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From lab to life:
Concordance between laboratory and caregiver
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By

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Abstract

From lab to life:
Concordance between laboratory and caregiver
assessment of emotion in dementia

by

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In recent years, laboratory methodologies for assessing emotional functioning have been applied to the study of dementia. These in-laboratory assessments have provided a number of insights into domains of loss, as well as preservation, of emotional functioning for different neurological illnesses. However, such laboratory tests of emotion have yet to be compared to measures assessing dementia patients' daily emotional lives. In clinical practice, family and spousal caregivers are often called upon to provide this real-world perspective. The current study tested concordance between a laboratory assessment of emotional functioning in dementia with the perspective of caregivers and informants on patients' and controls' emotion in daily life. Specifically, two domains of emotional functioning – emotional reactivity and empathic accuracy – were assessed for three emotion types – negative, positive, and self-conscious emotion – in patients diagnosed with a neurodegenerative illness, as well as in neurologically healthy controls. Patients' and controls' emotional functioning was assessed two ways: in the laboratory, using dynamic audiovisual stimuli, and via questionnaire, completed by informants (i.e., caregivers of dementia patients and family members of controls, reporting on patients' or controls' emotional functioning, respectively). The laboratory tasks measured reactivity through participants' physiological arousal, facial behavior, and self-reported experience to emotion-eliciting films; empathic accuracy was measured via participants' correct identification of target emotions expressed by characters in a second set of films. Participants' performance on the laboratory tasks was used to predict the ratings their informants made on the questionnaire for each emotion category. To account for possible bias in informant report due to the effects of caregiver burden, analyses controlled for informants' levels of depression and anxiety symptoms.

Results indicated that overall, laboratory assessments of emotional reactivity and empathic accuracy were in accord with informant-reported emotional functioning. Specific analyses of each emotion type, however, indicated that participants' self-conscious reactivity in the laboratory was not in concordance with their self-conscious reactivity according to informants. The findings indicate that, broadly speaking, an assessment of emotional functioning conducted in a laboratory using dynamic measures, and the report of caregivers on dementia patients' emotion in daily life, are each tracking the same constructs: ostensibly, representing the true emotional experiences and empathic understanding of dementia patients. However, these results also raise questions concerning the measurement of self-conscious reactivity. This work has important implications in refining the assessment of emotional

functioning in clinical settings through the use of more comprehensive tools to systematically capture emotional changes in dementia.

From lab to life:
Concordance between laboratory and caregiver
assessment of emotion in dementia

The study of emotion has advanced considerably over the past several decades, with definitions of emotional processes becoming more nuanced and tests to probe emotional systems, more ecologically valid (Levenson et al., 2008). Within psychology, emotions were once thought of as too nebulous and subjective for rigorous scientific study compared to cognitive processes, such as memory and language, which intuitively appeared more precise (Damasio, 2003; Kirkland & Cunningham, 2011; LeDoux, 2000). However, laboratory tests of emotion are now on par with those of cognition, parsing among key processes such as reactivity, empathy, and regulation (Levenson et al., 2008; Levenson, 2007), and discriminating among different populations, for example based on age (Haase, Seider, Shiota, & Levenson, 2011; Knight et al., 2007; Seider, Shiota, Whalen, & Levenson, 2011; Shiota & Levenson, 2009; Sze, Gyurak, Goodkind, & Levenson, 2011), gender (Derntl et al., 2010; McRae, Ochsner, Mauss, Gabrieli, & Gross, 2008; Schulte-Rüther, Markowitsch, Shah, Fink, & Piefke, 2008), and culture (Mauss & Butler, 2010; Mauss, Butler, Roberts, & Chu, 2010; Soto & Levenson, 2009; Soto, Levenson, & Ebling, 2005), as well as psychiatric (Gruber, 2011; Kring & Moran, 2008; Lee, Zaki, Harvey, Ochsner, & Green, 2011), neurodevelopmental (Golan, Baron-Cohen, Hill, & Golan, 2006), and neurological (Ascher et al., 2010; Eckart, Sturm, Miller, & Levenson, 2012; Sturm et al., 2011; Sturm, Ascher, Miller, & Levenson, 2008) disorders.

As affective science advances, the emotional changes that occur within different neurological illnesses are garnering needed attention and study. Yet, within dementia clinical practice, much of what practitioners learn about patients' emotional functioning comes from spouses or other close family members (e.g., Cummings et al., 1994), rather than objective tests of performance. Further, there are no standardized clinical tools that specifically assess the emotion system in dementia, from either an objective performance perspective akin to laboratory tasks, or from the perspective of close family informants. Each type of emotion assessment (laboratory tasks and informant report) has strengths and limitations. Laboratory tasks are objective and capture emotion *in vivo*, but require more time and resources, and assess a snapshot of emotion in a contrived setting. Informant report captures real-world emotional functioning, with the opportunity to gain a longer-term view, but it is subjective and may be prone to bias (e.g., caregivers experiencing symptoms of depression may be inclined to underestimate dementia patients' true abilities). As a step toward establishing the clinical utility of emotion assessment in dementia, an important question is to what extent these two perspectives of emotion agree. That is, despite their different measurement approaches, do family caregivers see their loved ones' emotions the same way a laboratory test does? Or is it possible that a patient can show, for example, empathic understanding in the laboratory, but is seen by his or her spouse as lacking in this regard? It may be that these measures do not agree at all, suggesting they are each measuring a different aspect of emotional functioning. Or perhaps, concordance exists between the two for some, but not all, categories of emotion. To the extent the two correspond, they can be seen to reflect a similar underlying aspect of emotional functioning.

Below, the building blocks that make up our emotion system are defined, followed by a review of laboratory measures of emotion and their use in dementia research. The focus will then shift to the literature on caregiver-informant report in dementia, with a discussion of the potential biases therein. In reviewing these two paths to emotion assessment in dementia –

laboratory tests and caregiver report – the stage will be set for the present study evaluating concordance between the two.

Taxonomy of Emotion

Current models of emotion delineate three distinct processes: reactivity, empathy, and regulation (Gross & Barrett, 2011; Izard, 2009; Levenson et al., 2008; Levenson, 2003). Reactivity entails the degree to which one experiences and expresses his or her own emotions, for example, how readily and intensely a person feels sad in the face of loss. Empathy involves understanding and responding to the emotions of others, such as picking up on whether a loved one is angry or hurt. Regulation involves a higher order process by which one controls the expression or experience of emotions.

Within each process, emotions can be further subdivided into negative (e.g., anger, sadness), positive (e.g., amusement, enthusiasm), and self-conscious (e.g., embarrassment). It is useful to differentiate between negative and positive emotions, as these serve very different functions in our environment, the former signaling threats and readying our bodies to fight or flee, the latter indicating rewards, forging social bonds, and restoring physiological equilibrium (Fredrickson, 1998; Levenson, 1994; Levenson, 2003). It is also important to distinguish the category of self-conscious emotions, as these represent a more complex level of emotional processing – calling for an awareness of the self as viewed by others (Tangney, 1999) – that occurs later, both phylogenetically and ontogenetically (Lewis, Sullivan, Stanger, & Weiss, 1989). Self-conscious emotions themselves can be either negative (e.g., shame) or positive (e.g., pride). Evidence from neurological patients and functional neuroimaging in healthy individuals suggests that these three emotion types – negative, positive, and self-conscious – may well be organized differently in the brain, with positive emotions associated with left hemisphere functioning, negative emotions with the right hemisphere, and self-conscious emotions with the frontal lobes (Beer, Heerey, Keltner, Scabini, & Knight, 2003; Davidson & Irwin, 1999; Fossati et al., 2003; Sackeim et al., 1982; Sturm et al., 2008; Sturm et al., 2012).

While these emotion processes and types work in concert – with each other as well as with cognitive systems – to navigate our complex social world (Gross & Barrett, 2011; Levenson, 2003), they can be separately tested through well-designed laboratory measures in order to evaluate a relative strength within one domain versus impairment in another. The present study focuses on the first two processes, reactivity and empathy, which tend to vary across different dementia diagnostic groups, as discussed later, in the section, Discriminant and Convergent Validity of Laboratory Assessments of Emotion in Dementia.

Indicators of Reactivity and Empathy

How do we know when another person is experiencing an emotion? While emotional expressivity can vary across individuals as a function of age (Haase et al., 2011; Orth, Robins, & Soto, 2010; Seider et al., 2011), culture (Matsumoto et al., 2008; Park, Brody, & Wilson, 2008; Roberts & Levenson, 2006; Soto et al., 2005), and gender (Brody & Hall, 2010), universal signs have been identified, including facial expressions and autonomic arousal (Ekman, 1992; Keltner, 1995; Levenson, 1992; Matsumoto et al., 2008; Matsumoto, 2007). To the extent that one has insight, self-reported emotional experience can be a third indicator (Barrett, 2004; Gohm & Clore, 2000; Robinson & Clore, 2002a). Some of these changes, such as facial expressions, self-report, and physical signs like sweating or blushing, can be readily observable in everyday life,

while others (e.g., increased heart rate, slight or rapid changes in facial expression) necessitate laboratory measurement. Such fine-grained measurement has shown these indicators – autonomic arousal, facial behavior, and self-reported experience – operate as part of a coherent system when activated by emotionally salient stimuli (Hsieh et al., 2011; Mauss, Levenson, McCarter, Wilhelm, & Gross, 2005; Sze, Gyurak, Yuan, & Levenson, 2010), though each measure also provides unique information about emotional states (Mauss & Robinson, 2009).

Conversely, how can we tell that another recognizes and understands the emotions we experience? This might be gleaned from our friend's facial expressions, such as showing concern or mirroring our own expressions, or more complex social behavior, such as attempts to cheer us up when we are feeling low. The most direct way is to ask our friend to identify the emotions we are feeling, which, while perhaps not the most socially savvy technique, is a useful tool in laboratory settings (Levenson et al., 2008). Thus, while the construct of empathy represents a network of complex and interrelated processes which may include recognizing another person's affect, sharing his or her emotional experience, and imagining his or her perspective in a given situation (Decety & Jackson, 2004; Singer, 2006), this is often operationalized as empathic accuracy, or the correct identification of a target individual's emotional state (Ickes, 1993).

Laboratory Assessment of Emotion

Laboratory assessments employ a number of tasks and measures to assess each emotion process. Such tasks use carefully selected stimuli in a controlled setting to elicit an emotional response in the viewer (i.e., reactivity), to probe the viewer to pick up on the emotion being portrayed by the stimulus (i.e., empathy), or to test the viewer's ability to control his or her emotional response to the stimulus spontaneously or on command (i.e., regulation). Stimuli can range in complexity from the simple: images or sounds (e.g., startling noises) used in isolation; to the complex: dynamic audiovisual stimuli, such as emotionally evocative scenes from movies and television (Gross & Levenson, 1995; Rottenberg, Ray, & Gross, 2007); to the naturalistic: social interactions between couples about an area of conflict in their relationship (Ascher et al., 2010; Levenson & Gottman, 1983; Levenson et al., 2008). The stimuli used in the present study are from the second, mid-level of complexity found in audiovisual scenes. Compared to static images and isolated sounds, such dynamic scenes approach a more ecologically valid form of emotion assessment, as emotional functioning in life usually requires the processing of dynamic interactions that unfold over time. Importantly, however, even these elaborated audiovisual stimuli are still an approximation of the actual complexity of emotional cues in the real world. While interpersonal interactions have higher ecological validity, by their very nature (e.g., they are idiosyncratic to each dyad), they limit the standardization possible and do not lend themselves to easy separation of the specific emotional processes of reactivity and empathy from each other and from emotion regulation (see Levenson, 2007; Levenson et al., 2008 for a fuller discussion of emotion assessment in the laboratory).

Discriminant and Convergent Validity of Laboratory Assessments of Emotion in Dementia

Dementia is a broad term for progressive neurological disorders that lead to functional decline. While laboratory assessments of emotion have long been applied to the study of emotional processing in neurologically healthy individuals (e.g., Ekman, Levenson, & Friesen, 1983; Lazarus, Speisman, Mordkoff, & Davison, 1962), the use of these assessments to study the

emotional changes that occur in dementia is relatively new. Such studies have focused on diseases known to target emotional and social functioning, with behavioral variant frontotemporal dementia (bvFTD) chief among these. This research often includes related illness in addition to bvFTD; such work serves to aid in understanding neuroanatomical correlates, improve diagnosis, and better define the clinical course of these diseases. Below, each type of dementia relevant to this work is described briefly, before reviewing the literature on emotional changes in dementia.

Patients with bvFTD – named as such because behavioral deficits are primary – can present with a range of socioemotional symptoms, including apathy, loss of empathy, disinhibition, problems with judgment, and compulsions, along with loss of insight (Boxer & Miller, 2005; Neary et al., 1998; Rascovsky et al., 2011). Semantic dementia (SD) and progressive nonfluent aphasia (PNFA) are related disorders in which language symptoms are primary. These are considered FTD subtypes distinct from bvFTD (Neary et al., 1998), reflecting possible shared underlying neuropathology and neuroanatomical changes (Davies et al., 2005; Hodges et al., 2004; Mesulam et al., 2008), and are also classified as subtypes of primary progressive aphasia (PPA), as language loss is focal (Gorno-Tempini et al., 2004; Gorno-Tempini et al., 2011). In SD, patients lose conceptual meanings (e.g., of objects, people, animals), though speech remains fluent (Gorno-Tempini et al., 2011). In PNFA, patients retain object knowledge, but speech may become agrammatical or halted, and they may have some comprehension difficulties (Gorno-Tempini et al., 2011). SD patients may eventually develop the behavioral symptoms seen in bvFTD, whereas PNFA patients typically do not develop such symptoms (Rosen et al., 2006).

Corticobasal syndrome (CBS) and progressive supranuclear palsy (PSP) are FTD-related movement disorders, with shared underlying neuropathology with some forms of FTD (Boeve, Lang, & Litvan, 2003; Lee et al., 2011); these each present with distinct movement issues and both may develop behavioral or cognitive changes (Lee et al., 2011; Litvan et al., 1996). Amyotrophic lateral sclerosis (ALS) is a movement disease involving the degeneration of motor neurons (Brooks, 1994; Brooks, Miller, Swash, & Munsat, 2000) that often occurs concurrently with FTD (Lomen-Hoerth, 2004; Lomen-Hoerth, 2011).

There have also been a number of studies looking at emotional functioning in AD, a type of dementia where memory difficulties and other cognitive changes are primary, while emotional functioning appears to be largely spared in the earlier stages of the disease (Fernandez-Duque & Black, 2005; Hodges et al., 1999; Lavenu, Pasquier, Lebert, Petit, & Van der Linden, 1999; McKhann et al., 1984). A diagnosis of mild cognitive impairment (MCI) indicates a decline in cognitive functioning that does not meet criteria for dementia (Petersen, 2004; Winblad et al., 2004); MCI may represent a precursor to AD in a subset of cases (Tabert et al., 2006).

Though the focus of the proposed study is on the comparison between behavior in the laboratory and daily life, to date, laboratory studies of emotion in dementia have focused on the questions of differential diagnosis (discriminant validity) and some have looked at associations between emotion and other abilities or measures (convergent validity). In terms of discriminant validity, laboratory-based assessments have shown their effectiveness in separating patients from neurologically healthy controls, distinguishing between different types of dementia, and, within diagnostic groups, discerning areas of impairment from domains of preserved functioning. In regard to convergent validity, researchers have found associations between laboratory emotional functioning and performance on neuropsychological tests as well as regional atrophy in brain areas purported to be important in emotion. This research is summarized below as it applies to

the emotion processes of reactivity and empathic accuracy. Though a wide range of stimuli have been used to study emotion in the laboratory, the following review emphasizes assessments using dynamic stimuli that approximate real-world emotion, as it unfolds over time, rather than static images.

Reactivity. At the most basic level measured, the physiological and behavioral defensive responses evoked by an unanticipated acoustic startle appear to be preserved in FTD (including bvFTD and subtypes) and AD, (Goodkind, Gyurak, McCarthy, Miller, & Levenson, 2010); an intact physiological response to the startle is also seen in patients with lesions to the orbitofrontal cortex (Roberts et al., 2004). For more complex stimuli such as simply-themed emotionally evocative films, FTD (including bvFTD and SD) patients showed comparable physiological, behavioral, and experiential reactions to those of neurologically healthy controls when viewing happy, sad, and fear-inducing films (Werner et al., 2007). Similarly, AD patients' spontaneous behavior and self-reported experience to amusing films were intact relative to healthy controls' behavior and experience (Henry, Rendell, Scicluna, Jackson, & Phillips, 2009). However, Eckart Sturm, Miller, and Levenson (2012) found that bvFTD patients expressed less disgust facially and via self-report, and showed lower physiological arousal, compared to controls when viewing a disgust-eliciting film.

As mentioned earlier, self-conscious emotions, such as embarrassment, rely on higher order processes of self-awareness and insight (Tangney, 1999) and on the integrity of frontal brain regions, including the orbitofrontal and pregenual anterior cingulate cortices (Beer et al., 2003; Sturm et al., 2012). One might expect that these more complex emotions would be impaired in diseases that affect the frontal lobes and rob patients of insight, such as FTD (Levenson & Miller, 2007; Rankin, Baldwin, Pace-Savitsky, Kramer, & Miller, 2005). Indeed that is what has been demonstrated in the laboratory; tasks that elicit embarrassment in neurologically healthy adults are markedly less effective in patients with FTD (Sturm et al., 2008; Sturm, Rosen, Allison, Miller, & Levenson, 2006). In one paradigm, participants were asked to sing a song, then watched the video of themselves singing. While viewing their own performances, controls displayed embarrassment and amusement in their facial expressions and were physiologically aroused; FTD patients (including bvFTD and SD) showed little emotion during the viewing and had less physiological arousal compared to controls (Sturm et al., 2008). In other dementias, such as AD, there are no studies of in-laboratory testing of self-conscious emotional reactivity per se. However, qualitative accounts suggest that AD patients continue to experience complex self-conscious emotions, such as guilt (Ward-Griffin, Bol, & Oudshoorn, 2006). Further, there is evidence that AD spares theory of mind (ToM) – that is, one's ability to infer the mental state of another (Gregory et al., 2002) – a process on which self-conscious emotion recognition (Heerey, Keltner, & Capps, 2003) and likely, reactivity, depend. On a number of tasks assessing ToM, including understanding when another holds a false belief, recognizing faux pas, and deducing mental states from images of the eyes, AD patients performed at the level of healthy controls; bvFTD patients were impaired on all these tasks (Gregory et al., 2002). Such findings point to self-conscious emotional reactivity as an area with a wide range of variability across dementia populations.

Empathic accuracy. As with reactivity, laboratory assessments have found differentiation in empathic accuracy in dementia. Werner et al. (2007) observed that FTD patients (including bvFTD and SD) were impaired at recognizing sadness and fear in characters in films, but were comparable to controls in recognition of happiness. One drawback to that

study was that happiness was the only positive emotion probed; there was only one positively themed film and “happy” was the only positive response choice, compared to an assortment of negatively-themed films and negative emotion choices. Thus there may have been a ceiling effect for the identification of positive emotion. Recently, this initial finding was followed up with an expanded set of films in which characters strongly displayed one of several emotions: positive (affection, amusement, calmness, or enthusiasm), negative (anger, disgust, fear, or sadness), or self-conscious (embarrassment, pride, or shame; Goodkind, Sturm, Ascher, Miller, & Levenson, in preparation). Using this expanded set of stimuli, bvFTD patients were impaired in recognizing emotions across all three categories, compared to both AD patients and controls, indicating that empathy difficulties in bvFTD are not limited to negative emotions. AD patients, by contrast, performed at levels comparable to controls.

In keeping with this finding of preserved empathic accuracy to films in AD, other studies have found that although AD patients show some impairment at identifying emotional facial expressions in still images, emotion recognition is preserved within a dynamic audio (i.e., prosody, music; Drapeau, Gosselin, Gagnon, Peretz, & Lorrain, 2009) or audiovisual (i.e., films; Henry et al., 2008) context. Using films assessing empathic accuracy as well as the ability to detect sarcastic versus sincere statements, Kipps, Nestor, Acosta-Cabronero, Arnold, and Hodges (2009) found that AD patients and patients with a bvFTD clinical syndrome, but *without* neuroimaging abnormalities, were comparable to controls in recognition of positive emotion, negative emotion, and sarcasm. BvFTD patients *with* scans showing neural atrophy were impaired in both emotion recognition and sarcasm detection. Looking at a subset of bvFTD patients and controls, the authors found an association between performance on these tasks and the integrity of the right lateral orbitofrontal cortex, amygdala, and temporal pole.

These laboratory studies of reactivity and empathy in dementia tell us many things about the diseases they assessed, and support two main points about the assessments themselves. One, that laboratory tests of reactivity and empathy have some degree of discriminant validity – not all patient types were impaired and those who were, were not impaired across all categories and contexts. Two, that these tests have convergent validity – they track with neural atrophy in expected regions. But, do they tell us anything about emotion in the daily lives of patients and caregivers?

Life Outside the Laboratory: The Context of Interpersonal Relationships

While a laboratory-based assessment of emotional functioning can be quite informative in characterizing different types of dementia, as indicated by the abovementioned studies, it is not yet known how the assessment relates to patients’ emotional functioning in a natural context, particularly as witnessed and experienced by family caregivers. Although direct observation (e.g., recording at-home behavior) could provide a less subjective comparison than close informant ratings, ratings by informants have the advantage of allowing the summary capture of behavior witnessed over longer time periods than are practical with observation (e.g., asking caregivers to rate functioning over the past month; Barkley, 1991). Further, family caregivers represent informants who are with patients day in and day out, seeing them at their best and worst. Thus, comparing laboratory assessments with ratings by these caregivers would speak to whether the time patients spend in the laboratory is representative of their day-to-day functioning. In support of the use of caregiver ratings, the relevant literature on the judgment of emotion within interpersonal relationships is reviewed below. This is first briefly discussed within healthy dyads, before turning to research in which one member of a dyad has dementia.

Emotion Judgments in Healthy Dyads

There is a vast literature concerning judgment and bias in interpersonal relationships, particularly in the area of personality traits, in which it has been consistently shown that close acquaintances are reasonably accurate judges of an individual's personality, showing high levels of agreement with each other, with the individual's self-reported traits, and with respect to predicting social behavior (e.g., Biesanz, 2010; Funder & Colvin, 1988; Kolar, Funder, & Colvin, 1996). As applied to couples research and, most relevant to the present study, is the examination of partners' ability to accurately infer each other's emotional state (Ickes, 1993).¹ Here, too, couples are moderately good at detecting what their significant others are feeling (e.g., Simpson, Orina, & Ickes, 2003) and are better judges of each other than are strangers (Thomas & Fletcher, 2003). In a recent meta-analysis using both self- and observer-ratings as benchmarks, Fletcher and Kerr (2010) found high rates of tracking accuracy and low levels of bias in couples' judgments of their partners; this was found across a range of domains and particularly when it came to judging psychological states including emotions.

Taking emotion judgments to a second level of abstraction, the present study asked informants not only to assess their partners' emotional reactivity, but how well their partners understand others' emotions (i.e., make judgments about partners' degree of empathic accuracy). The latter task – asking one partner how empathically attuned the other partner is (rather than simply what the other partner was feeling) – and directly comparing that with another measure of empathic accuracy, has not been addressed in healthy dyads (Busby & Gardner, 2008).

Caregivers as Informants in Dementia Research

Because of dementia's effects on memory and insight, patients are not always reliable reporters on their own impairments (Carr, Gray, Baty, & Morris, 2000; Kiyak, Teri, & Borson, 1994). Thus, caregivers have a long history as informants in dementia research and clinical care (e.g., Grut et al., 1993; see Davis, 2001 for a review). As most dementia research has focused on AD, caregivers have primarily been asked to report on patients' cognitive functioning and activities of daily living (ADL), areas that tend to be impaired early in the course of AD (Reisberg et al., 1989). As such, a number of caregiver-report measures have been developed and validated to assess these domains of functioning (e.g., Freilich & Hyer, 2007; Jorm, 1996; Lawton & Brody, 1969).

Limitations and strengths of caregiver report. Caregivers of dementia patients face a great deal of stress and a host of intense emotional experiences as they grapple with the inexorable losses of a deteriorating illness (e.g., Ascher et al., 2010). They tend to experience significantly higher rates of depression and anxiety than similarly-aged non-caregiving individuals (Schulz, O'Brien, Bookwala, & Fleissner, 1995). Such psychological effects of caregiving, particularly depression, are closely tied to degree of perceived burden (Schulz et al., 1995). Caregivers' levels of perceived burden and depression have been shown to be a source of

¹ In the marriage and relationships literature, this ability to infer partners' emotional states is termed "empathic accuracy," which, in the present study, corresponds to informants assessing their partners' emotional *reactivity*. To avoid confusion in terminology, note that this is distinct from making a judgment about one's partner's *skills* in empathic accuracy, which informants in the present study were also tasked with, as discussed in the following paragraph.

bias when it comes to rating patients' ADL compared to actual performance on objective tests. For example, Zanetti, Geroldi, Frisoni, Bianchetti, and Trabucchi (1999) found that although agreement between caregiver ratings and objective performance was high for some skills (walking and dressing), there was relatively low agreement for phone use, money use, and shopping, and no agreement for toileting. Degree of caregiver burden substantially contributed to these discrepancies. In terms of caregiver depression, Arguelles, Loewenstein, Eisdorfer, and Arguelles (2001) found that more depressed caregivers tended to underestimate patients' ADL, while caregivers who were less depressed tended to overestimate patient functioning. However, caregiver burden and depression do not appear to cause bias in caregiver ratings of patients' cognitive abilities (Hadjistavropoulos, Taylor, Tuokko, & Beattie, 1994; Mangone et al., 1993). The role of potential biases in caregiver ratings has not yet been applied to studies of emotional functioning in dementia patients.

Despite potential limitations, caregivers provide an important and necessary perspective on patient functioning. It is their perspective that often brings patients into a clinic or laboratory in the first place, and that ultimately determines if and when placement in a nursing home becomes necessary (Coehlo, Hooker, & Bowman, 2007). For example, in bvFTD, behavioral changes are reported by caregivers well before abnormalities are picked up by neuroimaging or neuropsychological tests (Gregory, Serra-Mestres, & Hodges, 1999). Established clinical measures such as the Clinical Dementia Rating Scale (Morris, 1993) and Neuropsychiatric Inventory (Cummings et al., 1994) rely on interviews with caregivers to assess severity of functional and behavioral impairment in dementia (though, relevant to the aims of the present study, such measures do not assess emotional functioning per se). Results of these measures often play a part in clinicians advising families on appropriate adjunctive support or the decision to move to institutional care.

Thus, information from caregivers plays a prominent role in virtually all aspects of dementia diagnosis and care. In the realm of emotional functioning, as findings from the laboratory become more applicable to differential diagnosis, it is crucial to understand whether those laboratory results are consistent with caregivers' views. As with other functional domains (e.g., cognitive changes), in practice, caregivers will be the first-line detectors of emotional impairment and will be relied upon to monitor decline (or progress, as treatments become available).

Caregiver report of emotional functioning. Caregiver reports of patients' emotional functioning are less common than reports of cognitive functioning and ADL, though there are a few such studies, reviewed below. While none included direct statistical comparisons of caregiver report and laboratory assessment, the results are, at least, consistent with diagnostic grouping, paralleling both group-level findings on emotional laboratory tasks and clinical accounts of the dementias studied.

Reactivity. Magai, Cohen, Gomberg, Malatesta, and Culver (1996) studied caregiver ratings of emotional reactivity in nursing home patients with late-stage AD. These family caregiver ratings were compared with two other assessments of emotional reactivity: ratings by nursing staff and objective coding by research staff; parenthetically, this provides the only direct comparison between caregiver ratings and an objective measure of reactivity in this brief review. The authors found that family members' ratings were more similar to those of objective coders than were nursing staff ratings, indicating that family caregivers were more accurate reporters of patients' emotional reactivity.

In a study of caregiver report alone (i.e., no comparison to other measures), Bathgate, Snowden, Varma, Blackshaw, and Neary (2001) found that caregivers of bvFTD patients reported “loss of emotions” more often than did AD caregivers. This parallels the reduced embarrassment and disgust that FTD patients show in the laboratory (Eckart et al., 2012; Sturm et al., 2006; Sturm et al., 2008) and clinical descriptions of emotional blunting and apathy in FTD syndromes (Neary et al., 1998), but is not consistent with findings that FTD patients show preserved reactivity to simpler stimuli such as an acoustic startle or a simply-themed film (Goodkind et al., 2010; Werner et al., 2007).

Empathy. In terms of empathy, there are a few studies including caregiver report, though none directly correlates caregiver-reported empathy with a laboratory measure (or any other objective measure) of empathic accuracy. The closest, by Lough and colleagues (2006), at least included both types of measures in the same study, asking caregivers to report on patient empathy pre- and post-illness and testing patients’ abilities to identify facial expressions of emotion in still images. Caregivers of bvFTD patients reported losses in empathy over time; correspondingly, bvFTD patients performed below the level of controls at identifying emotional facial expressions. While no analyses of concordance between caregivers and the laboratory task were conducted, the results suggest that the two assessments are at least aligned at the diagnostic group level.

Rankin and colleagues (2005) also examined caregiver-reported empathy and found that bvFTD and SD patients were rated as less empathic than both AD patients and healthy controls. No laboratory measure of empathy was included, but results are consistent with FTD patients showing impaired empathic accuracy in the laboratory (Goodkind et al., in preparation; Werner et al., 2007), as well as with loss of empathy in the clinical criteria of FTD (Neary et al., 1998; Rascovsky et al., 2011).

The Present Study

The present study compares laboratory assessments to close family informants’ perspectives of emotional functioning in individuals with and without neurological illness. These two measures do not share method variance, as one is based on a participant’s laboratory performance and the other, on an informant’s report; thus, a comparison between the two is not susceptible to the inflated correlations that can occur when measures share a common method (Lindell & Whitney, 2001; Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). Thus, finding significant agreement between the two would indicate they are capturing the same underlying phenomena with different tools. In addition to ruling out any shared method bias, given the potential biases inherent in caregiver report, this study controls for the effects of informant depression and anxiety, as indicators of burden. This approach enables the testing of the congruence between laboratory measures of emotion and informant-observed daily emotional functioning in an important clinical population. Because caregivers are so often relied upon as informants in dementia diagnosis and care, learning how a laboratory assessment compares to that of caregivers is critical in establishing the clinical utility of these measures of emotional changes in dementia.

Hypotheses

The present study aimed to test the concordance between laboratory performance and informant-reported emotional functioning in dementia patients and neurologically healthy controls. Emotional functioning included measures of reactivity and empathic accuracy for negative, positive, and self-conscious emotions.

1. **Reactivity.** Participants' performance on laboratory tasks designed to elicit negative, positive, and self-conscious emotions will predict informant-reported reactivity (overall and within each emotion type) above and beyond potential sources of caregiver burden or informant bias (i.e., informant depression and anxiety). That is, after controlling for these burden/bias variables,
 - (a) laboratory *total* reactivity will significantly predict informant-reported *total* reactivity;
 - (b) laboratory *negative* reactivity will significantly predict informant-reported *negative* reactivity;
 - (c) laboratory *positive* reactivity will significantly predict informant-reported *positive* reactivity;
 - (d) laboratory *self-conscious* reactivity will significantly predict informant-reported *self-conscious* reactivity.

Reactivity in the laboratory is measured through multiple modalities (facial expressions of target emotions, physiological arousal, and self-reported experience). It is expected that participants' facial behavior will be a better predictor than physiology and self-report in the four reactivity comparisons described above (total, negative, positive, and self-conscious reactivity).

Rationale. The laboratory tasks used in the present study were designed to sufficiently approximate participants' real emotional lives, providing ecologically valid measures of emotional reactivity through the use of dynamic, audiovisual stimuli covering a broad range of emotions. A perspective of that reality was gleaned through a measure of participants' degree of emotional functioning in their daily lives as seen by close family members. While informants may be biased by their own distress, both in couples in general (e.g., Schul & Vinokur, 2000), and particularly in the context of caring for an ill family member (e.g., Arguelles et al., 2001), controlling for the potential effects of this distress or burden (i.e., depression and anxiety) allows a comparison of the laboratory tasks with a more accurate perspective of participants' daily emotional reactivity.

As facial behavior represents an objective, observable indicator, it is expected that this mode of expression will provide the best predictor of informant-rated reactivity. By contrast, informants are not privy to participants' physiological arousal, and will have varying degrees of information about participants' emotional experience; thus these two laboratory indicators are not expected to predict informant-rated reactivity as strongly as the behavioral indicator.

2. **Empathic accuracy.** Participants' performance on laboratory tasks designed to test understand of negative, positive, and self-conscious emotions will predict informant-reported

empathic accuracy (overall and within each emotion type) above and beyond potential sources of caregiver burden or informant bias (i.e., informant depression and anxiety). That is, after controlling for these burden/bias variables,

- (a) laboratory *total* empathic accuracy will significantly predict informant-reported *total* empathic accuracy;
- (b) laboratory *negative* empathic accuracy will significantly predict informant-reported *negative* empathic accuracy;
- (c) laboratory *positive* empathic accuracy will significantly predict informant-reported *positive* empathic accuracy;
- (d) laboratory *self-conscious* empathic accuracy will significantly predict informant-reported *self-conscious* empathic accuracy.

Rationale. As with reactivity, the empathic accuracy laboratory tasks were designed to approximate participants' emotional understanding in daily life through dynamic stimuli sampling a variety of emotions. Close family informants provided a perspective of that reality; taking their potential biases taken into account enables laboratory empathy to be compared with a more accurate perspective of participants' real-world empathy. Thus, the two measures are expected to converge.

Methods

Participants and Informants

Neurological patients with a range of dementia diagnoses and disease severity, as well as neurologically healthy controls, were included in order represent a wide range of emotional functioning and gain the most variability across the measures. Patients were recruited by the Memory and Aging Center (MAC) in the Department of Neurology at the University of California, San Francisco (UCSF) for participation in a larger study conducted by the MAC, in collaboration with the Berkeley Psychophysiology Laboratory (BPL) in the Department of Psychology at the University of California, Berkeley. Patients were diagnosed by trained MAC staff through a review of data from neurological assessments, clinical interviews, case histories, neuropsychological tests, and brain imaging. Diagnoses were made in accordance with standard research criteria; patients included in the present study had a primary diagnosis of AD (McKhann et al., 1984), bvFTD (with comorbid ALS in a few cases; Brooks, 1994; Neary et al., 1998), PPA (Mesulam, 2001), PNFA (Neary et al., 1998), SD (Neary et al., 1998), CBS (Lee et al., 2011), PSP (Litvan et al., 1996), and MCI (Petersen, 2004; Winblad et al., 2004).

Patients with dementia symptoms who did not meet full research criteria for an illness were also included. In this subthreshold dementia symptoms (SDS) group, varied clinical phenotypes were represented, including: bvFTD, MCI, posterior cortical atrophy, and primary lateral sclerosis. SDS patients were included because of concerns that their clinical presentations may signify underlying pathological changes in the early stages of a neurodegenerative disease; although they did not meet research consensus criteria at the time of this study, the research team determined that symptoms may progress to fully developed neurodegenerative diseases such as those included in the present study.

For demographic data, SDS and MCI patients were considered together in a mild dementia symptoms (MDS) group; PNFA and SD patients were included in a PPA group, as these are considered PPA subtypes (Gorno-Tempini et al., 2011); CBS and PSP patients were

considered together as these represent movement disorders thought to be neuropathologically associated (Boeve et al., 2003). MAC and BPL staff also recruited control participants from the local community through advertisements and word of mouth; controls were neurologically and psychiatrically healthy as determined by clinical and neuropsychological screening. Thus, six diagnostic groups were included: control, AD, bvFTD, PPA, CBS/PSP, and MDS.

Each participant was accompanied by an informant. For patients, informants were close family members directly involved in caregiving (usually spouses or adult children). For controls, eligible informants included spouses, domestic partners, adult children, or siblings. For the present study, 141 participant-informant dyads were recruited from consecutive referrals to the BPL dementia research program over a three-year period. Of these, 3 participants were excluded from all analyses due to inconsistent or unavailable diagnoses (1 participant recruited as a healthy control was subsequently diagnosed with alcohol dependence, 1 participant recruited as a dementia patient was diagnosed with bipolar disorder, and 1 participant did not yet have diagnostic information available). An additional 18 participants were excluded due to missing data in key variables (either because data had not yet been processed or measures were incomplete). This yielded 120 participants included in either reactivity analyses, empathy analyses, or both. Participants with complete datasets for reactivity, but not empathy measures, were included in only the reactivity analyses, and vice versa. Thus, of the 120 participants included, 73 were included in both types of analyses, 10 were included in reactivity analyses only (for a total of 83 participants in the reactivity analyses), and 37 in empathy analyses only (for a total of 110 participants in the empathy analyses). Included and excluded dyads did not differ significantly with respect to age, sex, or participant-informant relationship types. Please see Tables 1, 2, and 3 for diagnostic and demographic information for the included samples.

General Procedure

The laboratory assessment was conducted at BPL. Upon arrival, each participant signed a consent form (approved by the Committee for the Protection of Human Subjects [CPHS] at the University of California, Berkeley) that described the experimental tasks. An experimenter also explained the procedure. An additional consent form regarding the future use of the videotapes was presented at the beginning of the day and signed at the end of testing so that all participants knew exactly what had been recorded. For dementia patients, all consent forms were co-signed by caregivers. Participants completed a health checklist regarding information about their medications and caffeine intake to insure that they had not taken substances that would disrupt their normal physiological responses. Participants were then seated in a comfortable chair in a well-lit, 3 m x 6 m room where an experimenter attached physiological sensors and briefly oriented the participants to the procedures. Stimuli were presented on a 21-inch television monitor placed directly in front of the participants. Participants were videotaped throughout the experimental tasks using a remote-controlled, high-resolution video camera that was partially concealed in the experiment room. Videos captured the participants' face and shoulders, taken from straight on. Video recordings were used for behavior coding as described later, in the section, Emotional behavior (reactivity). The laboratory assessment was conducted within one six-hour visit, with a break for lunch. A subset of tasks from this assessment is included in the present study; this subset took approximately two to three hours to complete.

Along with participants, informants signed CPHS-approved consent forms describing the informant measures. While participants completed the laboratory tasks, informants completed a questionnaire packet in a separate room. Measures used in the present study included one

questionnaire asking informants to rate the participants' functioning and another asking informants to rate their own functioning, described further in the section, Informant-Completed Measures.

Laboratory Tasks

Reactivity. Participants viewed film clips from television and movies, each selected to elicit a particular emotion (see below). Negative and positive film clips were found to elicit the target emotion considerably more than other emotions in pilot testing with undergraduate students, as indicated by self-reported emotional experience. The particular target emotions were chosen because they have been found to be reliably elicited with films (Gross & Levenson, 1995; Rottenberg et al., 2007). For negative emotion, sadness and disgust were used, but not anger or fear, as these have been more difficult to elicit using films in this population (Levenson et al., 2008; Levenson, 2007). Each clip was preceded by a 1-min baseline period, during which a black X was presented in the middle of a white screen and participants were instructed to relax and watch the X. Each clip then began after the 1-min baseline fixation. Stimulus clip lengths ranged from 1 min 32 s to 2 min 42 s as described below.

Negative emotion. Participants viewed two negatively themed film clips, as follows.

Sadness. To elicit sadness, a scene from the movie, "The Champ," was shown. This clip depicts a young boy learning that his father, a boxer, has just died after sustaining injuries during a boxing match. The boy cries and implores those around him to wake his father, in disbelief that his father is truly gone. The duration of the clip is 1 min 32 s.

Disgust. To elicit disgust, a clip from the television game show, "Fear Factor," was shown. This clip displays contestants eating cow intestines. The duration of the clip is 1 min 45 s.

Positive emotion: Amusement. Participants viewed one positively themed film clip to elicit a target emotion of amusement. The clip was a scene from the television show, "I Love Lucy," depicting two women wrapping chocolates in an assembly line and comically failing at that task when the conveyer belt speed increases. The duration of the clip is 1 min 51 s.

Self-conscious emotion: Embarrassment. To elicit embarrassment, participants were asked to sing the song, "My Girl," by The Temptations, karaoke style. That is, participants heard the song through headphones, with the lyrics appearing on the screen in front of them, and sang along to the music. Participants were then shown the video of themselves singing the song, a cappella. Thus, the actual stimulus was the video of each participant, beginning with the participant viewing the fixation screen for 1 min, then singing for 2 min 42 s. This singing task has been found to reliably elicit embarrassment, as indicated by facial behavior and self-reported emotional experience, in neurologically healthy adults (Shearn, Bergman, Hill, Abel, & Hinds, 1990; Sturm et al., 2008; Sturm et al., 2012).

Empathy. Participants viewed film clips from movies, each depicting a target character strongly displaying a particular emotion, as described below. In pilot testing, undergraduate students reliably identified the target emotion more often than the other emotion choices for each of the films selected. A broader range of target emotions was used for empathy compared to

reactivity because pilot testing showed that participants were able to discriminate among these emotions (i.e., empathic accuracy) despite not necessarily experiencing the same emotions in response to films. Each clip was preceded by a 30-s baseline period, during which a black X was presented in the middle of a white screen and participants were instructed to relax and watch the X. Each clip then began after the baseline fixation. Each stimulus clip was 37 s in length, for a total of 1 min 7 s viewing time, including the baseline.

Negative stimuli. Participants viewed four clips with characters portraying each of the following target negative emotions.

Anger. The anger clip was a scene from the movie, “Best In Show,” depicting a woman (target character) frantically searching her hotel room for a lost item, yelling at the hotel manager and maid the entire time, blaming them for misplacing her item.

Disgust. The disgust clip was a scene from the movie, “Indiana Jones and the Temple of Doom,” depicting a dinner party. As one of the dishes, a plate of large beetle-like insects, is presented to a woman (target character), she watches others eating the insects with a disturbed expression, and asks the boy next to her if she can borrow his hat so that she might “puke” in it.

Fear. The fear clip was a scene from the movie, “Pirates of the Caribbean,” depicting a woman (target character) running away from a pirate ghost, getting caught, and screaming several times during the chase.

Sadness. The sadness clip was a scene from the movie, “Playing by Heart,” depicting two women sitting on a bench at a cemetery. Both women are crying as one woman (target character) tells the other how much she will miss the man whose funeral they had just attended.

Positive stimuli. Participants viewed four clips with characters portraying each of the following target positive emotions.

Affection. The affection clip was a scene from the movie, “High Fidelity,” depicting a man (target character) embracing a woman, while dancing with her to music, smiling, and kissing her on the cheek.

Amusement. The amusement clip was a scene from the movie, “Patch Adams,” depicting a doctor entertaining a child patient by wearing a clown nose and doing tricks. The child (target character) smiles and laughs in response to the doctor.

Calmness. The calmness clip was a scene from the movie, “The Graduate,” depicting a man (target character) lounging on a float in a swimming pool, wearing sunglasses, smiling, and drinking a beer as pleasant music plays in the background.

Enthusiasm. The enthusiasm clip was a scene from the movie, “My Best Friend’s Wedding,” depicting a woman (target character) greeting two friends, hugging them, and saying how excited she is to meet them in a high, giggly voice.

Self-conscious stimuli. Participants viewed three clips with characters portraying each of the following target self-conscious emotions.

Embarrassment. The embarrassment clip was a scene from the movie, “The Princess Diaries,” depicting a teenage girl (target character) seated in a classroom full of students. Another girl interrupts the lesson to point out that the target character is wearing a hat in class, violating the dress code. The teacher instructs the target character to take her hat off. As she does so, the other students laugh at her and tease her as she shrinks in her seat.

Shame. The shame clip was a scene from the movie, “Bend It Like Beckham,” depicting a girl (target character) wearing a soccer uniform sitting on a bench next to the soccer field talking to her coach, telling him how she got a scar on her leg as she tries to cover and hide the scar, averting his gaze.

Pride. The pride clip was a scene from the movie, “The Karate Kid,” depicting the end of a karate competition. The winner is being held up on his teammates’ shoulders as they all cheer and a man (target character) watches and nods, with a slight smile, while uplifting music plays in the background.

Laboratory Measures

Physiological responding (reactivity). Twelve peripheral physiological responses were continuously monitored through a system consisting of BIOPAC polygraph modules and a computer with 32 channels of analog-to-digital capability. Software written by Robert W. Levenson was used to compute second-by-second averages of each channel: (a) heart rate (Vermed SilverRest EKG pregelled electrodes were placed in a bipolar configuration on opposite sides of the participant’s chest; the interbeat interval was calculated as the interval, in milliseconds, between successive R waves), (b) finger pulse amplitude (a UFI photoplethysmograph recorded the amplitude of blood volume in the finger using a photocell taped to the distal phalanx of the index finger of the non-dominant hand), (c) finger pulse transmission time (the time interval in milliseconds was measured between the R wave of the electrocardiogram [EKG] and the upstroke of the peripheral pulse at the finger site, recorded from the distal phalanx of the index finger of the non-dominant hand), (d) ear pulse transmission time (a UFI photoplethysmograph attached to the right earlobe recorded the volume of blood in the ear, and the time interval in milliseconds was measured between the R wave of the EKG and the upstroke of peripheral pulse at the ear site), (e) systolic blood pressure (a blood pressure cuff was placed on the middle phalanx of the middle finger of the non-dominant hand and continuously recorded the systolic blood pressure), (f) diastolic blood pressure (a blood pressure cuff was placed on the middle phalanx of the middle finger of the non-dominant hand and continuously recorded the diastolic blood pressure), (g) skin conductance (a constant-voltage device was used to pass a small voltage between BIOPAC electrodes [using an electrolyte of sodium chloride in unibase] attached to the palmar surface of the middle phalanges of the ring and index fingers of the non-dominant hand), (h) general somatic activity (an electromechanical transducer attached to the platform under the participant’s chair generated an electrical signal proportional to the amount of movement in any direction), (i) respiration period (a pneumatic bellows was stretched around the thoracic region and the intercycle interval was measured in milliseconds between successive inspirations), (j) respiration depth (the point of the maximum inspiration minus the point of maximum expiration was determined from respiratory tracing), (k) respiratory sinus arrhythmia (the rhythmic oscillation in heart period that accompanies breathing, which is an index of vagal control of the heart, was measured), and (l) finger temperature (a

BIOPAC surface temperature transducer attached to the distal phalanx of the little finger of the non-dominant hand recorded temperature in degrees Fahrenheit). These 12 measures were selected to provide a broad index of the activity of physiological systems important to emotional responding: cardiac, vascular, electrodermal, respiratory, and striate muscle.

Emotional behavior (reactivity). Videos of the participants taken while viewing the reactivity stimuli were coded by a team of trained coders, blind to participant diagnosis and the nature of the experimental trial. For the negative and positive reactivity film clips, the most intense 30-s segment of the clip was coded, as determined by undergraduate students' ratings. For the self-conscious stimulus, the video of the participant singing, the first 30 s after the baseline were coded. Coders followed a modified version of the Expressive Emotional Behavior coding system (Gross & Levenson, 1993), which is based in the Facial Action Coding System (Ekman & Friesen, 1978). Coders coded the participants' behavior during each second of the 30-s segments for nine emotional behaviors: anger, confusion, contempt, disgust, embarrassment, fear, happiness/amusement, sadness, and surprise. Each emotion was coded on a 0 to 3 intensity scale.

Self-report (reactivity and empathy).

Reactivity: Self-reported emotional experience. After viewing each reactivity stimulus, participants were asked to verbally indicate how they felt while viewing the video in two ways. First, they were asked for an open-ended response to "What emotion did you feel most strongly while watching the film?" (or "...while watching yourself singing?" for the singing task). Next, participants were asked to rate how intensely they felt each of 11 different emotions (affectionate, afraid, amused, angry, ashamed, calm, disgusted, embarrassed, enthusiastic, proud, and sad) on a three-point scale ("no," "a little," or "a lot"). Questions and response choices were presented, both in text and aloud, from the television screen directly after each stimulus. Participants were instructed to say their answers out loud. For patients who had difficulty responding to the questions via the video presentation, an experimenter came into the room after each stimulus and read the questions to the participant in person, with accompanying text on paper. Patients with speech difficulties were able to read along and point to their choices where necessary. After the self-conscious stimulus, for ease of administration, the questions were always read in person with accompanying text rather than presented on the screen.

Empathy: Emotion identification. After viewing each empathy stimulus, participants were shown a still image of the target character displaying a neutral expression and asked to verbally indicate which of 11 emotions (affectionate, afraid, amused, angry, ashamed, calm, disgusted, embarrassed, enthusiastic, proud, or sad) the target character in the film was feeling most strongly. As with the reactivity films, questions and response choices were presented via the television monitor in both text and voice.

Informant-Completed Measures

Participant functioning. Because there are no existing comprehensive measures of informant-rated social and emotional functioning, the Caregiver Assessment of Socioemotional Functioning (CASEF; Ascher et al., 2007) was developed for use in the present study and the larger patient research program being conducted by BPL and MAC. The CASEF consists of 44

items assessing six domains of emotional functioning (reactivity, empathic accuracy, emotional empathy/contagion, motivational empathy/compassion, regulation, and emotional memory) and six domains of social functioning (social norms/rules, morality, self-centeredness, social interest, social disinhibition, and insight). For each item, informants were asked to rate the participants' behavior over the past month on a five-point scale ranging from 0 ("not at all") to 4 ("a lot"). For the present study, only the 23 items from the reactivity and empathic accuracy subscales were used. See Appendix for the CASEF items organized by subscales.

Because the CASEF is a newly developed measure, full psychometric data are not yet available. In the present study, basic psychometric analyses were performed to determine internal consistency of the measure as a whole, as well as for each subscale used. To obtain as large a sample as possible for psychometric testing, all participant-informant dyads with completed CASEF questionnaires, or completed items for the subscale in question, were included in each analysis, regardless of whether data were available for the other study measures. These dyads were similar to the overall sample in terms of diagnoses, age, gender, and informant types. Internal consistency was excellent for the overall measure (Cronbach's $\alpha = .96$) and ranged from acceptable (Cronbach's $\alpha = .70$) to excellent (Cronbach's $\alpha = .98$) for subscales. Subscale alphas, sample sizes, and further details for each scale are reported in Table 4.

Informant psychological functioning. The Symptom Checklist (SCL-90; Derogatis, 1977) is a 90-item questionnaire assessing nine domains of psychopathology (somatization, obsessive-compulsive, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoid ideation, and psychoticism). For each item, informants were asked to rate how much they were bothered or distressed by that particular symptom (e.g., headaches) during the past month on a five-point scale ranging from 0 (not at all) to 4 (extremely). For the present study, only the depression and anxiety subscales were used to represent potential effects of caregiver burden (Schulz et al., 1995).

Data Reduction

Laboratory measures. Within each emotion process (reactivity and empathic accuracy) and within each measure (physiological responding, emotional behavior, and self-report), the laboratory measures were reduced to two levels of variables: (a) the *type* level, collapsing across tasks for analyses by emotion type (negative, positive, and self-conscious) and (b) the *process* level, collapsing across types for analyses of overall reactivity and empathic accuracy. These are described in detail in each section below.

Reactivity.

Physiological responding. For the reactivity tasks, physiological reactivity scores were computed for each measure by subtracting the average level for the 1-min baseline period from the average level during the emotional stimulus. To provide a single, more reliable measure of overall peripheral physiological responding, a composite score was calculated that comprised all physiological channels. To calculate this composite, standardized scores were computed for each physiological channel and reverse-scored as needed (i.e., cardiac interbeat interval, finger pulse amplitude, finger pulse transmission time, ear pulse transmission time, respiration period) so that larger values reflected greater physiological arousal. The standardized scores were then averaged, which resulted in a single physiological arousal score for each participant for each

task, where higher values indicate greater reactivity. From the individual task arousal scores, three type-level scores were derived: negative (average of disgust and sadness scores), positive (amusement score), and self-conscious (watch self singing score). Finally, these three were averaged to obtain a total physiological reactivity process-level score.

Emotional behavior. For each emotion code (anger, confusion, contempt, disgust, embarrassment, fear, happiness/amusement, sadness, and surprise) the intensity scores for each occurrence during the emotional stimulus period were summed. Presence of the target emotion while viewing each clip was considered an indicator of reactivity. Intensity scores for the target code for each task yielded a reactivity behavior score per task, where higher values indicate greater reactivity. From the individual task behavior scores, three type-level scores were derived: negative (average of disgust and sadness film scores), positive (amusement film score), and self-conscious (watch self singing score). Finally, these three were averaged to obtain a total process-level behavioral reactivity score.

Self-report. Participants received two scores for each reactivity task: one for the open-ended response and another for the multiple-choice emotion response. For the open-ended score, responses were coded for an indication of the target emotion by comparing the responses to an emotion word dictionary developed in our laboratory (Ascher et al., 2010). Naming the target emotion or its equivalent meaning (e.g., “amused” or “it was funny” for the amusement film) received a score of 2. A more general term of the same valence as the target emotion (e.g., “good” or “happy” for the amusement film; “bad” or “upset” for the sadness film) received a score of 1. Responses indicating a feeling different from the target emotion or its general category (e.g., “happy” or “fine” for the sadness film) received a score of 0.

For the multiple-choice score, each response (“no,” “a little,” or “a lot”) for the target emotion received a score of 0, 1, or 2, respectively. The open-ended score and multiple-choice score were summed to yield a total self-reported reactivity score for each task, where higher values indicate greater reactivity. From the individual task self-report scores, three type-level scores were derived: negative (average of disgust and sadness film scores), positive (amusement film score), and self-conscious (watch self singing score). Finally, these three were averaged to obtain a total process-level self-reported reactivity score.

Composites. For specificity analyses, within each emotion type, a composite score was derived by first computing standardized scores for the physiology, behavior, and self-report type-level scores, then averaging these. This yielded three composite scores: negative reactivity total, positive reactivity total, and self-conscious reactivity total.

Empathic accuracy. Empathic accuracy is based on the self-report measure only. For each empathy film, naming the target emotion earned a score of 2; naming another emotion of the same valence as the target earned a score of 1; naming an emotion that was not the valence of the target earned a score of 0. From these task scores, where higher values indicate better empathic accuracy, three type-level scores were derived: negative (average of anger, disgust, fear, and sadness film scores), positive (average of affection, amusement, calmness, and enthusiasm film scores), and self-conscious (average of embarrassment, pride, and shame film scores). Finally, these three were averaged to obtain a total process-level empathic accuracy score.

Informant-completed measures.

CASEF. Similar to the laboratory assessment variables, items from the CASEF within each emotion process (reactivity and empathic accuracy) were examined at two levels of variables: (a) the *type* level, averaging scores across items for analyses by emotion type (negative, positive, and self-conscious) and (b) the *process* level, averaging scores across types for analyses of overall reactivity and empathic accuracy. Relevant CASEF items are included in the Appendix, organized by subscales.

SCL-90. The 13 items from the depression subscale and 10 items from the anxiety subscale were each averaged to yield scores for informant depression and anxiety.

Data Analysis

Hierarchical regression analyses were used to test whether laboratory assessment variables were associated with informant-rated functioning for each emotion process (reactivity and empathic accuracy) both overall (i.e., collapsed across negative, positive, and self-conscious types) and looking at each emotion type separately. The CASEF was chosen as the dependent measure, with laboratory performance variables serving as predictors, to enable a comparison of the relative predictive power of the multiple domains that make up laboratory reactivity (physiology, behavior, and self-report). Thus, eight separate regressions were run with each CASEF score as a dependent variable. To control for possible biases due to informants' own distress or caregiver burden, informant depression and anxiety scores were entered in the first step of all regressions. The laboratory variables for the process being tested in a particular regression (e.g., negative reactivity) were entered as predictors in the second step. Within significant reactivity analyses, the magnitude of beta weights was compared to determine which laboratory variable was the best predictor (e.g., emotional behavior vs. physiology and self-report).

An alpha level of .05 was used for all statistical tests. A Bonferroni adjustment was applied when comparing multiple coefficients within a given regression. *P* values were adjusted by multiplying the observed *p* value by the number of predictors compared. In those cases, adjusted *p* values (p_{adj}) are reported.

Results

Reactivity

Descriptive statistics for the variables used in the reactivity analyses are reported in Table 5. Results of the reactivity analyses are reported below and in Table 6.

Total reactivity. The relationship between laboratory and informant-rated total reactivity (i.e., collapsed across negative, positive, and self-conscious reactivity) was first examined (controlling for informants' anxiety and depression symptoms). Model 1 was significant, accounting for 8.7% (R^2) of the variance, $F(2, 80) = 3.81, p = .026$. Informant depression was a stronger predictor ($p_{adj} = .016$) than anxiety ($p_{adj} = .117$) and in a negative direction, indicating that informants with higher levels of depression rated participants as less emotionally reactive (see Table 6 for beta weights). The addition of the three laboratory reactivity variables (physiology, behavior, and self-report) accounted for an additional 24.8%

(ΔR^2) of the variance above and beyond informant depression and anxiety, $F(3, 77) = 9.55, p < .001$. The final model was also significant, accounting for 29.1% (R^2) of the variance, $F(5, 77) = 7.74, p = < .001$. Of the three laboratory measures, behavioral reactivity was a significant predictor ($p_{\text{adj}} = .044$), as was physiological arousal ($p_{\text{adj}} = .046$), with both showing comparable predictive power in a positive direction, indicating greater reactivity to a target emotion in the laboratory was associated with greater informant-reported total reactivity. Self-report was in the expected direction, but was not significant ($p_{\text{adj}} = .931$; see Table 6 for beta weights). Thus, Hypotheses 1.a was supported in that the two measures agreed; both behavior and physiology emerged as strong predictors.

Negative reactivity. Informants' degree of anxiety and depression symptoms was entered first in a hierarchical regression predicting participants' informant-rated negative reactivity (CASEF Negative Reactivity score). This model accounted for 6.4% (R^2) of the variance in CASEF Negative Reactivity, $F(2, 80) = 2.75, p = .070$, with neither informant anxiety nor depression significantly predicting CASEF Negative Reactivity. Laboratory negative reactivity variables (physiological arousal, behavior, and self-report) entered in the second step explained an additional 14.9% (ΔR^2) of the variance above and beyond informant depression and anxiety, $F(3, 77) = 4.86, p = .004$. The final model was also significant, accounting for 21.3% (R^2) of the variance in CASEF Negative Reactivity, $F(5, 77) = 4.17, p = .002$. Self-reported negative reactivity was the best laboratory predictor, in a positive direction, indicating greater self-reported reactivity to target negative emotions in the laboratory was associated with greater informant-rated negative reactivity, though this was marginally significant after Bonferroni adjustment ($p_{\text{adj}} = .052$). Behavior ($p_{\text{adj}} = .358$) and physiology ($p_{\text{adj}} = .391$) were in the expected direction, but were not significant (see Table 6 for beta weights). Thus, Hypothesis 1.b was supported in that the two measures of negative reactivity corresponded, though behavioral reactivity was not the strongest predictor.

Positive reactivity. Informant anxiety and depression, entered first in the hierarchical regression, accounted for 22.5% (R^2) of the variance in CASEF Positive Reactivity, $F(2, 80) = 11.59, p < .001$. Informant depression was a stronger predictor ($p_{\text{adj}} < .001$) than anxiety ($p_{\text{adj}} = .416$) and in a negative direction, indicating that informants with higher levels of depression rated participants as less positively reactive (see Table 6 for beta weights). Laboratory positive reactivity variables (physiological arousal, behavior, and self-report) entered in the second step explained an additional 17.2% (ΔR^2) of the variance above and beyond informant depression and anxiety, $F(3, 77) = 7.31, p < .001$. The final model was also significant, accounting for 39.7% (R^2) of the variance in CASEF Positive Reactivity, $F(5, 77) = 10.12, p < .001$. None of the laboratory predictors were individually significant after Bonferroni adjustment; however, self-reported positive reactivity ($p_{\text{adj}} = .128$), behavior ($p_{\text{adj}} = .352$), and physiological arousal ($p_{\text{adj}} = .890$) were all in the expected direction, indicating greater reactivity to positive stimuli in the laboratory was associated with greater informant-rated positive reactivity (see Table 6 for beta weights). Thus, similar to the previous analysis, Hypothesis 1.c was supported in that the two measures of positive reactivity showed agreement, though behavioral reactivity was again not the strongest predictor.

Self-conscious reactivity. Informant anxiety and depression, entered first in the hierarchical regression, accounted for 6.8% (R^2) of the variance in CASEF Self-Conscious Reactivity, $F(2, 80) = 2.91, p = .060$, which approached significance. Though the model was not

significant, informant depression was a stronger, though not significant, predictor ($p_{\text{adj}} = .077$) compared to informant anxiety ($p_{\text{adj}} = .688$), and in a negative direction, suggesting that informants with higher levels of depression tended to rate participants as less self-consciously reactive (see Table 6 for beta weights). Laboratory self-conscious reactivity variables (physiological arousal, behavior, and self-report) entered in the second step only explained an additional 0.8% (ΔR^2) of the variance, which was not a significant change after controlling for informant depression and anxiety, $F(3, 77) = 0.22, p = .883$. The final model was also not significant, accounting for 7.6% (R^2) of the variance in CASEF self-conscious reactivity, $F(5, 77) = 1.26, p = .290$. Thus, Hypothesis 1.d was not supported in that the two measures of self-conscious reactivity did not correspond.

Empathy

Descriptive statistics for the variables used in the empathy analyses are reported in Table 7. Results of the empathy analyses are reported below and in Table 8.

Total empathy. The relationship between laboratory and informant-rated total empathic accuracy (i.e., collapsed across negative, positive, and self-conscious empathic accuracy) was first examined. Informant SCL-90 Anxiety and Depression were entered first in the regression predicting CASEF Total Empathic Accuracy. Model 1 was significant, accounting for 13.9% (R^2) of the variance, $F(2, 107) = 8.61, p < .001$. Informant depression was a stronger predictor ($p_{\text{adj}} = .004$) than anxiety ($p_{\text{adj}} = .602$) and in a negative direction, indicating that informants with higher levels of depression rated participants as less empathic (see Table 8 for beta weights). The addition of laboratory total empathic accuracy accounted for an additional 9.0% (ΔR^2) of the variance above and beyond informant depression and anxiety, $F(1, 106) = 12.43, p < .001$. The final model was also significant, accounting for 22.9% (R^2) of the variance, $F(3, 106) = 10.49, p < .001$. The relationship between laboratory and CASEF total empathic accuracy was positive, indicating better empathic accuracy in the laboratory was associated with higher informant-reported empathic understanding. Thus, Hypothesis 2.a was supported.

Negative empathy. Informant anxiety and depression together accounted for 14.9% (R^2) of the variance in CASEF Negative Empathic Accuracy, $F(2, 107) = 9.40, p < .001$. Informant depression was a stronger predictor ($p_{\text{adj}} = .004$) than anxiety ($p_{\text{adj}} = .850$) and in a negative direction, indicating that informants with higher levels of depression rated participants as less empathic for negative emotions (see Table 8 for beta weights). The addition of laboratory negative empathic accuracy accounted for a small, but significant, additional 3.6% (ΔR^2) of the variance above and beyond informant depression and anxiety, $F(1, 106) = 4.70, p = .032$. The final model was also significant, accounting for 18.6% (R^2) of the variance in CASEF Negative Empathic Accuracy, $F(3, 106) = 8.05, p < .001$. The relationship between laboratory and CASEF negative empathic accuracy was positive, indicating better empathic accuracy for negative emotions in the laboratory was associated with higher informant-reported empathic understanding for negative emotions. Thus, Hypothesis 2.b was supported.

Positive empathy. Informant anxiety and depression together accounted for 9.6% (R^2) of the variance in CASEF Positive Empathic Accuracy, $F(2, 107) = 5.70, p = .004$. Informant depression was a stronger predictor ($p_{\text{adj}} = .025$) than anxiety ($p_{\text{adj}} = 0.922$) and in a negative direction, indicating that informants with higher levels of depression rated participants as less

empathic for positive emotions (see Table 8 for beta weights). As with negative empathy, the addition of laboratory positive empathic accuracy accounted for a small, but significant, additional 5.7% (ΔR^2) of the variance above and beyond informant depression and anxiety, $F(1, 106) = 7.18, p = .009$. The final model was also significant, accounting for 15.4% (R^2) of the variance in CASEF Positive Empathic Accuracy, $F(3, 106) = 6.41, p < .001$. The relationship between laboratory and CASEF positive empathic accuracy was positive, indicating better empathic accuracy for positive emotions in the laboratory was associated with higher informant-reported empathic understanding for positive emotions. Thus, Hypothesis 2.c was supported.

Self-conscious empathy. Informant anxiety and depression together accounted for 11.5% (R^2) of the variance in CASEF Self-Conscious Empathic Accuracy, $F(2, 107) = 6.92, p = .001$. Informant depression was a stronger predictor ($p_{\text{adj}} = .006$) than anxiety ($p_{\text{adj}} = .444$) and in a negative direction, indicating that informants with higher levels of depression rated participants as less empathic for self-conscious emotions (see Table 8 for beta weights). The addition of laboratory self-conscious empathic accuracy accounted for 8.7% (ΔR^2) of the variance above and beyond informant depression and anxiety, $F(1, 106) = 11.57, p < .001$. The final model was also significant, accounting for 20.2% (R^2) of the variance in CASEF Self-Conscious Empathic Accuracy, $F(3, 106) = 8.93, p < .001$. The relationship between laboratory and CASEF self-conscious empathic accuracy was positive, indicating better empathic accuracy for self-conscious emotions in the laboratory was associated with higher informant-reported empathic understanding for self-conscious emotions. Thus, Hypothesis 2.d was supported.

Influence of Diagnosis on Relationship Between Measures

To increase variability in the sample, both patients and controls were included in all primary analyses. However, it is also important to determine whether the relationships between laboratory and informant measures tested above persist regardless of patient status. To explore this, the above regressions were run again, with the addition of patient status (dementia patient or control) as a predictor in step 1 of each regression. After controlling for the influence of diagnosis with this approach, the overall pattern of findings was still intact: the relationships between laboratory and informant-rated emotional functioning remained significant for total ($\Delta R^2 = .246, p < .001$), negative ($\Delta R^2 = .162, p = .002$), and positive ($\Delta R^2 = .143, p < .001$) reactivity, and for total ($\Delta R^2 = .024, p = .045$) and self-conscious ($\Delta R^2 = .037, p = .016$) empathy. The relationship between the measures was no longer significant for negative ($\Delta R^2 = .006, p = .310$) and positive ($\Delta R^2 = .016, p = .132$) empathy, but was in the expected direction.

Discussion

This study compared an in-laboratory assessment of emotional functioning in dementia patients and controls to informant-observed emotional functioning in daily life. In the research literature, laboratory measures are useful in distinguishing the emotional changes that occur with different types of dementia, but these tests have yet to be applied to the clinic, where information is often gleaned from close family members. However, caregivers' perspectives on emotional functioning, specifically, have not been systematically studied. Understanding where these two measures converge thus represents a step toward establishing the clinical utility of both.

The present study focused on two important domains of emotional functioning – emotional reactivity, or one's own emotional responses, and empathic accuracy, or the

understanding of others' emotions – and overall, found considerable agreement between the two measures in each domain. In seven out of eight possible comparisons, there was significant agreement between emotional responses measured in the laboratory and those reported by informants. That concordance was found across most categories is striking, given the lack of shared method variance between the two approaches (Lindell & Whitney, 2001; Podsakoff et al., 2003).

In terms of the strength of each relationship, when looking at participants' in-laboratory reactivity across all emotion tasks and, after controlling for the effects of potential informant rating bias, the laboratory performance measures accounted for a large proportion (25%) of the variance in informant-rated reactivity. Similarly, for empathic accuracy, laboratory performance predicted a small to medium proportion (9%) of informant ratings after accounting for potential sources of informant bias. Thus, when looking at laboratory responding in aggregate, the measures used in the present study were reasonably convergent with informant-observed emotion, with reactivity measures faring better than the assessment of empathy.

That empathic accuracy measures were not as strongly associated may speak to the relatively complex nature of empathy (Levenson et al., 2008). For example, empathic understanding can occur with or without any behavioral display – one may recognize what another feels without expressing that understanding – making way for a discrepancy due to measurement context: testing empathic accuracy in a laboratory, where participants are asked to convey their understanding, versus informants' knowledge of that understanding in daily life. The relative strength of the association for laboratory reactivity may also be due in part to the multi-measure approach used to capture this in the present study, where physiological responding, facial behavior, and self-reported experience were used together to predict informant ratings. The measurement of empathy in the laboratory, by contrast, was derived from one measure: the accuracy of participants' verbal responses.

Reactivity and empathy were also examined within the three emotion types, namely, negative, positive, and self-conscious emotion. Each of these was represented by tasks meant to elicit, or test understanding of, specific emotions from the category in question. When broken down by type, empathic accuracy testing in the laboratory modestly, but consistently, predicted informant-rated empathic accuracy for all three emotion types (explaining 4, 6, and 9% of the variance for negative, positive, and self-conscious emotion, respectively). Laboratory reactivity predicted informant-rated reactivity for negative and positive, but not self-conscious, emotion. This difference was dramatic: while laboratory responding to negative and positive films each moderately predicted informant-rated negative (15%) and positive (17%) reactivity, respectively, laboratory self-conscious responding predicted only 1% of the variance in informant-rated self-conscious reactivity.

Why was there so little agreement between self-conscious reactivity in the laboratory and that reported by informants? There are several possibilities. For one, it is possible that the laboratory tasks and informant observations have different temporal sensitivity, where deficits in self-conscious responding are evident sooner from either the laboratory or caregiver perspective. Longitudinal studies, with both measures assessing self-conscious responding over time, could disambiguate. If temporal sensitivity is the issue, one would expect the correlation to improve when corrected for time. A second possibility is that one or both of the measures do not assess self-conscious reactivity reliably. While the present study found the informant questionnaire to have good internal consistency, the full psychometric properties of the measure have yet to be tested and reliability issues cannot be ruled out. Similarly, test-retest reliability has not been

tested with respect to the laboratory measures; thus it is not known whether a participant would show more or less self-conscious reactivity from one testing session to the next.

The third possibility concerns validity; either the laboratory or informant assessment may not be an adequate measure of self-conscious reactivity. To speak to this issue, a follow-up study comparing both measures to a gold standard is necessary. Given the present state of research on self-conscious reactivity in dementia, such a gold standard has not been clearly established. Diagnostic grouping is a good candidate in that bvFTD has been found to have deficits in self-conscious reactivity across different types of laboratory tasks (Sturm et al., 2006; Sturm et al., 2008); however, one of those tasks was the very task used in the present study. In addition, patterns of self-conscious responding have not been systematically characterized in other diagnoses. Another option is to compare the two measures to neuroanatomy, looking for an association between self-conscious reactivity and the structural or functional integrity of brain areas thought to be part of a network important for self-consciousness, such as the medial prefrontal cortex (including the anterior cingulate cortex), the anterior insula, and orbitofrontal cortex (Beer et al., 2003; Morita et al., 2008; Shin et al., 2000; Sturm et al., 2012; Takahashi et al., 2004).

It is also possible that the two measures are assessing different aspects of self-conscious emotion. It may be that the measurement of self-conscious emotion in the laboratory – while quite telling in differentiating dementia diagnoses, characterizing aspects of the loss of self in bvFTD, and elucidating neuroanatomical correlates of emotions like embarrassment (Sturm et al., 2008; Sturm et al., 2012) – is not quite analogous to manifestations of self-conscious emotion from the perspective of close family members. This may be due to the limits of the laboratory self-conscious assessment used in the present study, which tested embarrassment (and possibly shame), compared to the broader nature of the informant assessment, which asked raters to report the participants' expression of a range of self-conscious emotions, including embarrassment, shame, guilt, and pride.

Within reactivity, it was hypothesized that the laboratory measure of facial behavior would better predict informant ratings than the measures of physiological arousal and self-reported experience. While this was supported for reactivity overall, it was not the case when looking at each emotion type. Instead, for both positive and negative emotion, self-reported experience was the best predictor (as discussed previously, for self-conscious emotion, laboratory measures did not have a significant association with informant ratings). It is surprising that behavior showed up as a strong predictor when looking at reactivity in aggregate, but not within each emotion type. Further, in the aggregate analysis, physiological arousal predicted caregiver ratings with comparable strength to behavior. This analysis pooled data from all reactivity laboratory tasks for the predictors and all reactivity CASEF items for the dependent variable, providing a robust assessment of overall reactivity. In general, the findings suggest that one cannot necessarily predict informant-reported emotional reactivity from any one laboratory measure or task, and speak to the value of multi-measure design.

Additional exploratory analyses revealed that even after controlling for diagnostic status (i.e., dementia patient vs. healthy control), the pattern of findings held for most categories of emotional functioning. This indicates that the agreement between laboratory performance and informant report persists across groups. The tests for negative and positive empathic accuracy were the exceptions, suggesting that the two measures of these categories of emotion may not converge within patients, controls, or both. It is of course possible that a significant effect across groupings would emerge if tested in a larger sample. Further study with more participants would

also allow for testing of the relationships within different types of dementia, an important next step in delineating the clinical applicability of both kinds of measures.

This study controlled for caregiver burden, operationalized as informants' levels of depression and anxiety, as a source of potential bias in their ratings of participants' functioning. In looking at the relationship between these burden measures and informant ratings, higher rates of depression among informants was significantly associated with informants reporting lower levels of emotional functioning on the part of participants (less reactive, lower empathic accuracy). Informants' anxiety, by contrast, was in the opposite direction, tending to be associated with rating participants as more expressive, particularly for negative emotions, though these relationships were not significant for the most part. Further, informant anxiety showed weak relationships with empathic accuracy ratings. These results suggest that depression is more strongly tied to how informants view others' emotional functioning. It is important to note that these relationships do not imply causation. Approaching from the frame of caregiver burden leading to rating bias, it is possible that depression among caregivers leads them to underestimate patients' reactivity and empathy abilities. Anxiety may also be biasing caregivers, particularly when providing feedback about their care recipients' reactivity, leading to potential overestimation of how much emotion is being expressed. On the other hand, patients' impairments in emotional functioning are likely contributing to symptoms of depression in caregivers; patients expressing a lot of negative emotion may lead to caregiver anxiety. Clarifying the nature of these relationships presents an avenue for further study.

Clinical Implications

Losses and changes in emotional functioning are recognized in the bvFTD diagnostic criteria (Neary et al., 1998; Rascovsky et al., 2011), but these have not been systematically studied across other neurodegenerative illnesses. The criteria that do address emotional changes are limited and do not reflect the scope and nuances of the problem, including domains of loss as well as areas of preservation, that have been identified in the research literature. Further, there are no existing clinical tools for comprehensively assessing emotional changes in dementia. The results of this study pave the way for precise measures of emotional functioning, such as those used in the present study, to be applied to the clinic (pending additional psychometric testing, as discussed later). Given the extent to which the two measures agree, one could argue for the use of an informant measure like the CASEF in clinics: it is administered quickly, can be completed by an informant without assistance, and provides comparable information to that of an objective laboratory assessment across a number of domains of emotional functioning (issues with self-conscious reactivity measurement notwithstanding). However, as the present results and previous research (e.g., Arguelles et al., 2001) indicate, informant measures are prone to bias and thus the informant's psychological state is important to assess and take into account with any clinical application of informant ratings. In addition, while there was significant agreement between the laboratory and informant perspectives, it is worth noting that there was not 100% agreement. A large proportion of the variance explained by each measure did not overlap, suggesting that each is providing some unique information that is important to explore. Given the time and resources required to carry out the current laboratory assessment, it may be beyond the scope of standard clinical practice; however, it may be possible to streamline this measure through further testing to determine the minimum necessary tasks and channels required to capture emotional changes in dementia.

That the pattern of results largely held after accounting for patient status suggests these measures of emotional functioning could be applied to assessing emotion in other populations with difficulties impacting the emotion system, such as mood, anxiety, or thought disorders. With additional studies validating the two measures in dementia, psychiatric, and healthy populations, aspects from each measure could be incorporated into diagnostic tools. Such rigorous testing of the emotion system would represent an important contribution to the process of clinical diagnosis, as current psychological and neurological assessment batteries lack systematic and differentiated probing of emotional functioning (e.g., different aspects of emotional functioning such as reactivity, regulation, and empathy; and different families of emotions including positive, negative, and self-conscious emotions). At this stage in the process of evaluating these measures, however, neither the laboratory nor informant assessment was considered to represent “ground truth.” Each has its own strengths, as well as biases and shortcomings, as reviewed earlier. Given the results of this study showing non-overlapping variance between the measures and possibly limited generalizability in some categories of emotion, it is not clear that either the in-laboratory assessment or the informant questionnaire could stand on its own as a diagnostic instrument. As a next step, the predictive ability of each measure in discriminating clinical and pathology-confirmed diagnoses is needed.

Limitations

The present study sampled across many neurological disorders, allowing for the testing of emotional functioning across a broad range of skill and functional decline. Further, the study controlled for sources of informant rating bias, thereby representing a more accurate picture of real-world emotion. However, there were a number of limitations. While the overall sample size was adequate, and relatively large compared to similar studies, as discussed above, the diagnostic group sizes were too small to test the relationship between the two measures of emotional functioning within particular diagnoses. Thus, it is not clear that the relationship found between laboratory and informant-rated empathic accuracy can be generalized across all disorders. In terms of broader generalizability, this study focuses on the measurement of emotional functioning within a particular clinical population (dementia) and age group (older adults); it is not known whether similar results would be seen in other psychiatric disorders and age ranges. The study also had certain limitations in terms of the emotions tested in the laboratory. While the empathic accuracy tasks assessed understanding of a range of emotions within each category, the reactivity tasks were more limited for positive and self-conscious categories in particular.

On the side of the informant measure utilized in the present study, informant report is one way of capturing information about participants’ daily emotional lives, but it is not the only way. Although the perspective of caregivers is an important and useful measure in clinical settings, there are multiple sources of bias therein. The present study attempted to control for some of this bias in terms of informant depression and anxiety, which could color informants’ perceptions of participants’ functioning (Arguelles et al., 2001; Zanetti et al., 1999). However, there are myriad potential influences on informant ratings that were not captured or analyzed in the present study, including: individual differences in empathic accuracy on the part of the informants (Ickes, 1993); informants’ semantic knowledge and working definitions with regard to emotion and terms for emotions (Barrett, 2006; Clore, Ortony, & Foss, 1987; Robinson & Clore, 2002b); and participants’ willingness to express certain emotions to informants, particularly in the context of patient-caregiver relationships (Monin, Martire, Schulz, & Clark, 2009), to name a few.

In addition, a number of potential moderators were not explored. For example, the length of time caregivers spend with patients, duration of the relationship, and degree of perceived emotional closeness may have influenced informant ratings. It is presumed that caregivers who have spent more time together with patients and have known patients longer are better able to assess their functioning. In terms of recognizing changes in dementia, more familiarity with a patient's emotional tendencies pre-illness might lead to greater recognition of any changes that occur as a disease progresses. Of course, the opposite effect might also occur; expectations based on longtime familiarity could lead to biases and "blindness" to behavioral changes. Similarly, duration of the patient's illness, diagnosis, and caregiver's degree of knowledge about the illness are all potentially important considerations. That bvFTD is associated with losses in emotional functioning is now better understood than it once was; however, such changes may be difficult for caregivers to recognize and accept, particularly earlier in the course of the illness. By contrast, caregivers of AD patients may not be as attuned to emotional changes, given the prominence of changes in cognitive domains and impairments in daily functioning. These factors could lead to underestimates of true deficits in emotional functioning.

Future Directions

Comparing laboratory and informant measures of emotional functioning in larger and more diverse samples, in addition to including a wider array of reactivity tasks, would address many of the study's limitations. In addition, to speak to the specific limitations of using informant report, studies measuring informants' individual differences in emotion ratings, examining interrater reliability among multiple informants per participant, and comparing informant ratings to in vivo behavioral observations would be useful. However, given the present finding that laboratory self-conscious reactivity failed to predict informant-rated reactivity, the validity of either the laboratory test or the informant measure is called into question with respect to measuring self-conscious responding. As discussed, while the laboratory embarrassment task has proved to be quite informative (Sturm et al., 2008; Sturm et al., 2012), it is important to consider whether what has been found vis-à-vis laboratory embarrassment is actually providing prognostic information about real-world self-conscious behavior. Perhaps the laboratory task is a lead indicator of self-conscious changes in neurodegenerative patients, or it may be measuring embarrassment in a context rarely probed in daily life, limiting its inferential utility. On the other hand, the informant measure asked each rater to indicate levels of self-consciousness in another individual, arguably a tall order given the private nature such emotions may take (Tracy & Robins, 2004). Future research can tease these issues apart through longitudinal, prospective tests measuring informant-rated and laboratory-tested self-conscious changes in dementia over time; utilizing an expanded set of laboratory self-conscious reactivity tasks using more naturalistic stimuli; and conducting full psychometric testing of both the laboratory and informant measures, including test-retest reliability, each measures' ability to predict diagnosis, and comparisons to objective indicators of decline.

Conclusions

This study demonstrated that basic biological systems, including autonomic arousal and facial expressions, as well as self-reported experience, measured in a laboratory setting using dynamic stimuli, are consistent with an informant's observations of another's day-to-day emotional responding in the world. Further, it was shown that measures of empathic accuracy to

laboratory dynamic stimuli parallel informant-reported emotional understanding in daily life. To the extent that laboratory and informant assessments agree, this study suggests both represent valid assessments of the real emotional lives of dementia patients. This work has important implications for clinical practice, suggesting that both laboratory findings and caregiver-reported emotional changes in dementia can provide meaningful information to clinicians, patients, and their families regarding diagnosis, prognosis, and care.

References

- Arguelles, S., Loewenstein, D. A., Eisdorfer, C., & Arguelles, T. (2001). Caregivers' judgments of the functional abilities of the Alzheimer's disease patient: Impact of caregivers' depression and perceived burden. *Journal of Geriatric Psychiatry and Neurology*, 14(2), 91-98. doi:10.1177/089198870101400209
- Ascher, E. A., Madan, A., Yuan, J. W., Sturm, V. E., Eckart, J. A., & Levenson, R. W. (2007). Caregiver assessment of socioemotional functioning. Unpublished instrument.
- Ascher, E. A., Sturm, V. E., Seider, B. H., Holley, S. R., Miller, B. L., & Levenson, R. W. (2010). Relationship satisfaction and emotional language in frontotemporal dementia and Alzheimer disease patients and spousal caregivers. *Alzheimer Disease and Associated Disorders*, 24(1), 49-55. doi:10.1097/WAD.0b013e3181bd66a3
- Barkley, R. A. (1991). The ecological validity of laboratory and analogue assessment methods of ADHD symptoms. *Journal of Abnormal Child Psychology*, 19(2), 149-178. doi:10.1007/BF00909976
- Barrett, L. F. (2004). Feelings or words? Understanding the content in self-report ratings of experienced emotion. *Journal of Personality and Social Psychology*, 87(2), 266-281. doi:10.1037/0022-3514.87.2.266
- Barrett, L. F. (2006). Solving the emotion paradox: Categorization and the experience of emotion. *Personality and Social Psychology Review*, 10(1), 20-46. doi:10.1207/s15327957pspr1001_2
- Bathgate, D., Snowden, J. S., Varma, A., Blackshaw, A., & Neary, D. (2001). Behaviour in frontotemporal dementia, Alzheimer's disease and vascular dementia. *Acta Neurologica Scandinavica*, 103(6), 367-378. doi:10.1034/j.1600-0404.2001.2000236.x
- Beer, J. S., Heerey, E. A., Keltner, D., Scabini, D., & Knight, R. T. (2003). The regulatory function of self-conscious emotion: Insights from patients with orbitofrontal damage. *Journal of Personality and Social Psychology*, 85(4), 594-604. doi:10.1037/0022-3514.85.4.594
- Biesanz, J. C. (2010). The social accuracy model of interpersonal perception: Assessing individual differences in perceptive and expressive accuracy. *Multivariate Behavioral Research*, 45(5), 853-885. doi:10.1080/00273171.2010.519262
- Boeve, B. F., Lang, A. E., & Litvan, I. (2003). Corticobasal degeneration and its relationship to progressive supranuclear palsy and frontotemporal dementia. *Annals of Neurology*, 54 Suppl 5, S15-9. doi:10.1002/ana.10570
- Boxer, A. L., & Miller, B. L. (2005). Clinical features of frontotemporal dementia. *Alzheimer Disease and Associated Disorders*, 19(Suppl. 1), S3-S6. doi:10.1097/01.wad.0000183086.99691.91
- Brody, L. R., & Hall, J. A. (2010). Gender, emotion, and socialization. In J. C. Chrisler & D. R. McCreary (Eds.), *Handbook of gender research in psychology* (pp. 429-454). New York, NY: Springer.
- Brooks, B. R. (1994). El Escorial World Federation of Neurology criteria for the diagnosis of amyotrophic lateral sclerosis. Subcommittee on Motor Neuron Diseases/Amyotrophic Lateral Sclerosis of the World Federation of Neurology Research Group on Neuromuscular Diseases and the El Escorial "Clinical limits of amyotrophic lateral sclerosis" workshop contributors. *Journal of the Neurological Sciences*, 124 Suppl, 96-107.
- Brooks, B. R., Miller, R. G., Swash, M., & Munsat, T. L. (2000). El Escorial revisited: Revised criteria for the diagnosis of amyotrophic lateral sclerosis. *Amyotrophic Lateral Sclerosis*

- and Other Motor Neuron Disorders: Official Publication of The World Federation of Neurology, Research Group on Motor Neuron Diseases*, 1(5), 293-299.
doi:10.1080/146608200300079536
- Busby, D. M., & Gardner, B. C. (2008). How do I analyze thee? Let me count the ways: Considering empathy in couple relationships using self and partner ratings. *Family Process*, 47(2), 229-242. doi:10.1111/j.1545-5300.2008.00250.x
- Carr, D. B., Gray, S., Baty, J., & Morris, J. C. (2000). The value of informant versus individual's complaints of memory impairment in early dementia. *Neurology*, 55(11), 1724-1726.
- Clore, G. L., Ortony, A., & Foss, M. A. (1987). The psychological foundations of the affective lexicon. *Journal of Personality and Social Psychology*, 53(4), 751. doi:10.1037/0022-3514.53.4.751
- Coehlo, D. P., Hooker, K., & Bowman, S. (2007). Institutional placement of persons with dementia: What predicts occurrence and timing? *Journal of Family Nursing*, 13(2), 253-277. doi:10.1177/1074840707300947
- Cummings, J. L., Mega, M., Gray, K., Rosenberg-Thompson, S., Carusi, D. A., & Gornbein, J. (1994). The Neuropsychiatric Inventory: Comprehensive assessment of psychopathology in dementia. *Neurology*, 44(12), 2308-2314.
- Damasio, A. R. (2003). *Looking for Spinoza: Joy, sorrow, and the feeling brain*. Orlando, FL: Harcourt.
- Davidson, R. J., & Irwin, W. (1999). The functional neuroanatomy of emotion and affective style. *Trends in Cognitive Sciences*, 3(1), 11-21. doi:10.1016/S1364-6613(98)01265-0
- Davies, R. R., Hodges, J. R., Kril, J. J., Patterson, K., Halliday, G. M., & Xuereb, J. H. (2005). The pathological basis of semantic dementia. *Brain*, 128(Pt 9), 1984-1995. doi:10.1093/brain/awh582
- Davis, L. L. (2001). Assessing functional ability in persons with dementia: Using family caregivers as informants. *Journal of Neuroscience Nursing*, 33(4), 194-5, 200-2. doi:10.1097/01376517-200108000-00005
- Decety, J., & Jackson, P. L. (2004). The functional architecture of human empathy. *Behavioral and Cognitive Neuroscience Reviews*, 3(2), 71-100. doi:10.1177/1534582304267187
- Derntl, B., Finkelmeyer, A., Eickhoff, S., Kellermann, T., Falkenberg, D. I., Schneider, F., & Habel, U. (2010). Multidimensional assessment of empathic abilities: Neural correlates and gender differences. *Psychoneuroendocrinology*, 35(1), 67-82. doi:10.1016/j.psyneuen.2009.10.006
- Derogatis, L. R. (1977). *SCL-90-R: Administration, scoring, and procedures manual I*. Baltimore: Clinical Psychometrics Research.
- Drapeau, J., Gosselin, N., Gagnon, L., Peretz, I., & Lorrain, D. (2009). Emotional recognition from face, voice, and music in dementia of the Alzheimer type. *Annals of the New York Academy of Sciences*, 1169, 342-345. doi:10.1111/j.1749-6632.2009.04768.x
- Eckart, J. A., Sturm, V. E., Miller, B. L., & Levenson, R. W. (2012). Diminished disgust reactivity in behavioral variant frontotemporal dementia. *Neuropsychologia*, 50(5), 786-790. doi:10.1016/j.neuropsychologia.2012.01.012
- Ekman, P., & Friesen, W. V. (1978). *Facial action coding system: A technique for the measurement of facial movement*. Palo Alto, CA: Consulting Psychologists Press.
- Ekman, P., Levenson, R. W., & Friesen, W. V. (1983). Autonomic nervous system activity distinguishes among emotions. *Science*, 221(4616), 1208-1210. doi:10.1126/science.6612338

- Ekman, P. (1992). An argument for basic emotions. *Cognition and Emotion*, 6, 169-200. doi:10.1080/02699939208411068
- Fernandez-Duque, D., & Black, S. E. (2005). Impaired recognition of negative facial emotions in patients with frontotemporal dementia. *Neuropsychologia*, 43(11), 1673-1687. doi:10.1016/j.neuropsychologia.2005.01.005
- Fletcher, G. J., & Kerr, P. S. (2010). Through the eyes of love: Reality and illusion in intimate relationships. *Psychological Bulletin*, 136(4), 627-658. doi:10.1037/a0019792
- Fossati, P., Hevenor, S. J., Graham, S. J., Grady, C., Keightley, M. L., Craik, F., & Mayberg, H. (2003). In search of the emotional self: An fMRI study using positive and negative emotional words. *American Journal of Psychiatry*, 160(11), 1938-1945. doi:10.1176/appi.ajp.160.11.1938
- Fredrickson, B. L. (1998). What good are positive emotions? *Review of General Psychology*, 2, 300-319. doi:10.1037/1089-2680.2.3.300
- Freilich, B. M., & Hyer, L. A. (2007). Relation of the Repeatable Battery for Assessment of Neuropsychological Status to measures of daily functioning in dementia. *Psychological Reports*, 101(1), 119-129.
- Funder, D. C., & Colvin, C. R. (1988). Friends and strangers: Acquaintanceship, agreement, and the accuracy of personality judgment. *Journal of Personality and Social Psychology*, 55(1), 149-158. doi:10.1037/0022-3514.55.1.149
- Gohm, C. L., & Clore, G. L. (2000). Individual differences in emotional experience: Mapping available scales to processes. *Personality and Social Psychology Bulletin*, 26(6), 679-697. doi:10.1177/0146167200268004
- Golan, O., Baron-Cohen, S., Hill, J. J., & Golan, Y. (2006). The “reading the mind in films” task: Complex emotion recognition in adults with and without autism spectrum conditions. *Social Neuroscience*, 1(2), 111-123. doi:10.1080/17470910600980986
- Goodkind, M. S., Sturm, V. E., Ascher, E. A., Miller, B. L., & Levenson, R. W. (in preparation). Patterns of empathic accuracy for positive, negative, and self-conscious emotions in frontotemporal dementia and Alzheimer’s disease.
- Goodkind, M. S., Gyurak, A., McCarthy, M., Miller, B. L., & Levenson, R. W. (2010). Emotion regulation deficits in frontotemporal lobar degeneration and Alzheimer’s disease. *Psychology and Aging*, 25(1), 30-37. doi:10.1037/a0018519
- Gorno-Tempini, M. L., Dronkers, N. F., Rankin, K. P., Ogar, J. M., Phengrasamy, L., Rosen, H. J., ... Miller, B. L. (2004). Cognition and anatomy in three variants of primary progressive aphasia. *Annals of Neurology*, 55(3), 335-346. doi:10.1002/ana.10825
- Gorno-Tempini, M. L., Hillis, A. E., Weintraub, S., Kertesz, A., Mendez, M., Cappa, S. F., ... Grossman, M. (2011). Classification of primary progressive aphasia and its variants. *Neurology*, 76(11), 1006-1014. doi:10.1212/WNL.0b013e31821103e6
- Gregory, C., Lough, S., Stone, V., Erzinclioglu, S., Martin, L., Baron-Cohen, S., & Hodges, J. R. (2002). Theory of mind in patients with frontal variant frontotemporal dementia and Alzheimer’s disease: Theoretical and practical implications. *Brain*, 125(Pt 4), 752-764. doi:10.1093/brain/awf079
- Gregory, C. A., Serra-Mestres, J., & Hodges, J. R. (1999). Early diagnosis of the frontal variant of frontotemporal dementia: How sensitive are standard neuroimaging and neuropsychologic tests? *Neuropsychiatry, Neuropsychology, and Behavioral Neurology*, 12(2), 128-135.

- Gross, J. J., & Barrett, L. F. (2011). Emotion Generation and Emotion Regulation: One or Two Depends on Your Point of View. *Emotion Review*, 3(1), 8-16.
doi:10.1177/1754073910380974
- Gross, J. J., & Levenson, R. W. (1993). Emotional suppression: Physiology, self-report, and expressive behavior. *Journal of Personality and Social Psychology*, 64(6), 970-986.
doi:10.1037/0022-3514.64.6.970
- Gross, J. J., & Levenson, R. W. (1995). Emotion elicitation using films. *Cognition and Emotion*, 9(1), 87-108. doi:10.1080/02699939508408966
- Gruber, J. (2011). Can feeling too good be bad? Positive emotion persistence (PEP) in bipolar disorder. *Current Directions in Psychological Science*, 20(4), 217-221.
doi:10.1177/0963721411414632
- Grut, M., Jorm, A. F., Fratiglioni, L., Forsell, Y., Viitanen, M., & Winblad, B. (1993). Memory complaints of elderly people in a population survey: Variation according to dementia stage and depression. *Journal of the American Geriatrics Society*, 41(12), 1295-1300.
- Haase, C. M., Seider, B. H., Shiota, M. N., & Levenson, R. W. (2011). Anger and sadness in response to an emotionally neutral film: Evidence for age-specific associations with well-being. *Psychology and Aging*. doi:10.1037/a0024959
- Hadjistavropoulos, T., Taylor, S., Tuokko, H., & Beattie, B. L. (1994). Neuropsychological deficits, caregivers' perception of deficits and caregiver burden. *Journal of the American Geriatrics Society*, 42(3), 308-314.
- Heerey, E. A., Keltner, D., & Capps, L. M. (2003). Making sense of self-conscious emotion: Linking theory of mind and emotion in children with autism. *Emotion*, 3(4), 394-400.
doi:10.1037/1528-3542.3.4.394
- Henry, J. D., Rendell, P. G., Scicluna, A., Jackson, M., & Phillips, L. H. (2009). Emotion experience, expression, and regulation in Alzheimer's disease. *Psychology and Aging*, 24(1), 252-257. doi:10.1037/a0014001
- Henry, J. D., Ruffman, T., McDonald, S., O'Leary, M. A., Phillips, L. H., Brodaty, H., & Rendell, P. G. (2008). Recognition of disgust is selectively preserved in Alzheimer's disease. *Neuropsychologia*, 46(5), 1363-1370. doi:10.1016/j.neuropsychologia.2007.12.012
- Hodges, J. R., Davies, R. R., Xuereb, J. H., Casey, B., Broe, M., Bak, T. H., ... Halliday, G. M. (2004). Clinicopathological correlates in frontotemporal dementia. *Annals of Neurology*, 56(3), 399-406. doi:10.1002/ana.20203
- Hodges, J. R., Patterson, K., Ward, R., Garrard, P., Bak, T., Perry, R., & Gregory, C. (1999). The differentiation of semantic dementia and frontal lobe dementia (temporal and frontal variants of frontotemporal dementia) from early Alzheimer's disease: A comparative neuropsychological study. *Neuropsychology*, 13(1), 31-40. doi:10.1037/0894-4105.13.1.31
- Hsieh, F., Ferrer, E., Chen, S., Mauss, I. B., John, O., & Gross, J. J. (2011). A network approach for evaluating coherence in multivariate systems: An application to psychophysiological emotion data. *Psychometrika*, 76(1), 124-152. doi:10.1007/s11336-010-9194-0
- Ickes, W. (1993). Empathic accuracy. *Journal of Personality*, 61(4), 587-610.
doi:10.1111/j.1467-6494.1993.tb00783.x
- Izard, C. E. (2009). Emotion theory and research: Highlights, unanswered questions, and emerging issues. *Annual Review of Psychology*, 60, 1.
doi:10.1146/annurev.psych.60.110707.163539
- Jorm, A. F. (1996). Assessment of cognitive impairment and dementia using informant reports. *Clinical Psychology Review*, 16(1), 51-73. doi:10.1016/0272-7358(95)00056-9

- Keltner, D. (1995). Signs of appeasement: Evidence for the distinct displays of embarrassment, amusement, and shame. *Journal of Personality and Social Psychology*, 68(3), 441-454. doi:10.1037/0022-3514.68.3.441
- Kipps, C. M., Nestor, P. J., Acosta-Cabrero, J., Arnold, R., & Hodges, J. R. (2009). Understanding social dysfunction in the behavioural variant of frontotemporal dementia: The role of emotion and sarcasm processing. *Brain*, 132(Pt 3), 592-603. doi:10.1093/brain/awn314
- Kirkland, T., & Cunningham, W. A. (2011). Neural basis of affect and emotion. *Wiley Interdisciplinary Reviews: Cognitive Science*, 656-665. doi:10.1002/wcs.145
- Kiyak, H. A., Teri, L., & Borson, S. (1994). Physical and functional health assessment in normal aging and in Alzheimer's disease: Self-reports vs family reports. *Gerontologist*, 34(3), 324-330. doi:10.1093/geront/34.3.324
- Knight, M., Seymour, T. L., Gaunt, J. T., Baker, C., Nesmith, K., & Mather, M. (2007). Aging and goal-directed emotional attention: Distraction reverses emotional biases. *Emotion*, 7(4), 705-714. doi:10.1037/1528-3542.7.4.705
- Kolar, D. W., Funder, D. C., & Colvin, C. R. (1996). Comparing the accuracy of personality judgements by the self and knowledgeable others. *Journal of Personality*, 64(2), 311-337. doi:10.1111/j.1467-6494.1996.tb00513.x
- Kring, A. M., & Moran, E. K. (2008). Emotional response deficits in schizophrenia: Insights from affective science. *Schizophrenia Bulletin*, 34(5), 819-834. doi:10.1093/schbul/sbn071
- Lavenu, I., Pasquier, F., Lebert, F., Petit, H., & Van der Linden, M. (1999). Perception of emotion in frontotemporal dementia and Alzheimer disease. *Alzheimer Disease and Associated Disorders*, 13(2), 96-101. doi:10.1097/00002093-199904000-00007
- Lawton, M. P., & Brody, E. M. (1969). Assessment of older people: Self-maintaining and instrumental activities of daily living. *Gerontologist*, 9(3), 179-186. doi:10.1093/geront/9.3_Part_1.179
- Lazarus, R. S., Speisman, J. C., Mordkoff, A. M., & Davison, L. A. (1962). A laboratory study of psychological stress produced by a motion picture film. *Psychological Monographs: General and Applied*, 76(34; whole number 553).
- LeDoux, J. E. (2000). Emotion circuits in the brain. *Annual Review of Neuroscience*, 23, 155-184. doi:10.1146/annurev.neuro.23.1.155
- Lee, J., Zaki, J., Harvey, P. O., Ochsner, K., & Green, M. F. (2011). Schizophrenia patients are impaired in empathic accuracy. *Psychological Medicine*, 41(11), 2297-2304. doi:10.1017/S0033291711000614
- Lee, S. E., Rabinovici, G. D., Mayo, M. C., Wilson, S. M., Seeley, W. W., DeArmond, S. J., ... Miller, B. L. (2011). Clinicopathological correlations in corticobasal degeneration. *Annals of Neurology*, 70(2), 327-340. doi:10.1002/ana.22424
- Levenson, R. W. (1992). Autonomic nervous system differences among emotions. *Psychological Science*, 3(1), 23-27. doi:10.1111/j.1467-9280.1992.tb00251.x
- Levenson, R. W. (1994). Human emotion: A functional view. In P. Ekman & R. J. Davidson (Eds.), *The nature of emotion: Fundamental questions* (pp. 123-126). New York: Oxford University Press.
- Levenson, R. W. (2007). Emotion elicitation with neurological patients. In J. A. Coan & J. J. B. Allen (Eds.), *Handbook of emotion elicitation and assessment* (pp. 158-168). New York: Oxford University Press.

- Levenson, R. W., Ascher, E., Goodkind, M., McCarthy, M., Sturm, V., & Werner, K. (2008). Laboratory testing of emotion and frontal cortex. In G. Goldenberg & B. L. Miller (Eds.), *Handbook of clinical neurology: Vol. 88 (3rd series). Neuropsychology and behavioral neurology* (pp. 489-498). Edinburgh: Elsevier.
- Levenson, R. W., & Miller, B. L. (2007). Loss of cells—loss of self: Frontotemporal lobar degeneration and human emotion. *Current Directions in Psychological Science*, 16(6), 289-294. doi:10.1111/j.1467-8721.2007.00523.x
- Levenson, R. W. (2003). Blood, sweat, and fears: The autonomic architecture of emotion. *Annals of the New York Academy of Sciences*, 1000, 348-366. doi:10.1196/annals.1280.016
- Levenson, R. W., & Gottman, J. M. (1983). Marital interaction: Physiological linkage and affective exchange. *Journal of Personality and Social Psychology*, 45(3), 587-597. doi:10.1037/0022-3514.45.3.587
- Lewis, M., Sullivan, M. W., Stanger, C., & Weiss, M. (1989). Self development and self-conscious emotions. *Child Development*, 60(1), 146-156. doi:10.2307/1131080
- Lindell, M. K., & Whitney, D. J. (2001). Accounting for common method variance in cross-sectional research designs. *Journal of Applied Psychology*, 86(1), 114-121. doi:10.1037/0021-9010.86.1.114
- Litvan, I., Agid, Y., Calne, D., Campbell, G., Dubois, B., Duvoisin, R. C., ... Zee, D. S. (1996). Clinical research criteria for the diagnosis of progressive supranuclear palsy (Steele-Richardson-Olszewski syndrome): Report of the NINDS-SPSP international workshop. *Neurology*, 47(1), 1-9.
- Lomen-Hoerth, C. (2004). Characterization of amyotrophic lateral sclerosis and frontotemporal dementia. *Dementia and Geriatric Cognitive Disorders*, 17(4), 337-341. doi:10.1159/000077167
- Lomen-Hoerth, C. (2011). Clinical phenomenology and neuroimaging correlates in ALS-FTD. *Journal of Molecular Neuroscience*, 45(3), 656-662. doi:10.1007/s12031-011-9636-x
- Lough, S., Kipps, C. M., Treise, C., Watson, P., Blair, J. R., & Hodges, J. R. (2006). Social reasoning, emotion and empathy in frontotemporal dementia. *Neuropsychologia*, 44(6), 950-958. doi:10.1016/j.neuropsychologia.2005.08.009
- Magai, C., Cohen, C., Gomberg, D., Malatesta, C., & Culver, C. (1996). Emotional expression during mid- to late-stage dementia. *International Psychogeriatrics*, 8(3), 383-395. doi:10.1017/S104161029600275X
- Mangone, C. A., Sanguinetti, R. M., Baumann, P. D., Gonzalez, R. C., Pereyra, S., Bozzola, F. G., ... Sica, R. E. (1993). Influence of feelings of burden on the caregiver's perception of the patient's functional status. *Dementia*, 4(5), 287-293.
- Matsumoto, D. (2007). Culture, context, and behavior. *Journal of Personality*, 75(6), 1285-1319. doi:10.1111/j.1467-6494.2007.00476.x
- Matsumoto, D., Yoo, S. H., Fontaine, J., Anguas-Wong, A. M., Arriola, M., Ataca, B., ... Grossi, E. (2008). Mapping expressive differences around the world: The relationship between emotional display rules and individualism versus collectivism. *Journal of Cross-Cultural Psychology*, 39(1), 55-74. doi:10.1177/0022022107311854
- Mauss, I. B., & Butler, E. A. (2010). Cultural context moderates the relationship between emotion control values and cardiovascular challenge versus threat responses. *Biological Psychology*, 84(3), 521-530. doi:10.1016/j.biopsycho.2009.09.010

- Mauss, I. B., Butler, E. A., Roberts, N. A., & Chu, A. (2010). Emotion control values and responding to an anger provocation in Asian-American and European-American individuals. *Cognition and Emotion*, 24(6), 1026-1043. doi:10.1080/02699930903122273
- Mauss, I. B., Levenson, R. W., McCarter, L., Wilhelm, F. H., & Gross, J. J. (2005). The tie that binds? Coherence among emotion experience, behavior, and physiology. *Emotion*, 5(2), 175-190. doi:10.1037/1528-3542.5.2.175
- Mauss, I. B., & Robinson, M. D. (2009). Measures of emotion: A review. *Cognition and Emotion*, 23(2), 209-237. doi:10.1080/02699930802204677
- McKhann, G., Drachman, D., Folstein, M., Katzman, R., Price, D., & Stadlan, E. M. (1984). Clinical diagnosis of Alzheimer's disease: Report of the NINCDS-ADRDA Work Group under the auspices of Department of Health and Human Services Task Force on Alzheimer's Disease. *Neurology*, 34(7), 939-944.
- McRae, K., Ochsner, K. N., Mauss, I. B., Gabrieli, J. J. D., & Gross, J. J. (2008). Gender differences in emotion regulation: An fMRI study of cognitive reappraisal. *Group Processes and Intergroup Relations*, 11(2), 143-162. doi:10.1177/1368430207088035
- Mesulam, M., Wicklund, A., Johnson, N., Rogalski, E., Leger, G. C., Rademaker, A., ... Bigio, E. H. (2008). Alzheimer and frontotemporal pathology in subsets of primary progressive aphasia. *Annals of Neurology*, 63(6), 709-719. doi:10.1002/ana.21388
- Mesulam, M. M. (2001). Primary progressive aphasia. *Annals of Neurology*, 49(4), 425-432. doi:10.1002/ana.91
- Monin, J. K., Martire, L. M., Schulz, R., & Clark, M. S. (2009). Willingness to express emotions to caregiving spouses. *Emotion*, 9(1), 101-106. doi:10.1037/a0013732
- Morita, T., Itakura, S., Saito, D. N., Nakashita, S., Harada, T., Kochiyama, T., & Sadato, N. (2008). The role of the right prefrontal cortex in self-evaluation of the face: A functional magnetic resonance imaging study. *Journal of Cognitive Neuroscience*, 20(2), 342-355. doi:10.1162/jocn.2008.20024
- Morris, J. C. (1993). The Clinical Dementia Rating (CDR): Current version and scoring rules. *Neurology*, 43(11), 2412-2414.
- Neary, D., Snowden, J. S., Gustafson, L., Passant, U., Stuss, D., Black, S., ... Benson, D. F. (1998). Frontotemporal lobar degeneration: A consensus on clinical diagnostic criteria. *Neurology*, 51(6), 1546-1554.
- Orth, U., Robins, R. W., & Soto, C. J. (2010). Tracking the trajectory of shame, guilt, and pride across the life span. *Journal of Personality and Social Psychology*, 99(6), 1061-1071. doi:10.1037/a0021342
- Park, S. H., Brody, L. R., & Wilson, V. R. (2008). Social sharing of emotional experiences in Asian American and European American women. *Cognition and Emotion*, 22(5), 802-814. doi:10.1080/02699930701529117
- Petersen, R. C. (2004). Mild cognitive impairment as a diagnostic entity. *Journal of Internal Medicine*, 256(3), 183-194. doi:10.1111/j.1365-2796.2004.01388.x
- Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology*, 88(5), 879-903. doi:10.1037/0021-9010.88.5.879
- Rankin, K. P., Baldwin, E., Pace-Savitsky, C., Kramer, J. H., & Miller, B. L. (2005). Self awareness and personality change in dementia. *Journal of Neurology, Neurosurgery, and Psychiatry*, 76(5), 632-639. doi:10.1136/jnnp.2004.042879

- Rankin, K. P., Kramer, J. H., & Miller, B. L. (2005). Patterns of cognitive and emotional empathy in frontotemporal lobar degeneration. *Cognitive and Behavioral Neurology*, 18(1), 28-36. doi:10.1097/01.wnn.0000152225.05377.ab
- Rascovsky, K., Hodges, J. R., Knopman, D., Mendez, M. F., Kramer, J. H., Neuhaus, J., ... Miller, B. L. (2011). Sensitivity of revised diagnostic criteria for the behavioural variant of frontotemporal dementia. *Brain*, 134(Pt 9), 2456-2477. doi:10.1093/brain/awr179
- Reisberg, B., Ferris, S. H., de Leon, M. J., Kluger, A., Franssen, E., Borenstein, J., & Alba, R. C. (1989). The stage specific temporal course of Alzheimer's disease: Functional and behavioral concomitants based upon cross-sectional and longitudinal observation. *Progress in Clinical and Biological Research*, 317, 23-41.
- Roberts, N. A., Beer, J. S., Werner, K. H., Scabini, D., Levens, S. M., Knight, R. T., & Levenson, R. W. (2004). The impact of orbital prefrontal cortex damage on emotional activation to unanticipated and anticipated acoustic startle stimuli. *Cognitive, Affective and Behavioral Neuroscience*, 4(3), 307-316. doi:10.3758/CABN.4.3.307
- Roberts, N. A., & Levenson, R. W. (2006). Subjective, behavioral, and physiological reactivity to ethnically matched and ethnically mismatched film clips. *Emotion*, 6(4), 635-646. doi:10.1037/1528-3542.6.4.635
- Robinson, M. D., & Clore, G. L. (2002a). Episodic and semantic knowledge in emotional self-report: Evidence for two judgment processes. *Journal of Personality and Social Psychology*, 83(1), 198-215. doi:10.1037/0022-3514.83.1.198
- Robinson, M. D., & Clore, G. L. (2002b). Belief and feeling: Evidence for an accessibility model of emotional self-report. *Psychological Bulletin*, 128(6), 934-960. doi:10.1037/0033-2909.128.6.934
- Rosen, H. J., Allison, S. C., Ogar, J. M., Amici, S., Rose, K., Dronkers, N., ... Gorno-Tempini, M. L. (2006). Behavioral features in semantic dementia vs other forms of progressive aphasia. *Neurology*, 67(10), 1752-1756. doi:10.1212/01.wnl.0000247630.29222.34
- Rottenberg, J., Ray, R. R., & Gross, J. J. (2007). Emotion elicitation using films. In J. A. Coan & J. J. B. Allen (Eds.), *Handbook of emotion elicitation and assessment* (pp. 87-108). New York, NY: Oxford University Press.
- Sackeim, H. A., Greenberg, M. S., Weiman, A. L., Gur, R. C., Hungerbuhler, J. P., & Geschwind, N. (1982). Hemispheric asymmetry in the expression of positive and negative emotions. Neurologic evidence. *Archives of Neurology*, 39(4), 210-218. doi:10.1001/archneur.1982.00510160016003
- Schul, Y., & Vinokur, A. D. (2000). Projection in person perception among spouses as a function of the similarity in their shared experiences. *Personality and Social Psychology Bulletin*, 26(8), 987-1001. doi:10.1177/01461672002610008
- Schulte-Rüther, M., Markowitsch, H. J., Shah, N. J., Fink, G. R., & Piefke, M. (2008). Gender differences in brain networks supporting empathy. *Neuroimage*, 42(1), 393-403. doi:10.1016/j.neuroimage.2008.04.180
- Schulz, R., O'Brien, A. T., Bookwala, J., & Fleissner, K. (1995). Psychiatric and physical morbidity effects of dementia caregiving: Prevalence, correlates, and causes. *Gerontologist*, 35(6), 771-791. doi:10.1093/geront/35.6.771
- Seider, B. H., Shiota, M. N., Whalen, P., & Levenson, R. W. (2011). Greater sadness reactivity in late life. *Social Cognitive and Affective Neuroscience*, 6(2), 186-194. doi:10.1093/scan/nsq069

- Shearn, D., Bergman, E., Hill, K., Abel, A., & Hinds, L. (1990). Facial coloration and temperature responses in blushing. *Psychophysiology*, 27(6), 687-693. doi:10.1111/j.1469-8986.1990.tb03194.x
- Shin, L. M., Dougherty, D. D., Orr, S. P., Pitman, R. K., Lasko, M., Macklin, M. L., ... Rauch, S. L. (2000). Activation of anterior paralimbic structures during guilt-related script-driven imagery. *Biological Psychiatry*, 48(1), 43-50. doi:10.1016/S0006-3223(00)00251-1
- Shiota, M. N., & Levenson, R. W. (2009). Effects of aging on experimentally instructed detached reappraisal, positive reappraisal, and emotional behavior suppression. *Psychology and Aging*, 24(4), 890-900. doi:10.1037/a0017896
- Simpson, J. A., Orina, M. M., & Ickes, W. (2003). When accuracy hurts, and when it helps: A test of the empathic accuracy model in marital interactions. *Journal of Personality and Social Psychology*, 85(5), 881-893. doi:10.1037/0022-3514.85.5.881
- Singer, T. (2006). The neuronal basis and ontogeny of empathy and mind reading: Review of literature and implications for future research. *Neuroscience and Biobehavioral Reviews*, 30(6), 855-863. doi:10.1016/j.neubiorev.2006.06.011
- Soto, J. A., & Levenson, R. W. (2009). Emotion recognition across cultures: The influence of ethnicity on empathic accuracy and physiological linkage. *Emotion*, 9(6), 874-884. doi:10.1037/a0017399
- Soto, J. A., Levenson, R. W., & Ebling, R. (2005). Cultures of moderation and expression: Emotional experience, behavior, and physiology in Chinese Americans and Mexican Americans. *Emotion*, 5(2), 154-165. doi:10.1037/1528-3542.5.2.154
- Sturm, V. E., Ascher, E. A., Miller, B. L., & Levenson, R. W. (2008). Diminished self-conscious emotional responding in frontotemporal lobar degeneration patients. *Emotion*, 8(6), 861-869. doi:10.1037/a0013765
- Sturm, V. E., McCarthy, M. E., Yun, I., Madan, A., Yuan, J. W., Holley, S. R., ... Levenson, R. W. (2011). Mutual gaze in Alzheimer's disease, frontotemporal and semantic dementia couples. *Social Cognitive and Affective Neuroscience*, 6(3), 359-367. doi:10.1093/scan/nsq055
- Sturm, V. E., Rosen, H. J., Allison, S., Miller, B. L., & Levenson, R. W. (2006). Self-conscious emotion deficits in frontotemporal lobar degeneration. *Brain*, 129(9), 2508-2516. doi:10.1093/brain/awl145
- Sturm, V. E., Sollberger, M., Seeley, W. W., Rankin, K. P., Ascher, E. A., Rosen, H. J., ... Levenson, R. W. (2012). Role of right pregenual anterior cingulate cortex in self-conscious emotional reactivity. *Social Cognitive and Affective Neuroscience*, doi:10.1093/scan/nss023
- Sze, J. A., Gyurak, A., Goodkind, M. S., & Levenson, R. W. (2011). Greater emotional empathy and prosocial behavior in late life. *Emotion*. doi:10.1037/a0025011
- Sze, J. A., Gyurak, A., Yuan, J. W., & Levenson, R. W. (2010). Coherence between emotional experience and physiology: Does body awareness training have an impact? *Emotion*, 10(6), 803-814. doi:10.1037/a0020146
- Tabert, M. H., Manly, J. J., Liu, X., Pelton, G. H., Rosenblum, S., Jacobs, M., ... Devanand, D. P. (2006). Neuropsychological prediction of conversion to Alzheimer disease in patients with mild cognitive impairment. *Archives of General Psychiatry*, 63(8), 916-924. doi:10.1001/archpsyc.63.8.916

- Takahashi, H., Yahata, N., Koeda, M., Matsuda, T., Asai, K., & Okubo, Y. (2004). Brain activation associated with evaluative processes of guilt and embarrassment: An fMRI study. *Neuroimage*, 23(3), 967-974. doi:10.1016/j.neuroimage.2004.07.054
- Tangney, J. P. (1999). The self-conscious emotions: Shame, guilt, embarrassment, and pride. In T. Dalgleish & M. J. Power (Eds.), *Handbook of cognition and emotion* (pp. 541-568). New York, NY: John Wiley & Sons.
- Thomas, G., & Fletcher, G. J. (2003). Mind-reading accuracy in intimate relationships: Assessing the roles of the relationship, the target, and the judge. *Journal of Personality and Social Psychology*, 85(6), 1079-1094. doi:10.1037/0022-3514.85.6.1079
- Tracy, J. L., & Robins, R. W. (2004). Putting the self into self-conscious Emotions: A theoretical model. *Psychological Inquiry*, 15(2), 103-125. doi:10.1207/s15327965pli1502_01
- Ward-Griffin, C., Bol, N., & Oudshoorn, A. (2006). Perspectives of women with dementia receiving care from their adult daughters. *Canadian Journal of Nursing Research*, 38(1), 120-146.
- Werner, K. H., Roberts, N. A., Rosen, H. J., Dean, D. L., Kramer, J. H., Weiner, M. W., ... Levenson, R. W. (2007). Emotional reactivity and emotion recognition in frontotemporal lobar degeneration. *Neurology*, 69(2), 148-155. doi:10.1212/01.wnl.0000265589.32060.d3
- Winblad, B., Palmer, K., Kivipelto, M., Jelic, V., Fratiglioni, L., Wahlund, L. O., ... Petersen, R. C. (2004). Mild cognitive impairment – beyond controversies, towards a consensus: Report of the International Working Group on Mild Cognitive Impairment. *Journal of Internal Medicine*, 256(3), 240-246. doi:10.1111/j.1365-2796.2004.01380.x
- Zanetti, O., Geroldi, C., Frisoni, G. B., Bianchetti, A., & Trabucchi, M. (1999). Contrasting results between caregiver's report and direct assessment of activities of daily living in patients affected by mild and very mild dementia: The contribution of the caregiver's personal characteristics. *Journal of the American Geriatrics Society*, 47(2), 196-202.

Table 1

Participant and Informant Demographic Information for Dyads Included in Either Reactivity or Empathic Accuracy Analyses

Group	Participant			Informant		
	Dyads <i>N</i>	Age <i>M (SD)</i>	Sex F : M	Relationship to participant	Age <i>M (SD)</i>	Sex F : M
Total	120	64.39 (8.07)	54 : 66	95 Spouse/partner/SO 10 Child 1 Child in-law 8 Sibling 1 Sibling in-law 5 Friend	59.63 (9.50)	81 : 39
	<i>n</i>					
Control	24	66.66 (6.48)	16 : 8	18 Spouse/partner/SO 2 Child 4 Friend	61.66 (9.19)	13 : 11
AD	30	63.59 (9.91)	14 : 16	21 Spouse/partner/SO 2 Child 5 Sibling 1 Sibling in-law 1 Friend	60.24 (10.52)	21 : 9
bvFTD	29 (26 bvFTD only, 3 bvFTD/ALS)	60.91 (8.50)	4 : 25	26 Spouse/partner/SO 2 Sibling 1 Child	57.98 (7.65)	25 : 4
PPA	8 (2 PPA, 3 PNFA, 3 SemD)	63.87 (5.47)	6 : 2	7 Spouse/partner/SO 1 Child	58.62 (13.23)	3 : 5
CBS/ PSP	20 (11 CBS, 9 PSP)	67.91 (5.68)	9 : 11	15 Spouse/partner/SO 4 Child 1 Child in-law	57.82 (9.98)	14 : 6
MDS	9 (4 MCI, 5 SDS)	64.83 (6.46)	5 : 4	8 Spouse/partner/SO 1 Sibling	62.38 (7.97)	5 : 4

Note. F = female, M = male, SO = significant other, AD = Alzheimer's disease, bvFTD = behavioral variant frontotemporal dementia, ALS = amyotrophic lateral sclerosis, PPA = primary progressive aphasia, PNFA = progressive nonfluent aphasia, SemD = semantic dementia, CBS = corticobasal syndrome, PSP = supranuclear palsy, MDS = mild dementia symptoms, MCI = mild cognitive impairment, SDS = subthreshold dementia symptoms.

Table 2

Participant and Informant Demographic Information for Dyads Included in Reactivity Analyses

Group	Participant			Informant		
	Dyads <i>N</i>	Age <i>M (SD)</i>	Sex F : M	Relationship to participant	Age <i>M (SD)</i>	Sex F : M
Total	83	64.79 (7.96)	35 : 48	68 Spouse/partner/SO 6 Child 1 Child in-law 5 Sibling 1 Sibling in-law 2 Friend	59.80 (9.69)	56 : 27
	<i>n</i>					
Control	18	66.25 (7.13)	11 : 7	15 Spouse/partner/SO 1 Child 2 Friend	61.32 (9.83)	9 : 9
AD	20	64.12 (10.63)	9 : 11	15 Spouse/partner/SO 2 Child 2 Sibling 1 Sibling in-law	60.22 (11.16)	14 : 6
bvFTD	20 (19 bvFTD only, 1 bvFTD/ALS)	62.53 (7.72)	1 : 19	18 Spouse/partner/SO 2 Sibling	59.23 (6.57)	18 : 2
PPA	5 (1 PPA, 2 PNFA, 2 SemD)	64.72 (5.11)	5 : 0	4 Spouse/partner/SO 1 Child	57.15 (16.30)	1 : 4
CBS/ PSP	14 (6 CBS, 8 PSP)	67.39 (5.54)	6 : 8	11 Spouse/partner/SO 2 Child 1 Child in-law	58.39 (9.80)	10 : 4
MDS	6 (3 MCI, 3 SDS)	64.24 (7.80)	3 : 3	5 Spouse/partner/SO 1 Sibling	61.22 (9.36)	4 : 2

Note. F = female, M = male, SO = significant other, AD = Alzheimer's disease, bvFTD = behavioral variant frontotemporal dementia, ALS = amyotrophic lateral sclerosis, PPA = primary progressive aphasia, PNFA = progressive nonfluent aphasia, SemD = semantic dementia, CBS = corticobasal syndrome, PSP = supranuclear palsy, MDS = mild dementia symptoms, MCI = mild cognitive impairment, SDS = subthreshold dementia symptoms.

Table 3
Participant and Informant Demographic Information for Dyads Included in Empathy Analyses

Group	Participant			Informant		
	Dyads <i>N</i>	Age <i>M (SD)</i>	Sex F : M	Relationship to participant	Age <i>M (SD)</i>	Sex F : M
Total	110	64.29 (8.05)	50 : 60	87 Spouse/partner/SO 10 Child 1 Child in-law 6 Sibling 1 Sibling in-law 5 Friend	59.36 (9.53)	75 : 35
	<i>n</i>					
Control	23	66.13 (6.06)	15 : 8	17 Spouse/partner/SO 2 Child 4 Friend	60.90 (8.60)	13 : 10
AD	26	63.73 (9.94)	13 : 13	18 Spouse/partner/SO 2 Child 4 Sibling 1 Sibling in-law 1 Friend	60.28 (10.75)	19 : 7
bvFTD	27 (25 bvFTD only, 2 bvFTD/ALS)	60.84 (8.73)	4 : 23	24 Spouse/partner/SO 2 Sibling 1 Child	57.96 (7.80)	23 : 4
PPA	7 (2 PPA, 2 PNFA, 3 SemD)	63.49 (5.80)	5 : 2	6 Spouse/partner/SO 1 Child	57.45 (13.83)	3 : 4
CBS/ PSP	19 (11 CBS, 8 PSP)	67.89 (5.84)	9 : 10	14 Spouse/partner/SO 4 Child 1 Child in-law	57.50 (10.14)	13 : 6
MDS	8 (4 MCI, 4 SDS)	64.65 (6.88)	4 : 4	8 Spouse/partner/SO	62.78 (8.42)	4 : 4

Note. F = female, M = male, SO = significant other, AD = Alzheimer's disease, bvFTD = behavioral variant frontotemporal dementia, ALS = amyotrophic lateral sclerosis, PPA = primary progressive aphasia, PNFA = progressive nonfluent aphasia, SemD = semantic dementia, CBS = corticobasal syndrome, PSP = supranuclear palsy, MDS = mild dementia symptoms, MCI = mild cognitive impairment, SDS = subthreshold dementia symptoms.

Table 4
Internal Consistency of the Caregiver Assessment of Socioemotional Functioning (CASEF)

Scale	<i>N</i>	Number of items	Cronbach's α
CASEF Total	70	44	.96
All reactivity and empathic accuracy items	91	23	.92
CASEF Total Reactivity	108	13	.75
CASEF Negative Reactivity	125	4	.70
CASEF Positive Reactivity	116	5	.82
CASEF Self-Conscious Reactivity	122	4	.74
CASEF Total Empathic Accuracy	99	10	.98
CASEF Negative Empathic Accuracy	108	4	.96
CASEF Positive Empathic Accuracy	122	2	.90
CASEF Self-Conscious Empathic Accuracy	101	4	.96

Table 5

Means and Standard Deviations for Informant-Completed and Laboratory Measures Used in Reactivity Analyses

Group	Total (N = 83) M (SD)	Control (n = 18) M (SD)	AD (n = 20) M (SD)	bvFTD (n = 20) M (SD)	PPA (n = 5) M (SD)	CBS/PSP (n = 14) M (SD)	MDS (n = 6) M (SD)
Informant-completed measures							
Informant SCL-90 ^a							
Anxiety	0.31 (0.38)	0.15 (0.27)	0.22 (0.23)	0.47 (0.36)	0.24 (0.23)	0.49 (0.64)	0.18 (0.12)
Depression	0.63 (0.60)	0.24 (0.27)	0.49 (0.40)	1.03 (0.69)	0.60 (0.47)	0.86 (0.72)	0.45 (0.43)
CASEF reactivity scores ^b							
Total	1.76 (0.59)	1.95 (0.45)	1.97 (0.51)	1.50 (0.65)	1.85 (0.59)	1.69 (0.57)	1.49 (0.79)
Negative	1.72 (0.91)	1.53 (0.91)	1.89 (0.67)	1.78 (1.05)	1.75 (1.12)	1.84 (1.00)	1.29 (0.90)
Positive	2.67 (0.93)	3.48 (0.55)	2.67 (0.87)	1.94 (0.84)	3.27 (0.37)	2.36 (0.82)	2.85 (0.86)
Self-conscious	1.13 (0.77)	1.24 (0.64)	1.52 (0.73)	0.90 (0.87)	0.90 (0.49)	1.04 (0.68)	0.67 (0.92)
Laboratory reactivity measures							
Physiological arousal ^c							
Total	0.02 (0.19)	0.12 (0.17)	0.01 (0.19)	-0.01 (0.15)	-0.11 (0.34)	-0.03 (0.14)	0.15 (0.29)
Negative	0.01 (0.23)	0.05 (0.22)	0.02 (0.28)	0.02 (0.19)	-0.17 (0.29)	-0.03 (0.19)	0.10 (0.16)
Positive	0.03 (0.28)	0.07 (0.30)	0.03 (0.30)	-0.04 (0.17)	0.02 (0.57)	0.01 (0.19)	0.16 (0.41)
Self-conscious	0.03 (0.36)	0.25 (0.33)	-0.03 (0.37)	-0.03 (0.26)	-0.17 (0.43)	-0.08 (0.25)	0.18 (0.64)
Facial behavior ^d							
Total	19.10 (11.97)	24.65 (7.08)	17.73 (12.18)	13.59 (9.00)	19.68 (20.88)	18.98 (12.06)	25.18 (17.19)
Negative	16.86 (12.72)	19.76 (10.19)	17.33 (14.51)	13.54 (11.20)	12.95 (16.24)	18.50 (14.32)	17.13 (13.42)
Positive	27.26 (21.94)	32.99 (16.65)	25.80 (21.11)	18.81 (20.61)	20.90 (29.87)	31.54 (23.65)	38.42 (28.66)
Self-conscious	13.17 (16.01)	21.19 (14.95)	10.05 (14.80)	8.41 (13.64)	25.20 (27.03)	6.89 (9.30)	20.00 (20.59)
Self-reported experience ^e							
Total	2.73 (0.87)	3.19 (0.54)	2.59 (0.92)	2.38 (0.99)	2.23 (0.35)	2.93 (0.72)	2.94 (1.10)
Negative	2.96 (1.04)	3.25 (0.97)	2.78 (1.12)	2.60 (1.12)	2.30 (0.57)	3.36 (0.77)	3.50 (1.00)
Positive	3.22 (1.24)	3.72 (0.75)	3.10 (1.33)	2.85 (1.42)	3.40 (0.89)	3.21 (1.25)	3.17 (1.60)
Self-conscious	2.02 (1.28)	2.61 (1.04)	1.90 (1.07)	1.70 (1.38)	1.00 (0.71)	2.21 (1.53)	2.17 (1.47)

Note. CASEF = Caregiver Assessment of Socioemotional Functioning, SCL-90 = Symptom Checklist—90 Item, AD = Alzheimer’s disease, bvFTD = behavioral variant frontotemporal dementia, PPA = primary progressive aphasia, CBS = corticobasal syndrome, PSP = progressive supranuclear palsy, MDS = mild dementia symptoms.

^a The range of each SCL-90 subscale is 0 to 4, with higher scores indicating greater symptomatology. ^b The range of each CASEF subscale is 0 to 4, with higher scores indicating greater reactivity. ^c Physiology scores were calculated by averaging the arousal z scores of each physiological channel for a given task, with higher scores indicating greater reactivity. ^d Behavior scores were calculated by summing the target emotion intensity codes for a given task; possible scores range from 0 to 90, with higher scores indicating greater expression of the target emotion. ^e Self-report scores were calculated by summing the open-ended and multiple choice scores for a given task; possible scores range from 0 to 4, with higher scores indicating greater experience of the target emotion.

Table 6
Summary of Reactivity Hierarchical Regression Analyses ($N = 83$)

Dependent variable	CASEF Total Reactivity		CASEF Negative Reactivity		CASEF Positive Reactivity		CASEF Self-Conscious Reactivity	
	Model 1 β	Model 2 β	Model 1 β	Model 2 β	Model 1 β	Model 2 β	Model 1 β	Model 2 β
Predictors								
Informant SCL-90								
Anxiety ^{a,b}	0.34	0.32	0.30	0.31	0.20	0.12	0.17	0.19
Depression ^{a,b}	-0.48*	-0.36*	-0.06	-0.02	-0.62***	-0.47**	-0.37	-0.38
Participant laboratory reactivity ^d		Total ^e		Negative ^f		Positive ^g		Self-conscious ^h
Physiology ^{a,c}		0.25*		0.16		0.11		0.07
Behavior ^{a,c}		0.29*		0.17		0.19		0.01
Self-report ^{a,c}		0.11		0.26		0.23		0.04
R^2	.09*	.33***	.06	.21**	.22***	.40***	.07	.08
ΔR^2		.25***		.15**		.17***		.01

Note. CASEF = Caregiver Assessment of Socioemotional Functioning, SCL-90 = Symptom Checklist—90 Item.

^a Bonferroni-adjustment was applied for the number of predictors being compared (p values were multiplied by ^b two or ^c three). ^d Individual measures represent reactivity for ^e tasks averaged across the three emotion types, or during tasks targeting ^f negative, ^g positive, or ^h self-conscious emotion.

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 7

Means and Standard Deviations for Informant-Completed and Laboratory Measures Used in Empathy Analyses

Group	Total (N = 110) M (SD)	Control (n = 23) M (SD)	AD (n = 26) M (SD)	bvFTD (n = 27) M (SD)	PPA (n = 7) M (SD)	CBS/PSP (n = 19) M (SD)	MDS (n = 8) M (SD)
Informant-completed measures							
Informant SCL-90 ^a							
Anxiety	0.34 (0.42)	0.16 (0.25)	0.27 (0.33)	0.45 (0.39)	0.23 (0.24)	0.59 (0.67)	0.23 (0.15)
Depression	0.68 (0.61)	0.30 (0.32)	0.60 (0.47)	0.95 (0.64)	0.55 (0.50)	1.01 (0.82)	0.50 (0.41)
CASEF empathic accuracy scores ^b							
Total	2.19 (1.11)	3.41 (0.61)	2.29 (1.15)	1.23 (0.85)	1.79 (0.65)	2.08 (0.56)	2.15 (0.97)
Negative	2.19 (1.15)	3.45 (0.62)	2.36 (1.13)	1.16 (0.93)	1.86 (0.88)	2.02 (0.52)	2.23 (0.96)
Positive	2.72 (1.07)	3.67 (0.54)	2.71 (1.18)	1.91 (1.04)	2.64 (0.69)	2.66 (0.73)	2.94 (0.82)
Self-conscious	1.91 (1.26)	3.23 (0.78)	2.02 (1.27)	0.96 (0.88)	1.29 (0.92)	1.86 (0.89)	1.69 (1.28)
Laboratory empathic accuracy measures ^c							
Total	1.71 (0.29)	1.91 (0.10)	1.66 (0.28)	1.61 (0.34)	1.40 (0.44)	1.74 (0.19)	1.81 (0.11)
Negative	1.81 (0.32)	1.96 (0.12)	1.82 (0.25)	1.72 (0.39)	1.46 (0.55)	1.86 (0.24)	1.84 (0.30)
Positive	1.74 (0.36)	1.97 (0.11)	1.58 (0.46)	1.69 (0.41)	1.50 (0.35)	1.79 (0.22)	1.84 (0.19)
Self-conscious	1.58 (0.38)	1.80 (0.24)	1.59 (0.37)	1.42 (0.41)	1.24 (0.57)	1.58 (0.35)	1.75 (0.15)

Note. CASEF = Caregiver Assessment of Socioemotional Functioning, SCL-90 = Symptom Checklist—90 Item, AD = Alzheimer's disease, bvFTD = behavioral variant frontotemporal dementia, PPA = primary progressive aphasia, CBS = corticobasal syndrome, PSP = progressive supranuclear palsy, MDS = mild dementia symptoms.

^a The range of each SCL-90 subscale is 0 to 4, with higher scores indicating greater symptomatology. ^b The range of each CASEF subscale is 0 to 4, with higher scores indicating greater empathic accuracy. ^c Laboratory empathic accuracy scores range from 0 to 2, with higher scores indicating more accurate identification of the target emotion in a given task.

Table 8
Summary of Empathy Hierarchical Regression Analyses (N = 110)

Dependent variable	CASEF Total Empathic Accuracy		CASEF Negative Empathic Accuracy		CASEF Positive Empathic Accuracy		CASEF Self-Conscious Empathic Accuracy	
	Model 1 β	Model 2 β	Model 1 β	Model 2 β	Model 1 β	Model 2 β	Model 1 β	Model 2 β
Predictors								
Informant SCL-90								
Anxiety ^a	0.16	0.13	0.12	0.12	0.12	0.11	0.19	0.14
Depression ^a	-0.49**	-0.42**	-0.48**	-0.47**	-0.40*	-0.37*	-0.47**	-0.37*
Participant laboratory empathic accuracy		Total 0.30***		Negative 0.19*		Positive 0.24**		Self-conscious 0.30***
R^2	.14***	.23***	.15***	.19***	.10**	.15***	.11**	.20***
ΔR^2		.09***		.04*		.06**		.09***

Note. CASEF = Caregiver Assessment of Socioemotional Functioning, ME = main effect, Spec = specificity, SCL-90 = Symptom Checklist—90 Item.

^a Bonferroni-adjustment was applied for the number of predictors being compared (p values were multiplied by two).

* $p < .05$. ** $p < .01$. *** $p < .001$.

Appendix

Caregiver Assessment of Socioemotional Functioning (CASEF) with Relevant Items by Subscale

Please rate the participant's behavior **in the past month** for the following:

	<i>not at all</i>		<i>a little</i>		<i>a lot</i>	<i>DON'T KNOW</i>
Negative Reactivity						
1. Expresses anger	0	1	2	3	4	☐
2. Expresses fear	0	1	2	3	4	☐
3. Expresses sadness	0	1	2	3	4	☐
4. Expresses disgust	0	1	2	3	4	☐
Positive Reactivity						
5. Expresses joy	0	1	2	3	4	☐
6. Expresses amusement	0	1	2	3	4	☐
11. Is warm/affectionate/loving toward spouse/partner/family	0	1	2	3	4	☐
12. Is warm/affectionate/loving toward friends	0	1	2	3	4	☐
13. Is warm/affectionate/loving toward animals/pets	0	1	2	3	4	☐
Self-Conscious Reactivity						
7. Expresses embarrassment	0	1	2	3	4	☐
8. Expresses shame	0	1	2	3	4	☐
9. Expresses guilt	0	1	2	3	4	☐
10. Expresses pride	0	1	2	3	4	☐
Negative Empathic Accuracy						
14. Recognizes and understands when others are feeling angry	0	1	2	3	4	☐
15. Recognizes and understands when others are feeling afraid	0	1	2	3	4	☐
16. Recognizes and understands when others are feeling sad	0	1	2	3	4	☐
17. Recognizes and understands when others are feeling disgusted	0	1	2	3	4	☐

	<i>not at all</i>		<i>a little</i>		<i>a lot</i>	<i>DON'T KNOW</i>
Positive Empathic Accuracy						
18. Recognizes and understands when others are feeling joyful	0	1	2	3	4	☐
19. Recognizes and understands when others are feeling amused	0	1	2	3	4	☐
Self-Conscious Empathic Accuracy						
20. Recognizes and understands when others are feeling embarrassed	0	1	2	3	4	☐
21. Recognizes and understands when others are feeling ashamed	0	1	2	3	4	☐
22. Recognizes and understands when others are feeling guilty	0	1	2	3	4	☐
23. Recognizes and understands when others are feeling proud	0	1	2	3	4	☐

Note. Only CASEF items used in the present study are included above. The version completed by informants does not contain subscale headings and presents the items in numerical order, rather than the order listed above. For scoring, items 11, 12, and 13 are averaged to obtain one affection item score.