance of the partner or the partner's views and opinions, which is important for facilitating positive social interaction (Coan & Gottman, 2007). Although this finding appears to be driven by bvFTD and AD patients' expression of validation, and not controls', this was not at the level of significance. This finding is consistent with previous research with AD couples, which found that AD patients continue to engage in rapport building behavior with their spouses (Gallagher-Thomson et al., 2001). In regards to patients with bvFTD, this finding stands in contrast to prior research, which found that bvFTD patients show a reduction in the building blocks of social interaction (i.e., mutual eye gaze) (Sturm et al., 2011). However, the study by Sturm and colleagues focused on the mutual exchange of eye contact and not on the unidirectional expression of a positively valenced emotional behavior (e.g., validation). The combination of these results again underscores the conclusion that although patients with bvFTD show a decline in the mutual exchange of social interaction (e.g., humor, positive emotion reciprocity), they still maintain some capacity for positive interpersonal engagement (e.g., validation). Importantly, our findings indicate that these efforts to engage may be positively impacting the caregiving spouse's sense of fulfillment from the relationship, as suggested by the positive association of validation and marital satisfaction.

Unfortunately, despite the presence of positive emotion in bvFTD marriages, moments of positive expression appear to quickly sour. Findings indicate that these couples engage in more positive-negative emotion reciprocity than control couples. Whereas negative-positive emotion reciprocity is the proverbial goldmine of conflict resolution and emotional soothing and is indicative of happy marriages (Gottman, 1999), bvFTD couples appear to engage in the opposite pattern (i.e., escalation of conflict). Indeed, findings from this study also show that negative-positive reciprocity is associated with marital dissatisfaction. Furthermore, bvFTD couples also express more belligerence than control couples. Belligerence serves the function of 'getting a rise' out of the partner through emotional provocation (Coan & Gottman, 2007). Indeed, bvFTD caregivers expressed more anger, criticism and sadness than controls, though not at the level of significance. Our findings also indicate that expression of criticism was predictive of negative marital satisfaction and sadness was predictive of higher levels of depression in the caregiving spouse. Additionally, caregiver spouses expressed more domineering behavior than patients in bvFTD couples, and this pattern was similar in AD couples as well. Domineering behavior was predictive of greater depression in the spousal caregiver. These set of findings are consistent with our hypotheses as well as

previous research indicating that bvFTD caregivers express more negative emotion than controls, that dementia caregiver spouses express more negative emotion than patients (Ascher et al., 2010) and that low positive emotional expression and high negative emotional expression are predictive of negative caregiver outcomes.

Importantly, there were few differences between the emotional expression of AD couples and control couples, a finding that is consistent with reports that AD patients continue to have preservation in emotional functioning. In terms of differences between AD and bvFTD couples, there was only one major area of significant difference. Patients with AD expressed more total negative emotion in comparison to bvFTD patients. Caregiver and clinician report has noted general emotional blunting in patients with bvFTD (Neary et al., 2005), whereas AD caregiver-report has indicated a preservation of emotional functioning, or even an increase in emotionality (Chatterjee et al., 1992, Sturm et al., 2013). Empirical studies are also establishing that patients with bvFTD have deficits in specific domains of emotional responding, including a decline in the expression of embarrassment and disgust (Sturm et al., 2006; Sturm et al., 2008, Eckart et al., 2012). The current findings offer further support for emotional preservation in AD patients and of emotional dampening in bvFTD patients, particularly in the context of a naturalistic interaction.

Overall, the combination of these findings paints a picture of marital interactions where bvFTD couples contend with powerful negative emotions, such as frustration and hurt, without the soothing influence of positive emotional engagement. These findings are in contrast to what would be predicted by traditional theories of aging, for instance, which suggest that older adults construct their environment to maximize positive emotion and minimize negative emotion (Carstensen, 1995). At the same time, it is possible that the positive emotional changes in the healthy spouse predicted by the socioemotional selectivity theory are buffering the negative impact of caregiving. For instance, although bvFTD couples exhibit emotional patterns of behavior similar to distressed couples (e.g. escalation of conflict, belligerence, criticism) and exhibit lower marital satisfaction than healthy and AD couples, they don't exhibit the full range of negative emotional behaviors predicted by theories of marital dissolution (e.g., contempt, negative emotion reciprocity). These findings help elucidate the emotional factors that may be contributing to the low marital satisfaction and heightened risk for negative emotional consequences, such as low marital satisfaction, burden and depression in bvFTD caregivers (Ascher et al., 2010, Mioshi et al., 2013, Wong et al., 2012).

Implications

Neurodegenerative diseases, particularly bvFTD, can have a profound impact on the emotional functioning of the patient, their spouse's psychological well-being and the marital relationship (Ascher et al., 2010, Braun et al., 2009). Previous research suggests that patients with FTD lose much of their capacity for rapport building in the context of dyadic interactions (Sturm et al., 2011). This is in contrast to patients with AD, who are able to maintain this important ability (Gallagher-Thomson et al., 2001). Additionally, our previous research found that both bvFTD and AD caregiver spouses use more negative language than their spouses (Ascher et al., 2010). The present study adds to our understanding of the areas of preserved and diminished emotional functioning in patients

with dementia and contributes new information about the emotional dynamics of couples living with dementia. Although previous research has been unable to find differences in the expression of positive emotion in couples with FTD (Ascher et al, 2010), the present study sheds light on the degree to which these couples are bereft of humor and positive emotion reciprocity. Additionally, this study provides additional evidence for elevated levels of negative emotional behavior in bvFTD couples in comparison to control couples. Furthermore, this study provides further evidence that not only are bvFTD spouses less satisfied with their marriage and experience greater levels of depression, but also the emotional dynamics during an interpersonal conversation is related to these two important factors.

These findings have important implications for our understanding of the emotional struggles faced by spouses of dementia patients, and the unique struggles faced by spouses of patients with bvFTD, including depression and lowered marital satisfaction (Asher, et al., 2010; Braun et al., 2010; Wong et al., 2012). These findings can also shed light on possible interventions. Prior research suggests that greater positive communication reciprocity during spousal conversations can protect caregiver spouses from depression (Braun et al., 2010). The current finding that bvFTD couples engage in low levels of shared positive emotion could be one pathway toward bvFTD caregiver spouse's increased risk of depression and other forms of psychopathology.

Furthermore, the current finding that bvFTD couples are low on positive and high on negative emotional behavior and the relationship between these behaviors and marital satisfaction as well as depression elucidates the specific couple dynamics that may lead toward low marital satisfaction, depression and high caregiver burden identified in these couples (Ascher et al., 2010; deVugt et al., 2006). This pattern of emotional behavior is consistent with our understanding of factors contributing to low marital satisfaction in healthy adult couples (Gottman, 1994) as well as of the relationship between low marital satisfaction and high caregiver burden and depression in dementia couples (deVugt et al., 2006, O'Rourke et al., 2011). However, the directionality of the association between emotional behavior, marital satisfaction and depression remains unclear and requires further empirical investigation.

Although it is unlikely that psychosocial interventions alone will undo the relational injuries that often accompany neurodegenerative diseases that degrade core socioemotional functioning, it is possible to intervene to ease caregiver depression and caregiver burden. The current findings reveal a loss of positive emotion and an exacerbation in negative emotion in couples with bvFTD during a disagreement. Furthermore, low positive emotion, high negative and conflict escalation is associated with low marital satisfaction and high negative emotion is related to increased levels of depression in the spousal caregiver. It is important to examine how interventions that aim to increase positive emotion, decrease negative emotion and de-escalate conflict may impact overall caregiver well-being. These interventions should not be one size fits all, but tailored to the specific emotional needs of the couple. Specifically, the interventions should focus not on the patient but on the caregiver, with the aim of helping the caregiving spouse (1) understand the symptoms of bvFTD, (2) understand that the symptoms (e.g., apathy, emotional blunting) are not willful, (3) recognize their own emotional responses (e.g., anger, sadness, escalation of conflict) to the symptoms (4) foster acceptance of the patient, their own emotional responses and the changed

relationship in order to (5) facilitate the decrease in negative emotion and allow for the possibility of experiencing positive emotion, if not with their spouse, than in other areas of their life.

Strengths and Limitations

The primary strength of this study was its use of direct observation and objective coding of particular emotional behaviors in couples during a naturalistic, marital interaction. This is the first study to use the SPAFF coding system to examine expression and reciprocity of emotional behaviors as they unfold over time in couples where one spouse either has bvFTD or AD, in comparison to healthy controls. Furthermore, this study looked at how couple interactions predict marital satisfaction and depression levels in the caregiver.

There were several limitations to the present study. The SPAFF coding system was designed to study healthy adult couples and not those where one spouse had dementia. For this reason, certain kinds of emotional behaviors that are readily identifiable based on social and conventional norms may not have the same meaning in dementia patients as in healthy adults. For instance, taunting questions and unreciprocated humor, which are coded as belligerence in SPAFF, are thought to function as attempts to “get a rise” out of the recipient by inciting anger. However, in patients with dementia, this behavior may simply be a reflection of their lack of social awareness as opposed to overt, intentional aggressiveness. In addition, the conflict conversation paradigm may not capture the full extent of interactions between dementia patients and their spouses and may not be representative of their marital interactions in general.

Another limitation of this study was its exclusive use of behavioral data without also making use of other important measures of emotion, such as physiology and self-report, both of which are collected in our laboratory and can contribute additional information about emotional functioning in these couples. Our collaborators are also collecting neuroanatomical data, the analysis of which could have important implications for our understanding of emotional changes in these couples, including information about why some areas of emotional functioning are preserved while others are lost, as well as identification of key neural circuits in emotional functioning that could serve as potential targets for future medical interventions.

In addition, this study did not examine the specific impact of gender on emotional behavior during the couple interaction. Given the influence of gender on emotional expression, marital satisfaction and caregiver burden (Thomson et al., 2004; Merrilees et al., in preparation), this question should be addressed more thoroughly in future studies with more gender-balanced samples. Furthermore, our dementia couples were recruited through a tertiary care clinic and were required to be high functioning enough to be able to participate in our assessment. Our healthy control couples were recruited from the San Francisco Bay Area, thus the results of this study may not be generalizable to other populations.

Lastly, this study did not make use of Actor Partner Interdependence Modeling (APIM) or formal mediation modeling. APIM is a powerful and flexible statistical tool for analyzing dyadic data. This tool would have been particularly useful in analyzing the relationships between couple emotional behavior and outcome variables (e.g., marital

satisfaction and depression). In this case, APIM would have provided both actor and partner effects, which would enable us to differentiate between the patient's and the spouse's effects on marital satisfaction and depression. Furthermore, formal mediation modeling would have enabled us to identify the causal association between our variables (MacKinnon, 2008). Specifically, mediation would have allowed us to know if differences in emotional behavior account for the diagnostic group differences found in depression and marital satisfaction.

Conclusion

Emotions are an integral part of marital interactions. Prior research indicates that patients with bvFTD experience significant impairments in socioemotional functioning (Levenson & Miller 2007). These changes in patients often strain marriages and can lead to a decline in marital satisfaction and increase the risk of depression in the healthy spouse (Ascher et al., 2010, Braun et al., 2010). However, few studies have explored the emotional dynamics of couples living with dementia (Braun et al., 2009). The current study found that the emotional interactions of couples with bvFTD have more hostility, more sadness, less humor and less positive emotion reciprocity compared to healthy control couples. Furthermore, the expression of positive emotion is related to marital satisfaction and the expression of negative emotion is related to marital dissatisfaction and depression in the caregiving spouse. This research helps us better understand the emotional climate of couples where one spouse has bvFTD, sheds light on the special emotional burdens of caregiving for bvFTD patients and helps identify possible areas for future interventions.

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Table 1: Participant demographic data

	Control Couples (N=29) Mean (SD)		AD Couples (N=30) Mean (SD)		bvFTD couples (N=30) Mean (SD)		Test Statistics	
	Patients	Caregivers	Patients	Caregivers	Patients	Caregivers	Patients	Caregivers
Age (SD)	66.9 _a (11.5)	59 _a (13.6)	65.1 _a (8.9)	61.3 _a (9.9)	63.3 _a (8.3)	59.2 _a (6.7)	$F(2,86) = 1.1$ $p = .35$	$F(2,78) = .56$ $p = .64$
Sex (M/F)	19/10 _a	10/19 _a	16/14 _a	14/16 _a	25/5 _b	5/25 _b	$\chi^2(2, N = 89) = 6.2$, $p < .05$	
CDR (SD)	.034 _a (.2)	--	.89 _b (.4)	--	1.0 _b (.45)	--	$F(2,86) = 66.2$ $p < .001$	
Emotion Recognition	.94 _a (.06)	--	.77 _b (.19)	--	.65 _b (.26)	--	$F(2,86) = 17.5$ $p < .001$	
Depression	--	24 _a (20)	--	59 _a (.53)	--	1.03 _b (.76)	$F(2,74) = 9.61$ $p < .001$	
Marital Satisfaction	--	126 _a (22)	--	112 _a (34)	--	91.6 _b (32)	$F(2,86) = 9.64$ $p < .001$	
Total Emotional Behavior	164 _{ab} (72)	210 _a (120)	203 _b (113)	231 _a (129)	130 _a (76)	281 _a (140)	$F(2,86) = 5.1$ $p = .008$	$F(2,86) = 2.4$ $p = .098$

Note: Means (standard deviations) are reported. Groups with different subscripts differed from each other at $p < .05$. Statistical test values for age, CDR, Emotion Recognition, Marital Satisfaction, Depression and Total Emotional Behavior are from a one-way ANOVA comparing the three diagnostic groups. Statistical test values for sex are from a crosstabulation using a Pearson Chi-Square test. Not all participants had CDR scores; 3 patients with bvFTD, 3 patients with AD and 19 control patients had missing data. Missing data was imputed based on the mean for each group. BvFTD = behavioral variant frontotemporal dementia; AD = Alzheimer's disease; CDR = clinical dementia rating (0-3 range, with 0 indicating no impairment).

Table 2: *Conflict Conversation Topic Distribution:*

Topic	Control	AD	bvFTD
Communication	12	2	1
Social Issues	5	3	1
Household	4	9	7
Family	3	5	2
Health/well-being	2	5	3
Free time	1	3	7
Inappropriate Behavior	0	0	5
Money	1	1	3
Could not come up with topic	1	2	1

Table 3: *Correlation coefficients for marital satisfaction and depression*

Variable	Marital Satisfaction	Depression
CDR	-.38**	.20
Spouse Age	.13	-.034
Spouse Gender	-.24*	.23*
Emotion Recognition	.08	-.26*

* $p < .05$

** $p < .001$

Table 4: *Emotional behavior*

SPAFF Code	Control Couples (N=29)		AD Couples (N=30)		bvFTD couples (N=30)	
	Patients	Caregivers	Patients	Caregivers	Patients	Caregivers
Total Positive	58.6(42.6)	65.3(33.0)	71.6(47.3)	66.6(43.8)	58.0(45.1)	53.2(49.4)
Affection	6.1(11.2)	8.8(18.5)	8.1(13.9)	12.2(20.7)	10.0(19.5)	11.4(24.8)
Interest	2.6(10.1)	3.4(8.6)	4.0(7.2)	2.7(4.4)	1.8(5.3)	3.6(7.6)
Enthusiasm	.14(.58)	.24(1.3)	.63(1.6)	.29(.95)	2.2(6.1)	2.7(9.2)
Humor	29.7(25.2)	32.2(27.1)	21.2(24.3)	22.1(23.3)	12.5(17.3)	13.6(19.4)
Validation	20.1(5.9)	20.1(4.2)	37.6(5.8)	29.4(4.1)	31.4(5.8)	21.9(4.1)
Total Negative	105 (83.1)	144 (132)	131(109)	164(136)	71.7(70.6)	228(161)
Anger	7.8(18.4)	21.1(36.2)	18.2(39.8)	24.1(58.3)	7.2(16.6)	41.6(82.6)
Belligerence	1.6(4.3)	1.8(6.3)	.76(2.7)	4.1(9.7)	6.1(17.6)	6.1(13.7)
Contempt	4.6(20.6)	2.6(5.3)	1.7(5.1)	2.2(5.9)	.42(1.8)	2.9(4.7)
Criticism	6.9(17.2)	6.9(13.3)	5.1(12.3)	9.1(17.1)	.67(2.8)	8.8(13.6)
Defensiveness	34.7(39.6)	39.2(55.4)	35.0(46.0)	26.8(36.8)	23.8(45.0)	8.7(10.5)
Disgust	.03(.19)	.31(1.3)	.08(.32)	.18(.77)	.32(1.2)	.23(.90)
Domineering	27.1(41.8)	57.5(97.7)	35.6(62.8)	82.2(98.8)	8.4(12.7)	116.2(109)
Fear/Tension	13.9(15.1)	9.8(16.2)	21.8(25.1)	11.3(13.6)	19.7(44.4)	16.1(19.1)
Sadness	7.7(32)	4.8(12.3)	12.2(25.9)	3.7(5.3)	4.8(8.9)	27.1(71.4)
Whining	.69(2.7)	.28(1.3)	1.3(4.0)	.10(.54)	.23(1.3)	.43(1.4)

Table 5: *Emotion reciprocity*

Sequence	Control Couples (N=29) Mean (SD)		AD Couples (N=30) Mean (SD)		bvFTD couples (N=30) Mean (SD)	
	Patient → Caregiver	Caregiver → Patient	Patient → Caregiver	Caregiver → Patient	Patient → Caregiver	Caregiver → Patient
Positive – Positive	4.6 (3.5)	4.5 (3.4)	3.2 (3.9)	3.3 (3.1)	2.1 (3.1)	2.2 (2.9)
Positive – Negative	-1.3 (1.5)	-2.9 (2.0)	-2.7 (2.3)	.25 (2.3)	.37 (1.7)	.44 (2.5)
Positive – Neutral	-.07 (2.5)	-.80 (1.8)	.83 (2.1)	-.16 (2.0)	-.78 (2.6)	.44 (1.9)
Negative – Positive	-.85 (2.3)	-.95 (2.0)	-.72 (1.8)	-1.0 (2.0)	-.54 (2.2)	-.11 (2.0)
Negative – Negative	-.10 (3.6)	-.17 (4.0)	-1.4 (3.8)	-1.7 (3.9)	-1.2 (3.3)	-1.4 (3.3)
Negative – Neutral	-3.0 (3.8)	-3.8 (2.8)	-3.7 (2.7)	-3.9 (3.6)	-3.0 (3.3)	-2.7 (3.0)
Neutral – Positive	-1.1 (1.7)	-.61 (2.5)	-.91 (1.5)	.12 (2.1)	.04 (2.0)	-.88 (2.3)
Neutral – Negative	-4.1 (3.5)	-3.6 (3.8)	-4.5 (3.4)	-3.8 (3.3)	-2.8 (3.1)	-2.4 (2.9)
Neutral – Neutral	-5.6 (4.2)	-5.4 (4.2)	-3.7 (3.8)	-3.7 (3.7)	-2.4 (4.5)	-2.9 (4.2)

Note: Data are presented as Allison-Liker z -scores, reflecting testing of conditional against unconditional probabilities of emotional sequences. Positive z -scores indicate that the consequent emotion tended to be expressed in the 5-seconds following the antecedent emotion. Zero indicates that the consequent emotion was displayed at the same rates regardless of the antecedent emotion. Negative z -scores indicate that the consequent emotion tended to be expressed at times other than the 5-seconds following the antecedent emotion.

Appendix A: *Kurtosis for emotional behaviors*

SPAFF Code	Non transformed		Log Transformed	
	Patients	Caregivers	Patients	Caregivers
Total Positive	.195	-.388	3.024	1.579
Affection	11.301	12.730	-.915	-.973
Interest	24.200	11.543	1.784	.286
Enthusiasm	29.646	53.232	8.583	15.476
Humor	2.783	1.328	-.842	-.784
Validation	4.322	1.261	-.104	-.094
Total Negative	.073	.700	1.392	1.904
Anger	31.082	19.839	-.609	-1.248
Belligerence	49.305	8.663	4.574	1.815
Contempt	76.533	7.229	11.017	.302
Criticism	15.618	5.864	2.704	-1.063
Defensiveness	3.799	8.456	-1.333	-1.038
Disgust	35.102	27.394	24.991	15.106
Domineering	12.926	3.265	-1.267	-.607
Fear/Tension	33.204	2.000	-.649	-1.021
Sadness	30.304	46.966	.557	.440
Whining	19.826	22.104	11.395	15.548

Appendix B: *Kurtosis for emotional sequence probabilities*

Sequence	Non transformed	
	Patient → Caregiver	Caregiver → Patient
Positive – Positive	1.521	.571
Positive – Negative	.118	.496
Positive – Neutral	1.537	-.356
Negative – Positive	1.691	.178
Negative – Negative	.160	.493
Negative – Neutral	1.129	1.333
Neutral – Positive	-.136	.515
Neutral – Negative	1.396	1.944
Neutral – Neutral	.129	.115