Sexual Functioning and Neurodegenerative Diseases

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Abstract

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Neurodegenerative diseases affect multiple domains of functioning, including cognition, emotion, and motor behavior. Sexual functioning is a domain that may also be affected but has received less attention within the field of research. Extant literature on sexual functioning among patients with neurodegenerative diseases tends to focus on clinical and caregiver reports of patient sexual behavior. To understand the response to sexual stimuli in patients with neurodegenerative diseases using non-invasive laboratory-based measures, two studies were conducted.

The first study examined reactivity of three diagnostic groups (18 behavioral variant frontotemporal dementia, 9 Alzheimer's disease, and 23 healthy controls). Participants were shown an erotic film clip and their responses: physiological, facial behavior, and self-reported affective response were recorded. A group difference emerged in physiological reactivity to the erotic film. More specifically, patients with behavioral variant frontotemporal dementia showed diminished physiological arousal in comparison with healthy controls. I found no statistically significant group differences in facial behavior and self-reported affective responses. With respect to facial behavior, nearly 90% of participants did not show the target facial behavior of happiness while watching the erotic film. With respect to self-reported affective response, all groups reported feeling sexually aroused to a small extent. Results suggest that the physiological measure, which captured more automatic responses to sexual stimuli, was better able to detect diagnostic group differences than facial behavior or self-reported affective response.

The second study examined whether the responses (physiological, facial behavior, and self-reported affective response) of patients with neurodegenerative diseases to sexual stimuli were associated with spousal caregiver depression and marital satisfaction. In addition, I assessed whether these associations were mediated by caregiver reports of patient sexual behavior using a multiple mediation model. Sixty-two patients with neurodegenerative diseases were shown the same erotic film clip as in study 1, and their respective spousal caregivers completed measures of depression, marital satisfaction, and patient sexual behavior. I found an association between patient facial behavior and caregiver marital satisfaction, in which higher displays of happiness on patients' faces while watching the erotic film was associated with lower caregiver marital satisfaction. A marginal association was found between patient self-reported affective response

and caregiver marital satisfaction, in which greater endorsement of feelings of sexual arousal while watching the erotic film was associated with lower caregiver marital satisfaction. No associations were found between patient physiological response and caregiver marital satisfaction or between any of the laboratory-based measures and caregiver depression. Although mediation did not occur in any of the analyses, one of the two mediators revealed that the less sexually responsive the patients were toward their spousal caregivers, the higher the caregiver depression and the lower the caregiver marital satisfaction.

The studies show that laboratory-based measures of response to sexual stimuli and caregiver reports of patient sexual behavior can reveal important information about the influence of neurodegenerative diseases on marital relationships.

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Introduction

Dementias are late-life neurodegenerative diseases that impact broad areas of human functioning, including cognition, motor behavior, and emotion. One area related to emotional functioning that may be impacted and yet has not been well studied, is sexual functioning. Sexual functioning is an important part of relationships, of which emotional and physical intimacy is a cornerstone (American Association of Retired Persons [AARP], 1999; DeLamater & Moorman, 2007; Sassler, 2010; Smith, 2006). DeLamater (2012) provides a definition of sexual functioning that acknowledges cognition, emotions, quality of sexual life, and the sense of sexual well-being: "Sexual functioning refers to one's ability to engage in sexual expression and sexual relationships that are rewarding, and the state of one's physical, mental, and social well-being in relation to his or her sexuality" (p. 127).

Among healthy adults, many measures have been used to assess sexual functioning, ranging from questionnaires that inquire about sexual interest, sexual satisfaction, and frequency of sexual activity, to laboratory tests to examine sexual response by assessing self-reported affective response and genital response to erotic stimuli. The more limited literature on sexual functioning among patients with neurodegenerative diseases relies on clinical observation and spousal caregiver report to better understand how patient sexual functioning affects spousal caregivers and intimate relationships. The literature suggests that declines in patient sexual functioning contribute to caregiver burden (Dourado, Finamore, Barroso, Santos, & Laks, 2010; Simonelli et al., 2008) and caregiver depression (Davies, Sridhar, Newkirk, Beaudreau, & O'Hara, 2012). Although studies of patients with neurodegenerative diseases have examined aspects of patient sexual functioning such as sexual interest and frequency of sexual activity, no studies to my knowledge have investigated response to sexual stimuli using objective non-invasive (i.e., non-genital) laboratory tests. To that end, I investigated two aspects of response to sexual stimuli. First, I assessed whether patients with behavioral variant frontotemporal dementia (bvFTD), Alzheimer's disease (AD), and healthy controls (HC) differed in response to sexual stimuli as measured in the laboratory. Second, I examined whether response to sexual stimuli as measured in the laboratory was related to spousal caregiver depression and to spousal caregiver marital satisfaction, and whether caregiver report of patient sexual behavior mediated these relationships.

In the sections that follow, our current understanding of bvFTD and AD, and spousal caregiver negative outcomes of caregiver burden and depression will be reviewed. I then discuss the measurement of sexual functioning, and findings associated with changes in sexual functioning in healthy aging and in the dementias. Then, I present an outline of the present study, including gaps in the literature that it addresses.

Dementias

Dementias are neurodegenerative diseases that erode cognitive, emotional, social, and motor skills. Two of the most common forms of early onset neurodegenerative dementia are AD and bvFTD, a behavioral variant of frontotemporal dementia (FTD). AD is characterized by profound changes in memory, cognition, and visuospatial skills (McKhann et al., 2011). Early symptoms include difficulty with planning, problem solving, and retaining new information, while emotional functioning (e.g., emotional responsivity, emotion recognition) remains largely preserved. AD primarily impacts the medial temporal, posterior temporal, and parietal regions, in

accordance with the memory and visuospatial deficits characteristic of AD (Krueger et al., 2010). One autopsy study found that patients with autopsy-proven AD performed worse than patients with autopsy-proven FTD on a clock drawing test, block design test, and a memory subscale (Rascovsky et al., 2002). Clinician and caregiver observations have revealed that patients in the early stages of AD tend to conceal their cognitive deficits by isolating themselves socially out of embarrassment or shame as opposed to lack of interest. At the same time, patients with AD retain social graces and the ability to remain empathic and emotionally connected with loved ones (Zhou & Seeley, 2014).

In contrast to AD, bvFTD is characterized by profound changes in emotional functioning, social behavior, and personality—emotional blunting and disinhibition are among the early and distinguishing characteristics of the disorder (Miller, Darby, Swartz, Yener, & Mena, 1995; Rankin, Kramer, & Miller, 2005; Snowden et al., 2001), whereas memory and visuospatial functioning remain spared in the early stages of disease. Behavioral variant frontotemporal dementia primarily impacts the frontal and temporal lobes and more specifically, the anterior insula, anterior cingulate cortex, the amygdala, and the thalamus, areas important for emotional and social processing (Zhou & Seeley, 2014). Clinician and caregiver observations indicate that patients with bvFTD lose emotional warmth and the ability to empathize, characteristics that negatively impact marriages and friendships. In a study of mutual gaze, a critical component of socioemotional functioning, patients with AD exhibited intact ability to maintain mutual gaze with their spousal caregivers during a conversation, whereas patients with bvFTD did not (Sturm et al., 2010). Sturm and colleagues posited that the ability to maintain mutual gaze helps nurture supportive relationships.

Researchers have assessed emotional functioning using laboratory measures in patients with bvFTD. In such studies, FTD (including bvFTD) has been characterized by relative preservation of emotional reactivity to low-level simple stimuli such as a loud acoustic startle (Sturm, Rosen, Allison, Miller, & Levenson, 2006) and to film clips that depict simple themes of happiness or sadness (Werner et al., 2007). Differences appear more pronounced for complex emotional reactivity. For example, whereas healthy[1] adults showed self-reported and facial behavior of embarrassment after they reacted in fear and surprise to a loud acoustic startle, patients with FTD showed deficits in such responses.

Patients with FTD and those with bvFTD in particular, have also shown deficits in the ability to recognize emotions in others, an ability that demands complex processing more than emotional reactivity (Levenson & Miller, 2007). Impairments have been found in patients with bvFTD in three types of emotion recognition (positive, negative, and self-conscious) compared to patients with AD and healthy adult controls (Goodkind et al., 2015). The ability to recognize emotion in patients with AD did not differ from healthy adult controls.

In sum, a vast literature on AD and bvFTD addresses changes in cognitive and emotional functioning. Many of those changes would be expected to have important consequences for sexual function.

Caregiver Negative Outcomes

The strain of caring for a spouse who has dementia can negatively impact the health and well-being of a spousal caregiver (Cooper, Balamurali, Selwood, & Livingston, 2007; Cooper,

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[1] This does not always mean healthy adults were screened for early cognitive decline.

Katona, Orrell, & Livingston, 2008; Garcia-Alberca, Lara, & Berthier, 2011; Molinari, 2008). The two most common caregiver outcomes measured are caregiver burden and caregiver depression. Researchers typically use the Zarit Burden Inventory (Zarit, Anthony, & Boutselis, 1987) to assess caregiver burden and the Beck Depression Inventory (BDI; Gallagher, Nies, & Thompson, 1982) or the Center for Epidemiological Studies Depression Scale (CES-D Scale; Radloff, 1977) to assess depression. Caregivers of patients with FTD report more burden, stress and symptoms of depression than do caregivers of AD patients (Boutoleau-Bretonniere, Vercelletto, Volteau, Renou, & Lamy, 2008; Kaiser & Panegyres, 2006; Mioshi et al., 2013a; Mioshi, McKinnon, Savage, O'Connor, & Hodges, 2013b; Riedijk et al., 2006). These findings may be attributed to a number of factors. First, bvFTD has a relatively young age of onset. It is more likely that couples are still in the higher earning stages of a career when one partner receives a diagnosis of early onset dementia (EOD), leading to derailed careers and financial burden. In addition, couples in which one partner has EOD are more likely to be responsible for children who are still in school, which can lead to a host of psychosocial problems in children and in the family system (Luscombe, Brodaty, & Freeth, 1998; van Vliet, de Vugt, Bakker, Koopmans, & Verhey, 2010). Second, the severity of behavioral problems in bvFTD seems to outweigh the cognitive problems that are more prevalent in patients with AD. A number of studies have demonstrated that behavioral changes characteristic of early stage bvFTD, such as psychosis (e.g., delusions), mood (i.e., anxiety, depression), disinhibition, apathy, and loss of empathy are highly associated with caregiver distress (de Vugt et al., 2006; Diehl, Mayer, Förstl, & Kurz, 2003; Diehl-Schmid et al., 2013; Mourik et al., 2004; Rascovsky et al., 2011). Third, fewer support groups for caregivers of bvFTD patients exist compared to caregivers of AD patients (Boutoleau-Bretonniere et al., 2008; de Vugt et al., 2006; Mioshi et al., 2013a; Riedijk et al., 2006).

Behavioral, cognitive and emotional changes within patients with AD and bvFTD can also negatively impact the marital relationship. In our research, we found lower marital satisfaction among spouses of FTD patients than those of AD patients (Ascher et al., 2010), reflective of the particular toll that caregiving for a partner who lacks emotional understanding and responsivity, empathy, and social awareness can take. In one study, researchers measured marital intimacy at the time of the study and retrospectively before dementia onset (Morris, Morris, & Britton, 1988). The measurement of marital intimacy encompassed eight aspects of intimacy that included affection, autonomy, cohesion, compatibility, conflict resolution, expressiveness, identity, and sexuality. Marital intimacy before disease onset and at the time of the study were associated with higher perceived strain and depression in caregivers. Caregivers who felt a significant loss of intimacy due to dementia reported more depression, but not more perceived strain.

In sum, an emergent literature has begun to address the impact of dementia on caregivers. It is clear that caregivers are at high risk for declines in marital satisfaction, and for high levels of burden. Accordingly, understanding factors that help preserve relationship satisfaction is a critically important need.

Measurement of Sexual Functioning

Very little research has been dedicated to the examination of changes in sexual functioning in dementia. In the sections that follow, I will discuss how sexual functioning is measured and findings regarding changes in sexual functioning in healthy aging adults, and then

in patients with dementia. I then turn to a discussion of methods that have rarely been used to understand the effects of aging or dementia on sexual function—laboratory-based performance measures.

Healthy Aging

Many methods are used to assess sexual functioning among healthy adults, ranging from questionnaires to performance-based measures conducted in laboratories. The most common forms of assessment across age groups (i.e., 18-80 years of age) are questionnaires, whereas performance-based methods have been used almost exclusively with younger adults (i.e., 18-31 years of age).

To assess sexual attitudes, practices, and function, researchers have primarily relied upon questionnaires. Many researchers in this domain have constructed questionnaires or tailored questions on standard questionnaires. For example, researchers used two questions to assess sexual desire among older adults, one of which was, "How frequently do you have sexual thoughts, fantasies, or erotic dreams?" (DeLamater & Sill, 2005). On a larger scale, a group of researchers created the International Survey of Relationships, with 125 questions that were in part original and in part adapted from other questionnaires to assess the roles sexuality and sexual behavior play in committed relationships among older adults (Heiman et al., 2011). Researchers also rely on psychometrically validated self-report inventories such as the Derogatis Sexual Function Inventory (DSFI; Derogatis & Melisaratos, 1979), the Female Sexual Function Index (FSFI; Rosen et al., 2000), and the International Index of Erectile Function (IIEF; Rosen et al., 1997). These inventories assess multiple domains of sexual functioning, including but not limited to sexual satisfaction, attitudes, arousal, and desire. Aspects of sexual functioning such as sexual desire may also be assessed through diaries and interviews (Ferreira, Narciso, & Novo, 2012; Laumann, Gagnon, Michael, & Michael, 1994).

Findings: Changes in sexual functioning with aging. The literature on sexuality and aging has shifted from a focus on sexual dysfunction, particularly in men, to sexual functioning (DeLamater, 2012). Findings from studies of sexual functioning among healthy aging adults derived primarily from questionnaire data, with an emphasis on functional processes as opposed to dysfunctional processes, will be reviewed.

With advancing age, sexual desire and frequency of sexual activity tends to decline. Nevertheless, research reveals that older adults remain sexually active well into their 70s and even into their 80s, particularly when they remain engaged in a committed intimate partnership and in good physical health (Beutel, Stöbel-Richter, & Brähler, 2007; Karraker, DeLamater, & Schwartz, 2011; Lindau et al., 2007; Schick et al., 2010; Waite, Laumann, Das, & Schumm, 2009). As they age, men are more likely to have a partner and engage in sexual activity than women, who are more likely to have partners who have died (Schick et al., 2010). Other factors that can contribute to changes in sexual functioning include biological and psychosocial factors (DeLamater, 2012).

As women age, menopause, defined by the cessation of menstruation, is an important biological factor. Research findings are mixed as to whether menopause negatively or positively impacts sexual functioning. Loss of estrogen, however, can contribute to vaginal dryness and loss of elasticity (DeLamater & Koepsel, 2015; Dunn, 1988). Loss of testosterone, which is considered critical to sexual health, can contribute to lowered sexual desire and pleasure (Ambler, Bieber, & Diamond, 2012). Nevertheless, menopause in general does not appear to dampen sexual desire (Carpenter, Nathanson, & Kim, 2006; Hinchliff & Gott, 2008) or to be

related to sexual satisfaction in women (Minkin, 2016; Thomas, Hess, & Thurston, 2015). Sexual activity changes depending on women's attitudes, which can be quite varied. Some women report finding freedom from worries about birth control; others report that the loss of fertility leads to a loss of meaning of sexual activity. Across the life course, negative attitudes about sexuality and a lack of sex-positive attitudes, interfere with sexual satisfaction, and continue to do so during menopause (DeLamater & Moorman, 2007; Dillaway, 2012).

Biological changes in men, such as reduction in testosterone production are more gradual. Declines in testosterone production can result in longer time to erection and less firm erections (Isidori et al., 2014). Rates of certain dysfunctions, particularly erectile dysfunction (ED), increase as men age (Feldman, Goldstein, Hatzichristou, Krane, & McKinlay, 1994; Johannes et al., 2000; Laumann et al., 2007; Smith, Mulhall, Deveci, Monaghan, & Reid, 2007). ED is related to biological conditions, such as cardiovascular disease (CVD), hypertension, low levels of testosterone, obesity, and diabetes (Minkin, 2016; Rew & Heidelbaugh, 2016). Despite these biological changes, scant evidence exists that normal healthy aging, devoid of major health issues such as CVD, diabetes, and dementia, and psychological issues such as depression and unresolved past sexual trauma, negatively impact more global perceptions of and satisfaction with sexual functioning for most men. Research indicates, however, that within cultures that glorify youth, the negative meaning individuals draw from the biological and physical consequences of aging can have a negative impact on sexual functioning (DeLamater, 2012; Slevin & Mowery, 2012).

Although psychosocial problems do not tend to increase with age, psychosocial problems can impact sexual functioning across age groups. Men and women who endorse symptoms of depression or anxiety experience more sexual problems such as lack of sexual desire, lack of pleasure, and erectile dysfunction (Laumann, Das, & Waite, 2008; Moreira, Glasser, King, Duarte, & Gingell, 2008) whether or not they are in a relationship. Depression emerged as one of the significant predictors of low sexual activity in the Study of Midlife Development (Thomas et al., 2015).

As frequency of sexual activity decreases with advancing age, healthy older adults report deriving increased satisfaction from physically affectionate activities that are not overtly sexual in nature such as cuddling and hugging (DeLamater & Koepsel, 2015; Lodge & Umberson, 2012). In sexually active older women, these gestures can create a sense of increased emotional intimacy with their partners, which in turn can generate more sexual desire and vaginal lubrication (Trompeter, Bettencourt, & Barrett-Conner, 2012). One of the beneficial effects of aging with one's partner is the opportunity to develop deeper, richer, and multi-dimensional intimacy over time (DeLamater & Koepsel, 2015).

Of particular relevance to this study, a large body of research shows the strong link between sexual functioning and satisfaction with an intimate relationship. A number of studies have shown that relationship satisfaction is positively associated with frequency (AARP, 1999; Smith, 2006) and satisfaction with the quality of sexual activity (McFarland, Uecker, & Regnerus, 2011; Thomas et al., 2015). More specifically, researchers have found that relationship satisfaction is positively associated with the frequency of physically affectionate activities such as hugging and kissing, and sexually intimate activities such as oral sex and vaginal intercourse (DeLamater & Moorman, 2007).

Overall, although sexual desire and frequency of sexual activity decline with age, healthy adults with partners remain sexually active into their 70s and 80s. Biological and psychosocial factors influence the degree of change observed in sexual functioning across the adult lifespan.

Among individuals who remain sexually engaged, the frequency and quality of sexual activity within a committed relationship contributes to physical and mental health, sexual desire, enhanced sexual functioning, and greater relationship satisfaction.

Dementias

Research on the sexual functioning of patients with dementia has been relatively rare. Within existing research, the methods used to measure sexual functioning have been quite diverse and encompass clinical observation, extensive medical chart reviews (e.g., Derouesne, Guigot, Chermat, Winchester, & Lacomblez, 1996), semi-structured interviews conducted in person, in-home or via telephone (e.g., Ballard et al., 1997; Dourado et al., 2010; Duffy, 1995; Eloniemi-Sulkava et al., 2002; Kuppuswamy, Davies, Spira, Zeiss, & Tinklenberg, 2007) with spousal caregivers, and questionnaires administered to spousal caregivers (e.g., Davies et al., 2012).

Researchers who used questionnaires to measure sexual functioning in dementia patients frequently adapted questions from standardized inventories. For example, researchers have incorporated two of the three questions from the Sexuality in Alzheimer's Disease Collaborative Study Experience of Intimacy with Partner Scales and one item from the Alzheimer's Disease Diagnostic and Treatment Centers (ADDTC) California Dementia Behavior Questionnaire (Davies et al., 2012; Victoroff, Nielson, & Mungas, 1997) or two questions from the Psychobehavioral Questionnaire (Derouesne et al., 1996). They have also combined items from other validated sexual functioning questionnaires (Kravetz, Drory, & Snaked, 1999; Morris et al., 1988; Rust & Golombok, 1985) to develop the Sexual Behavior and Intimacy Questionnaire (Ahmed et al., 2015). Others (Ballard et al., 1997; Dourado et al., 2010) have used previously validated scales, such as the Sexual Experience and Satisfaction questionnaire (Abdo & Oliveira, 2004) or the Marital Intimacy Scale (Morris et al., 1988), but supplemented with four questions pertaining to couples' sexual relationships (Ballard et al., 1997).

Findings: Changes in sexual functioning with dementia. The few available studies have found that sexual problems such as apathy, loss of sexual desire, and erectile dysfunction are common among those with dementias (Ballard et al., 1997; Eloniemi-Sulkava et al., 2002; Jagus & Benbow, 2002; Kuppuswamy et al., 2007). Despite beliefs that hypersexual behavior, sexual disinhibition, or inappropriate sexual behavior are highly common among dementia patients, caregiver reports indicate that such behavior is relatively rare, occurring in roughly 8% of dementia patients, across all dementias (Eloniemi-Sulkava et al., 2002; Jagus & Benbow, 2002; Miller et al., 1995). Although relatively rare, sexually disinhibited behavior tends to evoke embarrassment in caregivers. Despite the disruptions in sexual functioning among those diagnosed with some form of dementia, research reveals that nearly a quarter to over half of committed couples in which one partner has dementia remain sexually active with one another (Ballard et al., 1997; Eloniemi-Sulkava et al., 2002; Jagus & Benbow, 2002).

Among studies of sexual function in a specific form of dementia, the vast majority focus is on AD. Findings have generally been similar to those observed with studies that include a broader range of dementias in suggesting that a loss of sexual functioning is common (Ballard et al., 1997; Eloniemi-Sulkava et al., 2002; Jagus & Benbow, 2002). Nonetheless, in the face of impending loss, it has been posited that caregivers of patients with AD may feel motivated to maintain sexually intimate relationships with their partners to preserve the sense of warmth, closeness, affection, and intimacy that had characterized the relationship prior to diagnosis (Davies, Zeiss, Shea, & Tinklenberg, 1998). Despite initial losses in cognitive functioning and

memory, many patients with AD remain emotionally warm and affectionate toward their partners. Because patients with AD may forget the sequences of lovemaking or become distracted during vaginal intercourse, couples may engage in alternate forms of physical intimacy such as hugging, kissing, and massaging (Davies et al., 2012).

With disease progression, however, the nature of the marital relationship typically changes. Caregivers, and particularly female caregivers, report that the relationship becomes more akin to that of parent and child. Caregivers may therefore lose a sense of sexual intimacy with their partners and develop an aversion to sexual engagement with them (Duffy, 1995), with consequent decline in sexual satisfaction (Davies et al., 1998). Among female caregivers, lower sexual satisfaction has been found to correlate with higher caregiver burden (Dourado et al., 2010) and more depressive symptoms (Davies et al., 2012). Researchers have yet to examine the directionality of the association of sexual satisfaction with depression and burden.

Although researchers have studied sexual functioning in AD, relatively little is known about sexual functioning in FTD, let alone the behavioral variant of FTD. Case reports document that patients with FTD display hypersexuality or inappropriate sexual behavior (Mendez & Shapira, 2011; Perry et al., 2014; Poetter & Stewart, 2012; Reeves & Perry, 2013), although these symptoms do not appear to be common in FTD (Ahmed et al., 2015; Miller et al., 1995). In contrast to assumptions of hypersexuality, early behavioral symptoms of FTD but not AD include hyposexuality, in part attributable to neural loss in the frontal and temporal lobes (Miller et al., 1995). Among 14 patients with FTD and 14 patients with AD, patients with FTD (54%) were more likely than patients with AD (23%) to lose all interest in sexual activity. In a more recent study documenting specific dimensions related to hyposexuality (Ahmed et al., 2015), patients with bvFTD in comparison to patients with AD displayed significantly less affection toward their partners, less initiation of sexual activity with their partners, fewer responses to sexual overtures by their partners, and lower frequency of sexually intimate activity with their partners. Although patients with AD also showed decreases in their sexual initiation behaviors over time, they nonetheless tended to respond positively to overtures from their partners and remained capable of giving and receiving affection. In sum, patients with bvFTD show profound changes in sexual functioning that may negatively impact their intimate relationships.

Performance Measures

Although the literature above suggests the importance of understanding sexual function as people age, and the strong effects of dementia on sexual function, researchers to date have not tended to use the gold standard of assessment—performance-based measures. That is, a large literature validates measures of sexual reactivity to erotic stimuli in the laboratory, but these assessment tools have been rarely applied to understanding sexual function in older adults or patients with dementia.

Laboratory methods used to measure sexual reactivity include physiology, facial behavior, and self-reported affective response. The laboratory studies have used a broad range of erotic stimuli (e.g., Laan & Everaerd, 1995; Murnen & Stockton, 1997), including erotic narratives conveyed either in written or spoken format (e.g., Schmidt, Sigusch, & Schäfer, 1973), self-generated fantasy (e.g., Brody, Laan, & van Lunsen, 2003), pictures (e.g., Janssen, Everaerd, Spiering, & Janssen, 2000; Sigusch, Schmidt, Reinfeld, Wiedemannsutor, & Klein, 1970), and erotic films (e.g., Janssen, Carpenter, & Graham, 2003). Many studies examine gender differences in response patterns, while others examine patterns of response solely within groups of women or groups of men.

Physiological underpinnings of sexual reactivity. Sexual reactivity to erotic stimuli is distinct from the study of emotional reactivity to non-erotic stimuli in that sexual arousal signals can include moaning and body movements that accompany orgasm (Janssen & Everaerd, 1993), as well as increased blood flow to the genitals (Levin & Riley, 2007). Other channels of measurement overlap, including positive facial expressions (smiling), and general physiological markers of autonomic nervous system (ANS) activity (Janssen et al., 2000).

Broadly defined, the ANS regulates involuntary bodily functions such as heart rate, respiration, digestion, and sexual arousal. It has two branches: the sympathetic nervous system (SNS) and the parasympathetic nervous system (PNS). The SNS is considered responsible for actions such as heart rate acceleration, increases in blood pressure, contraction of the sphincter muscles, and reduced intestinal motility, whereas the PNS is considered responsible for actions such as heart rate deceleration, decreases in blood pressure, relaxation of the sphincter muscles, and increased peristalsis. Sexual arousal reflects an interplay of activation between the SNS and PNS, in which neither system dominates (e.g., Wenger, Averill, & Smith, 1968; Zuckerman, 1971).

During sexual arousal, an acceleration in heart rate and an increase in blood pressure allow for the increase in blood flow to the genitals (Levin & Riley, 2007). In one model of sexual arousal, Masters and Johnson (1966) conceptualized sexual arousal as including four phases: excitement, plateau, orgasm, and resolution. The pattern of autonomic response has been observed to fluctuate throughout the phases of arousal (Wenger, Averill, & Smith, 1968; Zuckerman, 1971). That is, the excitement phase is defined by vaginal lubrication increases in women and penis size increases in men, indicative of PNS and SNS activation. In the plateau phase, the SNS plays an increasing role and elicits hyperventilation, increased blood pressure and muscle tension. With the orgasmic phase comes involuntary muscle contractions, another characteristic of SNS activation. In the resolution phase, the PNS was observed to become more active as blood pressure decreases and muscles relax.

In a modification of the Masters and Johnson model of sexual arousal (Masters & Johnson, 1966), Levin (2001) added a new phase—sexual desire—and moved the plateau phase into the excitement phase. Regarding sexual desire, he rationalized that sexual arousal must be ignited—either spontaneously or in response to sexual stimulation. Regarding the plateau phase, Levin argued that the plateau phase is an extension of the excitement phase, and that it is marked by growing sexual arousal.

Research on ANS correlates of sexual reactivity to erotic stimuli has largely focused on genital response measures and to a lesser extent on other correlates such as heart rate, skin conductance, and blood pressure. One of the most direct ways to measure sexual arousal is through genital response measures: the vaginal photoplethysmograph for vaginal pulse amplitude (VPA) and the mercury-in-rubber electromechanical penile strain gauge for penile circumference, an index of erection (Julien & Over, 1988; Koukounas & McCabe, 2001), and more recently, thermography. Thermography is a newer psychophysiological method that assesses blood flow to the genitals through temperature change (Huberman & Chivers, 2015).

Multiple studies have examined how various forms of erotic stimuli (e.g., written or spoken erotic narratives, self-generated fantasy, erotic pictures or films) induce sexual arousal, as assessed by genital response measures and self-reported affective response (Both, van Boxtel, Stekelenburg, Everaerd, & Laan, 2005; Bradley, Codispoti, Sabatinelli, & Lang, 2001b; Heiman, 1980; Julien & Over, 1988; Koukounas & McCabe, 2001; Laan, Everaerd, van Bellen, & Hanewald, 1994; Sarlo, Palomba, Buodo, Minghetti, & Stegagno, 2005). Typically, visual films

evoke more sexual arousal than do other erotic stimuli. In one study, researchers found that as the intensity of an erotic film increased, so did VPA in women (Both et al., 2005). Similarly, another group of researchers found that the more arousing male participants found an erotic film, the more physiological sexual arousal they experienced in comparison to the non-erotic film as measured by the mercury-in-rubber strain gauge. Using the same strain gauge measure, researchers found that viewing erotic films produced greater physiological sexual arousal in men than imagining the filmed sexual encounter they had just viewed (Koukounas & Over, 1997). Researchers similarly found that women experienced significantly greater VPA reactivity to erotic films than to self-generated fantasies (Heiman, 1980).

Across studies women tend to experience sexual arousal more diffusely in their bodies; that is, less directly in their genitals. Accordingly, one researcher has asserted that genital measures of sexual response might not fully capture women's physiological arousal (Singer, 1984). Consequently, there is a need to integrate additional peripheral autonomic measures into studies to capture important information that might otherwise be missed.

Some studies of sexual reactivity have employed peripheral autonomic measures such as heart rate, skin conductance, and blood pressure (as opposed to genital response measures), parallel with the large literature on emotional reactivity to non-erotic stimuli. Researchers have found that among women and men, erotic images produced greater initial heart rate deceleration (as measured using peripheral indices as well as VPA among women [Heiman, 1980]), and larger changes in skin conductance response and blood pressure than do non-erotic images (e.g., threat, sport/adventure, household items, blood). In addition, women showed a greater decrease in heart rate compared to men at initial viewing of the stimulus, and men showed a significantly greater increase in blood pressure compared to women (Bradley, Codispoti, Cuthbert, & Lang, 2001a; Bradley et al., 2001b; Lang, Greenwald, Bradley, & Hamm, 1993; Sarlo et al., 2005).

Facial behavior. Research on facial behavior reactivity to erotic stimuli has largely focused on healthy young adults viewing erotic pictures from the International Affective Picture System (Lang et al., 1988). Researchers tend to use facial EMG and not facial behavioral coding systems such as the Expression Emotion Behavior Coding System (Gross & Levenson, 1993) or the Facial Action Coding System (Mograbi, Brown, Salas, & Morris, 2012) to measure facial behavior. Across studies, more pleasant pictures tend to activate greater zygomatic (smile muscle) activity and more unpleasant pictures tend to activate greater corrugator (frown muscle) activity (e.g., Lang et al., 1993). I am unaware of any studies of sexual reactivity using pictures or erotic films that have coded emotions displayed in facial expressions (e.g., happiness, confusion, interest, embarrassment; Gross & Levenson, 1993).

A number of studies have found that among women and men, erotic pictures generated larger EMG changes in the corrugator muscle, a response that is often observed in response to unpleasant pictures (Lang et al., 1993). Although sexual stimuli do tend to evoke increased activity of the zygomatic muscle (involved in smiling), the level of activity is generally less than that observed for non-erotic pictures (Bradley et al., 2001a, 2001b).

In this work, important gender differences have been observed. When presented with erotic pictures, women displayed a mix of motivations. They showed increased corrugator activity, indicative of aversive stimuli and at the same time, expressed feelings of amusement and embarrassment. Men expressed feeling excited and sexy (Bradley et al., 2001b). The researchers interpreted these gender-differences as reflecting motivational and sociocultural influences. That is, women tend to generally behave more reactively (measured by self-reported affective response and facial behavior) toward aversive stimuli, as opposed to the appetitive

motivational system. Men on the other hand, appeared to be more reactive toward appetitive cues that were erotic in nature. The researchers hypothesized that sociocultural expectations could have influenced gendered self-reported affective response and facial behavior to specific kinds of stimuli, such that women did not display facial behavior that is typically shunned in women but accepted and expected in males (Bradley et al., 2001b).

Taken together, a large literature supports the validity of performance-based measures of reactivity to erotic stimuli. Physiological and facial behavior correlates of sexual reactivity are well-characterized. Laboratory studies of sexual reactivity have traditionally used genital response measures, but peripheral autonomic measures such as heart rate and skin conductance are less intrusive and also have been validated as indicators of sexual reactivity. This is important, given that peripheral physiology indices are less intrusive and so may be more acceptable to research participants.

The Present Study

Despite the slow rise in the number of studies, many gaps remain in understanding sexual functioning and its effects across different forms of neurodegenerative diseases. For example, researchers have not yet used laboratory measures of sexual response (e.g., physiological, facial behavior, self-reported affective response) to erotic films in patients with neurodegenerative diseases. Indeed, little work has used these methods in older adults. This gap is notable in that research using laboratory measures have enhanced understanding of which facets of emotional reactivity to non-erotic stimuli are most affected by dementia (Eckart, Sturm, Miller, & Levenson, 2012; Goodkind et al., 2015; Sturm et al., 2006; Werner et al., 2007). To better understand sexual functioning in neurodegenerative diseases, physiological and facial behavior measures must be integrated. To measure physiology in a manner that is less intrusive, this study employs peripheral physiology as an index of sexual reactivity.

The present study addresses gaps in the literature by using a multi-method assessment of reactivity to sexual stimuli that includes objective, laboratory measures (i.e. physiological, facial behavior, self-reported affective response) of reactivity in patients with dementia and in similarly-aged individuals without neurodegenerative disease. These three discrete multi-modal measures will be compared across bvFTD, AD, and a comparison control sample of healthy adults. In addition, I will examine whether this multi-modal battery of reactivity to sexual stimuli is related to spousal caregiver depression and spousal caregiver marital satisfaction in a larger sample of patients with neurodegenerative diseases.

Ultimately, enhancing our knowledge of sexual functioning within neurodegenerative diseases, such as bvFTD and AD, will allow us to offer caregivers more information about their loved ones' sexual functioning. At the current time, little research base is available to guide dementia care in this area. The current study aims to provide information on how sexual functioning relates to caregiver mental health and wellbeing, and preservation of the marital relationship.

Aims

The present study has two aims. The first aim is to examine diagnostic group differences in sexual reactivity to an erotic film. The second aim is to determine whether reduced sexual reactivity (measured in the laboratory) is related to greater caregiver depression and to lower

caregiver marital satisfaction, and whether caregiver reports of reduced patient sexual behavior mediate these relationships.

Study 1: Comparisons of Patients with bvFTD, AD, and Healthy Controls

To assess diagnostic group differences in response to an erotic film, I compared physiological, facial behavior, and self-reported affective responses to an erotic film in patients with bvFTD, AD, and HC. For HC, in high arousal contexts, regardless of valence (e.g., pleasant/appetitive or unpleasant/aversive), HC show an acceleration in heart rate (after an initial deceleration) and increased skin conductance (Balconi, Brambilla, & Falbo, 2009). This pattern also holds when HC are exposed to erotic visual stimuli (Bradley et al., 2001a; Lang et al., 1993). Drawing on literature indicating that bvFTD is related to apathy, emotional blunting, hyposexuality, and loss of affection and warmth toward loved ones, it is likely that these characteristics would diminish responses (physiological, facial behavior, self-reported affective response) to the erotic film. Such impairments have not been found in patients with AD. That is, researchers who have examined emotional functioning have found that patients with AD do not differ significantly from HC (e.g., Goodkind, Gyurak, McCarthy, Miller, & Levenson, 2010; Goodkind et al., 2015; Lavenu, Pasquier, Lebert, Petit, & Van der Linden, 1999). Accordingly, it is hypothesized that patients with bvFTD will show diminished reactivity to sexual stimuli (i.e., slower heart rate and decreased skin conductance) in comparison to HC, and that patients with AD will show reactivity to sexual stimuli similar to HC.

Method

Participants
Dementia patients were drawn from a study of dementia and emotions, and caregivers who served as healthy controls (HC) were drawn from a concurrent study of caregiving at the Berkeley Psychophysiology Laboratory (BPL) between 2012 and 2016. Participants (bvFTD = 3; AD = 2; HC = 1) who asked to have the erotic film stopped once it began were excluded from current analyses, leaving data for the current analyses from 50 participants: 18 diagnosed with bvFTD, 9 with AD, and 23 HC. Most participants reside in California, although some traveled to UCSF and the BPL from other states.

Procedure
The Memory and Aging Center (MAC) at the University of California, San Francisco recruited patients and caregivers. Dementia patients completed comprehensive neurological, cognitive, and neuroimaging testing and received a diagnosis using consensus criteria for bvFTD (Rascovsky et al., 2011) and AD (McKhann et al., 1984). All patients were accompanied to the study by a caregiver who took part in separate measures not discussed as part of study 1. Accompanying caregivers in this study were primarily spouses of the patients, however, siblings, other relatives, or friends served as caregivers when spouses were not present.

HC were selected from a larger sample of caregivers of patients with a variety of neurodegenerative diagnoses including bvFTD, AD, Parkinson's disease, corticobasal degeneration, and progressive supranuclear palsy. They were all spouses of patients, with the exception of one HC, who was the sister of a patient. Caregivers who scored a 5 or below (scores range from 0 to 60; a score of 16 or higher is considered clinically significant) on the Center for

Epidemiologic Studies Depression Scale (CES-D; Radloff, 1977) were assigned to the healthy control group. Prior research has shown that one of the most pronounced negative outcomes of caregiving for patients with dementia, particularly with bvFTD, is increased depression (Boutoleau-Bretonniere et al., 2008; Kaiser & Panegyres, 2006; Mioshi et al., 2013a, 2013b; Riedijk et al., 2006), which could limit sexual responsivity. By choosing caregivers with little or no self-reported depression (caregiver depression scores ranged from 0 to 44 with a mean of 11.63), we aimed to capture a group of caregivers that would be similar to healthy adults who are not caregivers of patients with neurodegenerative diseases.

Upon arrival at the BPL, a graduate student experimenter reviewed the written consent forms with patients and caregivers (approved by the Committee for Human Subjects at the University of California, Berkeley), and both patients and caregivers signed the consent forms. The graduate student experimenter then described the schedule for the day. Patients and caregivers were informed that in the morning, patients and caregivers would be assessed in separate experiment rooms. After lunch, both patients and caregivers would be assessed on a task that required patients and caregivers to have a conversation with one another in an experiment room. After the conversation, patients and caregivers would be assessed in separate rooms again. With the exception of an interview conducted to evaluate patient insight, both patients and caregivers completed parallel tasks throughout the day.

The patients and caregivers then began the 6-hour laboratory session that consisted of a comprehensive assessment of emotional reactivity, emotion regulation, and emotion recognition (Levenson et al., 2008). At the start of the session, research assistants attached non-invasive physiological sensors to patients (see below). Participants were seated so that their upper body and face could be visually recorded by a partially concealed video camera. These recordings were used to code facial behavior at a later time (see below).

Participants watched a series of seven films (two of which are the focus here). To assess participants' mood before the experimental protocol and after each film clip, patients were asked to rate their emotional state using a 16-item self-report emotion scale that covered (a) the emotion the participant was feeling most strongly in that moment, (b) whether the participant felt "good," "neutral," or "bad," and (c) the extent to which the participant felt the following emotions: affectionate, afraid, amused, angry, ashamed, calm, disgusted, enthusiastic, embarrassed, proud, sad, sexually aroused, and surprised on a scale of "no," "a little," or "a lot."

Before the start of each film, participants were instructed to look at the black X on the screen and relax for a 1-minute baseline period. They were then instructed (visually and via audio if patients appeared to be slow readers) to watch the film and say stop if they needed the film stopped. After each film, a second black X appeared on the screen for a 1-minute resting period. After each resting period, participants responded to the 16-item self-report emotion scale described above, as well as a question that tested memory of the film clip just viewed. This question assessed for memory impairments, which could adversely affect reactivity scores.

At the end of the laboratory session, participants stipulated the extent to which their videotape records could be used for research and other purposes (e.g., in future talks to a research audience, to show the general public on television). At the end of the day, couples were paid $120.

Films. The present study focuses on data from two short film clip tasks: one intended to evoke amusement and a second intended to evoke sexual arousal. The amusement film was always the first film shown in a series of seven films, and the erotic film was the sixth film shown. The second to fifth film clips were chosen to evoke feelings of sadness and disgust (3

film clips). Each film clip was intended to evoke physiological activation and facial behavior in healthy adults.

The amusement film clip is from an episode of the television show *I Love Lucy* (110 seconds in length). The clip depicts the main character Lucy and her best friend Ethel on their first day of work at a chocolate factory. They stand in front of a conveyor belt, tasked with hand wrapping pieces of chocolate candy as the chocolates move toward them on the conveyor belt. Assuming the task is easy, Lucy and Ethel take their time wrapping the chocolates, using grand hand flourishes, smiling gaily, and exclaiming how fun and easy they find this job. Gradually the speed of the conveyor belt increases and Lucy and Ethel must hurry to wrap the pieces of chocolate. Overwhelmed, they begin to stuff chocolates down the front of their shirtdresses, under their chefs' hats, and even into their mouths. When their supervisor checks on them and sees that they are doing a fine job (although Lucy and Ethel cannot talk because of their stuffed mouths; they can only nod their heads), she bellows to an unseen worker in the back to "Speed 'em up!" and the chocolates appear at an even higher speed than before.

The sexual arousal film clip (75 seconds in length) depicts a newlywed couple (at the start of the clip the bride is wearing her bridal veil) making love in a sun-drenched room to the sounds of a saxophone playing in the background. The film clip (a) shows the couple kissing and caressing one another, (b) intimates that the groom intends to perform oral sex on the bride, and (c) depicts the simulation of vaginal intercourse. It ends with the couple lying in one another's arms looking satiated with the bridal gown lying on the floor in the foreground and the bridal veil hanging above the headboard.

Apparatus

Audiovisual. Video cameras recorded participants' upper body movement and facial behavior. Microphones placed on participants' clothing recorded their voices.

Physiology. A 23-channel BIOPAC system connected to a computer system with analog-to-digital capability. It was used to monitor and collect physiological data.

Measures

Physiology. A BIOPAC polygraph and a computer recorded twelve physiological measurements of analog ANS activity continuously. A program designed by Robert W. Levenson monitored and calculated second-by-second averages for the measures used in this study: (a) interbeat interval (IBI) for heart rate was computed according to the number of milliseconds between succeeding R waves, using electrodes placed on opposite sides of a participant's abdomen; and (b) skin conductance level (SCL): a constant-voltage device calculated skin electrical conductance to transmit voltage between two electrodes secured on the ring and index fingers of the non-dominant hand to measure the sweat response. IBI and skin conductance were chosen as the most commonly employed indices of autonomic nervous system activity in previous laboratory studies of sexual arousal (Bradley et al., 2001a, 2001b; Lang et al., 1993; Sarlo et al., 2005).

In addition to the physiological variables relevant to this study, additional physiological measures were gathered. These included (c) finger pulse amplitude (d) finger pulse transmission time, (e) ear pulse transmission time, (f) systolic blood pressure and (g) diastolic blood pressure, (h) finger temperature, (i) respiration intercycle interval, (j) respiration depth, (k) overall movement in the participant's chair, and (l) respiratory sinus arrhythmia (RSA). Although RSA

is interesting given the PNS effects observed in the sexual arousal cycle, too many artifacts were observed in the RSA data in the current sample to allow analyses.

Before each film, participants completed a 60-second rest period. The data were collected second-by-second throughout the rest period and the film. Visual inspection of data was conducted and documented to note any irregularities and to alert the individuals who would later clean the data using a data cleaning program developed by BPL (Levenson, 2014). Outliers (i.e., absolute z values more than 5) across baseline and the film clip were flagged and removed using the data cleaning program. Absolute z values up to 5 are included in studies from BPL to account for the range of physiological responses typically seen in patients with dementia, which can encompass a broader range of values than what is typically observed in HC (Eckart, Sturm, Miller, & Levenson, 2012; Goodkind et al., 2015; Sturm et al., 2006; Werner et al., 2007). The data cleaning program allowed for visual inspection before and after the cleaning process to ensure the visual depiction of the data was aligned with that of a cleaned dataset. Missing data that were shorter than 10 seconds were imputed by interpolating adjacent (i.e., pre-missing and post-missing) data points. If a participant's IBI or SCL recording were missing more than 25% of its data, that participant was not included in the study.

Visual inspection of the physiological data suggested the last 10 seconds of the rest period were relatively stable as compared to other periods within the rest period, and so this period was chosen as the baseline period. For both IBI and SCL, reactivity scores were calculated by taking the average obtained during the 10-second baseline and subtracting it from the average obtained during the 75 seconds of the film. This time frame accommodated the longer latency and duration of responses that are typical of physiological responses (Fredrickson & Levenson, 1998; Werner et al., 2007). Because lower scores for IBI correspond to increased activation, each score for IBI was multiplied by negative one. For both IBI and SCL reactivity, higher scores correspond to increased activation.

IBI and SCL values were normalized through a z-transformation, and then averaged to create a physiological composite score (e.g., Eckart et al., 2012; Sturm, Ascher, Miller, & Levenson, 2008; Sturm et al., 2013; Werner et al., 2007). Physiological composite variables have been used to reduce the number of dependent variables and related Type I error in previous studies of emotional functioning in frontotemporal dementia (e.g., Eckart et al, 2012; Sturm, Ascher, Miller, & Levenson, 2008; Sturm et al., 2006). In the multi-item scale development literature, a distinction is made between reflective and formative measures (e.g., Christophersen & Konradt (2008); Diamantopoulos & Winklhofer, 2001). Unlike reflective measures, which are considered interchangeable, formative measures are considered to be different indicators of a theoretical concept. Because a formative scale is developed based on a concept, it is not a given that its items will correlate (Diamantopoulos & Winklhofer, 2001). Moreover, Nunnally and Bernstein state that "internal consistency is of minimal importance because two variables that might even be negatively related can both serve as meaningful indicators of a construct" (1994, p. 489). Although the physiological composite in the present study was developed as a formative measure concept, its internal consistency was nonetheless assessed. The Cronbach's alpha reliability coefficient for the physiological composite for the erotic film (IBI and SCL) was .25.

Facial behavior. Trained coders unaware of participant diagnosis, the content of the film, and the research hypotheses coded participants' facial behavior using the Emotional Expressive Behavior coding system (Gross & Levenson, 1993) during the most intense 30 seconds of each film clip (scenes thought to elicit the greatest emotional response) as determined by a panel of experimenters. The most intense 30 seconds of the erotic film included scenes in

which the couple was engaged in intercourse, and the groom was moving his head toward the bride's nether regions to engage in oral sex. For the amusement film, the most intense 30 seconds included the scene that garnered the most laughs from the panel and the live audience that had viewed the scene, starting with the context-providing scenes. Raters coded intensity of ten emotional behaviors: anger, concern/confusion, contempt, disgust, embarrassment, fear, happiness, smiles, interest, sadness, and surprise. For each second, coders rated the intensity of each emotion on a scale from 0 (not present) to 3 (highest level of intensity). The inter-rater reliability for all the files was κ = .75.

A mean was calculated for each of the 20 facial behavior codes (e.g., happiness, interest, face tilt, yawn, etc.) for each participant by summing the intensity scores (0-3) for each second of the most intense 30 seconds then dividing by the total number of seconds in the film's most intense 30 seconds. Consequently, each participant had one score for each facial behavior per film. A participant could receive a score of zero, indicating that that particular facial behavior had not occurred. As the erotic film clip is considered a positive emotion film, the target facial behaviors for the sexual arousal film were happiness and interest. No participants displayed facial expressions of interest, and so only facial expressions of happiness were used in analyses.

Self-reported affective response. After viewing the film, participants were asked a series of questions and were instructed to say their answers aloud. The first question asked was open-ended: "What emotion did you feel most strongly while watching the film?" Responses were coded on a scale of 0 to 2, to the extent to which they fit the target response (e.g., "sexual arousal" for the erotic film). Responses were coded as 0 if they did not relate valence-wise or directly to the target response of the film; for example, if the participant responded "angry" for the erotic film. If the response was generally related to the target response (e.g., "good"), the response was given a score of 1. If the response was directly related to the target response (e.g., "passionate" for the erotic film), the response was given a score of 2. After the open-ended question, participants were then asked to choose whether the film made them feel "good," "neutral," or "bad," data which were not examined here. Participants were then instructed to state the extent to which they felt each of the following emotions as they watched the film: affectionate, afraid, amused, angry, ashamed, calm, disgusted, enthusiastic, embarrassed, proud, sad, sexually aroused, and surprised, using a 3-point Likert scale (0 = no, 1 = a little, 2 = a lot). The target emotional response for the amusement film was "amused." The target emotional response for the erotic film was "sexually aroused." Values for the open-ended response variable and the forced-choice response variable were averaged to create a self-reported affective response composite score. The Cronbach's alpha reliability coefficient for the self-reported affective response composite for the erotic film was .38.

Memory. To consider potential confounds from memory, participants were asked a multiple-choice question at the end of each film. The question started with, "What happened in the film?" The choices for the erotic film were: "A: A man and a woman have a talk;" "B: A woman vacuums;" and "C: A man and a woman make love." Every participant responded correctly to the question for the erotic film and for all of the other six films on this probe.

Dementia Severity. Trained staff members of the MAC administered the Clinical Dementia Rating (CDR; Morris, 1993), a structured interview designed to assess disease severity, to caregivers who reported on the functioning of their spousal dementia patients. A structured interview, the CDR evaluates 6 areas of daily functioning (memory, orientation, judgment and problem solving, community affairs, home and hobbies, and personal care). The CDR box score was calculated by adding the subscores from each domain (range of scores: 0 to

18, higher scores indicate greater impairment). The Cronbach's alpha reliability coefficient for the CDR box score was .87.

Data Analysis Plan

       The Statistical Package for the Social Sciences (SPSS, Version 22) was used for statistical analyses.

       Preliminary analyses. To begin, analyses were conducted to consider whether groups were well-matched demographically. To compare the ages of patients with bvFTD, AD, and HC, I used analyses of variance (ANOVA). To assess whether diagnostic groups were matched on gender and racial background, I used two chi-square tests. To assess whether the dementia groups (bvFTD and AD) were matched on dementia severity (CDR), I used an independent-samples t-test.

       Given research suggesting that women show more muted facial behavior and subjective affective responses to erotic film clips than men do (Kring & Johnson, 2018), three MANOVAs were computed to examine physiological, facial behavior, and self-reported affective responses and to assess whether gender might interact with diagnostic group status. In each MANOVA, gender and diagnostic group (bvFTD, AD, and HC) were considered as between-subject variables, and film clip as a within-subjects variable.

       Before considering reactivity to the erotic film clip, it was important to test whether the erotic film clip evoked responses that differed from another positively valenced film clip —an amusement film. I sought to ascertain whether participants' responses to sexual stimuli would distinguish themselves from the same participants' responses to a more generically-themed positively valenced film. It also seemed important to test whether film type (erotic, amusement) might interact with diagnostic group status. To do so, I used three separate, parallel repeated measures mixed ANOVAs to assess the DVs of the physiological composite variable (IBI and SCL), facial behavior variable (happiness), and self-reported affective response composite variable (open-ended and forced-choice responses). Film type (erotic, amusement) constituted the within-subjects factor and diagnostic group (bvFTD, AD, and HC) constituted the between-subjects factor.

       Diagnostic group differences. To test hypotheses, I used three separate, parallel one-way univariate ANOVAs to assess diagnostic group differences in response to the erotic film. Three parallel ANOVAs were used to assess the dependent variables of the physiological composite variable (IBI and SCL), the facial behavior variable (happiness), and the self-reported affective response composite variable (open-ended and forced-choice responses). For each, the independent variable (IV) was diagnostic group: bvFTD, AD, and HC. Planned simple contrasts compared patients with bvFTD versus HC and patients with AD versus HC. Eta squared statistics are reported as a measure of effect size. Eta squared values are considered small effects in the range of .01-.05, medium effects in the range of .06-.13, and large effects in the range of .14-.80 (Fritz, Morris, & Richler, 2011).

Results

Preliminary Analyses

       Table 1.1 summarizes the sociodemographic characteristics of each group. The average age across the three groups was 65.8 years ($SD = 8.7$). Most participants were White/Caucasian (92%). Analyses revealed no significant age ($F(2,47) = .71$, $p = .50$), race ($\chi^2(6) = 6.75$, $p = .35$),

or gender $(\chi^2(2) = .65, p = .72)$ differences among the three groups. The independent-samples t-test revealed dementia severity was significantly higher in the patients with bvFTD compared to the patients with AD $(t(25) = 2.08, p = .048, d = .90)$.

Tests were conducted to assess whether gender might interact with diagnostic group status. No interactions of Gender x Diagnostic Group were significant, all p's > .05, all $\eta^2 < .13$. Accordingly, gender was not included in tests of hypotheses.

Tests were also conducted to assess whether there were any differences in response to the erotic film in comparison with an amusement film, and whether film type (erotic, amusement) might interact with diagnostic group status. No differences between film type and no interactions of Film Type x Diagnostic Group were significant, all p's > .05, all $\eta^2 < .13$. Accordingly, the amusement film was not included in tests of hypotheses.

Descriptive Statistics

Descriptive characteristics of the physiological composite, facial behavior (happiness), and self-reported affective response composite variables for the erotic film and the amusement film are shown in Table 1.2. Descriptive characteristics of the component parts of the physiological composite (IBI, SCL) and self-reported affective response composite (open-ended, forced choice response) variables for the erotic film and the amusement film are shown in Table 1.3. Physiological reactivity and self-reported affective response variables for both the erotic and amusement films, and the facial behavior variable for the amusement film displayed roughly normal distributions, including estimates of skewness and kurtosis. As noted above, outliers for physiological reactivity—z-values above 5—were removed prior to analysis during the data cleaning process (Levenson, 2014). Therefore, any physiological values identified as outliers by SPSS (z-values between 3 and 5) were not adjusted for in the hypothesis testing process. No outliers for self-reported affective response were identified by SPSS.

The facial behavior (happiness) variable for the erotic film displayed a normal estimate of skewness, but a high level of leptokursis, 21.97 (S.E. = .34). Review of the data revealed that 40 of the 45 participants showed no facial expression of happiness during the erotic film. No transformations would address this low base rate, and so non-transformed data were used in analyses.

Tests for whether data were missing completely at random were conducted using Little's MCAR test (Little, 1988), and indicated that the data were missing completely at random. Multiple imputation was conducted using SPSS to address missing data associated with the erotic film (1 case for IBI, 2 cases for SCL, 5 for facial behavior, and 1 for self-reported affective response: open-ended response) and with the amusement film (2 cases for IBI, 2 cases for SCL, and 4 cases for facial behavior). Missing values were probabilistically calculated using regression parameters. The imputation process was conducted five times, resulting in five different datasets. Pooled estimates were created according to Rubin's (1987) rules, in which point estimates for model parameters are estimated in each dataset and then averaged.

Correlations

Correlations across channels are shown in Table 1.4. Correlations between the primary variables related to the erotic film and the variables related to the amusement film are displayed. The variables were unrelated to each other. Potential curvilinear relationships between corresponding variables from the two types of films (erotic, amusement) were considered by conducting three separate, parallel hierarchical multiple regression analyses. In the first step, the

three response variables (physiology, facial behavior, self-reported affective response) for the erotic film served as the DVs. The corresponding response variables for the amusement film served as the IVs. In the second step, the squared values (representing the quadratic function) of the response variables for the amusement film served as the IVs. All three of the linear regression models (step 1) were statistically nonsignificant (all p's > .05). The nonlinear additions to the three regression models (step 2) were also all statistically nonsignificant (all p's > .05).

Diagnostic Group Analyses

For each channel (physiology, facial behavior, and self-reported affective response), the following hypothesis was tested: Patients with bvFTD would be less reactive than HC in response to the erotic film, and patients with AD would show a physiological response commensurate with HC.

To test this hypothesis, I used three separate, parallel one-way univariate ANOVAs with the three response variables (physiology, facial behavior, self-reported affective response) for the erotic film as the DVs. Diagnostic group (bvFTD, AD, HC) served as the IV. Planned simple contrasts were used to examine differences between patients with bvFTD and HC and differences between patients with AD and HC. Table 1.2 summarizes the DV means of each group. Table 1.3 summarizes the raw score means of the component parts of the composite variables (IBI and SCL for the physiological composite, open-ended and forced choice responses for the self-reported affective response composite).

Physiology. A nonsignificant Levene's Test of Equality of Error Variance ($F(2,47) = .30$, $p = .75$) indicated that the assumption of equality of variances for the physiological composite for the erotic film across diagnostic groups was met. The univariate ANOVA with the physiological composite (IBI, SCL) as the DV and diagnostic group as the IV showed a statistically significant diagnostic group difference in the erotic film ($F(2, 47) = 3.47$, $p = .04$, $\eta^2 = .13$). Planned simple contrasts revealed that patients with bvFTD differed significantly in physiological response from HC ($p = .01$) and patients with AD did not differ significantly from HC ($p = .31$).

Given the significant difference between the two dementia groups in dementia severity, noted in the preliminary analyses section, I conducted tests to evaluate whether dementia severity could explain significant group differences in response to sexual stimuli. Within the two dementia groups, the correlation of dementia severity with physiological reactivity was calculated, $r(27) = -.17$, $p = .43$. Given the null effects, no further tests were conducted to assess dementia severity as a potential confound.

Facial behavior. A statistically significant Levene's Test of Equality of Error Variance ($F(2,47) = 7.82$, $p < .01$) indicated that the assumption of equality of variances for the physiological composite for the erotic film across diagnostic groups was not met. The univariate ANOVA with the facial behavior of happiness as the DV and diagnostic group as the IV showed no statistically significant diagnostic group difference in the erotic film ($F(2, 47) = 1.70$, $p = .19$, $\eta^2 = .07$). Planned simple contrasts revealed that patients with bvFTD did not differ significantly from HC ($p = .46$) and patients with AD did not differ significantly from HC ($p = .09$).[2]

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[2] Given previous work showing that embarrassment is a common response to viewing erotic film clips in laboratory settings, exploratory analyses were conducted to examine levels of embarrassment by group. No significant differences between diagnostic groups were observed during the erotic film clip, $F(2,42) = 2.10$, $p = .14$, and base rates were generally low, mean across groups = .0004, $SD = .002$.

Self-reported affective response. A nonsignificant Levene's Test of Equality of Error Variance ($F(2,47) = 2.44$, $p = .10$) indicated that the assumption of equality of variances for the self-reported affective response composite for the erotic film across diagnostic groups was met. The univariate ANOVA with the self-reported affective response composite (open-ended and forced choice responses) showed no significant diagnostic group differences in self-reported affective response to sexual arousal ($F(2, 47) = .03$, $p = .98$, partial $\eta^2 = .001$). Planned simple contrasts revealed that patients with bvFTD did not differ significantly from HC ($p = .87$) and patients with AD did not differ significantly from HC ($p = .99$).[3]

Discussion

The goal of study 1 was to examine how patients with bvFTD in comparison with patients with AD and HC would respond to an erotic film using objective, non-invasive laboratory tests. It was hypothesized that bvFTD would show blunted physiological, facial behavior, and self-reported affective response to an erotic film as compared to HC, whereas those with AD were expected to show intact reactivity, comparable to HC. This study took a multi-modal assessment approach. Bivariate correlations indicated that there was little correspondence across physiological, facial behavior, and self-reported affective responses to the erotic film clip. Separate analyses were conducted to examine these three channels.

Consistent with the hypothesis, patients with bvFTD showed significantly lower physiological arousal as evidenced by a composite of heart rate deceleration and decreased skin conductance in contrast to HC. The group effect size for the erotic film was at the upper end of the medium range. Although patients with bvFTD scored significantly higher than those with AD in dementia severity, dementia severity was not significantly related to physiological response and so did not appear to be a confound. Although the current study is novel in examining sexual reactivity, this finding fits with recent findings that patients with FTD react with lower physiological arousal to a variety of stimuli (Balconi et al., 2015; Joshi et al., 2014).

Contrary to my hypothesis, neither facial behavior now self-reported affective response differentiated groups. Indeed, responses to the erotic film were not significantly larger than responses to the amusement film, overall or for specific groups. One possibility is that larger responses would have been observed if the erotic film had not been the sixth film for participants to view. Although one possibility is that the nature of the stimulus was not powerful enough, specific issues may have interfered with the sensitivity of the facial behavior and self-reported affective response channels.

Regarding facial behavior, no more than 2 participants in any group showed facial expressions of happiness in response to the erotic film clip. Although not a primary hypothesis, embarrassment expressions were similarly low frequency. The low rate of positive facial behavior constrained the utility of my novel methodological approach. In many ways, the low rates of smiling are not surprising, given that participants sat in a chair connected to physiological sensors, aware that they were not only being watched by the experimenters in another room, their behavior was also being recorded—all while watching an erotic film. It is feasible to propose that participants willfully controlled their facial expressions to give no

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[3] Given the low reliability of the composite self-reported affective response score, post-hoc exploratory analyses examined open-ended and forced-choice responses separately. As with the composite scores, all group effects were nonsignificant.

indication of happiness while watching the erotic film. Previous research on facial behavior in response to erotic stimuli has tended to use EMG methods rather than facial coding, which can detect more minor facial movements. Researchers in that domain have found that whereas physiological responses are considered to be automatic, facial expressions can be "tactical." In other words, they can be manipulated to adapt to particular environmental contexts (Bradley et al., 2001b). In one study, erotic pictures elicited in HC the least amount of smiling in comparison to other pleasant pictures, such as images of families and of food (Bradley et al., 2001b). This finding suggests that it is not unusual for participants to not smile while being exposed to erotic stimuli.

Contrary to my hypothesis, diagnostic groups did not differ in their reports of sexual arousal while viewing the erotic film. The group effect size for the erotic film was minute ($\eta^2 = .001$; Fritz, Morris, & Richler, 2011) with a power of .05. Whether self-reported affective response was analyzed as a composite of open-ended response and forced-choice response or in its component parts (open-ended, forced-choice), the results and effect sizes remained the same: there were no statistically significant group differences and the group effect sizes were extremely small.

All three diagnostic groups generally endorsed feeling "a little" sexually aroused and offered positively-valenced descriptions of their affective responses to the erotic film clip. Some of the open-ended responses related to sexual arousal (e.g., "sexual arousal," "passion," "naked") while others did not ("curiosity," "happy," "good") to describe the emotion they felt most strongly while watching the film. As noted in the preliminary analyses, no statistically significant difference in affective response emerged between the erotic film and the amusement film. It could be that the topic of sex and its concomitant descriptors (e.g., "passion," "naked") and cues (i.e., a naked couple making love in a film) were basic and simple enough for patients with bvFTD to correctly identify and respond to with appropriate subjective affect, similar to previous studies in which bvFTD patients can correctly identify simple emotion-related themes in films, such as happiness and sadness (Eckart et al., 2012; Levenson & Miller, 2007; Sturm et al., 2008; Werner et al., 2007).

Despite the absence of diagnostic group differences, males and females did differ significantly in their self-reported affective response while viewing the erotic film. Across diagnostic groups, males endorsed feeling more sexually aroused than did females. Research indicates that males over-report and females under-report their sexual behavior and attitudes in adherence to social norms and gender expectations, which could then skew self-reports (e.g., Alexander & Fisher, 2003).

Limitations

Despite the novel insights, important limitations inform the interpretation of findings, beyond those limitations noted above. First, sample size was small, and particularly so for the AD group. This constrained statistical power. In order to detect a small effect size ($\eta^2 = .01-.05$ or $f = .10$) with the recommended power of .80, (Ellis, 2010; Fritz, Morris, & Richler, 2011), a minimum sample size of 969 would be needed per G*Power, Version 3.1 (Faul, Erdfelder, Buchner, & Lang, 2009). Future research should use larger sample sizes, and particularly for each subgroup of dementia. Patients with AD constitute an important counterpoint to patients with bvFTD because their emotional functioning is relatively intact.

A second limitation was that I was not able to use measures of penile or vaginal reactivity to sexual stimuli in populations that are typically not included in studies of sexual arousal (i.e.,

older and with dementia) and that have a physiological component (Both et al., 2005; Bradley et al., 2001b; Heiman, 1980; Julien & Over, 1988; Koukounas & McCabe, 2001; Laan et al., 1994; Sarlo et al., 2005). In an effort to capture similar forms of physiological measures using non-invasive, non-genital methods, I chose to use peripheral autonomic measures of heart rate and skin conductance, and to create a composite variable comprised of the two measures. The low correspondence of the physiological composite measure however (alpha = .25), challenges the idea that the physiological composite is a unified construct.

A third limitation was the unidimensional nature of the facial behavior variable. I initially focused only on two target facial behaviors, and then found that no participants displayed interest. In the end, because so few people showed happiness facially, I was limited in my ability to examine diagnostic group differences in facial behavior. Previous studies have used EMG methods, which detect facial muscle movements before they are detectable as full emotion expressions. The increased sensitivity of this technique warrants application in the study of bvFTD, AD, and HC, with the caveat that researchers who have used this method, aver that study participants are able to tactically control the magnitude of their facial behavior (Bradley et al., 2001b).

In a similar vein, a fourth limitation was the focus on only one forced-choice emotional response—sexual arousal. Participants, regardless of diagnostic status, endorsed feeling the equivalent of "a little" sexually aroused. Other types of emotional responses could differ by diagnostic group. In particular, embarrassment, which was not assessed, has been shown to be less present in relevant contexts for those with bvFTD (Levenson & Miller, 2007), and has also been found to be a common response to erotic film clip presentations in laboratory settings (e.g., Bradley et al., 2001b). In context to the self-reported level of sexual arousal variable, the open-ended probe asked participants to identify the emotion they felt most strongly while watching the film. The responses that participants gave—regardless of diagnostic status—could be construed as ambiguous in that they could have reflected what they were feeling in the moment (e.g., "love," "curiosity," "disgust") or what they had just seen (e.g., "naked," "sensuous," "it was beautiful"). This ambiguity may have contributed to the low correspondence, reflected in an inadequate alpha coefficient, for the two types of emotional response indices. Nonetheless, findings for the two response formats separately were also null. In other words, the self-reported affective response variable as measured was probably not complex enough to be able to detect any diagnostic group differences between patients with bvFTD and HC.

A fifth limitation was that self-reported affective response to the erotic film was stated aloud, with researchers listening. It is possible that participants, particularly female participants, asked to state their feelings aloud, could feel constrained by social norms and gender expectations, and so may have under-reported experiences of sexual arousal. Conversely, the context created a situation in which male participants could also have felt constrained by social norms and gender expectations, whereby they reported feeling more sexually aroused than they actually felt. One way to account for potential inhibited responses would be to add a question to ascertain comfort level in responding to queries about sexual arousal, such as whether they felt comfortable answering such items truthfully. Another potential method would be to allow participants to provide their answers privately.

Summary

Methodological difficulties may have limited the ability to understand the effects of facial behavior and self-reported affective response while viewing sexual stimuli. Nonetheless, the

study was informative regarding differences between patients with bvFTD and HC in their physiological response to sexual stimuli. The relatively stronger effects for physiological indices may be in part because physiological measurement captures a more automatic response than do facial behavior and self-reported affective response.

Study 2

Study 2 examined the relationship between laboratory measurements (i.e., physiology, facial behavior, self-reported affective response) of reactivity to sexual stimuli and spousal caregiver outcomes (i.e., caregiver depression, caregiver marital satisfaction). It also examined the relationship between the same laboratory measurements and measures of sexual behavior (i.e., initiation of sexual activity, sexual responsivity) in patients with neurodegenerative diseases. In study 2, patients with a broader range of neurodegenerative diseases were included, which allowed for a larger sample size. Because the focus of this study was solely on the erotic film, responses to the amusement film were not included in analyses.

Hypotheses

Hypothesis 2a

Drawing on findings that negative changes in the sexual functioning of patients with neurodegenerative diseases are associated with lower spousal caregiver sexual satisfaction and greater spousal caregiver depression (Davies et al., 2012), it is hypothesized that reduced reactivity to sexual stimuli in patients with neurodegenerative diseases will be related to higher spousal caregiver depression. Moreover, this effect was expected to be mediated by spousal caregiver reports of less frequent physically affectionate and sexually intimate behavior in patients with neurodegenerative diseases.

Hypothesis 2b

Drawing on findings that behavioral, cognitive, emotional, and sexual changes within patients with neurodegenerative diseases can negatively impact the marital relationship (e.g., Ascher et al., 2010), it is hypothesized that reduced reactivity to sexual stimuli in patients with neurodegenerative diseases will be related to lower spousal caregiver marital satisfaction. Moreover, this effect was expected to be mediated by spousal caregiver reports of less frequent physically affectionate and sexually intimate behavior in patients.

Method

Participants

Participants in this study consisted of 62 individuals diagnosed with neurodegenerative diseases, and their respective 62 spousal caregivers in heterosexual marriages or long-term partnerships. Of the patients, 12 were diagnosed with bvFTD, 9 with AD, 2 with AD frontal, 8 with non-fluent variant progressive primary aphasia (nfvPPA), 8 with semantic variant PPA (svPPA), 8 with corticobasal syndrome (CBS), 8 with progressive supranuclear palsy (PSP), 3 with Parkinson's disease (PD), 1 with mild cognitive impairment (MCI), 1 with a combined diagnosis of bvFTD and amyotrophic lateral sclerosis (ALS), 1 with a combined diagnosis of CBS and nfvPPA, and 1 with a combined diagnosis of bvFTD and CBS. All 12 of the patients

with bvFTD in study 2 were included in study 1, and the AD patients were the same 9 patients with AD in study 1 and 2.

Procedure

Procedures largely mirrored those of study 1. In one exception, accompanying caregivers of the patients in this study were all spouses of the patient.

Apparatus

Audiovisual and physiology. The same audiovisual apparatus and 23-channel BIOPAC system described in study 1 was used in study 2.

Measures

Data collected from patients with neurodegenerative disease.

Physiology, facial behavior, and self-reported affective response. The physiological composite of IBI and SCL, ratings of facial behavior of happiness, and self-reported affective response were parallel with study 1. As with study 1, facial coding for interest was not included in analyses because no participants displayed interest on their faces during the erotic film**.** The Cronbach's alpha reliability coefficient for the physiological composite was .02, and it was .73 for the self-reported affective response composite.

Data collected from spousal caregivers. Spousal caregivers completed all questionnaires in various settings. Some caregivers completed the questionnaires on iPads at the MAC during patient visits; some completed them on paper with pen at home.

Caregiver depression. The Center for Epidemiologic Studies Depression Scale (CES-D; Radloff, 1977), a 20-item self-report questionnaire, was used as an index of caregiver depression. Questions assess six domains of depression, including depressed mood and feelings of helplessness and hopelessness, and problems concentrating. Total scores range from 0 to 60, with higher scores indicating more depressive symptoms. A score of 16 or higher is considered to merit clinical attention. The Cronbach's alpha reliability coefficient for the CES-D in this study was .85.

Marital satisfaction. The Locke-Wallace Marital Adjustment scale (Locke & Wallace, 1959) is a well-validated self-report measure of marital satisfaction. It is comprised of 15 items regarding family finances, demonstrations of affection, sex relations, and philosophy of life along with a global question of, "Do you ever wish you had not married?" Response options include "(a) Frequently, (b) Occasionally, (c) Rarely, (d) Never." Scores range from 2 to 158, with higher scores indicative of greater marital satisfaction. Scores of 100 or above suggest satisfaction with marriage; scores below 100 suggest dissatisfaction with marriage. Cronbach's alpha reliability coefficient for marital satisfaction in this study was .69.

Spousal caregiver report of patient sexual behavior. A questionnaire from the ADDTC Behavior Checklist (Davies et al., 2012, Appendix A) was modified to evaluate the frequency of patient sexual behavior (e.g., initiation of and responsivity to sexual overtures in relation to the spousal caregiver) and the level of spousal caregiver satisfaction with physical affection and sexual intimacy in the last month. The modified scale consists of 11 items, e.g., "My spouse or partner initiated a physically affectionate activity with me (such as kissing, caressing, hugging)." Response options for each item range from 1 for "Never" to 5 for "Constantly." The Patient Initiation subscale consisted of the average of two items that assess patient initiation of physically affectionate and sexually intimate activities. The Patient Responsivity subscale

consisted of two items to cover positive patient response toward physically affectionate and sexually intimate activities initiated by the caregiver. Higher scores indicate greater frequency of patient initiation of physically affectionate and sexually intimate activities with spousal caregivers, and positive patient responsivity toward physically affectionate and sexually intimate overtures from caregivers. The Cronbach's alpha reliability coefficient for the Patient Initiation subscale was .80 and .67 for the Patient Responsivity subscale. Although the subscales are as correlated as the items within the scales, suggesting that these subscales are not separable, I believed enough of a conceptual distinction existed between the two subscales to merit separate analyses. I contend that just because some patients with neurodegenerative disease might not initiate sexual behavior with their spouses, does not necessarily mean that those patients will not be receptive to sexual overtures from their spouses.

       Disinhibition. To consider whether facial behavior and self-reported affective response were influenced by disinhibition within the dementia patients, a measure of disinhibition drawn from the Neuropsychiatric Inventory (NPI; Cummings, 1997) was administered. Trained staff members of the MAC administered the NPI to caregivers reporting on the psychopathology of their spouses (the dementia patients). The Disinhibition score is calculated based on frequency of the behavior (1 = occasionally, less than once per week; 4 = very frequently, once or more per day or continuously), multiplied by the severity level (1 = mild, 2 = moderate, 3 = severe). The mean score and standard deviation for disinhibition among patients were $M = 3.28$, $SD = 3.37$, range 0 to 12.

Data Analysis Plan

       Preliminary analyses. Descriptive analyses were conducted to identify the sociodemographic characteristics (age, gender, race) of patients with neurodegenerative diseases (see Table 2.1). To determine whether males and females differed in terms of their physiological, facial behavior, and self-reported affective responses, I used three separate, parallel one-way univariate ANOVAs to assess gender differences in response to the erotic film. Three parallel ANOVAs were used to assess the dependent variables of the physiological composite variable (IBI and SCL), the facial behavior variable (happiness), and the self-reported affective response composite variable (open-ended and forced-choice responses). For each, gender served as the independent variable. To determine whether Disinhibition (NPI) was related to the facial behavior and self-reported affective responses, I conducted a correlational analysis.

       Mediation model analyses. The Process macro version 3.0 for SPSS (Hayes, 2018; Preacher & Hayes, 2008) mediation model (Model 4) was used to test whether both patient sexual initiation and patient sexual responsivity (i.e., the mediators: M) mediate the relationship between physiological reactivity, facial behavior of happiness, or self-reported affective response (i.e., the independent variables: X) and caregiver depression and caregiver marital satisfaction (i.e., the dependent variables: Y). Standardized coefficients are reported. The direct effect of X on Y (i.e., c') represents the difference in Y between two cases that differ by one unit on X and that are equal on M. The indirect effect of X on Y through M (i.e., ab) represents the product of the coefficient that connects X to M (the a-path) and the coefficient that connects M to Y (the b-path). The total effect of X on Y (i.e., c) represents the sum of the direct effect and the indirect effect. Mediation occurs when analyses show that the indirect effect is significant (Hayes, 2018; Zhao, Lynch, & Chen, 2010).

       To approximate the sampling distribution, 5000 percentile bootstrap resamples, recommended by Hayes (2018), created 95% confidence intervals for the indirect effects. These

bootstrap confidence intervals, which are derived from empirical models of the sampling distribution of the indirect effect, do not assume any shape of the sampling distribution, allow for irregularities of the sampling distribution, and are higher in power in comparison to the healthy theory approach (Hayes, 2018; Zhao et al., 2010). Bootstrapping is preferable when sample sizes are small and are not normally distributed. This nonparametric method of analysis allows for mediation effects to be reported separate from the effects of additional mediators or control variables (Preacher & Hayes, 2008).

For each of the two dependent variables (caregiver depression and caregiver marital satisfaction), three mediation models were constructed to separately evaluate the physiological composite (IBI and SCL) as the IV (i.e., the X variable), the facial expression of happiness as the IV, and the self-reported affective response composite as the IV.

Results

Preliminary Analyses

Patients with neurodegenerative disease were primarily White/Caucasian (84%), with an average age of 66.58 years (SD = 7.56). The sample of patients was comprised of 45% females and 55% males. The average age of the spousal caregivers, who were all in a heterosexual relationship with their patient spouses, was 64.58 years (SD = 8.39) and they were primarily White/Caucasian (85.5%). Table 2.1 summarizes the sociodemographic characteristics of the patients with neurodegenerative disease.

Potential demographic confounds. Exploratory analyses were conducted to ascertain whether there were any gender differences in response to the primary variables. Gender was significantly associated with only one variable: the self-reported affective response composite ($F(1,60) = 5.17$, $p = .03$). Females reported feeling significantly less sexually aroused when watching the erotic film clip than did males. To ascertain whether gender was associated with the study's two outcomes, correlations of caregiver gender with caregiver depression and marital satisfaction were examined, $r(62) = .09$, $p = .49$, $r(62) = -.20$, $p = .13$, respectively. Results revealed no significant relationship of gender with caregiver depression or caregiver marital satisfaction. Consequently, gender was not controlled in further analyses of the effects of self-reported affective response on caregiver depression or caregiver marital satisfaction.

A correlational analysis was conducted to ascertain whether Disinhibition (NPI) was associated with the facial behavior and self-reported affective response variables. Results revealed no statistically significant relationship of disinhibition with facial behavior response ($r = .18$, $p = .16$) nor self-reported affective response ($r = -.11$, $p = .39$).

Descriptive Statistics

Descriptive characteristics of the physiological composite, facial behavior (happiness), and self-reported affective response composite variables for the erotic film are shown in Table 2.2. Physiological activity and self-reported affective response variables displayed roughly normal distributions, including estimates of skewness and kurtosis. No outliers for self-reported affective response were identified by SPSS.

The facial behavior (happiness) variable for the erotic film displayed a normal estimate of skewness, but was highly leptokurtic, estimate of 11.47 (S.E. = .60). Review of the data revealed that 45 of the 58 participants showed no facial expression of happiness during the erotic film. SPSS identified the non-zero values as outliers. Although the limited variability cannot be

addressed, to reduce the high kurtosis estimate, I added a constant to the distribution and performed a log transformation. The log transformation reduced the estimate of kurtosis to 3.64 (S.E. = .60). Ultimately, I reported results from the transformed facial behavior variable.

Tests for whether data were missing completely at random were conducted using Little's MCAR test (Little, 1988) and indicated that the data were missing completely at random. Multiple imputation was conducted using SPSS to address missing data associated with the erotic film (2 cases for IBI, 4 cases for SCL, 4 for facial behavior, 2 for self-reported affective response: open-ended response, and 1 for patient responsivity). Missing values were probabilistically calculated using regression parameters. The imputation process was conducted five times, resulting in five different datasets. Pooled estimates were created according to Rubin's (1987) rules, in which point estimates for model parameters are estimated in each dataset and then averaged.

Correlations

The bivariate correlation matrix is presented in Table 2.3. Correlations between primary variables are displayed. The laboratory-based scores were unrelated to each other and were unrelated to the indices of caregiver depression, caregiver marital satisfaction, and caregiver reported sexual behavior.

Mediation Model Analyses

Caregiver Depression

Hypothesis 2a predicted that diminished patient reactivity to sexual stimuli (i.e., physiology, facial behavior, self-reported affective response) would be related to higher caregiver depression and that this effect would be mediated by caregiver reports of fewer physically affectionate and sexually intimate behaviors (i.e., sexual initiation and responsivity) in patients.

Patient sexual initiation and patient sexual responsivity (b-path). As noted above, separate models were constructed for the three channels of reactivity to the erotic film. In each of the multiple mediation models of caregiver depression, two mediator variables (sexual initiation and sexual responsivity) were tested simultaneously in each model. Analysis of the b-path revealed that lower patient responsivity was associated with significantly higher caregiver depression. The relationship between patient sexual initiation and caregiver depression was not significant (see Tables 2.4, 2.6, and 2.7).

Patient physiological reactivity (direct and indirect effects). The physiological composite (comprised of IBI and SCL), entered as the X variable, showed no statistically significant direct effect on caregiver depression (Y; p = .61; see Table 2.4 for model coefficients). The indirect effects of physiological reactivity on caregiver depression through the mediator patient sexual initiation and the mediator patient sexual responsivity were also not statistically significant (see Table 2.5).

Patient facial behavior (direct and indirect effects). The facial behavior variable, entered as the X variable, showed no statistically significant direct effect on caregiver depression (Y; p = .09; see Table 2.6 for model coefficients). The indirect effects of facial behavior on caregiver depression through the mediator patient sexual initiation and the mediator patient sexual responsivity were also not statistically significant (see Table 2.5).

Patient self-reported affective response (direct and indirect effects). The self-reported emotional experience composite (comprised of open-ended and forced-choice responses), entered

as the X variable showed no statistically significant direct effect on caregiver depression (Y; p = .49; see Table 2.7 for a list of model coefficients). The indirect effects of self-reported emotional experience on caregiver depression through the mediator sexual patient initiation and the mediator patient sexual responsivity were also not statistically significant (see Table 2.5).

Caregiver Marital Satisfaction

Hypothesis 2b predicted that diminished patient reactivity to sexual stimuli (i.e., physiology, facial behavior, self-reported affective response) would be related to lower caregiver marital satisfaction, and would be mediated by caregiver reports of fewer physically affectionate and sexually intimate behaviors (i.e., sexual initiation and sexual responsivity) in patients.

Patient sexual initiation and patient responsivity (b-path). As noted above, separate models were constructed for each channel of reactivity to the erotic film. In each of the multiple mediation models of caregiver marital satisfaction, which had two mediator variables (sexual initiation and sexual responsivity) appearing simultaneously in each model, analysis of the b-path revealed that lower frequency of patient responsivity was associated with significantly lower caregiver marital satisfaction. A nonsignificant relationship was found between patient sexual initiation and caregiver marital satisfaction (see Tables 2.4, 2.6, and 2.7).

Patient physiological reactivity (direct and indirect effects). The physiological composite, entered as the X variable, showed no statistically significant direct effect on caregiver marital satisfaction (Y; p = .61; see Table 2.4 for model coefficients). The indirect effects of physiological reactivity on caregiver marital satisfaction through the mediator patient sexual initiation and the mediator patient sexual responsivity were also not statistically significant (see Table 2.5).

Patient facial behavior (direct and indirect effects). The facial behavior variable, entered as the X variable, showed a statistically significant direct effect on caregiver marital satisfaction (Y; p = .05; see Table 2.6 for model coefficients). The finding indicates that increased facial expression of happiness while watching the erotic film was related to lower caregiver marital satisfaction. The indirect effects of facial behavior on caregiver marital satisfaction through the mediator patient sexual initiation and the mediator patient sexual responsivity were not statistically significant (see Table 2.8).

Patient self-reported affective response (direct and indirect effects). The self-reported affective response composite, entered as the X variable, showed a marginally significant direct effect on caregiver marital satisfaction (Y; p = .06; see Table 2.7 for a list of model coefficients). The finding indicates that higher self-reported affective response to sexual arousal was marginally significantly related to lower caregiver marital satisfaction. The indirect effects of self-reported affective response on caregiver marital satisfaction through the mediator patient sexual initiation and the mediator patient sexual responsivity were not statistically significant (see Table 2.8).

Discussion

The goal of study 2 was to examine the relationship between laboratory-based measures of reactivity to an erotic film, measures of sexual behavior in patients with neurodegenerative diseases, and measures of spousal caregiver outcomes. It was hypothesized that lower patient reactivity to the erotic film would be related to higher caregiver depression and lower caregiver marital satisfaction, and that the relationships would be mediated by patient sexual behavior

(patient sexual initiation and responsivity). This study took a multi-modal assessment approach as in study 1. Bivariate correlations indicated that there was little correspondence across physiological, facial behavior, and self-reported affective responses to the erotic film clip. Separate analyses were conducted to examine these three channels. Therefore, six parallel mediation analyses were conducted to assess the effects of three laboratory-based measures (physiology, facial behavior, self-reported affective response) as X (independent) variables, and to consider caregiver depression and caregiver marital satisfaction as separate Y (or dependent) variables. The mediator variables, patient sexual initiation and patient sexual responsivity, were factored into all six parallel mediation analyses.

Patient sexual initiation and responsivity. Because the two mediator variables were considered jointly in all models, findings from one mediator variable must be interpreted in context to the other mediator variable. Analyses revealed a statistically significant relationship of patient sexual responsivity on caregiver depression and caregiver marital satisfaction when controlling for the effect of sexual initiation. Specifically, the more patients displayed sexual responsivity toward their spousal caregivers, the lower the ratings of caregiver depression and the higher the ratings of spousal caregiver marital satisfaction. In previous work, researchers showed that when a partner sees that their spouse is sexually receptive toward them, the partner feels understood, heard, desired, and accepted, which promotes the stability of a loving and caring relationship (Davies et al., 2012; Davies et al., 1998; de Vugt et al., 2003).

When controlling for patient sexual responsivity, patient sexual initiation does not appear to significantly impact caregiver depression or caregiver marital satisfaction. Even direct bivariate correlations were not significant, suggesting that sexual initiation was not strongly tied to caregiver depression or marital satisfaction. Some patients might show indiscriminate sexual initiation behaviors with any number of individuals, excluding or including their spouses (Ahmed et al., 2015). In some cases, where patients show initiation behavior toward their spouses, whether or not the behavior is deemed sexually inappropriate, the behavior might not be desired by spousal caregivers. This could help explain the limited effect of patient initiation behavior on caregiver outcomes. In contrast, patient responsivity, defined by receptivity to the sexual overtures of spousal caregivers, may help spousal caregivers feel cared for. This fits with clinical observations that receptivity on the part of patients strengthens caregiver relationship satisfaction and lessens caregiver burden (Davies et al., 2012; Davies et al., 1998; de Vugt et al., 2003).

Patient physiological reactivity. In two separate, parallel mediation analyses, no statistically significant relationships emerged of patient physiological reactivity to the erotic film with either caregiver depression or marital satisfaction. In addition, mediation did not occur in either analysis. Although novel in its approach, the exploration of patient physiological reactivity and its potential association with caregiver outcomes did not yield hypothesized results. Therefore, this particular measure of physiological reactivity (IBI, SCL) might not be a good measure to use in the future.

Patient facial behavior and self-reported affective response. Both patient facial behavior and self-reported affective response showed effects opposite the hypothesized directions with caregiver marital satisfaction. That is, the more happiness patients showed and the more they endorsed feeling sexually aroused while watching the erotic film, the lower the marital satisfaction of caregivers. These findings suggest that patients who have lost the ability to modulate their facial expressions and verbal affective responses while viewing an erotic film while under surveillance, have spouses who are less satisfied in their marriages.

Intentional control of facial expressions and verbal affective response may be a proxy for retention of social awareness among those with dementia. In turn, this could imply that the spousal caregivers of these socially adept patients would not have to be as vigilant when caring for their spouses with dementia, particularly when in public. This could ease stress within the spousal caregivers. The same argument could not necessarily be made for caregivers of patient spouses who have blunted affect or who are apathetic.

In contrast to the effects for marital satisfaction, patient facial behavior and self-reported affective responses to the erotic film were not significantly related to caregiver depression. It could be argued that these responses to the erotic film could be construed as more nuanced measures of emotion regulation and emotional awareness. Furthermore, it could be argued that the factors that might impact caregiver depression might be tied to more obvious and blatant patient behaviors such as disinhibition, apathy, and depression, which have been shown to contribute to increased caregiver burden (de Vugt et al., 2006; de Vugt et al., 2003).

Limitations

Despite the new insights, two important limitations inform the interpretation of findings from study two. First, although the physiological composite was derived from a theoretical concept and is therefore not as reliant on internal consistency (Diamantopoulos & Winklhofer, 2001; Nunnally & Bernstein, 1994) as pen and paper questionnaires, the alpha reliability coefficient was nonetheless extremely low (.02). A second limitation was that potential variations in physiology across the twelve types of neurodegenerative diseases examined in this study were not explored, and medications were not controlled for in this study. In sum, difficulties with methodology may have limited the ability to find a significant relationship between physiological reactivity and caregiver marital satisfaction.

Summary

Nevertheless, the study was informative regarding the unexpected directionality that the more happiness patients showed on their faces, the lower the caregiver marital satisfaction. Analyses of the relationship between patient self-reported affective response and caregiver marital satisfaction revealed the same pattern of directionality.

General Discussion

In the quest to better understand sexual functioning in neurodegenerative diseases, I used a novel approach of examining laboratory-based measures of responses to sexual stimuli. The goal of study 1 was to ascertain whether patients with bvFTD would show diminished responses to an erotic film in comparison with HC. The goal of study 2 was to ascertain whether diminished responses to the same erotic film in patients with neurodegenerative diseases would be associated with higher spousal caregiver depression and lower caregiver marital satisfaction, and whether those relationships would be mediated by caregiver reports of patient sexual behavior.

Study 1 results revealed that the physiological response measure was the only laboratory-based measure in which groups differed significantly. Minimal inferences could be drawn about patients with AD because there were so few of them relative to patients with bvFTD and HC. The results involving the remaining two laboratory-based measures, facial behavior and self-reported affective response, revealed that all three diagnostic groups responded comparably.

With facial behavior, the vast majority of participants did not show any signs of happiness on their faces. With self-reported affective response, participants endorsed feeling sexually aroused to a small degree. Indeed, responses to the erotic film clip were not more powerful than those observed for the amusement film clip in any channel. The low degree of variability and limited intensity of these responses may have interfered with the ability to test diagnostic group differences.

The findings, however, do imply that measures such as physiology, that capture automatic responses, may be helpful in detecting diagnostic group differences. Conversely, measures that capture responses that are easier to control, such as positive facial behavior and verbal affective response, were insensitive to potential diagnostic group differences.

Study 2 results revealed that expressions of happiness, and to a marginal degree, positive affective response to the erotic film clip, were associated with lower caregiver marital satisfaction. Although unexpected, I speculate that caregivers might feel more satisfied in their relationships when they have partners whose ability to regulate emotions and to be cognizant of social context is preserved. Contrary to this theory, though, disinhibition was not tied to facial behavior and self-reported affective responses.

In sum, it appears that physiology—a measure that recorded largely automatic functions that are not perceptible to others—had utility in detecting diagnostic group differences with patients with bvFTD, AD, and HC. In addition, it appears that facial behavior and self-reported emotional expression—measures that recorded functions that to varying degrees could be intentionally controlled if social awareness were intact and that are most easily perceived by caregivers—had utility in illustrating social dynamics. They also demonstrated utility in how the behavior of patients with neurodegenerative diseases have the potential to impact their spousal caregivers.

Future Directions

In future work in this domain, it will be important to test larger sample sizes, particularly for the AD group. I would also enhance the methods of analysis. For the assessment of physiology, given that the parasympathetic nervous system (PNS) is also critically important to sexual arousal, I would add the measure of respiratory sinus arrhythmia, a measure of PNS activity (Beauchaine, 2015) to analyses.

In understanding the effects of sexual response on caregiver outcomes, I would constrain the study to patients with bvFTD and AD to reduce heterogeneity in the nature of caregiver outcomes. For caregiver outcomes, I would continue to use the measures of caregiver marital satisfaction and caregiver depression, and add measures of caregiver burden (e.g., the Zarit Burden Interview; Zarit, Anthony, & Boutselis, M., 1987; Zarit, Orr, & Zrit, 1985). This would expand upon the nascent literature on sexual functioning and neurodegenerative diseases.

Conclusion

Sexual functioning is an integral part of intimate relationships. Prior research suggests that patients with bvFTD display emotional deficits that negatively impact their ability to relate with their spouses (Ascher et al., 2010). Few studies have investigated how patients' sexual behavior as reported by their spousal caregivers affects the spousal caregivers (Ahmed et al., 2015). No previous studies to my knowledge have explored how response to sexual stimuli in the

laboratory differentiates patients with bvFTD from AD and HC, or how the response of patients with neurodegenerative diseases to sexual stimuli in the laboratory might be related to caregiver depression or caregiver marital satisfaction.

Study 1 revealed that the measure of physiological responses to sexual stimuli in patients with bvFTD, AD, and HC appears to have utility and merits further exploration. Study 2 revealed that despite low base rates of patient displays of happiness while watching the erotic film, an effect nonetheless emerged. Study 2 also revealed that patients' responsivity to their spousal caregivers—and not their initiation behavior—influenced caregiver marital satisfaction.

In study 1, automatic responses (i.e., physiological) to the erotic film differed by diagnostic group, whereas more "tactical" responses (i.e., facial behavior and self-reported affective response) did not. The converse was true for study two: the more "tactical" responses were associated with caregiver marital satisfaction. Although findings from study 1 suggest that most patients with dementia were able to modulate tactical responses, findings from study 2 indicate that when patients could not regulate facial behavior, it had negative meaning for the caregivers.

The results of these studies provide one step toward understanding sexual functioning among patients with bvFTD using novel, laboratory-based approaches. More specifically, they provide a better understanding of how patients' behavior within a sexual context may affect spousal caregiver marital satisfaction. It is my hope that these findings provide a stepping stone toward designing interventions that minimize the burdens of caregiving.

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Table 1.1

Sample Description: Sociodemographic Characteristics

Variables	bvFTD	AD	HC	Skewness (SE)	Kurtosis (SE)
N	18	9	23		
Gender, % Female (N)	44 (8)	56 (5)	57 (13)		
Age, mean (SD)	65.4 (7.7)	68.9 (8.9)	64.9 (9.4)	-.96 (.34)	2.5 (.66)
Race/Ethnicity, % (N)					
White/Caucasian	83 (15)	100 (9)	96 (22)	--	--
Multi-Racial/Other	11 (2)	0 (0)	0 (0)	--	--
Latino/Chicano/Hispanic	6 (1)	0 (0)	0 (0)	--	--
Native American/Alaska Native	0 (0)	0 (0)	4 (1)	--	--
Clinical Dementia Rating Box Score	6.83	4.39	--	.27 (.45)	-.48 (.87)

Note. SE = standard error. Patient groups: bvFTD = behavioral variant frontotemporal dementia; AD = Alzheimer's disease; HC = healthy controls. Clinical Dementia Rating Box Score is a measure of dementia severity; HC were not assessed for dementia severity.

Table 1.2

Descriptive Characteristics of the Physiological Composite, Facial Behavior (Happiness), and Self-Reported Affective Response Composite Variables

Variables	bvFTD	AD	HC	Skewness (SE)	Kurtosis (SE)
N	18	9	23		
	M (SD)	M (SD)	M (SD)		
Erotic Film: Physiological Composite[*]	-.44 (.94)[a]	-.03 (1.18)	.35 (.87)[a]	.43 (.34)	3.45 (.66)
Amusement Film: Physiological Composite	.01 (1.33)	-.30 (.58)	.11 (.98)	1.05 (.34)	2.04 (.66)
Erotic Film: Facial Behavior (Happiness)	.03 (.08)	.06 (.17)	.00 (.01)	4.24 (.34)	21.97 (.66)
Amusement Film: Facial Behavior (Happiness)	.97 (.89)	.89 (.91)	.96 (.77)	.19 (.34)	-1.05 (.66)
Erotic Film: Self-Reported Affective Response Composite	.86 (.64)	.89 (.55)	.89 (.43)	.17 (.34)	-.68 (.66)
Amusement Film: Self-Reported Affective Response Composite	1.44 (.75)	1.56 (.53)	1.74 (.50)	-1.62 (.34)	1.78 (.66)

Note. For physiological composites, higher values indicate greater physiological arousal from baseline. Standardized values reported for physiological composites. *SD* = Standard deviation. No statistically significant group differences emerged in any channels between the erotic film and the amusement film. [a]Means are different from one another ($p < .05$). [*]$p < .05$.

Table 1.3

Descriptive Characteristics of the Interbeat Interval, Skin Conductance, and Self-Reported
Affective Response Open-Ended and Forced-Choice Response Variables

Variables	bvFTD	AD	HC	Skewness (SE)	Kurtosis (SE)
N	18	9	23		
	M (SD)	M (SD)	M (SD)		
Erotic Film: Interbeat Interval	-9.14 (31.84)	-5.35 (62.68)	12.97 (33.46)	-.94 (.34)	4.57 (.66)
Amusement Film: Interbeat Interval	-4.33 (44.08)	5.83 (25.15)	-1.08 (49.70)	-.04 (.34)	2.84 (.66)
Erotic Film: Skin Conductance	-1.06 (.29)	.03 (.16)	.06 (.25)	.26 (.34)	9.11 (.66)
Amusement Film: Skin Conductance	.18 (.37)	.00 (.07)	.20 (.25)	2.17 (.34)	6.20 (.66)
Erotic Film: Self-Reported Affective Response Open-Ended	1.00 (.94)	1.22 (.83)	1.09 (.60)	-.04 (.34)	-.88 (.66)
Amusement Film: Self-Reported Affective Response Open-Ended	1.39 (.85)	1.67 (.71)	1.78 (.52)	-1.58 (.34)	1.03 (.66)
Erotic Film: Self-Reported Affective Response Forced-Choice	.72 (.83)	.56 (.53)	.70 (.47)	.33 (.34)	-.60 (.66)
Amusement Film: Self-Reported Affective Response Forced-Choice	1.50 (.86)	1.44 (.73)	1.70 (.56)	-1.4 (.34)	.55 (.66)

Note. For physiological variables (interbeat interval and skin conductance), higher values
indicate greater physiological arousal from baseline. *SD* = Standard deviation.

Table 1.4

Inter-Correlations of Laboratory-Based Measures of Response to a Sexual Film

Variable	1	2	3	4	5	6
1 Erotic Film: Physiological Composite	--					
2 Amusement Film Physiological Composite	.25	--				
3 Erotic Film: Facial Behavior (Happiness)	.08	-.02	--			
4 Amusement Film: Facial Behavior (Happiness)	-.08	.16	-.14	--		
5 Erotic Film: Self-Reported Emotional Experience Composite	.16	.16	.18	-.07	--	
6 Amusement Film: Self-Reported Emotional Experience Composite	.14	.31*	.05	.18	.23	--

Note. The correlations reflect physiological, facial behavior of happiness, and self-reported affetive responses to the erotic film and the amusement film (N = 50). $^*p < .05$ (2-tailed).

Table 2.1

Sample Description: Sociodemographic Characteristics of Patients

Variable	Values
N	62
Gender, % Female (N)	45.2 (28)
Age, mean (SD)	66.58 (7.56)
Race/Ethnicity	
White/Caucasian	84 (52)
Multi-Racial/Other	4.8 (3)
Latino/Chicano/Hispanic	4.8 (3)
Native American/Alaska Native	1.6 (1)
Asian/Asian American	4.8 (3)
Diagnosis, % (N)	
bvFTD	19.4 (12)
AD	14.5 (9)
AD Frontal	3.2 (2)
nfvPPA	12.9 (8)
svPPA	12.9 (8)
CBS	12.9 (8)
PSP	12.9 (8)
PD	3 (4.8)
MCI	1 (1.6)
bvFTD/ALS	1 (1.6)
CBS/nfvPPA	1 (1.6)
bvFTD/CBS	1 (1.6)

Note. nfvPPA = non-fluent variant progressive primary aphasia; svPPA = semantic variant PPA; CBS = corticobasal syndrome; PSP = progressive supranuclear palsy; PD = Parkinson's disease; MCI = mild cognitive impairment; ALS = amyotrophic lateral sclerosis.

Table 2.2

Descriptive Characteristics of Laboratory-Based Measures, Caregiver Outcomes, and Caregiver-Reported Patient Sexual Behavior

Variables	Mean	SD	Skewness (SE)	Kurtosis (SE)
Erotic Film: Physiological Composite	0	1.00	.33 (.30)	2.18 (.60)
Erotic Film: Facial Behavior (Happiness)	.08	.21	3.30 (.30)	11.47 (.60)
Erotic Film: Self-Reported Affective Response Composite	1.11	.72	-.21 (.30)	-1.30 (.60)
Caregiver Depression	11.63	8.63	.81 (.30)	.10 (.60)
Caregiver Marital Satisfaction	101.23	28.00	-.77 (.30)	.10 (.60)
Caregiver-Reported Patient Initiative	1.34	1.02	.63 (.30)	-.17 (.60)
Caregiver-Reported Patient Responsivity	1.69	.95	1.28 (.30)	.21 (.60)

Note. Standardized values reported for physiological composite. *SD* = Standard deviation.

Table 2.3

Inter-Correlations of Laboratory-Based Measures, Caregiver Outcomes, and Caregiver-Reported Patient Sexual Behavior (N=62)

Variables	1	2	3	4	5	6	7
1 Erotic Film: Physiological Composite	--						
2 Erotic Film: Facial Behavior (Happiness)	-.06	--					
3 Erotic Film: Self-Reported Affective Response Composite	.02	.09	--				
4 Caregiver Depression	-.03	.22	.06	--			
5 Marital Satisfaction	-.07	-.24	-.18	-.56**	--		
6 Caregiver-Reported Patient Initiative	-.13	.00	.03	-.17	.22	--	
7 Caregiver-Reported Patient Responsivity	-.12	-.02	.07	-.33**	.41**	.78**	--

Note. $p < .05$, **$p < .01$

Table 2.4

Model Coefficients for Patient Physiological Composite, Caregiver-Reported Patient Sexual Initiative and Patient Sexual Responsivity, Caregiver Depression and Caregiver Marital Satisfaction

									Outcome								
		M (Patient Initiative)				M (Patient Responsivity)				Y (Caregiver Depression)				Y (Caregiver Marital Satisfaction)			
Independent Variable	P	Coeff.	SE	p	P	Coeff.	SE	p	P	Coeff.	SE	p	P	Coeff.	SE	p	
X (Patient Physiological Composite)	a	-0.13	0.13	0.33	a	-0.12	0.13	0.36	c'	-0.06	0.12	0.61	c'	-0.03	0.12	0.80	
M (Patient Initiative)		--	--	--		--	--	--	b	0.21	0.20	0.28	b	-0.25	0.19	0.20	
M (Patient Responsivity)		--	--	--		--	--	--	b	-0.30	0.20	0.01	b	0.60	0.19	0.002	
Constant	i_M	0.00	0.13	1.00	i_M	0	0.13	1	i_Y	0	0.12	1	i_Y	0.00	0.12	1.00	
		$R^2 = -.02$				$R2 = 0.02$				$R^2 = 0.13$				$R^2 = 0.19$			
		$F(1,60) = 1.03, p = .33$				$F(1,60) = 1.05, p = .36$				$F(3,58) = 2.94, p = .04$				$F(3,58) = 4.60, p = .006$			

Note. P = Path.

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Table 2.5

Indirect Effect of Independent Variables on Caregiver Depression with Caregiver-Reported Patient Sexual Initiative and Responsivity as Mediators

Variable	Effect	Boot SE	Boot lower limit confidence interval	Boot upper limit confidence interval
Caregiver Depression - Patient Initiative				
Physiological Composite	-0.03	0.04	-0.15	0.04
Facial Behavior of Happiness	0.00	0.22	-0.49	0.47
Self-Reported Affective Response Composite	0.006	0.04	-0.07	0.08
Caregiver Depression - Patient Responsivity				
Physiological Composite	0.06	0.07	-0.07	0.22
Facial Behavior of Happiness	0.03	0.37	-0.69	0.83
Self-Reported Affective Response Composite	-0.03	0.07	-0.11	0.11

Note. No statistically significant relationships were found.

Table 2.6
Model Coefficients for Patient Facial Behavior (Happiness), Caregiver-Reported Patient Initiative and Patient Responsivity, Caregiver Depression and Caregiver Marital Satisfaction

	Outcome															
	M (Patient Initiative)				M (Patient Responsivity)				Y (Caregiver Depression)				Y (Caregiver Marital Satisfaction)			
Independent Variable	P	Coeff.	SE	p	P	Coeff.	SE	p	P	Coeff.	SE	p	P	Coeff.	SE	p
X (Patient Facial Behavior - Happiness)	a	0.01	0.52	0.86	a	-0.07	0.52	0.86	c'	0.84	0.49	0.10	c'	-0.94	0.46	0.05
M (Patient Initiative)		--	--	--		--	--	--	b	0.21	0.19	0.23	b	-0.24	0.18	0.21
M (Patient Responsivity)		--	--	--		--	--	--	b	-0.49	0.19	0.01	b	0.59	0.18	0.00
Constant	i_M	0.00	0.14	0.95	i_Y	-0.007	0.14	0.95	i_Y	0.08	0.13	0.52	i_Y	-0.09	0.12	0.45
	$R2 = .000$				$R2 = 0.0008$				$R2 = 0.17$				$R2 = 0.24$			
	$F(1,60) = .04, p = .86$				$F(1,60) = .09, p = .86$				$F(3,58) = 4.02, p = .01$				$F(3,58) = 6.26, p = .001$			

Note. P = Path.

Table 2.7

Model Coefficients for Patient Self-Reported Affective Response Composite, Caregiver-Reported Patient Sexual Initiative and Patient Sexual Responsivity, Caregiver Depression and Caregiver Marital Satisfaction

		Outcome														
		M (Patient Initiative)				M (Patient Responsivity)				Y (Caregiver Depression)				Y (Caregiver Marital Satisfaction)		
Independent Variable	P	Coeff.	SE	p	P	Coeff.	SE	p	P	Coeff.	SE	p	P	Coeff.	SE	p
X (Patient Self-Reported Affective Response Composite)	a	0.03	0.13	0.84	a	0.07	0.13	0.60	c'	0.08	0.12	0.49	c'	-0.22	0.11	0.06
M (Patient Initiative)		--	--	--		--	--	--	b	0.23	0.20	0.26	b	-0.26	0.18	0.16
M (Patient Responsivity)		--	--	--		--	--	--	b	-0.52	0.20	0.01	b	.63	0.18	0.001
Constant	i_M	0.00	0.13	1.00	i_M	0.00	0.13	1.00	i_Y	0.00	0.12	1.00	i_Y	0.00	0.11	1.00
		$R2 < .001$				$R2 = 0.005$				$R2 = 0.14$				$R2 = 0.24$		
		$F(1,60) = .04, p = .84$				$F(1,60) = .28, p = .60$				$F(3,58) = 3.02, p = .04$				$F(3,58) = 6.07, p < .001$		

Note. P = Path.

52

Table 2.8

Indirect Effect of Independent Variables on Caregiver Marital Satisfaction with Caregiver-Reported Patient Sexual Initiative and Responsivity as Mediators

Variable	Effect	Boot SE	Boot lower limit confidence interval	Boot upper limit confidence interval
Caregiver Marital Satisfaction - Patient Initiative				
Physiological Composite	0.03	0.05	-0.07	0.13
Facial Behavior of Happiness	-0.001	0.25	-0.57	0.53
Self-Reported Affective Response Composite	-0.007	0.04	-0.10	0.07
Caregiver Marital Satisfaction - Patient Responsivity				
Physiological Composite	-0.07	0.08	-0.24	0.09
Facial Behavior of Happiness	-0.04	0.44	-0.95	0.82
Self-Reported Affective Response Composite	0.04	0.09	-0.14	0.20

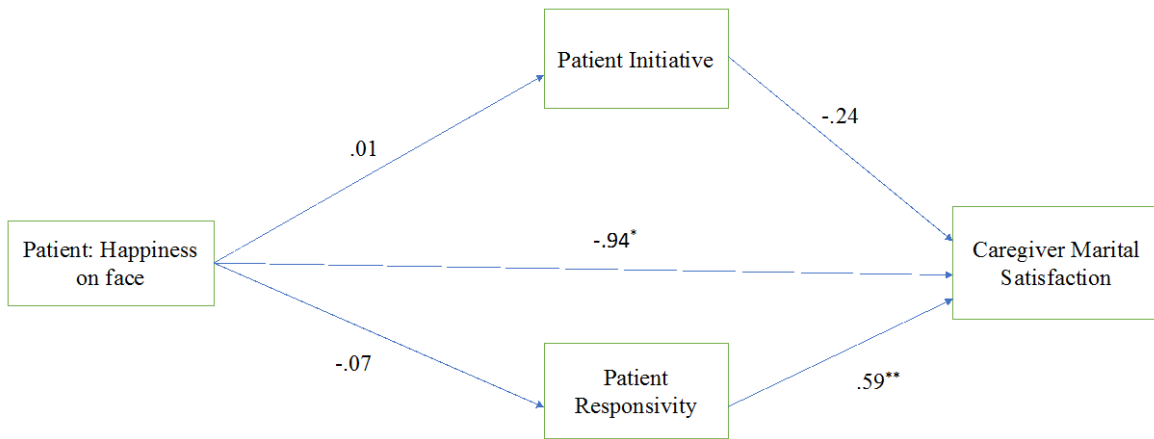*Note*. No statistically significant relationships were found.

Figure 2.1. Mediational path analysis for the relationship between facial behavior of happiness and caregiver marital satisfaction. * *p* = .05; ** *p* < .01