PhD thesis

Minding the gap between experience and expression: What contributes to the negative social perception of patients with Parkinson's disease?

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Statement of Originality

The two studies in this thesis are novel investigations designed to better understand the underlying emotional processing and expressive factors that contribute to how patients with Parkinson's disease (PD) are socially perceived. In Study 1, a novel set of emotion film elicitation stimuli were developed for, and validated in, an audience of older adults. In Study 2, these stimuli were used to evoke emotion in healthy control subjects and participants with PD. Subjects' responses served as the basis for expressivity judgments and social judgments by naïve raters, in order to understand how emotional experience is related to emotional expression and the formulation of social impressions. The two studies are presented in manuscript format for publication elsewhere. At the time of submission of this thesis to McGill University, the results of these studies have not yet been submitted for publication.

Contribution of Authors

This thesis was conceived, designed, and conducted by the first author, Rachel Schwartz, under the guidance of her supervisor, Dr. Marc D. Pell. The project design and statistical approach were significantly shaped by guidance from thesis committee member Dr. Judith A. Hall. The results were analyzed by the first author, with advice from Dr. Pell and Dr. Hall. Both manuscripts were written in full by the first author, with editorial suggestions from Dr. Pell and Dr. Hall.

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Abstract

Individuals with Parkinson's disease (PD) are perceived more negatively than their healthy peers; however the factors contributing to this negative social impression are currently unknown. The repercussions of such negative social impressions may directly contribute to patient health outcomes and overall quality of life; understanding how disease-related changes may differentially contribute to social perception outcomes is the first step towards addressing the social barriers PD patients face. In this thesis, we sought to disentangle the experiential and expressive factors that contribute to social impressions in two studies; Study 1 details the process by which we created and validated a set of emotion elicitation film stimuli specifically for use in a target audience of older adults. The films were balanced in terms of number of positive and negative valence items, and were designed to elicit Happiness, Tenderness, Sadness, and Fear, in addition to a Neutral affective state. Study 2 explores the relationship between subjective emotional experience (Experiment 1), facial expressivity of emotion (Experiment 2), and resulting social impressions formed on the basis of facial and vocal expressivity (Experiment 3). No significant group differences were found with regard to how intensely PD patients and healthy control (HC) participants reported feeling emotion, nor were group differences observed with respect to the accuracy with which subjects reported experiencing the target emotion. Participants with PD were judged to be significantly more expressive than control subjects when naïve observers rated silent videos of spontaneously elicited facial expression, contrary to what would be expected given the rigidity of facial expression associated with PD. Despite there being no significant group differences in how accurately raters perceived the emotion subjects reported experiencing, raters' errors patterned differently according to group status; PD participants were routinely mistaken for feeling a negative emotion, while HC participants were more often

misperceived as feeling a positive emotion. When subjects were judged across a number of social characteristics (Experiment 3), with the exception of Physical Attractiveness and Caring scales, for which there were no group differences, the PD group was consistently judged more negatively than the HC group across social attributes. These findings suggest that the negative social impressions associated with PD may be due to changes in expressivity patterns. It may be that the social costs associated with the disease are actually due to patients responding in a manner that is *more* expressive, particularly with respect to negative emotion, than what would normally be expected in healthy older adults.

Résumé

Les individus atteints de la maladie de Parkinson sont perçus de façon plus négative que les personnes saines; cependant les facteurs à l'origine de ce ressenti social négatif sont aujourd'hui inconnus. Les répercussions de telles impressions sociales négatives peuvent directement influencer l'état de santé des patients et leur qualité de vie globale ; comprendre comment des changements liés à la maladie peuvent ainsi influencer différentiellement les perceptions sociales est la première étape vers une prise en compte des barrières sociales auxquelles les patients atteints de Parkinson font face. Dans cette thèse, nous avons cherché à démêler les facteurs expressifs et liés à l'expérience personnelle qui contribuent aux impressions sociales à travers deux études; l'Etude 1 détaille le procédé par lequel nous avons créé et validé un ensemble de films stimulateurs d'émotions, spécifiquement à destination d'une audience d'adultes d'âge mûr. Les films étaient répartis selon leur nombre d'éléments de valence positive ou négative, et étaient conçus de façon à provoquer le Bonheur, la Tendresse, la Tristesse, et la Peur, en plus d'un état affectif Neutre. L'Etude 2 explore la relation entre le vécu émotionnel subjectif (Expérience 1), l'expressivité faciale des émotions (Expérience 2), et les impressions sociales résultantes formées à partir de l'expressivité faciale et vocale (Expérience 3). Aucune différence significative n'a été trouvée entre les patients malades et les participants sains témoins quant à l'intensité de l'expression des émotions, de même qu'aucune différence ne fut observée au niveau de l'adéquation entre l'émotion que les sujets rapportèrent avoir ressentie et l'émotion visée par l'expérience. Les patients atteints de Parkinson furent jugés significativement plus expressifs que les sujets témoins lorsque des observateurs extérieurs notèrent des vidéos silencieuses d'expressions faciales exprimées spontanément, à l'encontre de ce qui serait attendu étant donnée la rigidité d'expression faciale associée à la maladie de Parkinson. Malgré l'absence de différence

significative au niveau de la justesse avec laquelle les observateurs perçurent l'émotion que les sujets dirent avoir ressentie, les erreurs des observateurs se répartissent différemment selon les groupes: il fut régulièrement attribué à tort une émotion négative aux sujets malades, tandis que les sujets sains témoins furent souvent perçus à tort comme ressentant une émotion positive. Lorsque les sujets furent jugés sur un ensemble de caractéristiques sociales (Expérience 3), le groupe des patients malades fut régulièrement jugé de façon plus négative que le groupe témoin, sauf pour l'Attractivité Physique et l'Attachement. Ces résultats suggèrent que les impressions sociales négatives liées à la maladie de Parkinson pourraient être causées par des changements dans les motifs d'expressivité. Il se pourrait que les coûts sociaux dus à la maladie soient en réalité causés par le fait que les patients répondent de façon plus expressive, particulièrement dans le cas d'émotion négative, que ce qui est généralement attendu chez des adultes âgés sains.

General Introduction

Social perception in everyday life involves identifying dynamic, expressive behavior. Research in social psychology has shown that social inferences and judgments are strongly influenced by initial impressions; as a result, being able to identify the expressive factors which lead to social expectancies is central to understanding the processes underlying social cognition (Ambady, Bernieri, & Richeson, 2000). In individuals with Parkinson's disease (PD), emotional expressive and receptive tendencies are altered (Gray & Tickle-Degnen, 2010; Pitcairn, Clemie, Gray, & Pentland, 1990), and afflicted individuals face social communication challenges that have a significant, negative effect on their quality of life (Miller, Noble, Jones, & Burn, 2006; Schreurs, Ridder, & Bensing, 2000). However, the link between disease-related changes in emotion processing and expression, and the resulting negative social impression these individuals face, has yet to be clearly elucidated. The goal of this dissertation was to identify a) how subjective emotional experience and b) how emotional expressivity are altered by PD and c) to understand the relationship between the aforementioned two factors and resulting social impressions by age-peers.

Idiopathic Parkinson's disease is characterized by a degeneration of dopaminergic neurons in the substantia nigra of the basal ganglia. The basal ganglia (BG) is a midbrain region composed of the striatum, pallidum, substantia nigra and subthalamus nucleus (Parent & Hazrati, 1995). Neural output from the BG targets the primary motor cortex, the premotor cortex, and several regions of the prefrontal cortex: the dorsolateral prefrontal cortex, the lateral orbitofrontal cortex, and the anterior cingulate/medial orbitofrontal cortices (Alexander, DeLong, & Strick, 1986). In PD, dopamine depletion in the substantia nigra can fall to 10 to 20% of normal levels, causing interruption of neuronal transmission to these various brain regions that rely on dopaminergic pathways (Salgado-Pineda, Delaveau, Blin, & Nieoullon, 2005).

While dopamine depletion is the “hallmark” of PD, the levels of many other neurotransmitters are also affected by the disease, including GABA, acetylcholine, serotonin and noradrenaline (Braak & Braak, 2000; Yarnall, Archibald, & Burn, 2012). Although Parkinson’s disease is clinically diagnosed based on the presence of at least two out of four cardinal motor symptoms: rigidity, resting tremor, postural instability, or bradykinesia (slowness of movement) (Dietz, Bradley, Okun, & Bowers, 2011; Ishihara & Brayne, 2006), alterations in levels of neurotransmitters lead to dysfunction that extends into the non-motor realm. The extent of the disruption is far-reaching, as structural connectivity studies, lesion studies and PD studies have provided clear evidence that the BG are involved in cognitive, motor, and emotional processes and behavior (Haegelen, Rouaud, Darnault, & Morandi, 2009; Middleton & Strick, 2000; Salgado-Pineda et al., 2005). As such, it is unsurprising that PD patients’ list of non-motor symptoms spans the full range of cognitive, limbic, autonomic, sensory, and regulatory systems (Chaudhuri, Yates, & Martinez-Martin, 2005; Marsh, 2000; Stacy, 2011). Non-motor symptoms include cognitive impairment, communication disorders, difficulty with impulse control, visual and olfactory disorders, bladder and sexual difficulties, fatigue, communication and sleep disorders, to name but a few (Berg, Bjornram, Hartelius, Laakso, & Johnels, 2003; Bonnet, Jutras, Czernecki, Corvol, & Vidailhet, 2012; Monetta, Grindrod, & Pell, 2009; Monetta & Pell, 2007; Bonnet et al., 2012; Chaudhuri et al., 2005; Stacy, 2011). As a result of the fact that clinical diagnosis is based on the presence of motor symptoms (Lau & Breteler, 2006), the non-motor symptoms that patients experience, despite being equally disabling, frequently go underdiagnosed (Bonnet et al., 2012; Chaudhuri et al., 2005; Martinez-Martin, Rodriguez-Blazquez, Kurtis, & Chaudhuri, 2011; Witjas, Kaphan, & Azulay, 2002).

The diagnosis and treatment of PD is further complicated by the extreme heterogeneity of the disease; both symptoms and disease progression vary markedly from patient to patient (Foltynie, Brayne, & Barker, 2002). Such individual variation has made it difficult to characterize the exact nature of PD-induced disorders. While some authors have proposed the need for increased attention to sub-types of PD as a way of addressing the current variability (Marras, Lang, & Shulman, 2013), in many ways the unpredictable course of the disease necessitates a different type of treatment, one that attends to each person as an individual and assesses their needs accordingly. Given the constraints of the current medical system and the human mind, both of which rely on the ability to characterize the unknown, we need to better define the breadth of experiences lived by patients with PD in order to come closer to an understanding of how to address the significant challenges they face.

As Brod, Mendelsohn, and Roberts (1998) explain in their article on patients' experiences of PD, though not a life-threatening disease, Parkinson's is one that "leaves few areas of patients' lives unaffected" (p. 213). The emotional dysfunctions associated with PD are less well characterized than the cognitive and motor disabilities of the disease (Dietz et al., 2011), perhaps because emotion itself is dynamic, multifaceted and present in all aspects of our interactions. Appraisal theorists (e.g., Sander, Grandjean, Kaiser, Wehrle, & Scherer, 2007; Scherer, Schorr & Johnstone, 2001) hold that the emergence of emotional feelings and behaviors first involves the appraisal, consciously or unconsciously, of the significance of emotional stimuli, followed by the production of an affective response and an accompanying emotional feeling. Finally, the affective state and behavior undergoes regulation, inhibiting or modulating the emotional response to ensure that the resulting behavior is contextually appropriate (Phillips, Drevets, Rauch, & Lane, 2003). It appears that emotion recognition and subjective emotional experience may rely upon some of the same neural circuitry, such as the orbitofrontal and anterior cingulate circuits (Phan, Wager, Taylor, & Liberzon, 2002). However, some PD studies have reported preserved subjective emotional experience despite reduced emotion expressive ability (e.g., Simons, Pasqualini, Reddy, & Wood, 2004; Smith, Smith, & Ellgring, 1996), suggesting the neural processes required for experience, recognition, and expression of emotion may be at least partially distinct. Understanding the distinction, and interplay, between these emotional processes is necessary in order for us to understand PD patients' emotional realities.

In studying emotion processing, it is important to distinguish between emotion perception and emotion induction. As Davidson and Irwin (1999) note, asking subjects to observe facial imagery of emotion does not require that they *experience* emotion. Furthermore, in a meta-analysis examining brain activation in response to emotional stimuli, Phan, Wager, Taylor, & Liberzon (2002) found that the type of stimuli used—visual presentation, auditory presentation, or that which required emotional recall—activated different regions of the brain, indicating that the neural processes involved in these different aspects of emotion processing are at least partially distinct. As a result, what we know about facial and vocal emotion recognition abilities in PD patients should not be mistaken for what we know about patients' subjective emotional experience. Although our study is concerned with tracing individuals' emotional experience from its subjective origins (Experiment 1) to how it is expressed (Experiment 2) and perceived by age-peers (Experiment 3), we will begin with a discussion of facial and vocal emotion recognition abilities in PD patients because it is likely that impairments on a perceptual level would have ramifications on an interpersonal level should patients be unable to accurately perceive emotion in others (Gray & Tickle-Degnen, 2010).

Emotion processing in PD. In characterizing emotional processing deficits in PD, it is first important to understand how different theoretical approaches may shape our understanding of emotion. The "categorical perspective" takes a biological approach to emotions. Theorists who subscribe to this view (e.g., Ekman, 1992; Etcoff & Magee, 1992) posit that emotions are biologically-based, and that there are a set of "basic emotions" which are physiologically distinct from one another, occur unbidden, result in a distinctive subjective experience, have a rapid onset and brief duration (Ekman, 1992). Theorists who adhere to a "dimensional perspective," on the other hand (e.g., Feldman Barrett, 1998; Russell, 1980) suggest that emotion should be assessed along two dimensions: that of valence (pleasant/unpleasant) and that of arousal (low-activation/intensity to high activation/intensity). Together, these two dimensions form the basis for one's "core affect", a continuous assessment of one's current state (i.e., what might be referred to as "feeling"). Emotion is then defined by (a) a change in core affect, (b) an object (person, event, condition, thing towards which a mental state is directed) and (c) an attribution of core affect to the object. The body of literature on emotion processing in PD patients draws from both approaches; many studies attend to how PD may affect specific categorical emotions differently, yet many experiments have also examined dimensional qualities of emotion to explore how PD may affect the intensity with which emotions of a certain valence are experienced.

There has been much debate in the literature over the nature of emotion recognition deficits in PD. Results from studies, across vocal and facial modalities, are inconsistent with respect to whether the emotion recognition deficit is limited to specific emotions (e.g., recognition of fear and disgust were found to be impaired in PD patients in a study by Kan, Kawamura, Hasegawa, Mochizuki, & Nakamura, 2002; only recognition of anger was reported to be impaired in Lawrence, Goerendt, & Brooks, 2007; a disgust-specific impairment was reported in Suzuki, Hoshino, Shigemasu, & Kawamura, 2006), or whether the emotion recognition deficit is present across all emotions (Breitenstein, Van Lancker, Daum, & Waters, 2001; Sprengelmeyer et al., 2003; Yip, Lee, Ho, Tsang, & Li, 2003). Still others found no emotion recognition impairments in PD patients (Adolphs, Schul, & Tranel, 1998; Pell & Leonard, 2005). However, these studies differed in both their experimental approach and the modality of emotional stimuli used; given evidence from Phan et al. (2002) that the nature of the emotional stimuli alone (auditory vs. visual vs. induced emotion) will result in different brain activation, it is necessary to attend to studies' elicitation stimuli and task demands in considering whether the studies are even comparable.

In studies that have specifically examined whether the PD emotion recognition deficit is cross-modal, i.e., present both for tasks that involve recognition of emotion from vocal prosody as well as from facial imagery, results are still unclear. Ariatti, Benuzzi, & Nichelli (2008) and Yip et al. (2003) found evidence of impaired emotion perception in PD patients across facial and prosodic modalities. Ariatti et al. (2008) explored facial emotion recognition in 27 PD patients and matched controls using an emotion recognition battery based on the Ekman & Friesen (1976) Pictures of Facial Affect. Tasks included naming the emotion they observed, selecting a target emotion, matching emotions, and identifying the same person across pictures of different emotional expressions. Only a subset of PD patients in the study (11 out of the 27 participants) completed the vocal recognition portion of the Ariatti et al. (2008) study. The vocal recognition portion included both non-emotional tasks, such as discriminating between types of statements (interrogative vs. declaratory vs. exclamatory vs. imparative), as well as affect-naming and affect-discriminating tasks on the basis of vocal prosody, i.e., changes in pitch, rhythm and intonation. Ariatti and colleagues reported a severe facial emotion processing impairment for PD patients in response to sad and fearful faces, and a diffuse, general prosodic processing impairment that extended across emotional and non-emotional domains. Yip et al. (2003) similarly used photographs of emotional faces for affect recognition and discrimination tasks, and used a neutral prosodic statement ("I want to go see a movie") intoned in six different emotions for the vocal identification and discrimination tasks. They examined emotion processing in 64 PD patients and found that patients were significantly impaired, relative to healthy controls, at emotion identification across modalities.

In constrast, Clark, Neargarder, & Cronin-Golomb (2008) and Kan et al. (2002) both observed deficits only for facial emotion processing. Clark et al. (2008) used static photos for the facial emotion recognition task and neutral sentences spoken with different affective prosody for the vocal task, while Kan et al. (2002) used silent videoclips for the facial emotion recognition task, and a combination of semantically neutral, emotionally intoned sentences as well as nonsense sentences with emotional intonation for the prosodic recognition task. Yet another study, that of Pell & Leonard (2005), reported the opposite pattern, with preserved facial emotion recognition but impaired prosodic emotion recognition abilities in their PD participants. Pell & Leonard (2005) used static pictures for the emotional facial recognition task, while prosodic decoding ability was studied in-depth using a combination of nonsense sentences, semantically biasing sentences, non-emotional vocal discrimination tasks, and tasks requiring subjects to assess the degree to which each exemplar demonstrated a target emotion. Such differences in task demands between studies may have contributed to the differing results. Similarly, while a study by Caekebeke, Jennekens-Schinkel, Van der Linden, Burums, & Roos (1991) reported no deficits in PD emotion processing in either modality, the experimental paradigm they employed differed so markedly from the abovementioned studies that it is hardly comparable. Caekebeke et al. (1991)'s stimuli consisted of cartoon faces of facial emotions, and employed a more free-form reporting practice than other studies, allowing subjects to give free descriptions of the facial expressions as well as yes/no judgments in response to specific statements. For the prosodic task, Caekebeke and colleagues had subjects give a same/different judgment to verbally identical but prosodically different statements, and then comment on the verbal and prosodic content of each. As a result, it is difficult to compare their findings to those of the others.

A study by Paulmann & Pell (2010) further examined the potential cross-modal PD processing impairment by employing dynamic facial, prosodic and semantic stimuli across a combination of modalities. They developed three sets of uni-modal stimuli (dynamic facial expression of emotion, prosodic auditory emotion in the form of pseudosentences, and lexical sentences presented in the form of scrolling text). These channels were combined to form three bi-modal combinations (facial + prosodic cues, facial + semantic cues, prosodic + semantic cues), and one multi-modal (facial + prosodic + semantic cues) condition. The authors reported that for both healthy and PD groups, emotion recognition rates improved with increased numbers of channels available, however the PD group performed significantly more poorly than the healthy control group across all conditions. Paulmann & Pell (2010) suggested that PD may be associated with a broad-based impairment in the ability to process dynamic emotional expressions.

In order to make sense of these various findings, whose differences likely stem from, in addition to great inter-study variation in methodological approach, sample size, composition of the patient populations, differences in participants' cognitive abilities, and variability in medication status between PD participants (Assogna, Pontieri, Caltagirone, & Spalletta, 2008), meta-analyses can provide insight. Gray & Tickle-Degnen (2010) examined 34 studies on PD patients' emotion recognition abilities, and collapsed studies across facial and vocal modalities. The authors reported that, despite individual study variation, when taken together, there was evidence of a robust link between PD and impairment of both facial and prosodic emotion recognition ability.

Subjective emotional experience in PD. In contrast to their emotion recognition ability, the intensity with which PD patients report experiencing subjective emotion appears to be relatively preserved. Simons, Pasqualini, Reddy, & Wood (2004) and Smith, Smith, & Ellgring (1996) both used film stimuli to elicit emotion (amusement in Simons et al. (2004); happiness, sadness, fear, disgust and anger and neutral in Smith et al. (1996)) in patients with PD and healthy controls. After viewing the films, participants in both studies completed subjective rating scales that assessed the intensity with which they experienced specific categorical emotions. Both studies reported that PD subjects' self-reported intensity of emotional experience did not differ from that of the healthy controls. Vicente et al. (2011) similarly presented film stimuli to evoke happiness, anger, fear, sadness, disgust and a neutral state in PD and healthy subjects. Vicente and colleagues tested both patients with advanced PD as well as those in the early stages. Those with less advanced PD were tested both on and off of their dopaminergic medication. Intensity of subjective emotional experience did not differ between any of the PD groups and healthy controls, regardless of medicated state. This suggests that, despite the fact that regions of the brain thought to be responsible for subjective emotional experience, such as the orbitofrontal and anterior cingulate cortex, the amygdala, and the ventral striatum (Phan et al., 2002; Phillips, Drevets, Rauch, & Lane, 2003), are known to have significant dopaminergic innervation, it does not appear that a depletion of dopamine affects one's subjective experience of emotion in PD.

At first blush, claims by Bowers and colleagues (Bowers, Miller, Bosch, et al., 2006; Bowers, Miller, Mikos, et al., 2006) suggesting that PD patients exhibit a general "blunting" of emotional response might appear to conflict with accounts of preserved emotional experience. Bowers, Miller, Mikos et al. (2006) used random bursts of white noise to elicit startle eye-blink responses in participants during the presentation of images that were pleasant, unpleasant, or neutral in nature. They found that, relative to controls, PD patients had a significantly reduced amplitude of eyeblink response for unpleasant stimuli. However, researchers who have combined physiological measures of arousal with subjective reports of emotion have found that PD does not affect both measures equally. A study by Miller et al. (2009) reported finding reduced startle eye blink in PD patients relative to controls (using an experimental paradigm nearly identical to that of Bowers, Miller, Mikos et al., 2006, described above), yet observed that patients' subjective reports of emotional experience did not differ from that of the controls. Another study by Dietz, Bradley, Okun, & Bowers (2011) reported a similar dissociation between physiological and behavioral response in PD patients when they found no group differences in pupil dilation response to emotional stimuli, yet found that patients made fewer fixations and had shorter scan paths than healthy individuals. Dietz and colleagues proposed a unifying explanation for why some studies, such as that of Bowers, Miller, Mikos, et al. (2006), reported a blunted emotional response in PD while others found no change in emotional subjective experience: they suggest that PD patients may be experiencing peripheral autonomic dysfunction, not central hypoarousal deficits. In other words, they propose that emotional arousal is preserved in PD, it is only the physiological reaction to this arousal which is affected.

However, the relationship, on a neurological level, between physiological reactions and subjective emotional experience has yet to be clearly delineated. Located centrally within the limbic circuit of the basal ganglia (Hamani, Saint-Cyr, Fraser, Kaplitt, & Lozano, 2004), the subthalamic nucleus (STN) is thought to play a key role in integrating and synchronizing components of emotion processing (Mallet et al., 2007; Péron, Frühholz, Vérin, & Grandjean, 2013) that give rise to subjective emotional experience (Grandjean, Sander, & Scherer, 2008; Scherer, 2004). STN deep brain stimulation (DBS) is a procedure used to treat advanced PD symptoms (see meta-analysis by Kleiner-Fisman et al., 2006). By comparing pre- and post-operative patient performance on emotion-tasks, we can begin to understand the role this brain structure plays in integrating and evaluating emotional information. STN DBS has been associated with a variety of non-motor side-effects across the cognitive, emotional, and behavioral realms (see Volkmann, Daniels, & Witt, 2010 for a review), suggesting its central role in these processes. Several studies have reported impairments in emotional facial recognition following STN DBS (Dujardin et al., 2004; Péron et al., 2010; Schroeder, 2004). One study by Vicente et al. (2009) examined the relationship between STN and subjective emotional experience. Vicente and colleagues used film stimuli to elicit emotion in 13 pre-operative PD patients, 13 post-operative PD patients, and 16 healthy controls. They asked subjects to report, in a questionnaire format, the intensity of the emotions they were experiencing. Post-operative patients differed significantly from both the pre-operative group and controls by reporting that they experienced less of the target emotion, and more non-target emotions, for clips intended to evoke sadness and fear. Furthermore, the post-operative group reported feeling significantly less intense emotion than the control group for films designed to elicit fear and sadness. These findings provide evidence that subjective feeling and emotional arousal may be tied to STN activity. The underlying reasons for the discrepancy between preserved subjective emotional experience in PD and altered emotional experience after DBS remain unclear; further exploration into the relationship between the structural components required for the integration of emotionally-relevant cues and the neurotransmitters that facilitate communication between the various regions involved would provide valuable insight.

Emotional expression in PD. While intensity of emotional experience appears largely unaltered by PD, the same cannot be said for the expression of that emotion. The same groups of PD subjects who reported experiencing emotion as intensely as healthy controls in the studies by Smith et al. (1996) and Simons et al. (2004) exhibited significantly less spontaneous facial emotion in response to emotional film clips than controls when facial movements were assessed using Ekman and Friesen's (1978) Facial Affect Coding System (FACS). FACS enumerates all possible facial "action units" that result from facial movement. Such "action units" (AUs) indicate a muscular response component, such as brow furrowing or a cheek raise, and are considered the smallest visually discernible unit of facial movement (Vinciarelli, Pantic, & Bourlard, 2009). Several AUs together form a facial expression; as such, each AU is simply a motor unit of measurement, and is independent of social meaning. Even with the limitation that FACS do not represent full expressions, they are the most commonly-used unit of analysis for visual recognition of facial expressivity (Gunes, Piccardi, & Pantic, 2008).

Studies reporting less frequent and/or less intense expression of spontaneous facial emotion, on the basis of FACS analyses, for PD patients relative to healthy controls have been reported throughout the PD literature (e.g., Pitcairn et al., 1990; Simons, Ellgring, & Pasqualini, 2003). Additionally, a study by Mikos et al. (2009) found that PD patients are aware of this discrepancy between preserved intensity of emotional feeling and diminished expressivity. Mikos and colleagues had PD patients and healthy controls rate both the intensity with which they normally experienced emotions and their normal level of expressivity using the Berkeley Expressivity Questionnaire (BEQ; Gross & John, 1995, 1997). The same questionnaire was filled out by an informant who was a close friend or family member of the participant, to provide an independent measure against which to measure participants' self-report. Patients reported experiencing similarly intense emotion as controls, but reported expressing significantly less emotion than their healthy peers. These self-reports corresponded well with informants' reports, suggesting that PD patients were accurate in their perception of diminished emotional expressivity.

While the study by Mikos et al. (2009) addressed expressivity from a recollective, holistic standpoint, without distinguishing between spontaneous and posed expressions, studies that have specifically assessed PD patients' ability to voluntarily pose expressions have yielded inconsistent results. While some studies, such as Smith et al. (1996), report that posed expressions are not impaired by PD, the majority of studies report that volitional expressions are less intense and/or less identifiable in PD patients compared to healthy controls (Borod et al. 1990; Jacobs, Shuren, Bowers, & Heilman, 1995; Madeley, Ellis, & Mindham, 1995; Simons et al., 2004).

Bowers, Miller, Bosch, et al. (2006) offered a unifying explanation for differences in studies' reports of PD patients' volitional expressive ability by testing the hypothesis that posed expressions in PD may be affected on a scale too subtle to register using traditional standards of measurement. They proposed that posed expressions were affected by PD in much the same way other motor systems in the disease are, namely with a slowing of movement (bradykinesia) and less movement overall occurring relative to healthy individuals. To test this hypothesis, Bowers and colleagues videotaped PD patients and controls as they posed emotional expressions. Then Bowers et al. (2006) used a novel computer imaging technique to quantify facial movement. Unlike FACS, which relies upon facial muscle action units as the basis for a quantitative analysis of expressivity, the technique utilized by Bowers et al. (2006) defined facial movement based on changes in light that were analyzed at the pixel level. This technique allowed for an identification of both the amount of movement as well as the time course required to reach peak expression. They found support for their hypothesis, as PD patients were significantly slower than controls to reach peak expression and PD patients exhibited less movement overall than healthy controls for posed emotional facial expressions. Their finding highlights the need for studies that (a) are able to more sensitively index disease-related changes and/or that (b) focus on how the disease affects patients on an interactional level, instead of on a unit of analysis, such as the action unit of the FACS, that may not be perceptible on a level that matters in patients' daily lives.

The fact that when facial expression of PD patients was examined from a holistic, interpersonal level, both patients and their social partners perceived a reduction in expressivity (Mikos et al., 2009) suggests that PD interferes with the ability to communicate one's experience to others. Such emotional expressive difficulties span facial and vocal modalities; studies exploring emotional vocal production abilities in patients with PD have indicated that the disease results in a less intense or "flattened" speech affect (Caekebeke et al., 1991; Blonder et al., 1989; Pell et al., 2006). Prosodic emotional expressions produced by PD patients are less accurately perceived by listeners than those produced by healthy controls (Pell et al., 2006), which suggests that the emotion experienced by PD patients may be lost on social partners who are not aware that patients' emotional expression may be less robustly expressed as a result of the disease, despite the intensity of patients' emotional experience being undiminished.

Communication and social challenges. Communication challenges in PD are not limited to the emotional realm; studies by Miller and colleagues show that patients' communication challenges range from a deterioration in speech intelligibility and increased difficulty conveying their intended message to others, to feeling self-conscious and talked-over, which affects their feelings of self-worth (Miller, Noble, Jones, Allcock, & Burn, 2008; Miller et al., 2006; Miller et al., 2007). Patients also reported struggling with decreased attention spans, difficulty finding words and trouble with formulating ideas (Miller et al., 2006). These cognitive challenges not only affect patients' ability to communicate on the most basic level (e.g., formulating words, remembering what one wanted to say), but also interfere with higher-level aspects of communication (Berg et al., 2003), such as the ability to infer what a conversation partner is thinking and feeling, and to be able to respond in an appropriate manner. Such aspects of communication fall under the realm of "pragmatics", the study of how meaning is formed and inferred through language (Mengelberg & Siegert, 2003; Prutting & Kirchner, 1987).

Pragmatics concerns the use of verbal behavior (such as conversational turn-taking, the ability to select a topic of conversation and maintain it appropriately) paralinguistic cues (speech intelligibility, fluency, prosody, and vocal quality), and nonverbal cues (facial expression, gesture, eye gaze, and physical proximity) that give rise to meaning during social interactions (Prutting & Kirchner, 1987). There is a growing body of evidence suggesting that PD patients' pragmatic communication abilities may be significantly compromised, including their ability to comprehend non-literal speech, such as irony, metaphor and sarcasm, and the ability to infer another person's thoughts or beliefs (Freedman & Stuss, 2011; McNamara & Durso, 2003; Mengelberg & Siegert, 2003; Monetta et al., 2009; Monetta & Pell, 2007; Poletti, Enrici, Bonuccelli, & Adenzato, 2011).

Surprisingly few studies have examined social communication challenges in PD at a conversation-scale level. However, one recent study by Griffiths et al. (2012) did make an attempt; on the basis of reports from patients citing conversational overlap as a main source of communication difficulty, Griffiths et al. (2012) evaluated this one aspect of social communication using conversational analysis. Conversational analysis involves videotaping interactions that are then transcribed in detail, noting such details as periods of talk and silence, gesture, body language, prosody, eye gaze, and overlap in speech between partners (see Sidnell (2010) for a comprehensive introduction). Griffiths and colleagues suggested that PD patients' perceptions of being "talked over" in their daily interactions likely stemmed from having fewer communicative resources at their disposal (e.g., the ability to alter speech volume, speech rate, and pitch) with which to make themselves heard when normal overlap occurs. The authors suspected that patients' difficulty initiating speech and their reduced cognitive processing abilities (not explicitly assessed in the study, but presumably inferred by pauses in PD patients' speech) further hampered their ability to manage conversational overlap effectively. While this work is a promising first step towards identifying the factors that contribute to social communication ability in PD, it is important to note the limitations of that study's experimental method. First, conversational analysis (CA) involves qualitative, subject-specific analysis. Due to the time-demanding nature of CA, studies that employ it necessarily focus on only a few individuals at a time. This limits sample sizes and therefore the extent to which findings can be extrapolated. No quantitative tool currently exists with which to assess everyday conversations between PD patients and their significant others (Forsgren, Antonsson, & Saldert, 2013). However, Forsgren et al. (2013) note that there is a real need for valid quantitative outcome measures because there is such complexity in natural conversations that small changes, too subtle to be meaningfully analyzed, may still hold significance on an interpersonal level. The goal of the current study was to gain an understanding of *which* changes, brought on by PD, are contributing to the negative social perceptions patients with PD face.

To summarize: at present, we know that the social challenges PD patients face are formidable. Interactions on an interpersonal level are compromised by many aspects of the disease, ranging from limited mobility causing increased dependence on others, which spurs feelings of shame and worries of being a burden (Brod et al., 1998; Solimeo, 2008), to the abovementioned difficulty reading others accurately (Clark, Neargarder, & Cronin-Golomb, 2008; Kawamura & Koyama, 2007; Mengelberg & Siegert, 2003; Monetta et al., 2009), to trouble expressing themselves in a voice that is clear and loud enough to be heard (Fox & Ramig, 1996; Furtado et al., 2012; Illes, Metter, Hanson, & Iritani, 1988; Miller et al., 2007). On an emotional level, studies have shown that patients' subjective experience is often not communicated to others in a manner that preserves the intensity of patients' experience (Mikos et al., 2009; Simons et al., 2004). Even those closest to patients, such as their caregivers and close friends, when asked about the patients' experience of symptoms or their emotional reality and quality of life, provide reports that differ significantly from the patient's own (Fleming, Cook, Nelson, & Lai, 2005; Khlebtovsky et al., 2012; Martínez- Martín et al., 2004; Sitek, Soltan, Wieczorek, Robowski, & Slawek, 2010).

All of these communication challenges likely contribute to the widespread reports of PD patients' social isolation (Brod et al., 1998; Dakof & Mendelsohn, 1989; Singer, 1973), however it is unclear to what extent this isolation is due to patients' own choice to withdraw from social situations that have become more challenging to navigate, versus how often the isolation occurs as a result of decisions made by their social partners. While studies have shown that PD makes talking more effortful than before, PD patients also report that the way social partners respond to them is different than before (Miller et al., 2006; Solimeo, 2008). Patients' subjective perceptions of these social changes are corroborated by evidence suggesting that young adults and even trained healthcare professionals do, in fact, tend to rate PD patients negatively across a wide range of social attributes (Jaywant & Pell, 2010; Pentland, Pitcairn, Gray, & Riddle, 1987; Pitcairn, Clemie, Gray, & Pentland, 1990; Tickle-Degnen & Lyons, 2004). PD Patients are rated less friendly, less engaged, less interested, and less happy than healthy individuals, across both facial cue-only, vocal cue-only, and combined audiovisual cue studies (Jaywant & Pell, 2010; Pentland, Pitcairn, Gray, & Riddle, 1987; Pitcairn, Clemie, Gray, & Pentland, 1990; Tickle-Degnen & Lyons, 2004). These negative perceptions are far-reaching, such that measures of patients' personality characteristics are even misperceived. For example, studies by Pentland et al. (1987) and Pitcairn et al. (1990) demonstrated that PD patients were judged to be more introverted, more anxious and less likeable than patients with a non-neurological illness, despite the two groups performing similarly on standard, self-report measures of personality.

However, some studies do point to evidence that PD may have an effect on personality characteristics, although the degree to which such personality changes are pre- versus postmorbid are highly debated because most exploration into the Parkinsonian personality has taken place retrospectively (Isihara & Brayne, 2006; Glosser et al., 1995; Koerts, Tucha, Leenders, & Tucha, 2013; Mendelsohn, Dakof, & Skaf, 1995). Numerous studies have described a "Parkinsonian personality" type marked by low novelty seeking, high harm avoidance and attributes such as being rigid, controlled, cautious, slow-tempered, anhedonic, industrious, frugal, conscientious and trustworthy (see Ishihara & Brayne (2006); Menza (2000), & Todes & Lees (1985) for review articles). One study by Glosser et al. (1995) attempted to address the question of whether the personality characteristics associated with PD were, in fact, disease-specific by asking patients with PD, patients with probable Alzheimer's Disease (AD), and patients with non-neurological chronic illnesses (rheumatoid arthritis and osteoporosis) to rate their personality (using the NEO Personality Inventory; Costa & McCrae, 1985) twice; once for how they currently were, and once for how they were "in [their] 30's". Close friends of the PD and AD participants were asked to fill out parallel forms as a more objective measure of potential personality change. The authors found good concordance between patients' self-reports and friends' reports, which showed that both the AD and PD groups exhibited a similar set of personality changes brought about by neurological illness. These personality changes included becoming more introverted, less exploratory or curious, less organized, less disciplined, and less emotionally well adjusted. They did not find evidence for a pre-morbid PD personality. This suggests that the personality type observed for PD patients may well be a result of the increased physical and psychological demands of living with a neurodegenerative illness.

While we would expect certain personality traits to be affected by the motor, cognitive, and communicative challenges of PD, it appears that personality features that patients self-report may be misunderstood by those around them. Tickle-Degnen and Lyons (2004) reported that both expert and novice healthcare workers in the fields of physical therapy, occupational therapy, medicine, and speech language pathology, were largely inaccurate at judging personality traits of PD patients from video recorded interviews. The authors noted that raters' perceptions of patients' conscientiousness was most accurate (as defined by comparison to patient's own self-report) while accurate judgments of extraversion were poor. While the study by Glosser et al. (1995) noted that PD patients were more introverted than the healthy control and non-neurological medical control group, it is important to note that in the study by Tickle-Degnen and Lyons (2004), the focus was not on personality differences between groups but rather the degree to which participants' self-reports corresponded with raters' perceptions.

Differences in raters' accuracy at perceiving participants' self-reported personality in the study by Tickle-Degnen and Lyons (2004) could be explained by the cues used to infer respective personality characteristics. Conscientiousness, according to post-experiment interviews conducted by Tickle-Degnen and Lyons (2004), was judged primarily from the content of the dialogue. Apart from the presence of additional pauses and changes in prosodic characteristics of speech, such as pitch range and volume (Blonder, Gur, & Gur, 1989; Cheang & Pell, 2007; Monetta, Cheang, & Pell, 2008; Pell, Cheang, & Leonard, 2006), PD does not appear to affect raters' perception of the content of patients' speech (Jaywant & Pell, 2010). As such, it is not surprising that individuals' levels of conscientiousness could still be accurately ascertained. However, extraversion is judged on the basis of expressive and affective cues, which are diminished in PD due to patients' faces becoming less expressive and taking on a fixed "mask"-like appearance (Hemmesch, Tickle-Degnen, & Zebrowitz, 2009; Mikos et al., 2009). Neuroticism, in contrast, is considered one of the most difficult personality traits to infer accurately in healthy adults (Borkenau & Liebler, 1992), largely because healthy adults will attempt to hide their neuroticism as it involves negativity (Magnus, Diener, Fujita, & Pavot, 1993), and the expression of negative affect is generally not considered to be socially desirable (DePaulo, 1992). Neuroticism is conveyed primarily through nonverbal cues, such as subtle facial activity and fidgeting (Tickle-Degnen & Lyons, 2004). If raters are able to accurately perceive PD patients' neuroticism, this could suggest that PD impairs individuals' ability to consciously regulate their self-presentation.

While the same neural circuitry impacted by PD is thought to be responsible for impulse control (Beauregard, 2007; Salgado-Pineda, Delaveau, Blin, & Nieoullon, 2005; Volkmann et al., 2010), to the best of our knowledge no studies have yet investigated how PD may influence individuals' ability to control the expression of emotions that are socially undesirable. Facial masking dampens the presentation of spontaneous facial emotion in PD patients, reducing the ability for patients to display the positive emotion they experience (Tickle-Degnen & Lyons, 2004). While some studies have indicated that the ability to volitionally pose an emotion is preserved in PD (e.g., Smith et al., 1996), others, such as Borod et al. (1990) noted no difference in intensity of posed expression between controls and PD patients, but reported a decrease in raters' accuracy at perceiving the target emotion on the faces of PD patients. Still other studies found that PD patients were impaired in their ability to mask a negative response with a positive one, as might be needed in order to be polite in social scenarios (Simons et al., 2003). Taken together, it is unsurprising that PD patients are rated more negatively than healthy controls given the combination of decreased ability to display positive affect and difficulty controlling the expression of negative affect that they demonstrate.

Empathy and PD. In exploring the relationship between emotional processing in patients with PD and how they are perceived by their healthy age-peers, interactional aspects of emotion processing, such as empathic ability, may factor into resulting social impressions. It is currently unclear how PD affects patients' empathic ability. Empathy is a complex concept that is defined differently by different authors (see Batson, 2009 for a review). Perhaps the most common definition of empathy, upon which the most current assessments of empathy are based, relies upon a distinction between cognitive empathy and affective empathy (Davis, 1983; Mehrabian, Young, & Sato, 1988; Shamay-Tsoory, Aharon-Peretz, & Perry, 2009). Cognitive empathy is akin to theory of mind (ToM) and involves being able to make a cognitive appraisal of another's state, and understand how another person would think, feel or behave in a given situation (Poletti et al., 2011; Premack & Woodruff, 1978). Affective (also called "emotional") empathy, on the other hand, involves one person having an emotional response to the affective display they observe another person experiencing. Recent evidence from brain imaging studies has suggested that cognitive and affective empathy are neurologically distinct processes (Shamay-Tsoory et al., 2009; Singer, 2006; Vollm et al., 2006), which lends credence to this dual-definition of empathy. For the purposes of this study, "empathy" will refer to the abovementioned, multidimensional definition. In other words, we define an "empathic response" as one that involves adopting the perspectives of other people *and* having an emotional reaction to the experiences of others.

Some argue that empathic ability requires the ability, on an unconscious, automatic level, to mimic the expressions we see in others in order to induce an empathic response in ourselves (see Decety, 2011 and Gallese, 2003 for reviews). Yet studies exploring empathic ability in various populations with impaired motor or neurological abilities have yielded conflicting results. Studies by Danziger and colleagues explored how patients with congenital insensitivity to pain (CIP), who are largely unable to experience stimulus-induced pain, performed relative to healthy controls on measures of empathy. Danziger, Prkachin, & Willer (2006) asked patients with CIP to perform a variety of tasks assessing their ability to experience pain and observe it in others. While CIP patients differed from control subjects in their ability to differentiate hypothetical painful situations from non-painful situations, they did not differ from controls in their ability to estimate others' pain in hypothetical scenarios. CIP patients performed similarly to controls when judging others' pain from facial expressions, and displayed no significant difference in emotional empathy as determined from the Balanced Emotional Empathy Scale (BEES; Mehrabian & Epstein, 1972). A later study by Danziger, Faillenot, & Peyron (2009) explored the brain responses of patients with CIP in an fMRI study that required subjects to observe pictures of body parts in painful situations and facial expressions of pain while in the scanner. They found that the CIP patients displayed normal fMRI responses to pain, providing evidence that the ability to perceive another's distress does not necessarily rely on the ability to experience pain first-hand.

In contrast, Chauhan et al. (2008) found that patients with primary autonomic failure, which consists of deficits in motor, cerebellar, autonomic, sympathetic and parasympathetic systems, were significantly empathically impaired (as determined by scores on the BEES test (Mehrabian & Epstein, 1972)). Additionally, a study by Cummins, Piek, & Dyck (2005) found that children with motor coordination problems had significant empathic deficits. Cummins et al. (2005) used an empathy test, the Emotion Recognition Scales (ERS) (Dyck, Ferguson, & Shochet, 2001; Dyck, Farrugia, Shochet, & Holmes-Brown, 2004; Dyck, 2012), which consisted of a set of tasks examining participants' ability to accurately recognize both static and fluid emotional facial expressions, as well as their ability to comprehend emotion (based on an emotion-vocabulary test, a comprehension test, and an unexpected outcomes test). The authors reported that while children with motor coordination disorders performed no differently than unimpaired kids in terms of being able to conceptually understand emotion, children with motor impairments were both slower and less accurate than controls in recognizing facial emotion. These results suggest that emotion recognition and emotion understanding may reflect differentiable aspects of social cognition (Cutting & Dunn, 1999).

Cummins et al. (2005)'s claim that emotion recognition ability is dissociable from emotion understanding may lead us to question reports from other authors indicating that patient populations impaired in their ability to recognize and express emotion are not empathically impaired, particularly if the studies have relied exclusively upon empathy tests which assess emotion understanding. One such example is a study by Trinkler, De Langavant, & Bachoud-Levi (2013) that explored the connection between emotion recognition, emotion expression, and empathic ability in 13 patients with Huntington's disease (HD) and 13 age-matched healthy controls. Trinkler et al. (2013) used the self-report Interpersonal Reactivity Index (IRI) empathy scales (Davis, 1980; Davis, 1983), which requires participants to answer yes or no questions about how they would feel in hypothetical situations which assess respondents' tendencies to adopt the perspectives of others and experience emotional reactions to others' situations, the self-report BEES empathy scale (Mehrabian & Epstein, 1972), as well as a short story and set of questions they developed in-house to test participants' ability to infer others' feelings or beliefs. Additionally, Trinkler et al. (2013) employed a self-report test of the ability to recognize one's own emotions ("alexithymia" assessed using the Toronto Alexithymia Scale-20 (TAS20), Taylor, Bagby, & Parker (1997)) as well as tests of emotion recognition and emotion expression.

The authors reported that although HD patients were significantly impaired at both emotion recognition and emotion expression, their performance on the empathy and alexithymia scales was not significantly different from that of healthy controls.

While such understanding of feelings in self and other may be able to be labeled as "intact" based on conceptual tests of emotion vocabulary and hypothetical situations involving empathy, the true test of whether or not a person is empathically impaired would be evident in social outcomes. The study by Cummins et al. (2005), in addition to the ERS task, included a questionnaire which assessed social functioning in children (the Child Behavior Checklist (CBCL); Achenbach, 1991) and indeed found that the greater the child's motor impairment, the greater their social problems. The potential for a link between motor abilities and social outcome measures suggests that empathic ability, defined as the ability to adopt the perspectives of others and experience emotional responses to others' challenging situations, should be examined for PD patients as well.

In considering factors that may contribute to PD patients' social communication ability, it is relevant to examine how the disease may affect empathic ability. To the best of our knowledge, only one study to date has assessed whether empathic aptitude is affected in PD. Narme et al. (2013) used a battery of tests to assess emotional processing and social cognition in patients with PD. They used Davis (1980)'s Interpersonal Reactivity Index (IRI) to measure patient empathy; however, they had caregivers fill it out on behalf of the patient instead of having the patient fill it out themselves. These proxy scores were then compared with healthy control subjects' self-report IRI scores. In light of evidence that PD patients and their caregivers' reports do not always converge (Khlebtovsky et al., 2012; Martínez- Martín et al., 2004), even on such objective measures as exercise frequency (Fleming et al., 2005), it seems necessary to gather self-report IRI data for PD patients. When Narme and colleagues had caregivers complete the IRI for the PD group, but controls complete the IRI for themselves, the authors found a significant decline in empathy in the patient population. However, in order to control for the difference between self- and other-report of such subjective measures, it would have been necessary for the authors to have individuals who knew the healthy controls serve as comparable "proxies" in completing controls' IRI forms as well. As it stands, it is still unclear to what degree PD affects empathic ability.

PD patient-proxy agreement. As mentioned above, studies that have assessed PD patient-proxy agreement on subjective measures (such as self-reported health-related quality of life variables) have shown that PD patients' and caregivers' reports do *not* consistently converge (Fleming et al., 2005; Khlebtovsky et al., 2012; Martínez- Martín et al., 2004; Sitek et al., 2010). Most notably, the more severe the disease status, the more patient and caregiver's reports diverge (Martinez-Martin et al, 2004; Sitek et al., 2010). PD Patients with depression were also less accurately perceived by caregivers who filled out subjective report questionnaires, with patients reporting greater prevalence of symptoms than caregivers had appreciated (Sitek et al., 2010). While these findings should bear on future research's methodological considerations by highlighting the necessity for patient self-report over proxy-report whenever possible, these results also serve to provide further evidence that PD patients have difficulty accurately conveying their experience to others. This study seeks to identify where these interpersonal gaps in the communication of emotional experience occur.

Summary. It is clear that PD interferes with the ability to accurately and effectively communicate one's emotional experience to others. While the intensity of patients' subjective emotional experience appears preserved, the physiological response to this arousal is diminished. This difference between experience and expression may be contributing to the social challenges PD patients experience; however, it is currently unclear how these changes in emotional expressivity contribute to social impression formation by healthy age peers. The goal of this dissertation is to identify, in the same cohort of PD and healthy control subjects, how subjective emotional experience relates to emotional facial expressivity, and how these factors may differentially contribute to age-peers' social impressions of the subjects. Our hope is that, by better understanding the relationship between disease-related changes in expressivity and their social ramifications, we can begin to develop options for reducing the social costs of PD.

Study 1

Eliciting emotion in older adults & clinical populations: Development of a film database

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Abstract

Although several film databases have been created to elicit emotion in young adults, to the best of our knowledge, no such stimuli have been developed and validated to reliably elicit emotion in older adults. Older adults have different physiological and cognitive responses to emotional stimuli than younger adults do, which necessitates the development of age-appropriate elicitation stimuli for studies assessing emotional response in healthy adults, and clinical populations, over the age of 50. From a candidate set of 24 film clips, we selected 11 stimuli that were: (1) uniformly short in duration (1:05 minutes to 2:05 minutes), (2) balanced in terms of valence, with an equal number of positive and negative emotion film clip items, (3) able to reliably elicit one of the target emotions (happiness, tenderness, sadness and fear, plus a "neutral" unemotional response category) more strongly than all other emotions, (4) able to elicit an emotion that is moderate to strong in intensity (4 or greater on a scale from 0-6). The selected film stimuli provide preliminary evidence of being able to reliably elicit the target emotions in a pilot study of 10 healthy older adults between the ages of 50-80.

Introduction

In recent years, researchers have raised concerns over traditionally-used methods for evoking emotion, citing the need to use stimuli which more closely mimic real-life situations (Arsalidou, Morris, & Taylor, 2011; Yoshikawa & Sato, 2006). In response, several databases of film stimuli have been developed and, in several cases, extensively validated to provide tools for reliably eliciting target emotions in the testing room. These include, among others, emotional film databases by Philippot (1993), Gross & Levenson (1995) and, more recently, by Schaefer et al. (2009) and Carvalho, Leite, Galdo-Álvarez, & Gonçalves (2012). However, all of these databases were validated using exclusively undergraduate-aged populations. There is reason to believe that film clips that arouse distinct emotions in younger audiences are not necessarily going to evoke the same emotional response in older adults.

Older adults have been shown to experience emotion differently than young adults, both on physiological as well as cognitive levels (Carstensen, Pasupathi, Mayr, & Nesselroade, 2000; Levenson, Carstensen, Friesen, & Ekman, 1991; Scheibe & Blanchard-Fields, 2009; Tsai, Levenson, & Carstensen, 2000). In two studies which assessed physiological arousal in response to emotional stimuli (in the form of cardiovascular response, in the case of Tsai et al., 2000 and in the form of heart rate, skin conductance, finger temperature and overall somatic movement in the study by Levenson et al., 1991), the magnitude of physiological response was significantly lower in older adults as compared to young adults. In keeping with this physiological shift, researchers have shown that older adults experience significant gains in emotion regulation ability not seen in young adults (Gross et al., 1997; Urry & Gross, 2010). Despite evidence of dampened physiological responses, older adults do not appear to differ from young adults in their self-reported intensity of emotional experience (Levenson et al., 1991; Tsai et al., 2000). It may be that age-related changes in emotion processing extend beyond what can be attributed to cognitive decline (Mitchell, 2007; Orbelo, Grim, Talbott, & Ross, 2005; Sullivan & Ruffman, 2004). Instead, emotion cognition itself may be altered by life experience.

While emotion processing studies have reported a general decline in emotion recognition accuracy in older, as compared to younger, populations (see meta-analysis by Ruffman, Henry, Livingstone, & Phillips, 2008), studies that have more closely examined the nature of this decline have revealed that it may not be a result of age-related degeneration so much as a qualitative shift in how emotion is perceived. A study by Montepare, Koff, Zaitchik, & Albert (1999) compared older and younger adults' performance on decoding emotion through body movement and gesture. Montepare et al. (1999) found that when older adults made errors, they tended to misinterpret an emotional gesture as neutral. While the authors propose several theories for this neutral error trend (including the possibility that older adults are simply more cautious than their younger counterparts, and thus were being conservative in their decision about what constituted an emotion), Carstensen et al. (2000) suggests that older adults actually experience more complex mixes of emotion, with less distinctly independent positive and negative emotions than is experienced in young adults. Carstensen et al. (2000) had 184 participants, ranging in age from 18-94, record their emotions over the course of one week. The authors found that relative to the young adults, older participants reported more complex mental representations of emotion, in addition to better emotion regulation. As a result, Carstensen and colleagues suggest that more dimensions are needed in order to characterize older adults' emotional experience, relative to younger adults'.

Lima, Alves, Scott, & Castro (2014) provided corroborating evidence for increased complexity of emotional experience in older adults in a study that explored how emotional vocalizations were perceived in 43 older (*M* age= 61.4 years) and 43 younger (*M* age = 22 years) adults. By employing a multidimensional, instead of a forced-choice, rating task, Lima and colleagues were able to examine the distribution of responses in a manner where target and non-target responses were independent. As was reported in other studies, including Paulmann, Pell, & Kotz (2008), Montepare et al. (1999), and the meta-analysis by Ruffman et al. (2008), Lima et al. (2014) found that older adults had lower overall scores on target emotion recognition than did young adults. However, when the authors examined the pattern of the errors, they discovered that older adults had reported perceiving higher levels of emotions that were related in nature (either acoustically or emotionally) to the target. Similarly to Carstensen et al. (2000), Lima and colleagues hypothesized that, as we age, boundaries between emotion categories may become less distinct. Regardless of the exact nature of age-related emotional processing changes, the literature consistently shows that there *is* a measurable difference between how older and younger adults make sense of emotional stimuli. In order to explore the specific nature of emotion processing in older adults, it seems necessary to develop stimuli specifically designed for, and validated in, this target population.

There are many clinical populations composed primarily of older adults, including patients with Parkinson's disease, Alzheimer's disease, stroke-induced aphasia, and dementia, to name only a few. In order to assess how these conditions affect emotion processing, researchers have had to rely upon emotion elicitation stimuli that were only known to be effective in eliciting strong emotion in young healthy adults. As a result, what we know about emotion processing in older adults may not be wholly accurate; this would be akin to basing everything we know about boys' emotion processing on showing them a set of films designed to elicit emotion in girls, whose gender (like those of younger adults as compared to older adults) is known to experience and emote more intense emotion (e.g., Grossman & Wood, 1993; Hall, 1998; LaFrance, Hecht, & Paluck, 2003). By developing a set of film stimuli that can reliably evoke moderate to strong emotion in a population of older adults, we can ascertain, in greater detail, the subtle ways in which emotion may be affected by aging. The goal of the present study was to develop a set of film stimuli that are: (1) uniformly short in duration, in order to minimize testing duration and eliminate potential confounds for those with cognitive deficits such as working memory; (2) balanced in terms of number of films per valence (positive/negative); (3) able to reliably elicit a range of target emotions; (4) able to elicit a moderate to intense emotional reaction in an audience of older adults.

Emotional Stimuli: Features and Considerations

While multiple theories on the nature and processing of emotions currently exist, the debate about how to characterize emotion has historically followed one of two main approaches: a "categorical perspective" or a "dimensional" theory of emotion processing. The discrete or "categorical perspective" of emotions (e.g., Ekman, 1992; Etcoff & Magee, 1992) propose that there are a set of "basic emotions" which have neurobiological substrates that are evolutionarily old, and have an accompanying feeling component and expressive, behavioral actions (Izard, 2007). Categorical theorists hold that emotions must occur unbidden with a rapid onset, have a brief duration, and result in a distinctive subjective experience (Ekman, 1992). In contrast, "dimensional perspective" theorists (e.g., Feldman Barrett (1998) and Russell (1980) suggest that emotion consists of two primary dimensions: its valence (pleasant/unpleasant) and level of arousal (low-activation/intensity to high activation/intensity). While the two theories are not mutually exclusive, each highlights and prioritizes different aspects of the emotional experience.

In developing the current database of emotion elicitation materials, we followed a categorical approach, while accepting that discrete emotions vary in intrinsic valence and arousal level.

There has traditionally been an underrepresentation of positive emotions in the literature on emotion processing (Lima et al., 2014; Sauter & Scott, 2007; Shiota, Neufeld, Yeung, Moser, & Perea, 2011). Of the five "basic emotions" (anger, enjoyment/happiness, fear, disgust, and sadness; Ekman, 1992), only *one* is positive in valence. While it is possible that this disparity between the number of positive and negative emotions is reflective of our biological needs (i.e., it may be more necessary to differentiate between negative valence emotions as they signal threats to our survival, unlike with positive emotions), this imbalance may skew our understanding of emotion processing in experimental settings. Most of what we know about processing positive emotions may be an artifact of the contrast between Happiness and all other negative emotions and their respective properties. In selecting stimuli for the current film database, our goal was to provide elicitation stimuli that would be balanced in terms of the number of exemplars per valence category. We chose to select two negative emotions (sadness and fear) for the current database, and two positive emotion categories (happiness and tenderness), plus a neutral affect.

In deciding which two negative emotions to select, we considered the social function of different negative emotions for older adults. We chose to focus on fear and sadness due to these emotions' adaptive social functions. While anger and disgust are associated with social withdrawal and aversion (Curtis, de Barra, & Aunger, 2011; Marsh, 2000; Olatunji & Sawchuk, 2005), fear and sadness evoke social approach and support responses (Buss & Kiel, 2004; Marsh, Ambady, & Kleck, 2005). Older adults are known to prune their social networks as they age (Carstensen, Isaacowitz, & Charles, 1999), relying on fewer individuals to satisfy their needs for social support. As a result, emotions that facilitate social support seem particularly crucial to the well-being of our target population, and thus were selected for inclusion in our database.

While happiness (also referred to in the literature as "amusement" or "joy"), is commonly tested in emotion research as the one positive valence emotion, we sought to include a second positive emotion in order to provide a balanced number of items per valence category. Tenderness, like happiness, is pleasant and positive, however it contains something more: it is characterized by an impulse towards caregiving behavior, a sense of feeling protective and valuing the welfare of the object of emotion (Kalawski, 2010). It is distinguished from love, which Ekman (1992) classified as an "emotional attitude" that was more sustained than an emotion and involved more than one emotion. Instead, tenderness is very specific and of an emotion-appropriate duration: it refers specifically to the emotional surge accompanying caregiving love (Kalawski, 2010). While tenderness is not considered one of the "basic" emotions, some argue that it *should* be, as new evidence suggests that tenderness meets the criteria established by Ekman (1992) that a basic emotion has both an autonomic response and an expressive component that is emotion-specific (Kalawski, 2010; Shiota et al., 2011). Bloch and colleagues reported finding a set of physiological responses distinct to tenderness which included decreased heart rate, slow and even breathing, a pause following exhalation, a sideways head tilt, a slight smile, and an object-directed gaze (Bloch, Lemeignan, & Aguilera, 1991; Bloch, Orthous, & Santibanezh, 1987; Santibanez & Bloch, 1986). Kalawski (2010) conducted an experiment assessing whether tenderness was distinct from happiness (or "joy/amusement" in his experiment) by showing different film clips and asking subjects to rate the emotion and intensity of felt emotion along four emotional scales: anger, sadness, joy/amusement and tenderness. Results showed that some of the films elicited tenderness without joy, some tenderness with joy, and some joy without tenderness (Kalawski, 2010). This differentiation suggests that tenderness is an emotion that is indeed distinct from that of amusement/happiness/joy. By developing a database that is balanced in its positive and negative valence emotion items, we hope to gain a more comprehensive understanding of how the valence of stimuli affects emotion processing in older adults. Furthermore, this database was intended to be useful in assessing older adult patient populations that may have systematic biases for processing negative versus positive emotions (e.g., Calder, Keane, Manes, Antoun, & Young (2000) regarding populations with brain injury; Dara, Monetta, & Pell (2008) and Gray & Tickle-Degnen (2010) regarding Parkinson's disease patients; Fernandez-Duque & Black (2005) regarding patients with dementia; Johnson et al. (2007) regarding patients with Huntington's disease). As a result, we decided it was best to create materials that offered equal numbers of each exemplar type.

Film Stimuli As Emotion Elicitation Tools

The ability to elicit emotional affect in a laboratory setting is still a relatively new approach, with Polivy, in a 1981 review article, expressing concern about whether it would even be possible to reliably elicit discrete emotions for experimental purposes. Since then, emotion researchers have made great strides towards demonstrating that film clips can not only elicit strong, discrete emotion, but may offer many advantages over other methods of emotion elicitation due to the medium's ecological validity (Gross & Levenson, 1995; Rottenberg, Ray, & Gross, 2007). Music has been shown to be a powerful tool for eliciting emotion (Juslin & Laukka, 2004; Juslin & Västfjäll, 2008; Scherer & Zentner, 2001), which makes it beneficial to include film clips with musical soundtracks to evoke strong emotion in an experimental setting. Furthermore, neuroimaging studies that have compared dynamic visual or audiovisual stimuli with static imagery or unimodal stimuli have shown that dynamic visual or audiovisual stimuli evoke significantly greater brain activation than static or uni-modal elicitation material (Arsalidou et al., 2011; Robins, Hunyadi, & Schultz, 2009; Yoshikawa & Sato, 2006). Additionally, dynamic visual stimuli have been shown to elicit a spontaneous facial mimicry response in viewers (Sato & Yoshikawa, 2007; Yoshikawa & Sato, 2006). From an ecological perspective, film stimuli are superior to static or uni-modal stimuli because they more closely resemble the type of real-world encounters that elicit emotion in daily life (Gross & Levenson, 1995).

Currently, several validated databases exist to elicit emotion from researchers who hold both categorical and dimensional perspectives about the structure of emotion (see Gross & Levenson, 1995 and Philippot, 1993 for the former, Carvalho, Leite, Galdo-Álvarez, & Gonçalves, 2012 for the latter). An exhaustively validated, open-source film database for emotional elicitation was produced by Schaefer, Nils, Sanchez, & Philippot (2010). The films in this database were selected on the recommendation of 50 film rental store managers (considered to be "film experts"), who proposed memorable scenes from blockbuster movies such as *Schindler's List, The Shining, Forrest Gump, When Harry Met Sally*, etc. The film experts were asked to complete a questionnaire in which they recalled, described, and rated the emotional arousal of three film scenes per emotional category (amusement, tenderness, neutral, sadness, fear, anger, disgust). From an initial candidate set of 824 film clips, 10 film clips per emotion category were selected on the basis of how many film experts agreed (based on their questionnaire report) on the emotion that the film evoked, as well as how intensely the film experts rated each film clip (with more intense films being selected for inclusion). The films ranged in length from one to seven minutes, were dubbed in French, and included the original music soundtrack. They were validated on 364 undergraduate students (mean age = 19.6 years) who viewed the films in groups of three to five people. While not suited for our study, which was in English, the methodological concerns of Schaefer et al. (2010) served as the basis for the development of our own database.

The Current Study

The goal of this project was to develop a set of film stimuli that can reliably elicit a target emotion in an audience of adults between the ages of 50-80. The database is balanced in terms of number of positive and negative valence items, and includes a neutral affect category. Film clips were designed to be uniformly short in duration, produce high recognition rates in the target emotion, and have the ability to elicit moderate to high intensity emotion (i.e., 4 or greater on a scale of 0-6). Finally, the selected film clips needed to elicit a "pure" emotion, with no more than half the participants reporting experiencing a secondary emotion during the film clip. By constructing a set of film stimuli that are well-validated in an older adult population, we hope to provide an open-source research tool that can further our understanding of how both healthy and clinical populations above the age of 50 experience and process emotion.

Methods

Stimuli Development

Inspired by the stimuli constructed by Schaefer et al. (2010), we developed a new set of film stimuli that could reliably evoke positive (happy, tender) and negative (sad, fear) emotion in English-speaking older adults, as well as three film clips that could serve as "neutral", non-emotional stimuli. We additionally sought to select films that, despite being short, would contain sufficient narrative for participants to be able to retell what took place in the scene, and therefore provide options for eliciting samples of vocal emotion. To source film clips which met our selection criteria, we conducted an exhaustive survey of published and unpublished work on emotion elicitation using dynamic video stimuli. Additionally, we consulted social media compilations of emotional film clips, and carefully examined additional footage from films known for their ability to evoke strong emotion in a naturalistic manner (e.g., those already within the validated Schaefer et al. (2010) database, and classics known for their ability to elicit strong emotion).

The results of this search yielded a set of 29 film clips, all of which were between 42 seconds and 2.5 minutes in length. These films were screened before an audience of 13 volunteers, ranging in age from 20 to 45, who were asked to report, in written form, the main basic emotion (anger, disgust, happiness, tenderness, sadness, fear, surprise, or neutral) they felt while watching each film clip, as well as the intensity (on a scale of 0-6) with which they felt their selected emotion. From this set of 29 film clips, five that did not reliably elicit the target emotion were dropped, and the remaining 24 movie clips were selected for use in the current study with older adults. Descriptions of these 24 movie scenes, as well as data on the accuracy and intensity of the emotions they elicited in an audience of 10 older adults (5 male, 5 female), can be seen in Tables 1.1-1.5, according to each separate emotion category.

Participants

Ten healthy older adults (mean age = 61.3, *SD* = 6.1), five male, five female, were recruited for the film stimuli selection study through electronic ads placed on online forums. All subjects were native English speakers with normal, or corrected to normal, hearing and vision. A hearing test was performed prior to the start of the experiment to confirm that all participants were able to hear at a level of 30dB or better when tested at 500, 1000, and 2000 Hz. Participants were financially compensated for their time.

Procedure

Participants were informed that this was a study on emotion processing and provided consent to take part. Participants were told that they were about to see a series of short video clips and their task was to decide both what emotion they felt while watching the clips, and how intensely they felt it. They were instructed to select the one *main* emotion the film clip evoked in them from a set of 7 emotions (anger, happiness, sadness, fear, disgust, tenderness and neutral / no emotion). They were told that if the emotion they felt was not on the list, they should choose the emotion closest to what they were experiencing. After selecting an emotion, they were taken to a new screen where they were asked how intensely they felt that one main emotion, on a scale from 0 (“not at all”) to 6 (“very much”), with 3 being marked “somewhat/neutral”. Finally, they were given the option of selecting additional emotions, from the same list of 7 emotions, they had felt while watching the film clip which were less intense than the main emotion they had selected.

Incidental to this report, participants were simultaneously recorded as they watched the videos by a computer-mounted webcam and SensoriMotoric Instruments (SMI) RED-m infrared remote eye tracker positioned below the screen. Eye-tracking data were collected for use in a separate study, and required that participants follow a moving dot on the screen with their eyes in order to calibrate the eye-tracker mounted just below the laptop computer screen. Apart from the initial calibration procedure, during which participants followed a red dot on the screen with their eyes, the eye-tracking should not have affected the viewing experience. A webcam located on top of the laptop began recording at the start of the experiment and captured participants' facial movements and vocalizations throughout the experiment. Participants were told that after some of the film clips, they would be asked to speak into the webcam and describe, as if to a friend who wasn't present, what happened in the clip they had just seen and how it made them feel. The purpose of this was to elicit a vocal sample, ideally one that reflected the target emotion of the film clip.

All participants were guided through a practice round which, as in the practice procedure employed by Gross & Levenson (1995), employed a film clip which was mildly positive in valence. We selected a film clip from *The Red Balloon* for the practice trial. The full practice round, in keeping with the real trials that would follow, consisted of first the film clip, followed by the choice of main emotion, the self-rated intensity of that emotion, a choice of any additional emotions (from the list of angry, happy, sad, tender, disgust, fear and neutral / no emotion), and finally, participants were asked to click a box indicating whether or not they had seen the film before. Following the practice trial, participants were shown 24 film clips in an order that was randomized per participant. Please see Tables 1.1-1.5 for detailed descriptions of the films, according to emotion category. After one specific film per emotion category ("Jurassic Park" for Fear, "As Good As It Gets" for Tender, "Stepmom" (the clip with the high school boy scene) for Happiness, "The Green Mile" (the clip where the prisoner is describing his life) for Sadness), participants were prompted to speak into the webcam and describe the last film they saw and how it made them feel. The order of the film clips was randomized for each participant. The experiment was self-paced, with participants pressing the space bar to initiate the start of each new film clip.

Results

Please see Tables 1.1 through 1.5 for a comprehensive description of participants' emotional responses to the 24 happy, tender, sad, fear, and neutral film clips. With the exception of Neutral films, which were designed to not elicit emotion, all films evoked an average group emotional intensity of 3.25 or greater on a 0-6 scale. Accuracy rates differed according to emotional category, with Tender films garnering the lowest hit rates. Hit rates were calculated as the number of target responses out of the total number of responses for that film item, resulting in the percentage of accurate responses. When participants reported experiencing multiple emotions, the secondary emotion fell primarily within the same valence category for Happy, Tender, and Fear films, while Sad films were more likely to evoke Tenderness as the secondary emotion.

Table 1.1
Mean Recognition Accuracy and Emotional Intensity Ratings of Film Clips Assessed for Suitability in Eliciting Happiness in Older Adults

*Films in B**old** Were Selected For Inclusion in Our Database*

Happy clip *Film name* (minute: second) Scene	Intensity rating of target emotion (0-6 scale)	Hit rate*	Confused main emotion with	Those reporting target emotion also felt	Proportion of viewers who had seen film before**
***500 Days of Summer* (1:29) A man dances, cheered on by others**	**4.25**	**80%**	**Neutral (20%)**	**Tender (13%)**	**0%**
***Stepmom* (1:11) A mother and her children lip sync**	**4.6**	**70%**	**Neutral (20%) Anger (10%)**	**Tender (43%)**	**20%**
Stepmom (2:10) A girl makes a boy she likes jealous	3.4	80%	Neutral (20%)	Tender (25%) Anger (25%)	30%
Free Willy (0:42) A whale jumps to freedom	3.33	60%	Tender (20%) Neutral (10%) Disgust (10%)	Tender (33%)	20%
Forrest Gump (0:55) A boy wearing leg braces learns he can run	4.25	80%	Neutral (20%)	Tender (50%)	80%
Harry Potter Order of the Phoenix (1:00) Harry teaches students to cast a spell	3.7	70%	Neutral (30%)	Tender (14%)	10%

*The hit rate is the percentage of subjects who indicated that they felt the target emotion more intensely than any of the other non-target emotions.
**Reports of whether the participants had seen the movie before were not always consistent between different scenes from the same movie, as some scenes were more recognizable than others.

Table 1.2
Mean Recognition Accuracy and Emotional Intensity Ratings of Film Clips Assessed for Suitability in Eliciting Tenderness in Older Adults
*Films in B**old** Were Selected For Inclusion in Our Database*

Tender clip *Film name* (minute: second) Scene	Intensity rating of target emotion (0-6 scale)	Hit rate*	Confused main emotion with	Those reporting target emotion also felt	Proportion of viewers who had seen film before**
Forrest Gump **(2:00) A man learns he has a son**	**4.5**	**89%**	**Happy (11%)**	**Happy (25%) Sad (13%)**	**80%**
Ghost **(1:44) A couple get cozy at the potter's wheel**	**4.6**	**50%**	**Happy (30%) Disgust (20%)**	**Happy (20%) Sad (20%)**	**50%**
As Good As It Gets (1:29) A woman receives the best compliment of her life	4.67	30%	Happy (70%)	None	50%
Dead Poets Society (1:40) Students take a stand to support their teacher	4.33	30%	Happy (30%) Sad (20%) Neutral (20%)	Happy (33%) Sad (67%)	50%

*The hit rate is the percentage of subjects who indicated that they felt the target emotion more intensely than any of the other non-target emotions.

**Reports of whether the participants had seen the movie before were not always consistent between different scenes from the same movie, as some scenes were more recognizable than others.

Table 1.3
Mean Recognition Accuracy and Emotional Intensity Ratings of Film Clips Assessed for Suitability in Eliciting Sadness in Older Adults
*Films in B**old** Were Selected For Inclusion in Our Database*

Sad clip *Film name* (minute: second) Scene	Intensity rating of target emotion (0-6 scale)	Hit rate*	Confused main emotion with	Those reporting target emotion also felt	Proportion of viewers who had seen film before**
Marley and Me **(2:01) A sick dog is euthanized**	**5.13**	**90%**	**Anger (10%)**	**Tender (44%)** **Disgust (22%)**	**20%**
The Champ **(2:05) A boy grieves over the death of a boxer**	**5.3**	**80%**	**Anger (10%)** **Disgust (10%)**	**Tender (50%)** **Anger (13%)**	**30%**
The Green Mile (1:00) A prisoner explains how hard his life has been	5	80%	Tender (10%) Neutral (10%)	Tender (50%) Anger (13%) Disgust (13%)	50%
The Green Mile (1:42) A prisoner is executed	5.33	60%	Disgust (20%) Fear (10%) Anger (10%)	Anger (33%) Disgust (33%) Tender (17%)	50%
Dangerous Minds (2:05) A teacher tells her class that a student was killed	3.75	80%	Disgust (10%) Neutral (10%)	Anger (25%) Fear (13%) Tender (13%) Disgust (13%)	20%
My Girl (1:22) A girl attends the funeral of her best friend	4.6	90%	Fear (10%)	Tender (67%) Disgust (11%)	30%

*The hit rate is the percentage of subjects who indicated that they felt the target emotion more intensely than any of the other non-target emotions.

**Reports of whether the participants had seen the movie before were not always consistent between different scenes from the same movie, as some scenes were more recognizable than others.

Table 1.4
Mean Recognition Accuracy and Emotional Intensity Ratings of Film Clips Assessed for Suitability in Eliciting Fear in Older Adults
*Films in B**old** Were Selected For Inclusion in Our Database*

Fear clip *Film name* (minute: second) Scene	Intensity rating of target emotion (0-6 scale)	Hit rate*	Confused main emotion with	Those reporting target emotion also felt	Proportion of viewers who had seen film before**
***Copycat* (1:27) Police officer is attacked in a restroom**	**4.11**	**90%**	**Neutral (10%)**	**Disgust (33%) Anger (11%)**	**20%**
***Jurassic Park* (1:41) Children in a car are attacked by a dinosaur**	**4.11**	**90%**	**Neutral (10%)**	**Anger (22%)**	**50%**
The Sixth Sense (0:58) A boy is scared by a ghost under the bed	3.25	80%	Neutral (20%)	Happy (13%)	40%
The Shining (1:29) A deranged man breaks into a bathroom where his family is hiding from him	5.5	40%	Disgust (20%) Neutral (20%) Sad (10%) Happy (10%)	None	50%

*The hit rate is the percentage of subjects who indicated that they felt the target emotion more intensely than any of the other non-target emotions.

**Reports of whether the participants had seen the movie before were not always consistent between different scenes from the same movie, as some scenes were more recognizable than others.

Table 1.5

Mean Recognition Accuracy and Emotional Intensity Ratings of Film Clips Assessed for Suitability in Eliciting a Neutral Affect in Older Adults
Films in Bold Were Selected For Inclusion in Our Database

Neutral clip *Film name* (minute: second) Scene	Intensity rating of target emotion (0-6 scale)	Hit rate*	Confused main emotion with	Those reporting target emotion also felt	Proportion of viewers who had seen film before**
***Fly Away Home* (1:06) Men discuss how to build a plane**	**3.8**	**50%**	**Happy (30%) Disgust (10%) Anger (10%)**	**None**	**10%**
***Dead Poets Society* (1:12) Boys are given assignments at the start of term**	**1.83**	**60%**	**Anger (10%) Disgust (10%) Tender (10%) Happy (10%)**	**None**	**20%**
***A Perfect World* (1:05) A woman meets her new colleagues**	**2.38**	**89%**	**Disgust (10%)**	**None**	**0%**
Stranger Than Fiction (0:50) A man keeps to his schedule using his wristwatch	1.83	60%	Happy (40%)	Happy (17%)	0%

*The hit rate is the percentage of subjects who indicated that they felt the target emotion more intensely than any of the other non-target emotions.

**Reports of whether the participants had seen the movie before were not always consistent between different scenes from the same movie, as some scenes were more recognizable than others.

Film Selection

After gathering intensity and accuracy data on the 24 films, we selected two films per emotion category (plus three films from the Neutral category) for inclusion in our final database. These 11 films were chosen by a combination of the following criteria: having the highest hit rate per emotion category (and not being confused with any of the other target emotions more than 30% of the time); eliciting a mean group intensity rating greater than 4 on a scale of 0-6 (with the exception of Neutral affect items, which were specifically designed to *not* evoke intense emotion); and evoking the purest emotion (i.e., having as few participants as possible rate that they "also experienced" other emotions in addition to the target). The three Neutral clips were selected based on their low confusion rates; i.e., participants did not report experiencing any specific emotion greater than 30% of the time. For some emotion categories, such as Tender, where only two of the four items had acceptable accuracy rates, the two best films were easy to identify. For other emotions, the choice was less clear, and we took into consideration a combination of accuracy, intensity, and purity scores to make our final decision. Only data from the 11 films selected for inclusion in our database were entered into statistical analyses.

Statistical Analyses

Accuracy was defined as the hit rate for when participants reported experiencing the target emotion. Intensity ratings were calculated exclusively from trials where the subjects reported experiencing the target emotion. Repeated measures ANOVAs were conducted to assess accuracy and intensity differences between categories of target emotions. Due to technological error, data from three participants were excluded from these analyses, leaving data for seven participants as the basis for each assessment. To explore the effects of familiarity on accuracy and intensity of emotion elicitation, we ran correlations between each emotion's accuracy and intensity ratings and the percentage of participants who had reported seeing the films previously. We also calculated the effects of sex on accuracy and intensity of emotion elicitation, as sex differences have been reported in previous studies on emotion elicitation (see Gross & Levenson, 1995; Schaefer et al., 2010, among others).

Emotion Elicitation Accuracy

Chance level for selecting an emotion was 14.3% (as each forced emotion choice had seven options: Happy, Sad, Tender, Fear, Anger, Disgust and Neutral). All target emotions were elicited at well above chance level. A repeated measures ANOVA, with participant response as the unit of analysis, emotion category as the independent variable, and accuracy rate as the dependent variable, was conducted to determine whether accuracy levels differed significantly between our target emotion categories of Happy, Tender, Sad, Fear and Neutral. We found a significant difference in the hit rate (calculated by dividing the number of target emotion responses per emotion category by the total number of responses for the category) between target emotions: $F(4, 24) = 3.14$, $p = .03$, $\eta^2 = .34$. Pairwise comparisons showed that Neutral ($M = .76$, $SD = .25$) was significantly less accurately elicited than each of the following three emotions: Happy ($M = .93$, $SD = .19$), Sad ($M = .93$, $SD = .19$) and Fear ($M = 1.00$, $SD = 0$). Please note that hit rates were calculated in decimal form, such that a perfect score would equal 1.00. Thus, a Happy mean hit rate of .93 means that 93% of Happy film trials succeeded in evoking Happiness in participants. There was not a significant difference between accuracy rates for recognition of Tender ($M = .79$, $SD = .27$) and Neutral, however both of these lowest-accuracy emotions still had recognition rates above 75%.

Intensity of Emotion Elicitation

A repeated measures ANOVA, with participant response as the unit of analysis, emotion category as the independent variable, and intensity as the dependent variable, was conducted to determine whether intensity of emotional experience differed significantly between target emotion categories (Happy, Tender, Sad, Fear and Neutral). We found a significant difference between experienced emotions with respect to intensity: $F(4, 24) = 12.84$, $p = .000$, $\eta^2 = .68$. Pairwise comparisons revealed that, on an intensity scale of 0-6, Neutral (*M* = 2.05, *SD* = 1.43) was significantly less intense than each of the other emotions (where Happy *M* = 4.36, *SD* = 1.14; Tender *M* = 4.64, *SD* = .90; Sad *M* = 5.36, *SD* = .48; and Fear *M* = 4.36, *SD* = .80). The difference between intensity ratings for Happy and Sad stimuli was marginally significant (*p* = .056), with Sadness being more intensely evoked than Happiness.

Familiarity Effects

To explore what effect prior exposure to the film clip may have had on the emotional response it elicited, we ran Pearson product-moment correlations between the intensity ratings per emotion (Happy, Tender, Sad, Fear and Neutral) and whether the subjects had seen the film before. We additionally ran correlations between the accuracy ratings per emotion category and whether the subjects had seen the film before. The only significant correlation between familiarity with the film clips and outcome measures was for Happy stimuli accuracy rates, which yielded a negative correlation of $r(6) = -.80$, $p = .02$. Given our small sample size, it may be meaningful to consider the magnitude of the correlations: while not reaching the level of significance, we observed large correlations between familiarity and accuracy rates for Tender films ($r(6) = -.60$) and Neutral films ($r(6) = .52$). We also observed large correlations between familiarity and intensity for Happy films ($r(6) = -.69$) and Sad films ($r(6) = .54$). Medium strength associations were seen between familiarity and accuracy for Sad films ($r(6) = .40$) and Fear films ($r(6) = .45$).

Discussion

In this study, we developed, from a candidate set of 24 films, a database of 11 films (2 Happy, 2 Tender, 2 Sad, 2 Fearful, and 3 Neutral) that reliably elicited the target emotion, with mean accuracy rates ranging from 76% (Neutral) to 93% (for Sad and Happy films), in an audience of 10 older adults. Neutral films elicited significantly less intense emotion than the other four categories, as would be expected since films in this category were specifically designed to *not* elicit emotion. The fact that all four positive and negative emotion film categories were rated significantly more intense than the Neutral stimuli category is strong evidence that the film clips were effective in eliciting both non-neutral, as well as neutral, emotion.

Unlike Gross & Levenson (1995), we did not find an association between prior viewing of the film clips and increased intensity of emotional experience. While our small sample size may have contributed to our lack of significant familiarity effects, our correlations, on the whole, did not echo the findings of the abovementioned authors. While we did observe a large (though not significant) positive correlation between familiarity and intensity of Sad films, we also observed a large *negative* correlation between familiarity and intensity of Happy films, no correlation for Tender films, and a small negative correlation for Fear films. These differences between our study and that of Gross & Levenson (1995) may be due to a difference between the two studies in the length of film clips utilized; ours were significantly shorter (compare, for example, our scene from *The Champ* at 2:05 minutes with Gross & Levenson's same scene at 2:51 minutes). The short duration may have contributed to lower recognition rates overall in our study (recognition rates in Gross & Levenson (1995) were not reported, so we are unable to determine how overall recognition rates compare). This lack of a familiarity effect is promising for our database, as it suggests that the intensity and accuracy of emotion elicitation are not systematically affected by whether or not participants had viewed the film previously. However, having a larger sample size of participants view the films in our database will help clarify to what extent familiarity with the film clips may play a role in the resulting intensity of one's emotional experience.

This study is a first step towards developing a robust database of film stimuli that have been designed for, and validated in, a target audience of older adults. The database would benefit from the inclusion of additional items, particularly for the Tender emotion category, which had the lowest accuracy rates of any category except for Neutral. The low accuracy rates we observed for Tender films may be due to the complexity of the emotion itself; as Kalawski (2010) notes, because of the pleasant quality of the emotion, it is possible that people reporting Tenderness also experienced Happiness. Furthermore, the situations that give rise to Tenderness often evoke multiple emotions; for example the Tender scene we used from the film *Forrest Gump* involved the main character suddenly learning he had a son, which appears to make him both sad and happy before the scene culminates in a Tender moment. In developing our database further, it would be useful to include additional Tender items in order to learn whether the low accuracy rates we observed for this emotion category are due to the complexity of the emotion itself or whether they are simply an artifact of the stimuli we used to elicit the emotion. Including a larger number of older adults in the sample would also be helpful. Future use of the stimuli in clinical populations of older adults would be helpful in determining the database's versatility. As it stands, we are hopeful that our database may serve as a useful tool for understanding emotion processing in older adults.

Availability of Film Stimuli

All 24 film clips used in this study are freely available for use in other studies. Please visit the Pell Lab website, https://mcgill.ca/pell_lab/ , to obtain a copy of the film clips. Of the 24 films, three (the clip from *Marley and Me,* the Tender scene from *Dead Poets Society*, and the execution scene from *The Green Mile*) were altered from the original film version by editing out segments not central to the emotional state and adding transitions in order to reduce the total duration of the clip to fall within our database's uniform time range.

Preface to Experiment 2

Study 1 was designed to ensure that the stimuli used to elicit emotion in Study 2 were able to reliably evoke a set of target emotions in an audience of healthy older adults. To date, no database of film stimuli exists that was specifically designed to evoke emotion in older adults, despite evidence that older adults respond differently to emotional stimuli than young adults do on both a physiological level (Tsai et al., 2000) as well as in how they recognize emotion from facial, vocal, and gestural cues (Lima et al., 2014; Montepare et al., 1999; Ruffman et al., 2008). The findings of Study 1 provided evidence that we had generated a set of 11 film stimuli that could reliably elicit happiness, sadness, tenderness, fear, and a neutral affective state in older adults. The goal of Study 2 was to use the film clips developed in Study 1 to study how healthy older adults and those with Parkinson's disease (PD) experience emotion (Study 2, Experiment 1); how these two groups may differentially express emotion that was spontaneously produced while watching the film stimuli generated in Study 1 (Study 2, Experiment 2); and how healthy older adults and those with PD are perceived socially, by their age peers, on the basis of video footage extracted from subjects describing their response to three of the film stimuli produced in Study 1 (Study 2, Experiment 3).

Study 2

The relationship between emotional experience, expression, and social perception of patients with Parkinson’s disease

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Abstract

Patients with Parkinson's disease (PD) consistently receive more negative social impressions than their healthy peers, yet it remains unclear what disease-related factors contribute to this negative social perception. In a set of three experiments designed to trace PD patients' emotional experience from its subjective, experiential origins to its social, expressive outcome, we assessed: (1) how healthy controls (HC) and patients with PD report their intensity of felt experience in response to emotionally-evocative film clips, (2) how trained expressivity raters judged HC and PD participants' facial responses to emotionally evocative material, and (3) how older adults made social judgments of HC and PD participants on the basis of audiovisual interview samples. Results indicated that although disease status did not significantly affect either accuracy or intensity of participants' subjective emotional response (Experiment 1), subjects with PD were rated as significantly *more* facially expressive than HCs (Experiment 2). These findings run counter to what would be expected given facial masking and the monotone vocal changes associated with PD. No group differences were found in Experiment 2 with respect to raters' accuracy in determining which emotion subjects were experiencing, although misattribution of emotion differed according to disease status, with PD patients being routinely mistaken for feeling a negative emotion, whereas HCs were mistaken for experiencing a more positive emotion than they actually felt. Finally, we found that PD patients were rated by healthy age-peers as significantly less socially desirable than HCs (Experiment 3), both on global measures of social desirability (e.g., "Would you be interested in getting to know this person better?") and on measures of social attributes. Specifically, PD patients were rated less involved, less interested, less friendly, less optimistic and less attentive than their healthy matched controls. Taken together, the results of Experiments 1, 2 and 3 suggest that the social

communication challenges patients with PD face are not due to disease-related changes in individuals' ability to *experience* emotion, but may instead be a result of changes in the ability to modulate the expression of negative emotion. This, in turn, may be contributing to the negative social perception consistently attributed to this clinical population.

Introduction

There are many situations in which accurate interpersonal communication is critical, ranging from navigating workplace politics (Ray, 1993), to medical visits (Beck, Daughtridge, & Sloane, 2000), to managing the daily interactions which serve to establish and maintain one's social support system (Pinquart & Sorensen, 2000). Although Parkinson's disease (PD) is identified primarily by its motor symptoms of resting tremor, rigidity, impaired postural stability and bradykinesia (Gilbert, Belleville, Bherer, & Chouinard, 2005; Hoehn & Yahr, 1967; Jankovic, 2008), its non-motor symptoms, including communication disorders, are consistently rated by patients as *more* disabling than the motor symptoms (Chaudhuri et al., 2005; Stacy, 2011; Witjas et al., 2002; Yarnall et al., 2012). In fact, communication disorders are frequently cited as one of the top symptomatic concerns of patients with PD (Miller et al., 2007; Terriff, Williams, Patten, Lavorato, & Bulloch, 2012).

Communication disorders experienced by patients with PD can range from word-finding difficulty, to stammering, to challenges speaking loudly enough, or with a speaking voice that lacks appropriate emotional inflection (Fox & Ramig, 1996; Furtado et al., 2012; Miller et al., 2007). Cognitive deficits associated with PD, including difficulty with working memory and attention (Breitenstein, Van Lancker, Daum, & Waters, 2001; Dalrymple-Alford, Kalders, Jones, & Watson, 1994; Lewis et al., 2003; Owen, Sahakian, & Robbins, 1998), have been linked to a host of communication challenges, including high-level, pragmatic communication processes, where context is necessary to infer an utterance's meaning (Berg, Bjornram, Hartelius, Laakso, & Johnels, 2003; McNamara & Durso, 2003; Monetta, Grindrod, & Pell, 2009; Monetta & Pell, 2007). Patients with PD have been shown to have difficulty processing emotion from faces and voices (Blonder, Gur, & Gur, 1989; Dara, Monetta, & Pell, 2008; Paulmann & Pell, 2010; Pell & Leonard, 2003), and the disease has been associated with impairment in expressing emotion both facially and vocally (Bowers et al., 2006; Jacobs, Shuren, Bowers, & Heilman, 1995; Monetta, Cheang, & Pell, 2008; Pell, Cheang, & Leonard, 2006; Rinn, 1984, 2007).

The combination of perceptual, expressive, and cognitive deficits patients with PD face has serious repercussions for these individuals' social communication abilities. Studies have shown that PD patients are perceived as less likable than their healthy, age-matched peers, both by members of the public as well as by health care professionals (Jaywant & Pell, 2010; Pentland, Pitcairn, Gray, & Riddle, 1987; Pitcairn, Clemie, Gray, & Pentland, 1990; Tickle-Degnen & Lyons, 2004). This negative perception has ramifications for PD patients, as communication efficacy appears to affect the type of social life patients with PD are able to maintain, which, in turn, has a direct impact on their overall quality of life (Miller, Noble, Jones, & Burn, 2006; Parkinson Survey Committee, 2002; Rod, Bordelon, Thompson, Marcotte, & Ritz, 2013). This link between social support and beneficial health outcomes has been known for years (see Uchino (2006) for a review), yet very little work has been done to identify specific disease-related factors which detrimentally affect social support systems for patients with PD.

To our knowledge, only one study has examined how PD patients are perceived socially by their age peers (Hemmesch, Tickle-Degnen, & Zebrowitz, 2009). In this study, the authors had 58 older adults (40 female, 18 male) view videotaped interviews of 12 people with PD (6 female, 6 male) who had either high or low facial masking, a symptom of PD where the face appears rigid and fixed (Rinn, 1984; Simons, Pasqualini, Reddy, & Wood, 2004; Tickle-Degnen & Lyons, 2004). Viewers were asked to rate their interest in forming a relationship with the target, as well as provide their judgments of the target's likelihood to engage in specific positive and negative social behaviors. By comparing the targets' self-report of engagement in positive and negative social behaviors with the viewers' predictions, the authors were able to determine the accuracy with which age-peers made social judgments. Results suggested that women with higher levels of facial masking were judged to be less socially desirable than men with similar levels of masking. Furthermore, it appeared that age-peers' social impressions of PD patients with higher levels of masking were largely inaccurate; observers' ratings did not correspond well with PD targets' self-ratings on the personality and quality of life questionnaires. However, this study did not include a healthy control group, and so was unable to determine how social perception differed according to disease status. Given that peer relationships are considered a fundamental factor in older adults' well-being (Pinquart & Sorensen, 2000), our study sought to address the current dearth of peer-perception knowledge by conducting a careful examination of the factors influencing social perception of PD patients by their age-peers.

Most current emotion theorists believe that emotion is multi-componential, consisting of a combination of factors including physiological arousal, motor expression, and subjective feeling (the "reaction triad"; Scherer, 2000). If we are to gain a better understanding of the variables that affect social interaction, it is necessary to know how emotional components interact. For example, if PD patients exhibit facial masking, how does this relate to their felt emotional experience? Gender and cultural norms, among other factors, dictate the extent to which we express our felt emotion (Ekman et al., 1987; Grossman & Wood, 1993), so it is known that one can dissociate felt emotion from expressed emotion. But does expressed emotion accurately reflect felt emotion in the case of patients with PD, or could it be that the disease interferes with the relationship between emotional experience and spontaneous emotional expression? If so, this could partly explain the negative social impression of PD patients that is well-documented in the literature (e.g., Jaywant & Pell, 2010; Pentland et al., 1987; Pitcairn et al., 1990), as patients could be seen as inauthentic (or "unfriendly", "uncaring", "less involved", etc.), were their true emotional experience not accurately reflected in their expression. In keeping with the idea that the relationship between emotional experience and expression is likely multifactorial in nature (Boiger & Mesquita, 2012; Scherer, 2000), the current study takes a three-pronged approach by (a) providing new data on the relationship between healthy and PD participants' emotional experience (Experiment 1), (b) comparing spontaneous emotional expression in PD and healthy control subjects (Experiment 2) and (c) providing social impressions of these same subjects from their age-peers (Experiment 3).

Emotion Processing & Experiential Emotion in PD (Experiment 1)

Until recently, the literature has been inconclusive regarding whether PD patients exhibited emotion-specific deficits in emotion recognition (Assogna et al., 2008). Some studies reported disgust-specific deficits (e.g. Sprengelmeyer et al., 2003; Suzuki, Hoshino, Shigemasu, & Kawamura, 2006), while others reported combinations of emotions being impaired (e.g., fear & disgust in Kan, Kawamura, Hasegawa, Mochizuki, & Nakamura, 2002; fear and sadness and sadness and disgust in different sub-groups of Yip, Lee, Ho, Tsang, & Li, 2003; fear and sadness in Saenz et al., 2013). Still other experiments reported no difference between healthy normal subjects and PD subjects' performance on emotion recognition tasks (Adolphs et al., 1998; Pell

& Leonard, 2005; Pell et al., 2014). To make sense of these varying reports, Gray & Tickle-Degnen (2010) conducted a meta-analysis in which they calculated effect sizes from 34 studies in order to provide a more reliable estimate of the magnitude of the emotion processing deficit in the PD population. The authors used Hedges' *g* for their effect size, and reported an overall significant medium mean effect size of $g = 0.52$ and concluded that, on average, individuals with PD are indeed impaired in their ability to recognize emotion, and particularly *negative* emotion, from both facial and prosodic displays. Gray & Tickle-Degnen (2010) chose to collapse data across facial and vocal modalities, which limits our understanding, from a meta-analytic perspective, of the extent to which PD may differentially affect each modality. Results from studies that have specifically explored PD patients' emotion recognition from both visual and prosodic domains have been inconsistent in their results, with some reporting cross-modal PD impairment of emotion recognition (Ariatti et al., 2008; Yip et al., 2003) while others reported evidence of a deficit in only one modality (facial only for Clark et al., 2008 and Kan et al., 2002; prosody only for Pell & Leonard, 2003). Methodological differences and variation in patient samples may well have contributed to the varying results. When taken together, however, these cross-modal studies provide evidence that PD affects emotion processing across both facial and vocal channels.

The current study focused on the following four emotions: sadness, fear, happiness, and tenderness. In selecting our two negative emotions, we considered the social function of each; Fear and Sadness serve to elicit social support (Buss & Kiel, 2004; Marsh, Ambady, & Kleck, 2005) while Anger and Disgust provoke an aversive social response (Curtis, de Barra, & Aunger, 2011; Marsh, 2000; Olatunji & Sawchuk, 2005). Given that the overarching goal of this study was to understand how emotion processing and expression relates to social perception of patients with PD, we specifically wanted to explore emotional responses that relate to social support tendencies. As such, Sad and Fear were the two negative emotions best suited for our study.

We selected two positive emotions for inclusion in the current study in order to address the, "historical underrepresentation of positive emotions in psychological research" (Shiota, Neufeld, Yeung, Moser, & Perea, 2011; p.1368; see also: Sauter & Scott, 2007). While Tenderness has not traditionally been considered one of the five "basic" emotions (Ekman, 1992), recent evidence suggests that it may meet all of the criteria defined by Ekman (1992) necessary to qualify (Kalawski, 2010; Shiota et al., 2011). According to Ekman (1992), basic emotions must be of short duration, and have both an autonomic response and expressive component that is emotion-specific. Tenderness refers specifically to the emotional surge that accompanies caregiving love (Kalawski, 2010). Bloch and colleagues found a distinctive physiological response associated with Tenderness that consisted of slow and even breathing, decreased heart rate, a head tilt, a pause following exhalation, a slight smile, and a gaze directed towards the object of tenderness (Bloch, Lemeignan, & Aguilera, 1991; Bloch, Orthous, & Santibanezh, 1987; Santibanez & Bloch, 1986). By implementing an experimental design that is balanced in the number of positive and negative emotion items, we hoped to gain a better understanding of how emotion processing in PD may be affected by valence.

The vast majority of what we know about emotion processing in PD has been drawn from studies that relied upon emotion recognition tasks, in either visual (e.g., Dujardin, 2004; Pell & Leonard, 2005; Suzuki, Hoshino, Shigemasu, & Kawamura, 2006) or auditory (e.g., Breitenstein et al., 2001; Dara et al., 2008; Pell et al., 2006; Pell & Leonard, 2003) modalities, or both (Paulmann & Pell, 2010; Pell et al., 2014). In contrast to the impairment observed in PD patients for recognizing emotion from facial or prosodic modalities, studies whose task focused on *eliciting* emotion consistently yield no group differences in participants' intensity of subjective emotional experience (Simons et al., 2004; Smith et al., 1996; Vicente et al., 2011). Simons et al. (2004) and Smith et al. (1996) explored the relationship between facial expressivity and subjective reports of emotional intensity in PD subjects and healthy controls. Both studies used emotional film stimuli to evoke emotion, and both found no significant group differences in subjects' self-reported emotional experience, despite reduced facial expressivity in the PD group. Similarly, Vicente et al. (2011) had 15 newly diagnosed PD subjects, 18 subjects with advanced PD, and 15 healthy controls watch emotional film stimuli and rate the intensity of their emotional response. The authors reported that neither of the PD groups differed from the healthy controls in their intensity of emotional response, suggesting that subjective emotional experience is preserved in PD, even at later stages of disease progression. Taken together, these results highlight a potential disease-induced disconnect between emotional experience, which appears preserved in PD, and the ability to spontaneously express that emotion.

Self-Perception of Communicative Competency in PD

It could be argued that the most important aspect to measure when assessing social communication in PD is a patient's own perceptions of communicative competence, as this self-perception, whether accurate or not, will affect how the individual chooses to engage with their world (Baylor, Burns, Eadie, Britton, Yorkston, 2011). Recently, attention has been focused on developing a tool with which to assess communicative participation, i.e., an individual's ability to engage in various situations requiring communication in daily life. Research by Baylor and colleagues evaluated reports of how 44 patients with a variety of communication disorders (PD, multiple sclerosis, stroke, stuttering, amyotrophic lateral sclerosis, laryngectomy) felt that their condition affected their communicative participation in various situations encountered in daily life. Despite disease-specific differences, reports of reduced social participation were surprisingly similar across all subjects (Baylor et al., 2011). The authors noted that communicative participation was dependent upon many variables, including environmental noise level, degree of familiarity with conversational partners, frequency of interaction with conversation partners, and cognitive and motor challenges (e.g., struggling to find words, difficulty thinking quickly, ability to modulate speech volume and intonation, and needing to slow down speech rate in order to be understood). After nearly ten years of development, Baylor and colleagues produced a Communicative Participation Item Bank (CPIB) consisting of 46 questions that could reliably assess individuals' ability to engage in environments requiring communication (Baylor et al., 2013). They also developed a short-form test, containing only ten questions, which we used in the current study to measure self-perception of communicative competency in patients with PD (please see Appendix). By correlating patients' subjective perceptions of their ability to communicate effectively in everyday life with objective measures of their expressive behavior, we can gain a more holistic understanding of how PD affects social communication, laying the foundation for future work which will improve opportunities for communicative participation for patients with PD.

Empathic Ability in PD

To date, very little is known about how empathic ability is affected by PD. In order to understand the formulation of social impressions related to patients with PD, it is necessary to explore how the disease may affect interpersonal processes, such as patients' ability to respond empathically. While no commonly agreed-upon definition for empathy currently exists (Batson, 2009), most assessments of empathy distinguish between cognitive empathy and affective empathy (Davis, 1983; Mehrabian, Young, & Sato, 1988; Shamay-Tsoory, Aharon-Peretz, & Perry, 2009). Cognitive empathy involves being able to cognitively appraise another's emotional state, understanding how the person would think, feel, or behave given a particular situation (Poletti et al., 2011; Premack & Woodruff, 1978). Affective empathy, in contrast, involves having an emotional response to another person's affective display. For the purposes of the current study, we chose to adopt this multidimensional definition of empathy. In other words, we define an empathic response as one in which a person is able to adopt the perspectives of other people (e.g., as assessed by the "perspective taking" scale of the Interpersonal Reactivity Index (IRI) by Davis, 1980, 1983) and tends to have an emotional reaction to others' challenging experiences (e.g., as assessed by the "empathic concern" scale of Davis' IRI).

To the best of our knowledge, only one study, Narme et al. (2013), has examined empathic ability in PD patients. However, their experimental design relied upon a caregiver proxy-report of empathic ability. It seems important to re-examine how empathy may be affected in this population using patients' own self-report, in light of evidence of the disparity between PD patient and proxy reports (Fleming et al., 2005; Khlebtovsky et al., 2012; Martínez‐Martín et al., 2004; Sitek et al., 2010). Given that conceptual understanding of emotion is dissociable from emotion recognition abilities (Cummins et al., 2005; Trinkler, Cleret de Langavant, & Bachoud-Lévi, 2013), it is possible that self-report assessments of empathic ability may not bear on real-world interactions (for patients and healthy controls alike). As such, the empathy scale used in the current study, Davis' Interpersonal Reactivity Index (IRI; Davis, 1980, 1983), is designed to serve as an additional measure of participants' self-perception rather than as a definitive measure of participants' empathy.

The Current Study

To date, there is little understanding of how age-peers perceive individuals with PD, and what factors contribute to such social impressions. The design of the one study that has employed age-peer social perceptions of PD speakers, that of Hemmesch et al. (2009), did not include controls to assess how these healthy individuals viewed PD patients versus how they viewed healthy people. We wished to gather knowledge about how socially desirable PD patients are compared to healthy individuals when judged by their age-peers. The current study employed a quantitative analysis to provide data on how specific factors affect social perception of PD speakers. By separately measuring PD patients' emotion recognition, spontaneous emotional facial expression, self-perception of communicative competency, and peers' social perceptions, we can begin to understand the relationship between how deficits in one or more of these areas contribute to larger social processes that impact patient quality of life.

Following extensive evidence suggesting that PD patients are impaired in emotion perception (see Gray and Tickle-Degnen, 2010 for a meta-analysis) and emotion expression (Bowers, Miller, Mikos, et al., 2006; Jacobs et al., 1995; Rinn, 2007; Simons, Ellgring, & Pasqualini, 2003), it is predicted that PD participants will be less accurate in their perception of emotions and will rate the emotions they observe (in photos and auditory stimuli as part of the background emotion recognition tests) as less intense than will healthy controls. Additional predictions include that:

- PD participants will have greater difficulty processing negative emotions relative to positive-valence emotions (Dara et al., 2008; Gray & Tickle-Degnen, 2010).

- We do not expect to find group differences on empathy scores, as assessed by self-report on the IRI (Davis, 1980), because subjective emotional experience appears to be unaltered by PD, even in advanced stages of the disease (Vicente et al., 2011).
- Based on precedence from Simons et al. (2004), Smith et al. (1996) and Vicente et al. (2011), we expect that PD patients will not differ from healthy controls in their subjective emotional experience of film stimuli in Experiment 1.
- We expect PD patients to be rated as less emotionally expressive than HC subjects in Experiment 2, given the facial masking associated with PD and studies demonstrating reduced spontaneous expressivity in PD patients (Rinn, 1984; Simons et al., 2004; Tickle-Degnen & Lyons, 2004).
- Finally, based on the body of literature which shows that patients with PD are rated more negatively than their healthy peers, we expect that our PD group will be considered by healthy peer observers to be less socially desirable than control participants based on video footage in which participants describe their emotional response to particular film scenes in Experiment 3.

Experiment 1

Methods

Participants

Seventeen patients with idiopathic Parkinson's disease (eight male, nine female) and 22 age and education-matched healthy controls (twelve male, ten female) were recruited in Montreal through a combination of existing participant databases, online study advertisements, and through fliers posted in movement disorder clinics at the McGill University Health Centre and Parkinson's disease support groups at the Cummings Centre. Diagnosis of idiopathic Parkinson's disease was confirmed by patients' respective neurologists. The average number of years since Parkinson's diagnosis was 9.9 years (*SD* = 6.2 years). Only 11 of our 17 PD participants agreed to take part in a motor assessment, as it required going off medication for 12 hours. Of these 11 participants, the average motor score on the Unified Parkinson's disease Rating Scale (UPDRS) was 24.82 (*SD* = 12.65). This would roughly fall into the range of "slight" or "mild" impairment[1] (where the motor impairment progression is: slight, mild, moderate, severe) (Stebbins & Goetz, 1998; Stebbins, Goetz, Lang, & Cubo, 1999). Ten of our patients had a score of 1 or 2 on the Hoehn & Yahr (1967) scale, while the eleventh had a score of 3. This would indicate that our patient sample had mild motor impairment, on the whole. Sixteen of our PD patients were tested while optimally medicated on their dopaminergic replacement therapy, while the remaining patient was not yet receiving any medication for the disease. The two groups did not significantly differ in age or years of education, with the patient participants having a mean age of 64.7 years (*SD* = 6.8) and a mean education of 16.8 (*SD* = 2.6) while the control participants had a mean age of 62.8 years (*SD* = 7.4) and a mean education of

[1] For comparison, a study by Rodriguez-Blazquez et al. (2013) of 435 PD participants with a median Hoehn & Yahr score of 2 had a mean motor UPDRS score of 32.46 (*SD* = 16.30).

16.9 years (*SD* = 1.6). Two of the male healthy control participants were later excluded from the study due to not adhering to task instructions and having an undisclosed history of neurological injury, respectively. The remaining 20 controls had no history of neurological or psychiatric disorders (by self-report). Participants were native English speakers with normal or corrected-to-normal vision and had acceptable hearing as determined by an audiometric screening test administered prior to testing (minimum criteria of 35 dB in the better ear when exposed to frequencies of .5, 1 and 2 kHz) Participants were screened for dementia using the Dementia Rating Scale (Mattis, 1988) to ensure that all patients were high functioning; although neither group had individuals who performed at a level that would indicate the presence of dementia, the PD group had significantly lower scores on this measure than the HC group who performed near ceiling overall, $F(1,36) = 7.38$, $p < .05$.

Background Tests

To establish a detailed profile of perceptual, cognitive, and emotional functions of individuals in the two participant samples that could inform how they performed in the experiment and how they are perceived socially, each PD and HC participant completed a battery of background tests in addition to the experimental tasks. An overview of these measures and main findings is provided in Table 2.1.

a) Attention, perception and executive functions

To assess attention, executive functions, and the perception of nonverbal stimuli, each PD and HC participant completed the following:

(i) Forward digit span – to evaluate short-term auditory memory/attention (score from 1-9);

(ii) Working memory/auditory listening span task - developed by Tomkins et al. (1994) for use with adult clinical populations and characterized by increasing lists of true/false statements. The total number of final words correctly recalled was analyzed (out of 42 total);

(iii) Tower of London task (Culbertson & Zillmer, 2001) – to evaluate mental flexibility, organization, and planning in the nonverbal domain. Analyses focused on the total correct (out of 10);

(iv) Verbal fluency task – to evaluate organizational abilities and strategic processing of verbal information; following Breitenstein, Van Lancker, Daum, & Waters (2001), both a simple and alternating version were performed, where participants had one minute to name as many animals as possible, or as many alternating pairs of men's first names-vegetables (e.g. "Greg-asparagus"). The results from these two tasks were averaged per participant to provide a measure of overall verbal fluency (score = number of correct, unique items or pairs, depending on the task, provided per minute).

(v) A test of facial recognition ability (Benton & van Allen, 1983) – to evaluate the ability to process facial identity features (score was out of 54).

A series of one-way ANOVAs was performed on each measure to examine potential differences between the PD and HC groups. The two groups differed significantly only with regard to scores on verbal fluency (combined score). In examining verbal fluency scores at an individual level, it was noted that only one member of the PD group contributed a score that was an extreme outlier (> 2 SD from the mean). Working memory scores were marginally different, with lower scores in the PD group: $F(1, 36) = 3.69$, $p = .06$. Please see Table 2.1 for a presentation of background test performance by each group.

b) Emotional processing, personality attributes, empathy, and depression

To establish a context for how individuals in the PD and HC group perceived and recognized emotion from different stimulus types and to assess empathy, the following tasks were presented:

(i) Emotional face recognition - Ekman & Friesen (1976) Pictures of Facial Affect stimuli to establish a "standard" measure of our participants' ability to recognize static emotional facial expressions. Although the target emotion categories in the main experiment were restricted to happy, sad, fearful, tender and neutral stimuli, for the sake of assessing patients' emotion recognition ability, we chose to include five basic emotions (happy, sad, angry, disgust, fearful), plus neutral, in the background emotion recognition tasks (score out of 36 total).

(ii) Emotion recognition from prosody - To assess participants' ability to process emotional prosody, we used the vocal recognition task described by Pell (2005a, 2005b). The vocal emotion recognition task consisted of nonsense, "pseudo-utterance" sentences spoken with different emotional prosody (sad, happy, fearful, angry, disgust, and neutral) selected from a validated database which has been used in previously published papers (Pell, 2005a, 2005b). Participants were told that they would hear a voice and their task was to determine which emotion was being conveyed by the speaker (score out of 36).

(iii) Emotion recognition from speech prosody and semantics - We assessed participants' normal sentence processing abilities in a similarly constructed experiment to the one above, except employing semantically normal sentences instead of pseudo-utterances (score out of 36).

(iv) Depression - Participants were screened for depression using the Geriatric Depression Scale (GDS; Yesavage & Sheikh, 1986). Total score was out of 30, with a score of 10 or greater indicating depression.

(v) Empathy – To assess empathy a multidimensional self-report test (The Interpersonal Reactivity Index (IRI; Davis, 1980; Davis, 1983)) was used to assess empathy in PD patients and matched healthy controls. Given that recent literature has reported that not all of the sub-scales composing the IRI are psychometrically valid (see Rankin et al., 2006 and Rankin, Kramer, & Miller, 2005), only the two subscales, Empathic Concern (EC) and Perspective Taking (PT), which have been consistently and reliably correlated with more objective measures of real-life functioning, were assessed. Following Rankin et al. (2006), the scores from these two sub-scales were summed together to provide a total empathy score, however the two scales were also analyzed separately to determine whether any subscale-specific differences existed between healthy and patient groups. Each sub-scale consisted of 7 questions, each of which had a possible 4 points (total score for our two sub-sets was out of a possible 56 points).

(vi) Personality – To assess whether participants differed in personality features which could potentially contribute to emotion processing or communication outcomes, we used the Ten Item Personality Inventory (TIPI; Gosling, Rentfrow, & Swann, 2003), a short form of the standard NEO-PI. Each subscale (Extraversion, Agreeableness, Conscientiousness, Emotional Stability, Openness to Experience) had a possible highest score of 7 points.

A series of one-way ANOVAs was performed on each measure to examine potential differences between the PD and HC groups. We found no significant group differences on any of the emotion processing, empathy, or depression measures (all *p*'s >.05). Please see Table 2.1 for details on background test performance by group.

c) Self-perception of communicative competency

The Communicative Participation Item Bank (CPIB; Baylor et al., 2013) was used to assess PD patients' self-perception of how their condition affects their daily communication. This ten-item questionnaire samples perceptions of daily communication activities (e.g., asking questions, speaking with strangers, conversational turn-taking, etc.) and in the current experiment serves as a global measure of individual patients' sense of communicative competency. Higher scores indicate higher communicative participation, i.e., lower levels of impairment. Thus, someone with a CPIB score of 30 has no impairment, while someone with a score of 2 has significant impairment of communicative participation. It is important to note that the CPIB specifically indexes aspects of *spoken* communication. Our PD sample had a mean CPIB score of 19.53 (*SD* = 9.29), with approximately 23% of our sample (N = 4) reporting communicative participation in the lowest range (scores from 0-10), 18% (N = 4) representing the middle range (scores of 11-20) and 59% (N = 10) reporting the least communicative challenges (scores of 21-30).

The mean CPIB score of 19.53 for our patient sample was quite similar to that reported by Baylor et al. (2013) in their sample of 701 individuals who had a diagnosis of PD (N = 218), multiple sclerosis (N = 216), amyotrophic lateral sclerosis (N = 70) and head and neck cancer (N = 70). Baylor et al. (2013) converted summary scores to both theta values (logit scale) and standard T scores, where the mean value corresponded to a summary score of approximately 18. It is not surprising that our patient sample would exhibit a slightly higher mean than those who took part in the Baylor et al. (2013) study, as their sample included head and neck cancer patients whose primary mode of communication included esophageal speech (N = 17), tracheo-esophageal puncture (N = 64), the use of an electrolarynx (N = 36) and writing (N = 2).

Table 2.1
Characteristics of Patients with Parkinson's Disease (PD) and Healthy Controls (HC) on Standardized Neuropsychological Tests

	PD (N=17)		HC (N=20)		
Test type	*Mean*	*SD*	*Mean*	*SD*	*Significance*
Digit Span (/9)	7.71	0.85	7.45	0.94	*n.s.*
Working Memory (/42)	33.53	6.64	37.00	4.26	*n.s.*
Tower of London (/10)	6.33	2.46	5.65	2.72	*n.s.*
Verbal Fluency-Average	11.50	2.94	17.25	3.07	$p < .05$
Benton Facial Recognition (/54)	46.71	4.25	49.10	3.65	*n.s.*
Ekman Facial Emotion Recognition (/36)	31.35	2.94	32.85	2.43	*n.s.*
Pell Prosody (/36)	24.59	5.22	25.95	3.98	*n.s.*
Pell Semantics (/36)	33.35	1.93	34.35	1.27	*n.s.*
Depression (GDS) (/30)	7.53	4.81	5.85	4.78	*n.s.*
Empathy (IRI)--Empathic Concern (/28)	22.00	4.97	22.00	3.37	*n.s.*
Empathy (IRI)--Perspective Taking (/28)	15.76	3.15	15.65	3.44	*n.s.*
Personality-Extraversion (/7)	4.56	1.84	4.13	1.68	*n.s.*
Personality- Agreeableness (/7)	5.59	1.08	5.13	0.93	*n.s.*
Personality- Conscientiousness (/7)	5.65	1.17	5.45	1.11	*n.s.*
Personality- Openness to Experiences (/7)	5.50	1.17	5.23	1.32	*n.s.*
Personality-Emotional Stability (/7)	5.00	1.48	4.60	1.26	*n.s.*
Communicative Competency (CPIB) (/30)	19.53	9.29	n/a	n/a	n/a

Note on scoring: For the Geriatric Depression Scale (GDS) a score of 10 or higher indicates depression; For each of the IRI empathy subscales, a higher score indicates higher empathy; For the CPIB, a higher score indicates a higher level of perceived communicative competency (i.e., less impairment). All tests were two-tailed.

Materials

Questionnaire. Following Simons et al. (2004), we used an Emotion Rating Scale (ERS) at the start of the experiment to assess participants' baseline levels of emotion. This self-report measure consists of 12 different emotional feelings (Anger, Happiness, Excitement, Fear, Disgust, Surprise, Contempt, Amusement, Irritation, Relaxation, Sadness, Boredom). Participants were asked to mark, on a Likert scale of 0 (not at all) to 100 (very strongly) accompanying each emotion, to indicate their current state. Of the twelve emotional states, participants reported experiencing, with an intensity of at least 50 out of 100 points, only the following four emotions: Happy, Relaxed, Excited, and Amused. Both PD and HC participants rated themselves, as almost equally Happy (PD $M = 72$, $SD = 14$; HC $M = 75$, $SD = 13$), Excited (PD $M = 61$, $SD = 8$; HC $M = 69$, $SD = 23$), Relaxed (PD $M = 73$, $SD = 15$; HC $M = 70$, $SD = 13$) and Amused (PD $M = 68$, $SD = 19$; HC $M = 69$, $SD = 11$). One-way ANOVAs run on these scales indicated no significant differences between groups in their self-reported baseline emotional state.

Experimental stimuli. Film stimuli were selected from a database of film clips we constructed and validated in an audience of 10 healthy older adult participants (mean age = 61.3, $SD = 6.1$; five male, five female). From a candidate set of 24 film clips, we selected 11 for use in the current study on the basis of each film clip's ability to reliably elicit the target emotion more strongly than all other emotions and to elicit a target emotion that is moderate to strong in intensity (i.e., 4 or greater on a scale from 0-6). The 11 film clips included in the current study were controlled for their duration (between 1:05 minutes and 2:05 minutes) and balanced in number of items per positive and negative valence categories. We used two film clips per each of the following emotion categories: Happy, Tender, Sad and Fear. Additionally, three film clips were neutral in nature and served as buffers between clips of different emotional categories. Please refer to Study 1 for descriptions of the film clips, and Table 2.2 for descriptive data on the emotional film stimuli selected for use in the current study.

Table 2.2
Descriptive Data of the Experimental Stimuli

Emotion of film	Number of films per category	Mean recognition rate	Mean intensity (0-6)	Mean duration (minute: second)
Happy	2	75%	4.43	1:20
Tender	2	70%	4.55	1:42
Sad	2	85%	5.22	2:03
Fear	2	90%	4.11	1:34
Neutral	3	66%	2.76	1:08

Procedure

Participants were randomly assigned to view the films in one of two different sequences. "Group A" viewed positive valence films first (Happy films, followed by Tender films), then negative valence films (Fear first, followed by Sad). "Group B" began with negative valence films (Fear clips first, followed by Sad clips), then positive films (with Happy films followed by Tender films). Neutral films served as buffers between different emotional categories. The choice to block films according to valence was designed to minimize any potential emotional carry-over affects, as had been reported in one study involving emotional film clips (Tsai, Levenson, & Carstensen, 2000). As we wanted to ensure that all participants were responding to the same interview prompts, the order of emotions within each block needed to be held constant. As a result, the order of emotion categories within each valence block was held constant in order to position the film that was to be the subject of the interview prompt to occur at the end of each valence block. Separating valence blocks with interview sections was designed to further limit the potential for emotional carry-over effects. In selecting the specific films that would serve as interview prompts, we chose the one film per valence category (including Neutral) that had a combination of highest accuracy in eliciting the target emotion and most intense response, according to results from 10 older adult participants in Study 1. The selected film clips were “Forrest Gump” for the positive valence interview, and “Marley and Me” for the negative. For Neutral films, the interview clip was selected based on which of the three candidate films we believed would provide the greatest narrative opportunity (we selected the clip from “Dead Poets Society”). Ten healthy control participants were randomly assigned to Group A, the other ten to Group B. In the PD group, nine were randomly assigned to Group A and 8 were in Group B. Please see Figure 1 for a description of film order blocks.

In the initial consent form, delivered prior to any background tests, subjects were asked to participate in an experiment on emotion processing. Participants gave their consent to be videotaped, and acknowledged that they were comfortable watching emotionally-evocative film clips. Their hearing was then tested, and they were given the Emotion Rating Scales and asked to mark, on Likert scales of 0-100, how much they were currently feeling each of the 12 emotional feeling options. After completing this self-report questionnaire, participants were seated in front of a computer screen containing a webcam and microphone. The webcam was centered on participants’ faces, and began recording as soon as the experiment began. Although the current study was concerned only with participants’ behavioral responses to the stimuli, eye-tracking data were gathered simultaneously for use in a separate study. Stimuli were presented on Sensorimotor Instruments’ (SMI) RED-m system. This eye-tracking system consisted of a laptop with an infrared eye-tracker that rested at the base of the laptop screen. The experimenter led the participant through the initial eye-gaze calibration, then took a seat slightly behind the participant. The experimenter's presence could be felt by the participant, but her face was not visible to the participant, and the experimenter did not respond to the film clips in any way. The reason for the presence of the experimenter was to simulate a social environment more likely to result in emotion expression; for example, Jakobs, Manstead, & Fischer (1999) and Simons et al. (2004) reported that both healthy individuals and PD patients are significantly more facially expressive when viewing film clips with others present.

Participants were told that they were about to see a set of films and their task was to decide, from a limited set of emotion choices, what emotion the film evoked in them, and how intensely. They were told that if the emotion they felt was not one of the choices available, to please select the emotion closest to the one they were experiencing. Additionally, they were told that after some of the films, they would be asked to describe what they had just seen and how it made them feel, as if they were giving a review of the film clip to a friend who had not seen it. Participants were first led through a practice round which familiarized them with the task. The practice trial was the same for all participants, and consisted of a clip from *Harry Potter and the Order of the Phoenix* (Yates, 2007) judged to evoke a mild level of happiness during pilot testing. In the practice trial, participants first watched the 59 second film clip, then saw a screen which read "What was the **main** emotion you felt while watching this clip? Please select how intensely you felt that **one** emotion." Participants clicked a box on the screen corresponding with one emotion from the following list of options: Happy, Tender, Sad, Fear, Angry, Disgust, Neutral/No emotion. The order of emotion choices varied in a set random order after each movie clip, to encourage participants to read through and consider the options each time. Next, another screen appeared with the question, "How intensely did you experience that emotion?" followed by a scale from 0 to 6, where (Not at all) was listed under the 0, (Somewhat, Neutral) was listed underneath the 3, and (Very Much) appeared underneath the 6. After this, a page appeared with the question, “Did you experience any other emotions while watching the last film clip?”. The answer options to this question were: No, Yes [Mark which one(s) below], Angry, Fear, Disgust, Tender, Happy, Sad. Again the order of emotions was varied to encourage participants to consider the full range of options. At a final stage, the participant had to indicate whether or not they had seen the film before (Yes/No).

Finally, as the last portion of the practice trial, and again after the final movie in each valence block (see Figure 1 for details), a screen appeared which read, “While looking at the webcam, please explain, as if you’re speaking to someone who hasn’t seen the film: What was that last movie clip about and how did it make you feel? Press the space bar when you are done.” In order to elicit a spontaneous, natural vocal sample, participants were allowed to talk for as long as they wanted. However if, during the practice round, participants gave a very short answer, the experimenter reminded them of the full question by prompting them with what they neglected to comment on, e.g., “…and how did it make you feel?” or “Can you explain what you saw happening in the clip?” At the end of the practice round, participants were asked if they had any questions about the procedure before the official testing began. The film portion of the experiment lasted approximately 35 minutes. All background assessments, described earlier, took place after the film viewing to prevent the possibility of task-induced fatigue influencing emotional responses.

Figure 1. The two orders of film stimuli presentation

Valence	Emotion	Group A	Group B	Emotion	Valence
		Practice: Harry Potter [+Interview]	Practice: Harry Potter [+ Interview]		
POSITIVE	HAPPY	Stepmom	Jurassic Park	FEAR	NEGATIVE
POSITIVE	HAPPY	500 Days of Summer	Copycat	FEAR	NEGATIVE
POSITIVE	Neutral	Fly Away Home	Dead Poets Society [+Interview]	Neutral	NEGATIVE
POSITIVE	TENDER	Ghost	Champ	SAD	NEGATIVE
POSITIVE	TENDER	Forrest Gump [+Interview]	Marley & Me [+Interview]	SAD	NEGATIVE
	Neutral	A Perfect World	A Perfect World	Neutral	
NEGATIVE	FEAR	Jurassic Park	Stepmom	HAPPY	POSITIVE
NEGATIVE	FEAR	Copycat	500 Days of Summer	HAPPY	POSITIVE
NEGATIVE	Neutral	Dead Poets Society [+Interview]	Fly Away Home	Neutral	POSITIVE
NEGATIVE	SAD	Champ	Ghost	TENDER	POSITIVE
NEGATIVE	SAD	Marley & Me [+Interview]	Forrest Gump [+Interview]	TENDER	POSITIVE

Results

Accuracy of Reported Emotion

Table 2.3 shows the proportion of trials in which each of the seven emotional responses was reportedly felt by participants in each group following the question, “What was the **main** emotion you felt while watching this clip?” Inspection of these data suggests that emotional films designed to elicit Happiness and Sadness were most likely to successfully evoke these target emotions in both groups (as reflected in the highest hit rates), whereas films associated with neutral affect or Tenderness tended to have lower accuracy rates in both groups.

Nonetheless, it can be seen that accuracy rates for all target emotions were high, exceeding five times chance performance (14.3%) in this task for all emotions in each participant group, suggesting that all emotions of interest were elicited successfully by the stimuli. In terms of error patterns, films associated with Tenderness were most frequently confused with Happiness, and fear-evoking films were frequently reported as Neutral, again in a similar manner for both groups. Interestingly, reported feelings of Disgust were more evident in the PD versus HC group in response to films meant to elicit both positive and negative emotions.

Table 2.3

Confusion Matrices Showing the Proportion of Correct Responses Per Target Emotion Category (Across) and Actual Reported Response (Vertical). Cells in ***Bold*** *Display Accuracy Hit Rate (i.e., When Subjects Reported Feeling the Target Emotion More Strongly Than Any Other Emotion)*

	PD group reported feeling						
Target emotion	Happy	Tender	Sad	Fear	Neutral	Anger	Disgust
Happy	**0.85**	0.06			0.06		0.03
Tender	0.17	**0.71**	0.06		0.03		0.03
Sad		0.06	**0.88**				0.06
Fear		0.03		**0.79**	0.12		0.06
Neutral	0.12	0.04	0.02	0.04	**0.73**	0.06	
	HC group reported feeling						
Target emotion	Happy	Tender	Sad	Fear	Neutral	Anger	Disgust
Happy	**0.88**	0.02			0.10		
Tender	0.10	**0.78**	0.07		0.05		
Sad		0.05	**0.90**			0.02	0.03
Fear	0.05		0.05	**0.80**	0.10		
Neutral	0.05	0.17	0.02	0.03	**0.68**	0.03	0.02

*Due to different numbers of participants per group, all PD hit rates were calculated out of 34 trials (17 participants with two films per emotion category), except Neutral, which was out of 51 (due to three Neutral films). All HC hit rates were calculated out of 40 trials (20 participants with two films per emotion category), except Neutral, which is out of 60.

We performed a 2 x 2 x 5 repeated measures mixed analysis of variance (ANOVA) on the hit rates, where an "accurate" response was defined as participants reporting that they felt the target emotion of the film clip in the trial. This analysis considered differences in Group (PD, HC) and Sex (Male, Female) with repeated measures of Emotion (Happy, Tender, Sad, Fear, Neutral) of the film clip. We found a significant main effect of Emotion on Accuracy, $F(4, 132) = 3.29$, $p = .01$, $\eta^2 = .09$. Pairwise comparisons using a Bonferroni correction showed that accuracy for Sad trials ($M = .89$, $SD = .21$) was significantly greater than for Neutral trials ($M = .70$, $SD = .29$); no interactions emerged (all F's < .99, all p's > .44). Please refer to Figure 2 for a display of accuracy rates according to emotion and group.

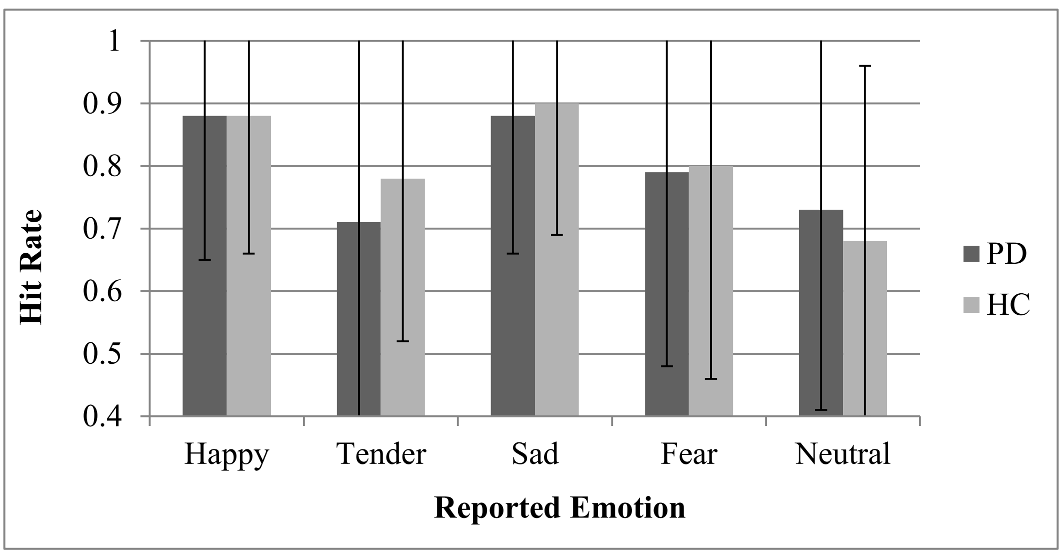

Figure 2. Mean accuracy rates of reported emotion, by group. Error bars refer to standard deviations.

Intensity of Felt Emotions

We ran two separate analyses on intensity ratings of participants' reported emotion: one that included all intensity ratings, regardless of the accuracy of reported emotion, and one that only included intensity ratings from trials in which subjects reported experiencing the target emotion. For both analyses, we conducted mixed repeated measures ANOVAs to explore the separate and interactive effects of Group (PD, HC), Sex (male, female), and Emotion of the film clip (Happy, Tender, Sad, Fearful) on intensity (how intensely participants reported feeling each emotion, on a scale of 0-6). Neutral was not included as an emotion in this analysis because Neutral films were specifically designed to *not* evoke an emotion of any intensity, so an intensity value for a film that participants felt neutral about would not be meaningful. Both analyses ultimately yielded the same significant main effect, though the *F* and *p* values differed slightly (as did the mean values for each emotion, as this analysis included 52 data points more than the analysis that included only correct trials). For the analysis incorporating all trials, we observed a significant main effect of emotion intensity, $F(3, 99) = 7.33$, $p = .001$, $\eta^2 = .18$. Bonferroni pairwise comparisons revealed that Sad films ($M = 4.93$, $SD = .89$) were rated significantly more intense than Fear films ($M = 3.78$, $SD = 1.66$). No significant differences were found between the intensities of the other emotion categories. All two- and three-way interactions were non-significant (all p's > .56, all F's < .70).

Data showing the intensity of *correctly* reported emotions, along a scale from 0-6, for each group are furnished in Table 2.4, along with data showing the proportion of participants, per group, who had seen each film clip before. For the 2 x 2 x 4 repeated measures ANOVA analyzing the group by sex by intensity of emotion for correct trials only, we observed a significant main effect of Emotion on reported intensity ratings, $F(3, 78) = 4.97$, $p < .01$, $\eta^2 = .16$. Pairwise comparisons showed that there were overall differences ($p < .05$) in emotional intensity between Sad, which received the highest ratings overall ($M = 5.10$, $SD = .71$) and both Tender ($M = 4.57$, $SD = .90$) and Fear ($M = 4.26$, $SD = 1.38$). The intensity of Happy trials did not differ significantly from the other three emotions. No significant main effect of Group (F(1,

26) = .04, p = .85, η^2 = .001), Sex (F(1, 26) = .05, p = .82), or interactions between Group and Emotion intensity (F(3, 78) = .38, p = .77, η^2 = .01), Sex and Emotion intensity (F(3, 78) = 1.65, p = .19, η^2 = .06) or Group x Sex x Emotion intensity (F(3, 78) = .03, p = .99, η^2 < .01) were produced for this analysis. Please see Figure 3 for a display of intensity ratings according to reported emotion and group status.

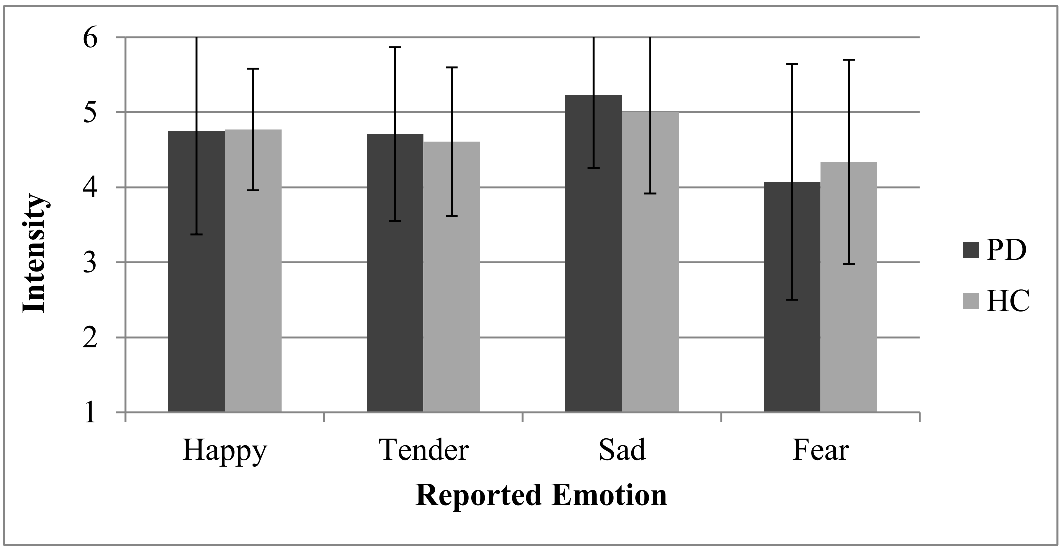

Figure 3. Mean reported intensity, on a scale of 0-6, according to emotion of stimuli and group status.

Familiarity with Emotional Stimuli

To briefly assess whether familiarity with emotional stimuli might have differentially contributed to participants' accuracy and intensity results, we ran a 2 x 5 mixed ANOVA on the proportion of participants who had seen the films in each emotion category according to Group (PD, HC) x Emotion (Happy, Tender, Neutral, Sad, Fear). There were no significant differences between groups in terms of familiarity with the film clips (F(1, 35) = .047, p = .83, η^2 = .75). There was a significant main effect of Emotion, F(4, 140) = 31.72, p <.001, η^2 = .48. Pairwise comparisons showed that Tender films (*M* frequency of having seen previously = .66, *SD* = .37) had been seen significantly more often than films in all other emotion categories. Additionally, Fear films (*M* = .31, *SD* = .30) were reported as having been seen significantly more than both Happy films ($p = .02$; *M* = .09, *SD* = .20) and Neutral films ($p < .001$; *M* = .11, *SD* = .21). The interaction between Group and Emotion was not significant, $F(4, 140) = .17$, $p = .96$, $\eta^2 = .01$. Pearson correlations looked at a possible relationship between participants' familiarity with the film and their accuracy (i.e., reporting feeling the target emotion), and/or reported emotional intensity; no significant relationships were uncovered (all *p*'s > .15).

Table 2.4
Mean Results for Hit Rates (out of 1.00) of Target Emotions and Intensity Ratings (on a Scale of 0-6) in Experiment 1 (Standard Deviations in Parentheses)

	PD group reported feeling		
Target emotion	Hit rate	Mean intensity	Seen before*
Happy	.88	4.75 (1.38)	.09
Tender	.71	4.71 (1.16)	.57
Sad	.88	5.23 (0.97)	.12
Fear	.79	4.07 (1.57)	.29
Neutral	.73	n/a	.12
	HC group reported feeling		
Target emotion	Hit rate	Mean intensity	Seen before
Happy	.88	4.77 (0.81)	.10
Tender	.78	4.61 (0.99)	.65
Sad	.90	5.00 (1.08)	.18
Fear	.80	4.34 (1.36)	.33
Neutral	.68	n/a	.10

*Refers to proportion of participants who reported being familiar with the film clip

Discussion

In this Experiment, we sought to determine how PD affects subjective emotional experience. We used film clips to elicit happy, tender, fearful, and sad emotion in 17 PD and 20 age- and education-matched HC participants. We found no significant group differences in subjects' report of what emotion each film clip had elicited in them (i.e., the "accuracy" measure), nor did we find group differences in subjects' reports of how intensely they had experienced each of the four emotions. Our results were consistent with the findings of Simons et al. (2004), Smith et al. (1996) and Vicente et al. (2011), all of whom also used video clips to elicit emotion and similarly found that PD patients' subjective emotional experience did not significantly differ from that of healthy controls. In the case of Simons et al. (2004) and Smith et al. (1996), this preserved subjective emotional experience was observed in the presence of reduced expressivity in the PD group, suggesting a potential dissociation between emotional experience and emotional expression in this clinical population.

Similar results were reported by Mikos et al. (2009) in a reflective self-report study that compared 37 PD and 21 healthy controls' self-perception of their intensity of emotional experience as well as their overall self-perception of emotional expressivity. To assess the accuracy of participants' judgments of expressivity, subjects' ratings were compared to objective ratings of subjects' expressivity made by close friends and family members. The authors reported that PD subjects' self-report of intensity did not significantly differ from that of the controls, as in our study. However, patients rated themselves significantly less expressive than controls, and this diminished expressivity was accurate when compared to reports of expressivity from close friends and family members. This indicates that PD subjects are aware of their expressive deficits, and, given the contrast between patients' undiminished intensity of emotional experience, essentially suggests that PD patients are experiencing an emotional reality whose magnitude and quality they are not able to convey to others.

This distinction between preserved intensity of emotion in the face of diminished physiological responses was echoed in the results of a study by Miller, Okun, Marsiske, Fennell, & Bowers (2009). Miller and colleagues examined eye-blink response to aversive static visual stimuli in PD patients and healthy controls. In addition to measuring the eye-blink rate, Miller and colleagues collected a self-report rating of intensity of emotional response from participants. Although PD patients displayed a blunted physiological response to highly-arousing stimuli, their self-reported emotional experience did not differ from that of controls.

However, another study displayed the opposite pattern: Wieser et al. (2006) presented emotional pictures to 14 PD patients and matched controls while recording EEG response and asking participants to rate, on separate Likert scales, the valence of each photo and how aroused they felt while viewing it. Interestingly, EEG early posterior negativity responses, thought to reflect early attentional processing, did not differ between healthy controls and the PD participants, however PD participants rated photos with highly arousing content as significantly less arousing than did control participants. In order to gain a unifying explanation for such conflicting results, we may need to pay greater attention to how different methodological approaches rely on the activation of different neural networks. It is known that different task demands, even within the single realm of emotion recognition tasks, activate different regions of the brain (Phan et al., 2002). Future studies that pay attention to the link between functional neuroanatomy, task demands, and behavioral correlates will allow us to come closer to an understanding of the nature of emotion processing deficits in PD patients.

It is possible that functionally distinct subdivisions of the STN may be able to explain results, such as those from Miller et al. (2009) and Mikos et al. (2009), that demonstrate impairments in physiological responses to emotion but preserved subjective intensity of emotion. It is proposed that the STN contains three functional subdivisions: a limbic region, a motor region, and a central associative region (Alexander, Crutcher, & DeLong, 1990; Joel & Weiner, 1997; Lambert et al., 2012). While the degree to which these regions can be functionally separated remains debated due to much interaction between the different regions (Mallet et al., 2007), the fact that structural connectivity studies (e.g., Lambert et al., 2012) have found distinct regions for motor, limbic, and associative functions may shed light on study results that demonstrate preserved subjective emotional experience in PD patients despite the presence of other emotion processing deficits. Furthermore, in patients with PD, STN neurons have been shown to fire irregularly, with an apparent loss of specificity in receptive fields (Hamani et al., 2004). Such inconsistency in neuronal firing, combined with STN studies employing different modalities of stimuli (static visual versus dynamic audiovisual) make it difficult to conclusively determine why subjective emotional experience may be preserved in PD patients, despite evidence of PD-related impairments in other realms of emotion processing.

Regardless of the underlying neuropathology, having a preserved subjective experience of emotion yet a reduced capacity to physiologically express this emotion, as was reported in the Mikos et al. (2009), Simons et al. (2004) and Smith et al. (1996) studies, likely means that many patients are experiencing an emotional reality that they are unable to communicate to those around them. This finding could be contributing to PD patients' experiences of social isolation and choice to withdraw from social situations (Brod, Mendelsohn, & Roberts, 1998; Schreurs, Ridder, & Bensing, 2000). In the following experiment, we explored spontaneous facial expression, in the same cohort of PD and HC subjects, in order to learn how PD affects facial expressivity in subjects whose subjective emotional experience is unimpaired.

Experiment 2: Emotional facial expressivity in PD

Parkinson's disease has been shown to cause reduced facial expressivity for both voluntary and spontaneous facial expressions (Bowers et al., 2006; Rinn, 1984; Simons, Ellgring, & Pasqualini, 2003). Many patients develop a facial "mask", where the face appears fixed and rigid (Rinn, 1984; Simons et al., 2004; Tickle-Degnen & Lyons, 2004). This likely compromises social interactions, because when a conversation partner exhibits less facial expressivity than normal, this leads to the social perception that the person is disengaged (Elefant, Lotan, Baker, & Skeie, 2012). Hemmesch et al. (2009) explored the relationship between facial masking in PD and its effect on social perception. Twelve PD patients were classified into either a high or low facial masking group such that there were 3 men and 3 women per group. These individuals were matched across groups with regard to their self-rated personality traits of anxiousness and extraversion, their disease severity and age. Video stimuli consisted of PD patients responding to a question about a positive coping experience they had in the past week. Only targets' face and upper body was visible in the video clips, and speech was content-filtered to eliminate verbal information while preserving prosody, loudness, emotionality, and other nonverbal components. Fifty-eight healthy older adults rated the video clips of PD patients according to how likely they, the observers, would be to want to form a relationship with the target individual, and how likely the observers thought the targets would be to engage in positive and negative social behaviors. The authors reported that observers were significantly less accurate when rating the supportiveness of women with PD compared to men with PD. Female observers were significantly more accurate than male raters when viewing targets with higher levels of facial masking, in keeping with a previously established "female decoding advantage" which states that women are more adept than men at perceiving nonverbal cues of emotion (Hall, 1978; Rosip & Hall, 2004).

Women have often been shown to be more accurate than men in their ability to read others' emotional expressions, for both vocal and visual stimuli (Hall, 1984; Hall & Matsumoto, 2004; Hall, 1978; Hampson, Vananders, & Mullin, 2006; Schirmer, Kotz, & Friederici, 2002). An event-related potential (ERP) study by Li, Yuan, & Lin (2008) examined the neurological basis for this female emotion processing advantage, and found that women appear to be more sensitive than men to negative emotional stimuli of low saliency. This evidence, combined with that of studies which have shown that social cognition abilities decline with age (Slessor, Phillips, & Bull, 2007; Sullivan & Ruffman, 2004), led us to recruit only young women as our expressivity raters in Experiment 2.

In light of evidence that PD patients experience emotions evoked by films in a manner similar to their age-matched peers, the goal of Experiment 2 was to determine whether participants' spontaneous facial expressivity in response to the film clips differed according to disease status. We defined effective expressivity as *the ability to communicate, via spontaneous facial expression, the emotion (both its category and its intensity) one is experiencing.* As a result, our metric for evaluating facial expressivity consisted of (a) analyzing the relationship between participants' self-reported emotion and the ability of independent observers to detect that emotion; and (b) examining how raters' perceived intensity of emotional experience differed according to participants' disease status and the emotional category of stimuli used to evoke the emotion.

Thin-Slice Sampling for Social Perception

In order to quantitatively assess social interaction, we employed thin-slice analysis, a method that involves sampling short segments (< five minutes in length) from within a longer dynamic recording to use as the basis for analyses. In selecting a sample of dynamic expression upon which to base our social perceptions, common sense would suggest that a longer segment of behavior would contain more information, and therefore should lead to more accurate results. However, research on thin-slice sampling suggests otherwise (Ambady et al., 2000). Several studies have used thin-slices of 10 seconds in length as the basis for personality judgments (e.g., naïve observers were asked to rate how likeable, hostile, attentive, honest, optimistic, warm, etc. the subject of the video clip was) and reported high consensus among raters and between target self-report and rater judgments (Ambady & Rosenthal, 1993; Babad, Bernieri, & Rosenthal, 1991; Simons, Pasqualini, Reddy, & Wood, 2004). In the current study, we used a thin-slice approach to sample and analyze new data on how facial expressivity and audiovisual content, respectively, inform social impressions of PD and HC individuals.

Methods

Participants

The same 17 PD participants and 20 HC participants who took part in Experiment 1 provided the video footage used as stimuli for Experiment 2. In addition, a new group of "expressivity raters", ten healthy young women (mean age = 25.6 years, *SD* = 2.46; mean years of education = 17.35 years, *SD* = 1.20), were recruited through a university affiliated electronic advertisement to judge the facial expressivity of participants in the PD and HC groups. Only young healthy females were recruited because the goal of this study was to ascertain, as accurately as possible, how expressive were the participants in Experiment 1, and females have been shown to be more sensitive and accurate than males are in perceiving emotion in others (Hall, 1978; Rosip & Hall, 2004). All raters were native English speakers, with normal hearing and vision (by self-report). Participants provided informed consent prior to the start of the study, and were financially compensated for their time.

Stimuli

Stimuli consisted of 30-second silent video clips extracted from the webcam footage obtained in Experiment 1; recall that a webcam recorded participants' facial expressions as they watched all video clips presented during Experiment 1. The webcam footage (in .wmv video format) was then edited using Windows Media Player by the first author into segments that consisted of subjects' facial expressions in response to only the last 30 seconds of each movie clip they were shown. In order to ensure that the full emotional effect had taken place, we chose to uniformly sample the 30 seconds of expressive footage because the film clips used to evoke the facial expressions ranged from 1:05 minutes to 2:05 minutes in length, with the emotional apex of the clip often not appearing until near the end of the clip. Sound was removed from the webcam footage in order to mask the ability to determine what film subjects were watching.

In Experiment 1, each participant was shown two video clips per emotion category designed to elicit each of the following: happiness, sadness, fear, and tenderness. Video footage from three neutral video clips, which served as "buffers" between the different emotion categories, was not included in the current experiment. Based on participants' self-report ratings in Experiment 1 for (a) what emotion they were experiencing during a given video clip and (b) how intensely they were experiencing that emotion, we selected for use in the current experiment webcam footage from the one film per emotion category for which each participant reported experiencing the highest intensity of the target emotion. In some cases, only one of the two film clips per emotion category was reported to elicit the target emotion, in which case webcam footage from that one film was used. In cases where participants rated both films as equally intense, the choice of which movie's webcam footage to use was selected at random. In 7 cases, a participant failed to report experiencing the target emotion during both clips per emotion category. In these 7 cases, no video footage for that participant for that particular emotion category was entered into Experiment 2. This occurred for 4 PD participants in the "Tender" category, and 2 HC and 1 PD participants in the "Fear" category. The participants who did not report experiencing the target emotion were different people (i.e., the PD participant who did not experience Fear was different from the ones who did not report experiencing Tender). This process resulted in selecting 141 trials for Experiment 2: 37 Happy trials (17 from PD subjects, 20 from HC subjects), 33 Tender trials (13 PD, 20 HC), 37 Sad trials (17 PD, 20 HC), and 34 Fear trials (16 PD, 18 HC).

Procedure

The participants in the current experiment will henceforth be referred to as "expressivity raters" or "raters", so as not to be confused with "subjects/participants" which refer to those who took part in Experiment 1 and who provided the video footage used as stimuli in the current experiment. Expressivity raters were told only that this was a study about emotion processing in older adults. The study began with two practice trials to familiarize the raters with the task. Video footage used in the practice trials came from a participant in Experiment 1 who was excluded from participation in the full experiment due to an undisclosed history of stroke that made him ineligible for the healthy control group. His footage was used to ensure that no familiarity effects from the practice trials would bias raters' later performance. After the practice rounds, raters were encouraged to ask any questions they might have prior to beginning the actual experiment.

The experiment was constructed and presented using SuperLab 4.5 software (Cedrus Corporation, USA). The experiment consisted of 141 trials, where each trial began with a 30 second silent video in which a subject's face and shoulders were visible. The presentation order was randomized for each rater. The subjects appear to be staring into the webcam, and responding to what they were viewing on the computer screen. Following the silent video clip, questions appeared which mirrored the task each participant in Experiment 1 had performed, with the only difference being that questions in this experiment were phrased in the third person. Raters were asked first, "What emotion were they experiencing?" and were given the choice of selecting happy, tender, neutral, fear, disgust, anger or sad. After clicking on an emotion, expressivity raters were shown another screen that asked, "how intensely were they experiencing that emotion?". Raters then had to select a number between 0 ("not at all") and 6 ("very much"). Raters were given a self-timed break after every 20 trials. To exclude the possibility of familiarity effects influencing expressivity ratings, at the end of the experiment, we had participants fill out a questionnaire which asked whether they had known anyone who appeared in the videos (none had), whether they knew people who had communication disorders, and whether they knew anyone who had Parkinson's disease. While three of the ten raters had experience with people who had communication disorders (two had known stutterers, while another volunteered with aphasic patients), none had known anyone with PD on more than an acquaintance level.

Results

Inter-rater Reliability

We first ran two separate analyses of inter-rater reliability, using Cronbach's alpha (Cronbach, 1951), to assess (1) the degree to which our 10 raters agreed in their accuracy in perceiving the same emotion that the target subject had reported feeling and (2) the degree to which our 10 raters agreed in their judgments of PD and HC subjects' intensity of facial expressivity. Inter-rater reliability was calculated according to the emotion of the stimuli used to evoke the 30-second silent video footage of Experiment 1 subjects' facial expression. For example, the "Sad" inter-rater reliability analysis was based on video footage from clips where subjects in Experiment 1 were shown a sad movie *and* reported that the main emotion they experienced during the movie clip was sadness. Thus, an "accurate" trial for Experiment 2 would be one in which the rater correctly perceived the emotion that the target subject had experienced. Inter-rater reliability was good with respect to the level of accuracy with which raters perceived the same emotion that the target subject had reported feeling. This agreement held true across emotion categories. Sad and Tender trials had the lowest inter-rater agreement, at $\alpha = .76$ for both. Raters performed similarly on Happy trials and Fear trials as well, with $\alpha = .80$ for Happy trials and $\alpha = .81$ for Fear trials. The "intensity" inter-rater reliability analysis was also coded according to the emotion of the stimuli used to evoke the facial expression in target subjects; however, the analysis did not take into account *which* emotion the rater perceived, but only the intensity of emotion they reported observing on the target's face. Our motivation for including intensity data from trials in which the rater did not accurately perceive the target's emotion was to assess how emotion is communicated from multiple perspectives; the "accuracy" inter-rater reliability analysis captured information on how emotion is conveyed from a categorical perspective, while the "intensity" inter-rater reliability analysis gathered information on how effectively a dimensional measure, in this case, arousal, is conveyed by silent video footage of PD and HC subjects. For intensity ratings, inter-rater reliability detecting subjects' emotional expressions ranged from good to excellent (Cronbach, 1951), depending on which emotion had been elicited in the target subjects that raters were viewing**.** Raters had the lowest agreement on Sad trials ($\alpha = .86$), followed by Tender trials ($\alpha = .91$) and Happy trials ($\alpha = .92$). Raters agreed most highly on Fear trials ($\alpha = .94$). Such high alpha levels suggest that the ten raters were overall in agreement with respect to the intensity of emotion they perceived in the silent video footage of Experiment 1's subjects.

Accuracy

The confusion matrices presented in Table 2.5 show the proportion of raters' responses assigned to each emotion category according to the *felt* emotions reported by individuals in the PD and HC groups when raters were exposed to silent videos. Cells in **bold** indicate when raters perceived the same emotion that the subject reported experiencing (i.e., when raters were "accurate" at perceiving the reported emotion). There appeared to be group differences whereby negative emotions (Fear, Sad) were detected more accurately when posed by the PD participants, whereas positive emotions (particularly Happy) were detected better when posed by healthy controls. In general, it can be seen that accuracy tended to be low overall, with correct recognition rates in the range of approximately .10 to .40 of trials where participants reported feeling a particular emotion. In particular, rates for detecting Tender from the face were notably lower than other emotions. With respect to errors, the confusion matrix suggests that when raters misjudged *any* emotion, they were most likely to rate it as Neutral (with the only exception being for Happy trials where HC participants were the target. In that case, Happiness was most often confused with Tenderness, followed closely by Neutral). Apart from Neutral, the prevalence of other errors varied by group. For example, Tender was confused for Sad 32% of the time in the PD group targets, but only 10% of the time in HC targets, whereas Tender was confused for Happy 25% of the time in HC group targets, and only 6% of the time in PD targets. Fear was primarily confused for expressing Disgust in PD targets (21%), whereas it was predominantly confused for Happiness when raters were watching the HC group targets (21%).

We analyzed the effect of Group (PD, HC), sex (male, female) and emotion (Happy, Tender, Sad, Fear) as repeated measures, in a separate 2 x 2 x 4 ANOVA to determine whether the ten raters differed in their *accuracy* of perceived emotion in relation to the emotion participants reported experiencing for each trial. There was no significant Group effect: $F(1, 9) = .05$, $p = .82$, $\eta^2 = .01$. However, there was a significant Emotion main effect: $F(3, 27) = 10.13$, $p = .002$, $\eta^2 = .53$. Pairwise comparisons with a Bonferroni correction showed that raters were significantly less accurate overall at perceiving Tenderness from facial expressions than any of the other emotion categories, with a mean hit rate of .11 ($SD = .10$). There was also a significant main effect of Sex: $F(1, 9) = 218.52$, $p <.001$, $\eta^2 = .96$, with women being perceived significantly more accurately than men (women: $M = .31$, $SD = .15$; men: $M = .14$, $SD = .10$).

These patterns were informed by a significant interaction of Group x Emotion: $F(3, 27) = 12.68$, $p < .001$, $\eta^2 = .59$. There was a significant interaction effect of Group x Sex, $F(1, 9) = 19.27$, $p < .01$, $\eta^2 = .68$. There was no significant Emotion x Sex interaction, $F(3, 27) = 1.81$, $p = .17$, $\eta^2 = .17$.

Table 2.5
Raters' Confusion Matrices Indicating Proportion of Target Responses (in bold) and Non-Target Responses Per Emotion Category

		Raters' perceived emotion						
PD reported emotion	N*	Happy	Tender	Sad	Fear	Anger	Disgust	Neutral
Happy	17	**0.25**	0.16	0.18	0.08	0.03	0.06	0.24
Tender	13	0.06	**0.06**	0.32	0.12	0.09	0.09	0.26
Sad	17	0.10	0.06	**0.35**	0.06	0.06	0.08	0.29
Fear	16	0.09	0.03	0.13	**0.24**	0.06	0.21	0.24
Average		0.13	0.08	0.25	0.13	0.06	0.11	0.26
HC reported emotion	N*	Happy	Tender	Sad	Fear	Anger	Disgust	Neutral
Happy	20	**0.40**	0.20	0.05	0.06	0.04	0.06	0.19
Tender	20	0.25	**0.14**	0.10	0.06	0.03	0.07	0.35
Sad	20	0.09	0.07	**0.23**	0.07	0.10	0.08	0.36
Fear	18	0.21	0.07	0.07	**0.13**	0.12	0.12	0.28
Average		0.24	0.12	0.11	0.08	0.07	0.08	0.30

*N = number of stimuli items contributing to the hit rate analysis

There was a significant three way interaction between Group, Sex, and Emotion accuracy, $F(3, 27) = 4.38$, $p = .01$, $\eta^2 = .33$. Bonferroni pairwise comparisons showed that when raters judged subjects experiencing happiness, they were significantly more accurate at perceiving Happiness in HC women as compared to PD women ($p = .003$; HC women Happy $M = .54$, $SD = .22$; PD women Happy $M = .26$, $SD = .18$). For Tender trials, raters were also significantly more accurate at detecting this emotion in HC women as compared to in PD women ($p = .02$, HC women Tender $M = .24$, $SD = .10$; PD women Tender $M = .10$, $SD = .10$). For negative stimuli, the pattern was reversed: for Sad stimuli, raters were significantly more accurate ($p < .05$) at detecting this emotion in PD female subjects ($M = .48$, $SD = .18$) as compared to female HC subjects ($M = .32$, $SD = .20$). For Fear trials, the only significant difference between groups was for men. Raters were significantly more accurate ($p = .04$) at perceiving fear on the faces of PD men (*M* = .19, *SD* = .14) as compared to HC men (*M* = .05, *SD* = .07). In summary, positive emotion was more accurately perceived in healthy control women, whereas negative emotion was better perceived in PD men and women. Please see Figure 4 for accuracy rates with respect to group and subject disease status.

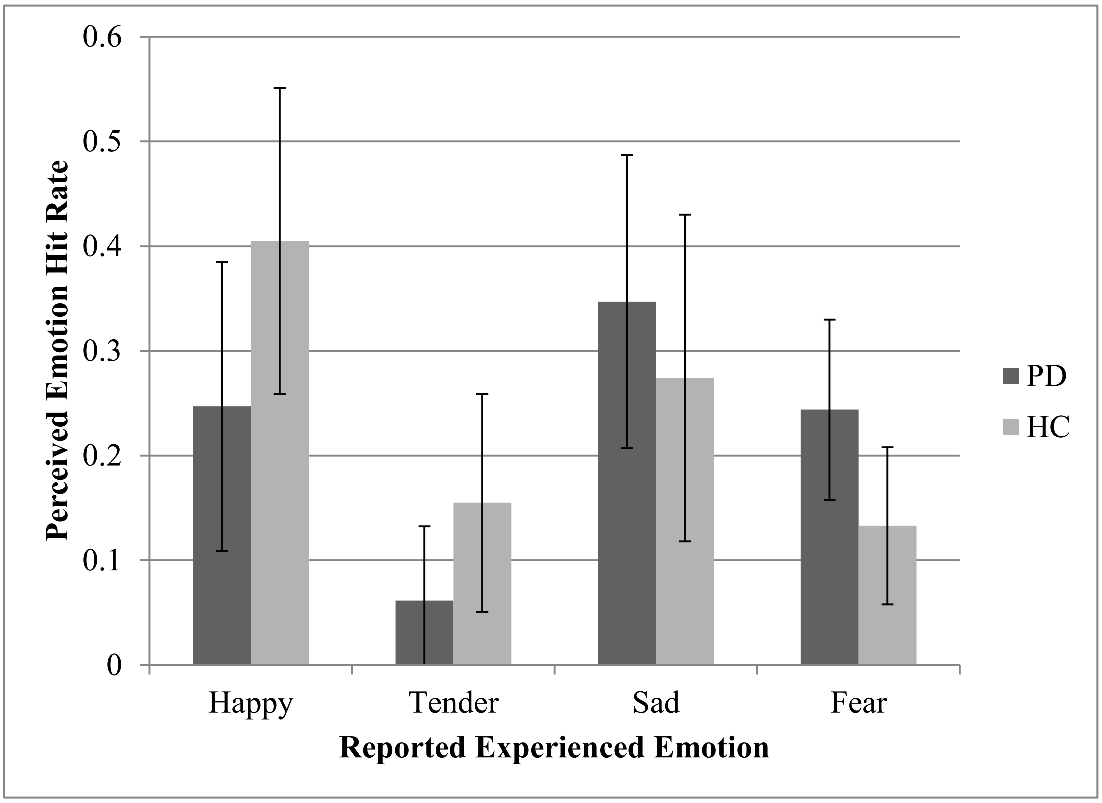

Figure 4. Expressivity raters' accuracy rate (out of 1.0) of correctly perceiving the emotion individuals with PD and healthy controls reported experiencing. Please note: error bars refer to standard deviation.

Intensity

We analyzed the effects of disease status and emotional category of stimulus on raters' perception of the emotional intensity reflected in the faces of participants in Experiment 1 using a Group by Sex by Emotion (2 (PD, HC) x 2 (Male, Female) x 4 (Happy, Tender, Sad, Fear)) repeated measures ANOVA. We found a main effect for Group: $F(1, 9) = 7.66$, $p = .02$, $\eta^2 = .46$ and a main effect of Emotion, $F(3, 27) = 12.69$, $p < .001$, $\eta^2 = .59$. The interaction of Group x Emotion was significant: $F(3, 27) = 6.78$, $p = .001$, $\eta^2 = .43$. Bonferroni pairwise comparisons performed on the interaction revealed that there was a marginally significant difference between groups in perceived intensity of Tender trials (PD *M* = 2.21, *SD* = .94; HC *M* = 1.86, *SD* = .65) and Sad trials (PD *M* = 2.34, *SD* = 1.05; HC *M* = 1.63, *SD* = .69). In both cases, the PD group was rated as experiencing more intense emotion than the HC group. These patterns can be seen in Figure 5.

We observed a main effect of Sex, $F(1, 9) = 80.28$, $p < .001$, $\eta^2 = .90$. There was also a significant Group x Sex interaction, $F(1, 9) = 73.72$, $p < .001$, $\eta^2 = .89$. Bonferroni pairwise comparisons indicated that there was a significant group difference in intensity ratings between PD men (*M* = 1.50, *SD* = .76) and HC men (*M* = 1.84, *SD* = .59) as well as between PD women (*M* = 3.16, *SD* = 1.03) and HC women (*M* = 2.29, *SD* = .71). Healthy men were rated as appearing to experience more intense emotion than PD men, while PD women were rated as appearing to experience more intense emotion than HC women. There was no significant Emotion x Sex interaction, $F(3, 27) = 1.81$, $p = .20$, $\eta^2 = .17$. The three way interaction was also non-significant, $F(3, 27) = 1.34$, $p = .28$, $\eta^2 = .13$.

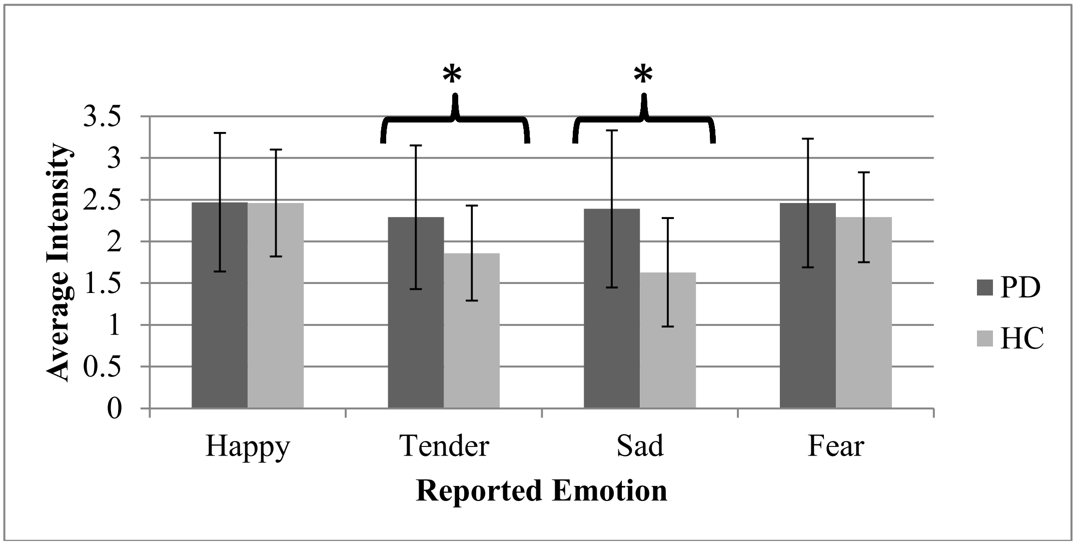

Figure 5. Raters' average emotional intensity (on a scale of 0-6) of facial expression by group and category of experienced emotion (error bars refer to SD).

Correlations Between Patients' CPIB Scores and Raters' Expressivity Judgments

We ran Pearson product-moment correlations to assess the relationship between patients' self-perception of communicative competency in daily life, as represented by the score on the CPIB questionnaire background measure, and raters' expressivity accuracy and intensity ratings collected in Study 2. Unlike the main analyses, which assessed individual raters' scores across the two groups of participants (PD and healthy controls), the CPIB correlation examined the relationship between an individual patient's CPIB score and the 10 raters' expressivity ratings for that one patient. We found no significant correlations between patients' CPIB scores and raters' expressivity or intensity scores when correlations were run according to each emotion (happy, tender, sad, and fear).

Discussion

In this experiment, ten female undergraduates served as "expressivity raters", reporting both the emotion they perceived from 30-second silent video clips, and the corresponding intensity of the emotion. The video clips that served as stimuli in the current experiment were drawn from Experiment 1, and reflected spontaneous emotion elicited in a group of 17 PD participants and 20 healthy age- and education-matched controls. Inter-rater reliability with respect to raters' perception of which emotion they were observing was good, while the inter-rater reliability of the intensity of emotion they observed ranged from good to excellent.

We found no significant group main effect for raters' accuracy, defined as a hit rate reflecting when the rater perceived the same emotion that the target subject reported experiencing in Experiment 1. We did find that raters were significantly less accurate at perceiving tenderness from facial expressivity across groups. Similarly, we found that fear was less accurately perceived than was Happiness or Sadness. Interestingly, raters were significantly more accurate for the HC group for Happy trials, while raters were significantly more accurate at perceiving fear in the PD group.

Interestingly, inaccurate responses in our experiment differed according to target subjects' disease status. For example, although Tender trials were poorly perceived regardless of group status, raters more often misattributed the facial emotion elicited in the PD group by Tender stimuli to be "Sad" (32% of the time), whereas raters misjudged HC participants' Tender trials as "Happy" (25% of the time). Apart from the most common error of declaring an emotion "Neutral" when the subject had actually reported feeling an emotion, raters predominantly misjudged PD participants' Fear clips to be "Disgust" (21% of the time) whereas raters predominantly misjudged HC participants' Fear clips to be "Happy" (21% of the time). This misattribution falls along valence lines, with HC subjects more commonly being misperceived as experiencing a positive emotion, whereas PD subjects were more likely to be misperceived as experiencing a more negative emotion than the one they actually were feeling.

This pattern of higher expressivity of positive emotions being seen for healthy controls and higher expressivity of negative emotions being seen in the PD group was also reported by Brozgold et al. (1998). Brozgold et al. (1998) videotaped 20 PD subjects, 21 healthy controls, as well as three additional neurological populations (those with schizophrenia, right hemisphere brain damage, and uni-polar depression) as they were asked to remember and speak about a pleasant and unpleasant personal emotional experience. Fifteen-second sections of the videos were extracted to provide eight positive trials and eight negative valence trials. Six naïve adults then rated the video segments with respect to the amount of positive and negative emotion each contained, as well as the perceived intensity of emotion. Additionally, Brozgold and colleagues correlated expressivity patterns with measures of social functioning. Not only was the PD group rated as expressing more negative emotion and less positive emotion than the healthy controls, but contrary to what might be expected, Brozgold et al. (1998) found that for PD patients, expression of more positive emotion was correlated with poorer social functioning (as determined by three different standardized assessment measures). The authors suggested that PD patients' expressivity practices may have been violating social display rules for what constitutes an appropriate emotional display. To the best of our knowledge, this is the only study, apart from ours, which has reported increased facial expressivity for negative emotions in the PD group when compared to healthy control subjects.

We did not find a correlation between PD patients' degree of self-perceived communicative impairment, as indicated by self-report scores on the Communicative

Participation Item Bank questionnaire (CPIB; Baylor et al., 2013), and raters' perception of PD patients' expressivity. The lack of correlations is not surprising, given that the CPIB specifically assesses patients' perceptions of their *spoken* abilities (e.g., asking for directions, persuading others, and communicating with friends or strangers), while raters' expressivity judgments for this experiment were based on silent facial expressions. Our choice to explore potential correlations between CPIB scores and facial expressivity was motivated by evidence that patients' self-reports of symptom severity may be reflected in some aspects of facial expressivity. For example, Lyons and Tickle-Degnen (2005) found a highly significant correlation between patients' self-reports of severity of PD-related symptoms (such as the ability to talk clearly or loudly, to express emotions facially, to gesture, to change posture, etc.) and raters' reports of smiling behavior in videotaped patient conversations. However, in keeping with our findings, Lyons and Tickle-Degnen (2005) did not observe a significant correlation between patients' self-report scores and raters' overall expressivity judgments. Future studies specifically exploring the relationship between patients' perceptions of communicative impairment (across *both* facial and vocal modalities) and raters' perception of these patients' expressivity would shed light on the degree to which patients' self-perception of impairment may reflect, or even *influence*, their social persona.

While raters' accuracy rates in our study were quite low overall, such low accuracy rates would only be surprising when compared to accuracy rates for posed emotional facial expressions, which tend to be unambiguous (Motley & Camden, 1988). Despite certain arguments that posed facial expressions are not representative of what we encounter in the real world (Gunes et al., 2008), the vast majority of studies exploring facial expression, as well as assessing subjects' ability to recognize facial expression, have relied upon posed images of facial expressions, usually taken from existing inventories such as the Ekman & Friesen (1976) Pictures of Facial Affect or the Penn Emotion Recognition Test (PERT; Gur et al. 2002), among others. However, the difference between spontaneous, involuntary expressions and volitional, posed expressions is significant, on both neurological and behavioral levels. Spontaneous and posed facial expressions are innervated by different neural pathways, with volitional, posed expressions originating in the cortical motor strip while involuntary, spontaneous expression is thought to originate from subcortical brain regions (Rinn, 1984). Spontaneous and posed facial expressions are also known to differ in the pattern of muscles that are activated (Ekman, 1991). Thus, most of what we know about emotion processing, in both healthy and clinical populations, may only hold true for posed expressions of emotion. Currently, very little work has explored individuals' perceptual abilities using spontaneous displays of emotion.

In fact, we could only find one study other than ours, that of Motley & Camden (1988), that explored rater accuracy for decoding both the categorical emotion and its intensity from samples of spontaneously elicited emotion. These authors had subjects engage in a naturalistic conversation with confederates who tailored the conversation to evoke anger, confusion, disgust, happiness, sadness and surprise at key moments in the dialogue. Subjects were wired with polygraph electrodes in order to provide physiological evidence of emotional arousal, and a photograph of the subject's facial expression was surreptitiously taken at a point in time tailored to correspond with the height of physiological arousal. These photos, along with additional photos of the same subjects posing the six emotional facial expressions, were then shown to naïve raters who were asked to determine what emotion they saw in the photos, and its intensity. Motley & Camden (1988) reported accuracy rates for these spontaneous expressions that, apart from Happiness, were not better than chance performance. When averaged across emotion categories, Motley & Camden (1988) reported recognition rates of 26% for spontaneously evoked facial expression, which was similar to our own rates of 23% rater accuracy averaged across emotion categories. However, raters in Motley & Camden's study performed significantly better when asked to judge the emotion of posed expressions, with an average of 81.5% correct ratings. The authors attributed the low accuracy rates for spontaneous emotion to the fact that we use contextual cues to guide our interpretations of emotion in real-world interpersonal communication. Work by Hall and Schmid Mast (2007) exploring spontaneous expression of feelings similarly found that naturalistic expression is hard to interpret for a number of reasons; such expressions can be unfamiliar to perceivers, complex and possibly idiosyncratic. As a result, such spontaneous expressions alone may not be particularly useful in guiding perceivers towards meaning. Thus, it may be that future studies wishing to use naturalistic, spontaneously-evoked emotion samples must take care to include situational context that will cue raters in a manner more closely resembling real-world interpersonal communication if they wish to achieve higher recognition accuracy rates. For example, if raters were provided with a narrative, situational context for the expressions they were viewing, it is likely that the subtleties of expression that surface with spontaneously-elicited emotion would be more accurately perceived. While spontaneously-elicited emotion samples in the absence of contextual cues are unlikely to provide accuracy rates representative of real-world emotion processing, such stimuli may still be more representative of real-world processing than experiments employing posed expressions, which are thought to rely on different neural enervation and different sets of facial muscles than naturalistically-elicited emotion (Ekman et al., 1997; Rinn, 1984).

Regarding the intensity of expressed emotion, in our study we observed a group main effect where PD participants were rated as *more* intensely facially expressive than their HC counterparts. This finding contradicts what has been reported in the majority of studies that have examined emotional expressivity in PD patients collected through video recordings (Simons et al., 2004; Smith et al., 1996; Saku & Ellgring, 1992; Simons et al., 2003) as well as through patient self-report questionnaires (Mikos et al, 2009). The only exception to this pattern was with the aforementioned study by Brozgold et al. (1998). This difference in findings may be due to methodological approach; most studies that reported decreased facial expressivity in PD patients used the Facial Affect Coding System (FACS; Ekman & Friesen, 1978) to quantify muscle movements (e.g., Saku & Ellgring, 1992; Simons et al., 2003; Smith et al., 1996), or else used computer imaging techniques to quantify dynamic facial movement (Bowers, Miller, Bosch, et al., 2006). In contrast, our expressivity ratings were based on global assessments, quantified on the scale of human perception rather than muscle units.

While the study by Mikos et al. (2009), which reported a decrease in emotional expressivity in the PD group, also relied on global assessments, their assessment took the form of a self-report questionnaire, the Berkeley Expressivity Questionnaire (Gross & John, 1995, 1997), requiring a judgment based on memory, not physical evidence, of emotional responses. In contrast, our raters based their assessment of subjects' expressivity on an impression gathered from 30 second silent video clips displaying subjects experiencing spontaneous emotion. Sampling for our expressivity occurred at the height of intense emotional experiences, in contrast to previous studies that sampled video footage during posed emotional situations (Bowers et al., 2006), while watching only amusing film clips or engaging in pleasant conversation (Simons et al., 2004), or while smelling potent, distasteful odors (Simons et al., 2003; Saku & Ellgring, 1992). The format of our elicitation paradigm most closely mirrored that of Smith et al. (1996), who did sample video footage from material elicited using emotional stimuli of both positive and negative valence, but their expressivity findings were based on FACS analyses, not social impressions. The only study whose findings resembled ours, Brozgold et al. (1998), was the only study, also like ours, to use holistic rater reports. We speculate that such holistic ratings may be more indicative of real-world expressivity perceptions on a social, meaningful level than are findings resulting from measurements of muscle action units. However, as noted above, one methodological drawback to both our and Brozgold et al. (1998)'s study was that spontaneously elicited emotion samples were presented in the absence of situational context; future studies using spontaneously elicited emotion would benefit from providing raters with additional contextual cues in order to more closely approximate real-world emotion processing. For example, raters could be provided with background specifics about narratives of the film scenes that were used to evoke the emotional responses. This might allow for improved accuracy rates, without limiting the ability to test for recognition of a broad range of emotions.

We have two potential explanations for why holistic sampling of spontaneous emotional expressions in PD and healthy control samples led to increased reports of PD negativity in both our study and that of Brozgold et al. (1998). The first, proposed by Brozgold and colleagues, is that PD subjects may be violating social display rules in the way they display emotion. That is, it is possible that healthy subjects were able to down-regulate their negative expression in a manner that conforms to socially-expected norms, whereas PD patients, due to the neuropathology of the disease, were not. The ability to voluntarily control one's experience or expression of negative affect has been explored in studies using neuroimaging techniques while subjects were asked to either suppress emotion or reappraise an emotionally evocative situation in a more detached or unemotional manner in order to lessen the intensity of their emotional response (Goldin, McRae, Ramel, & Gross, 2008; Ochsner & Gross, 2004; Ochsner et al., 2004; Ochsner, Bunge, Gross, &

Gabrieli, 2002; Ohira et al., 2006; Phan et al., 2005). This process of cognitively controlling emotion, and specifically negative emotion, appears to involve activation in the dorsal and medial regions of the frontal cortex and orbitofrontal cortex (e.g., Ohira et al., 2006; Phan et al., 2005; Ochsner et al., 2002; Goldin et al., 2008), with the exact structures involved differing according to the specific experimental task. The fMRI study whose task most resembled ours was that of Levesque et al. (2003) who had twenty healthy adult females view sad film clips under two conditions: a natural viewing and one in which they were asked to suppress any emotional response. During the suppression task, increased activation was found in subjects' right dorsolateral prefrontal cortex (DLPFC) as well as in the right orbitofrontal cortex, suggesting that these regions are involved in voluntary suppression of feelings of sadness. As children, we are conditioned to learn a set of social display rules which govern our behavior and dictate the amount of emotional expressivity that is considered "normal" in certain situations (Ekman & Friesen, 1969). In our experimental situation, such rules would have been in effect, as subjects were viewing film clips in the presence of an experimenter. As such, it might be expected for subjects to socially down-regulate or mask the intensity of their negative emotion in order to conform to social norms. However, it is known that PD affects the same regions of the brain, specifically the dorsolateral prefrontal cortex, that appear to be required for the down-regulation of negative emotion and other high-level cognitive control (Cools, Stefanova, Barker, Robbins, & Owen, 2002; Cropley, Fujita, Innis, & Nathan, 2006; Owen, 2004).

To the best of our knowledge, the link between PD patients' neuropathology and their ability to voluntarily suppress intense expressions of negative emotion has yet to be explored. On a behavioral level, Simons et al. (2003) noted that PD patients had difficulty, relative to healthy controls, in masking a negative olfactory experience with a positive facial expression. The authors postulated that this difficulty stemmed from disease-induced challenges in performing two tasks of opposite nature simultaneously. However we suspect that patients' inability to mask their negative experience effectively may indicate a more complex deficit. Evidence from positron emission tomography (PET) studies and fMRI studies provide evidence that the dopamine depletion incurred by PD disrupts the frontal-striatal neural circuitry required for controlling one's negative affect in a manner that is socially acceptable (see Cropley et al. (2006) for a review). However, at present, the relationship between dopaminergic deficiencies and the ability to modulate one's social affect has yet to be elucidated. Future studies that specifically attend to the relationship between individual subjects' neuropathology and their ability to modulate their expression of negative emotion would be important in order to understand how expressive differences may influence how PD patients are socially perceived.

A second possible explanation for the increased expressivity we observed in the PD group involves a symptom of PD known as emotionalism (House, Dennis, Molyneux, Warlow, & Hawton, 1989). This symptom involves a heightened and excessive sentimentality that is not under patients' conscious control and is often socially inappropriate (Madeley, Biggins, Boyd, Mindham, & Spokes, 1992; Marsh, 2000). Upon becoming emotionally aroused past a certain threshold, patients with symptoms of emotionalism may cry uncontrollably, regardless of whether it was a happy, sad, or other type of intense emotion they were experiencing. Only one of the 17 patients in our study (or roughly 6% of the patient group) had this as a diagnosed symptom in her medical records, however other PD studies have reported a similar or higher prevalence of this symptom. Anecdotal evidence during our recordings had 35% (six out of 17 people) of our patient group demonstrating various stages of crying (ranging from tearfulness to uncontrolled sobbing), compared to more restrained tearfulness in 10% (two out of 20 people) of our healthy control group. Siddiqui et al.(2009), in a large-scale study that included patients with various neurological diseases, found that 4.7% (18/387) of idiopathic PD patients in their sample, and 7.8% (8/108) of patients with other forms of PD, reported episodes of uncontrollable crying during which they did not feel sad. Madeley et al. (1992), in a study of 47 PD patients, found that 38% of the patients reported experiencing increased tearfulness since disease onset, while full emotionalism (as defined in the study by House et al., 1989 and including such characteristics as weepiness coming suddenly, with little warning, and having no control over stopping it) was present in nearly 11%. A study by Houeto et al. (2002) identified the symptom (referred to by these authors as "emotional hyperreactivity") in 15 out of the 24 patients in their study, a startling 62.5% of the sample. As a result, it is possible that more intense emotion appeared on the faces of PD participants than HC participants in our study, even though there were no group differences in Experiment 1 with respect to how intensely the two groups reported their subjective emotional experience of the film clips. Indeed, we found that raters in Experiment 2 perceived PD patients to be expressing sadness more than twice as often, on average, as HC participants (25% versus 11%).

On a social level, the direction of expressivity may matter less than the fact that PD patients appear to be *differently* expressive than healthy controls. Furthermore, our own, as well as additional studies (Mikos et al., 2009; Miller et al., 2007; Miller, Noble, Jones, Allcock, & Burn, 2008) have shown that PD patients' expressivity does not accurately reflect patients' subjective emotional experience. The fact that our experiment showed a consistent tendency for raters to misattribute more negative emotion to PD patients than to HC participants, despite both groups reporting similar levels of emotional affect, may have significant social consequences; it would be no surprise if such a misattribution would contribute to a more negative overall social perception of this patient population, as has been widely reported in the literature (Hemmesch et al., 2009; Jaywant & Pell, 2010; Pentland et al., 1987; Pitcairn et al., 1990). This highlights the need for PD patients' social partners, caregivers and healthcare workers to find new ways, not dependent upon facial expressivity, to understand PD patients' emotional reality.

Experiment 3: Social Perception of Patients with PD

Normal spoken communication requires the ability to integrate a large number of dynamic cues from multiple modalities (visual, auditory, temporal, spatial) to draw meaning from the exchange (Massaro & Stork, 1998). Such a complex interaction requires participants to perceive emotional cues, which can be as subtle and dynamic as a change in vocal intonation or a facial micro-expression lasting between .5 ms and 4 seconds (Ekman, Matsumoto, & Friesen, 1997), as well as respond in an appropriate manner (Wolpert, Doya, & Kawato, 2003). Studies have shown that conversational partners experience a greater sense of rapport when they are more aligned with each other as opposed to when their speech or body gestures diverge (Bernieri, 1988; Koss & Rosenthal, 1997). This alignment of vocal prosody and bodily gesture is referred to as "interactional synchrony" or "entrainment" and facilitates a sense of interpersonal connection (Lakin, Jefferis, Cheng, & Chartrand, 2003; Shockley & Fowler, 2003). However, engaging in such an attuned exchange demands a high level of temporal precision and motor control to be able to execute appropriately nuanced vocal, facial, and gestural responses (Wolpert et al., 2003). Patients with PD may face significant social barriers due to motor, cognitive, and emotional processing deficits that interfere with their ability to both perceive and express the vocal and gestural cues that are integral to social communication (Bavelas, Black, Lemery, & Mullett, 1986; Jacobs et al., 1995; Meltzoff, 2002; Zgaljardic, Borod, Foldi, & Mattis, 2003).

There is evidence that PD patients' deficits in basic emotion processing and expression may lead to severe social consequences. Several studies have reported that speakers with PD are perceived more negatively than their healthy counterparts when listeners are naïve to patients' disease status. Using a picture description task, Jaywant & Pell (2010) asked listeners to rate 70 speech samples on a series of dichotomous personality traits (e.g., bored-interested, angry-friendly, sad-happy, unintelligent-intelligent, etc.) of the speaker. Listeners rated speakers with PD as significantly less interested, less involved, less friendly and less happy than healthy speakers. These results echo the findings of Pentland, Pitcairn, Gray, & Riddle (1987) and Pitcairn, Clemie, Gray, & Pentland (1990) who found that both health care professionals and naïve members of the public, respectively, rated Parkinson's speakers as more anxious, more suspicious, less happy, less interested, less likable, and as establishing a poorer rapport with the interviewer than control speakers. Interestingly, in the Pentland et al. (1987) study, listeners formed this negative opinion of PD patients solely from visual cues, as their task was to rate silent video recordings depicting an interaction between patients (with or without PD) and doctors. The fact that Pitcairn et al. (1990) and Jaywant & Pell (2010) reported the same negative impression of PD patients from acoustic cues as Pentland et al. (1987) did from visual cues provides consistent evidence that PD patients face considerable social communication barriers. Jaywant and Pell (2010) suggested that these negative social impressions would likely have significant ramifications for patients' social engagements, limiting opportunities for social interaction and effective communication.

Given evidence that PD patients report experiencing emotions in a manner similar to healthy controls when shown emotional films (Experiment 1), but that their corresponding facial expressions are judged to be more intense than those of healthy controls by naïve raters

(Experiment 2), a final experiment was run to gauge how *age-matched peers*, naïve to group status, formed social impressions of the same cohort of PD and HC participants who served as the basis for Experiments 1 and 2, across a number of social attributes.

Participants

Twenty healthy older adults, ten male, ten female (Age $M = 67.04$, $SD = 7.54$; Education $M = 16.15$, $SD = 2.92$) were recruited through fliers posted in the Montreal Neurological Institute and through the McGill Registry for Cognitive Neuroscience Research. Participants were native English speakers (some native English/French bilinguals), reported having normal (or corrected-to-normal) hearing and vision, and were judged to not have dementia, based on background screening measures using the Montreal Cognitive Assessment (MOCA; Charbonneau, Whitehead, & Collin, (2005)). Participants were financially compensated for their time and transportation costs associated with taking part in the experiment.

Stimuli

Recall that participants in Experiment 1 were asked to describe "what happened and how it made them feel" following a subset of the films they viewed, i.e., after one specific film clip per emotion valence category ("Forrest Gump" for positive, "Marley and Me" for negative, "Dead Poets Society" for neutral). These narrative samples served as a basis for constructing stimuli in the current Study that focused on social judgments of participants with and without PD. The length of time participants in Experiment 1 spoke during these interview segments varied considerably; some spoke for less than 10 seconds, while others spoke for several minutes. We chose to use the final (roughly) 10 seconds of each interview to present as stimuli in order to capture more emotional aspects of the narrative, as most people started by talking about what happened in the film and ended by describing their emotional reaction to it. We selected the final ten seconds instead of the first ten seconds with the goal of consistently providing a sample that ended naturally, to capture nuances about how each participant might choose to end a topic in normal conversation. Interviews were edited in this manner by the experimenter, resulting in stimuli that lasted between 9 and 11 seconds, allowing some variation to avoid cutting a speaker mid-word. All interview segments were faded in to soften the initial edit. Three interview segments, one per valence category, were constructed for each of the 37 participants in Experiment 1, yielding 111 trials for the Social Judgment task.

The presentation order of the interview clips was randomly generated to form a movie "Version A", ensuring that no two clips from the same subject ever appeared in successive order. All of the clips, as well as built in rating time, were made into a single movie lasting approximately 111 minutes. "Version B" used a presentation order that was the mirror image of the first, to mitigate potential order effects in the ratings.

Procedure

As mentioned above, this experiment was designed to take place during group viewing sessions, although due to scheduling constraints, two social raters did the experiment alone. The rest took part in groups of between two and four people. Groups were randomly assigned to one version of the movie. Eleven social judgment raters (six female) were randomly assigned to Version A, and nine raters (four female) were assigned to Version B (the slight imbalance between lists was due to scheduling issues). After providing written consent, participants were handed a paper answer sheet and went through a practice round to familiarize themselves with the scoring system. All participants were naïve to patient group status, and were told only that this was a study about social perceptions.

Participants first saw a 10 second practice clip with a participant who was excluded from Experiment 1 due to not adhering to task instructions, and then were told to make an "x" along a series of dichotomous scales to indicate their social judgments. Each scale had a midpoint marked on it, and a word on either end. The selection of adjectival scales included in the current study was modeled on Jaywant & Pell (2010), Hemmesch et al. (2009), and Miller et al. (2008), but included additional items to tap into factors thought to be central to rapport-building (as identified by Tickle-Degnen & Rosenthal, 1990). Each trial's scales began with the two questions, "Would you be interested in getting to know this person better?" and "How likely do you think it is that you could have a happy/fulfilling social life with this person?". After each of those questions, participants had to make a mark on scales that read "Unlikely" on the left end, and "Very likely" on the right end. Next, raters were told to "Please mark your perception of this person:" along dichotomous scales with one word at each end and a mark indicating the midpoint. Half of the questions had the positive attribute on the right side and half had the positive attribute on the left end. These scales included "Involved—Passive", "Interested—Bored", "Unfriendly—Friendly". After making these judgments, participants were again shown the same interview clip, then asked to make their remaining social decisions about the subject for the following personality attributes: "Caring—Unfeeling", "Unintelligent—Intelligent", "Pessimistic—Optimistic", "Attentive—Distracted", "Not physically attractive—Very physically attractive". After the practice round, raters were encouraged to ask any questions they might have. The raters were instructed to go with their initial impressions, and were told that they would be seeing the same person multiple times but they did not need to remember how they had rated the person previously, but should make a fresh set of social judgments each time. As this was a group test for most of the participants, the experimenter controlled the pacing of the experiment by pausing the film at the end of each trial to ensure that all raters had sufficient time with which to make their judgments. Breaks were built in after every 25 trials, and the duration of the breaks were dependent upon the needs of the members of each group but generally lasted between two and five minutes.

At the end of the experiment, social raters were given an exit survey to learn whether they knew any of the participants they had seen in the videos. Despite random sampling, a few of the raters reported being familiar with the subjects in Experiment 1. To control against effects of familiarity on social judgments, we excluded raters' social judgment ratings for trials where they knew the person. This resulted in 4 PD subjects and 2 HC subjects' video footage being rated by 19 social judgment raters, instead of 20. An additional HC participant from Experiment 1 was known by two separate raters, so that one HC subject's social assessments were based on data from 18 raters.

The exit survey we administered checked whether any of the participants knew people who had PD. Of the 20 raters, 9 had known people (ranging from a relative to a friend or colleague) who had Parkinson's disease. Only after completing the exit survey were subjects told that this was an experiment about Parkinson's disease. When they learned this, more than 75% of the participants expressed surprise and said that they hadn't been aware that any of the videos had been of adults with PD. The entire social judgment experiment took about 2.5 hours per testing session.

Results

Scales for the social attributes were recoded when appropriate by the first author to correspond with a score of 0 to 6, with the positive social attribute always corresponding with the "6" while the negative social attribute was on the side valued at "0". For the global social judgment scale, a 2 x 3 x 2 repeated measures ANOVA was conducted to assess the effects of Group x Interview Valence x Sex on raters' perception of social desirability. A series of 2 x 3 repeated measures ANOVAs was conducted to assess the effects of Group (PD, HC) x Interview Valence (Negative, Neutral, Positive) on all social judgment measures. Interview Valence refers to the nature of the film clip (i.e., a Tender film, a Sad film, and a Neutral film) used to evoke the audiovisual narrative sample that served as the basis for this experiment.

Please see Table 2.6 (located on page 136) for a summary of mean social judgment ratings assigned to each group according to each social attribute. With the exception of scales for Physical Attractiveness and Caring, for which there were no significant group differences, all other social judgment scales yielded significant group differences, with the more positive social judgments consistently attributed to the healthy control group (see below for statistical reporting). Valence of the film clip used to evoke the interview that served as the basis for the social judgments did appear to make a significant difference in all but two social judgment outcomes (with the exception being for the Global Social Judgment scale and the Physical Attractiveness scale).

Global Social Judgment Ratings

A significant Group main effect, $F(1, 19) = 51.15$, $p < .001$, $\eta^2 = .73$, was observed for the global social judgment question, which was calculated by taking an average of the two scores generated (on a 0-6 scale, with 0 = "not at all" to 6 = "very likely) from the questions "How likely do you think it is that you could have a happy/fulfilling social life with this person?" and "Would you be interested in getting to know this person better?". Pairwise comparisons with a Bonferroni adjustment showed that raters were significantly more interested ($p < .001$) in socially engaging with HC subjects ($M = 2.36$, $SD = .75$) than they were with PD subjects ($M = 2.15$, $SD = .73$) overall. The main effect of interview Valence for the global social judgment ratings was significant at $F(2, 38) = 5.69$, $p = .02$, $\eta^2 = .23$. Overall, participants responding to negative valence stimuli were viewed significantly more favorably by raters ($M = 2.41$, $SD = .80$) than when responding to positive valence stimuli ($M = 2.26$, $SD = .72$). The main effect of sex was not significant, $F(1, 19) = .94$, $p = .34$, $\eta^2 = .05$. There was a significant interaction of Group x Target Sex, $F(1, 19) = 6.54$, $p = .02$, $\eta^2 = .26$, with significantly higher ratings for HC members of each sex (HC men: $M = 2.47$, $SD = .74$; PD men: $M = 2.07$, $SD = .77$; HC women: $M = 2.44$, $SD = .76$; PD women: $M = 2.23$, $SD = .68$). The three-way interaction effect was not significant, $F(2, 38) = 3.07$, $p = .058$, $\eta^2 = .14$.

Rating of Specific Social Characteristics

Passive—Involved: There was a significant effect of Group on how involved participants were judged to be, $F(1, 19) = 33.79$, $p < .001$, $\eta^2 = .64$. There was also a significant effect of the Valence of stimuli on perceived Involvement, $F(2, 38) = 25.66$, $p < .001$, $\eta^2 = .58$. The interaction effect was not significant, $F(2, 38) = 2.34$, $p = .11$, $\eta^2 = .11$. Pairwise comparisons revealed that PD subjects were rated as significantly less Involved than HC participants. Subjects who were responding to Neutral stimuli were rated significantly less involved compared to when they were talking about either Positive or Negative stimuli.

Bored—Interested: There was a significant effect of Group on how interested participants were perceived to be, $F(1, 19) = 6.54$, $p = .019$, $\eta^2 = .26$. There was also a significant effect of the Valence of stimuli on the perceived interest level of participants, $F(2, 38) = 48.50$, $p = .000$, $\eta^2 = .72$. The analysis did not yield a significant interaction effect, $F(2, 38) = 1.64$, $p = .21$, $\eta^2 = .72$. Healthy control participants were judged to be significantly more interested than PD participants. Participants, across groups, were judged to be less interested when responding to stimuli that were Neutral in valence.

Unfriendly—Friendly: There was a significant effect of Group on Friendliness scores, $F(1, 19) = 67.68$, $p < .001$, $\eta^2 = .78$. Valence of stimuli used to evoke the interview sample also appeared to play a significant role in how Friendly participants appeared, $F(2, 38) = 25.63$, $p < .001$, $\eta^2 = .58$. There was a significant interaction effect of Group and Valence, $F(2, 38) = 5.30$, $p = .01$, $\eta^2 = .22$. Pairwise comparisons revealed that each group and valence category was significantly different from each other, with the HC group responding to Positive stimuli rated as most Friendly, followed by the HC group responding to Negative stimuli, Followed by the HC Group responding to Neutral stimuli (the PD group was rated significantly less friendly than the HC group across all Valence categories).

Unfeeling—Caring: No significant effect of Group was observed for the perception of how caring subjects appeared, $F(1, 19) = .07$, $p = .79$, $\eta^2 < .01$. There was a significant effect of Valence, $F(2, 38) = 75.76$, $p < .001$, $\eta^2 = .80$, as well as a significant interaction effect of Group by Valence, $F(2, 38) = 71.25$, $p < .001$, $\eta^2 = .79$. Pairwise comparisons showed that PD subjects were rated significantly more caring than HC's when responding to Negative valence stimuli, while HC subjects were rated significantly more caring than PD subjects when responding to Neutral valence stimuli. HCs were rated as significantly more caring when responding to (in decreasing order) Positive stimuli, then Negative, then Neutral, whereas PD subjects were rated as most caring when responding to Negative, then Positive, then Neutral stimuli.

Unintelligent—Intelligent: There was a significant effect of Group on perceived Intelligence, $F(1, 19) = 16.31$, $p = .001$, $\eta^2 = .46$. A significant main effect of Valence was observed on raters' perception of subjects' Intelligence, $F(2, 38) = 26.85$, $p < .001$, $\eta^2 = .59$. There was also a significant interaction effect of Group x Valence, $F(2, 38) = 6.96$, $p = .003$, $\eta^2 = .27$. Pairwise comparisons revealed that PD participants were rated significantly more intelligent than HC subjects when responding to Negative stimuli, while HC participants were rated significantly more intelligent than PD subjects when responding to either Neutral or Positive stimuli.

Pessimistic—Optimistic: There was a significant effect of Group on how Optimistic subjects were perceived to be, $F(1, 19) = 38.49$, $p < .001$, $\eta^2 = .67$. There was also a main effect of Valence on the perception of Optimism, $F(2, 38) = 11.83$, $p < .001$, $\eta^2 = .38$. There was no significant interaction effect, $F(2, 38) = .33$, $p =.72$, $\eta^2 = .02$. Subjects with PD were perceived to be significantly less Optimistic than their healthy counterparts. Participants, across groups, were perceived as most optimistic when speaking about Positive valence stimuli, and least optimistic when speaking about Neutral stimuli.

Distracted—Attentive: There was a significant main effect of Group on Attentiveness ratings, $F(1, 19) = 19.80$, $p < .001$, $\eta^2 = .51$. There was also a significant effect of Valence of stimuli on perceived Attentiveness, $F(2, 38) = 39.55$, $p < .002$, $\eta^2 = .68$. The interaction for

Distracted—Attentive was marginal at $F(2, 38) = 3.22$, $p = .051$, $\eta^2 = .15$. All HC subjects were rated significantly more attentive, across valence categories, than PD subjects, however the valence order varied by group; HC subjects were rated most attentive (in descending order) when speaking about Positive stimuli, followed by Negative, followed by Neutral, whereas PD subjects were rated most attentive when speaking about Negative stimuli, followed by Positive stimuli, followed by Neutral.

Not Physically Attractive—Very Physically Attractive: No significant Group differences were observed for Attractiveness ratings $F(1, 19) = 1.48$, $p = .24$, $\eta^2 = .07$. There was also no significant effect of Valence, $F(2, 38) = 1.13$, $p = .30$, $\eta^2 = .06$. The interaction effect was similarly non-significant, $F(2, 38) = .93$, $p = .35$, $\eta^2 = .05$.

In summary, with the exception of physical attractiveness, group status significantly altered the way subjects were perceived by their age-peers. Subjects with PD were consistently rated more negatively than healthy controls, across social attributes. The valence of stimuli used to evoke the interviews that served as the basis for the social judgment task did have an effect on how involved, interested, friendly, caring, intelligent, optimistic, and attentive participants appeared. The underlying valence of the interview segments did not affect perceptions of global social desirability, nor perceptions of physical attractiveness.

Correlations Between Experiments

We ran correlations between data collected in Experiment 1, Experiment 2, and Experiment 3 to determine the relationship between: (a) Subject’s self-reported intensity of positive valence stimuli (Experiment 1) and Expressivity raters’ perceived intensity of subjects’ facial expressions in response to positive valence stimuli (Experiment 2) and social judgment raters' global social judgment scores on trials where subjects were responding to positive valence film clips (Experiment 3). We also ran correlations on the three experiments' corresponding negative valence scores, as well as the accuracy rates between the three experiments, both globally and according to valence of stimuli.

Table 2.6

Mean rater scores on social attribute scales assigned to PD and HC subjects (higher scores indicate more of the positive attribute)

Social Attributes Scale	HC				PD				Significance		
	Positive	Negative	Neutral	Total	Positive	Negative	Neutral	Total	Group	Valence	Interaction
Global Social Judgment	2.57	2.54	2.35	2.49	2.18	2.15	2.12	2.15	$p < .001$	$p = .06$	n.s.
Passive--Involved	3.5	3.44	3.06	3.33	3.13	3.26	2.65	3.01	$p < .001$	$p < .001$	n.s.
Bored--Interested	3.57	3.49	2.92	3.33	3.54	3.36	2.73	3.21	$p = .02$	$p < .001$	n.s.
Unfriendly--Friendly	3.67	3.46	3.35	3.49	3.42	3.12	2.83	3.13	$p < .001$	$p < .001$	$p < .001$
Unfeeling--Caring	3.79	3.66	3.17	3.54	3.74	4.14	2.78	3.55	n.s.	$p < .001$	$p < .001$
Unintelligent--Intelligent	3.98	3.65	3.62	3.75	3.67	3.66	3.48	3.60	$p < .001$	$p < .001$	$p < .001$
Pessimistic--Optimistic	3.19	2.88	2.82	2.96	2.87	2.62	2.56	2.68	$p < .001$	$p < .001$	n.s.
Distracted--Attentive	4.01	3.82	3.43	3.76	3.66	3.78	3.23	3.56	$p < .001$	$p < .001$	$p = .05$
Not Physically Attractive--Very Attractive	2.86	2.78	2.68	2.78	2.62	2.7	2.59	2.64	n.s.	n.s.	n.s.

(The HC and PD columns are grouped together under the heading "Group & Valence".)

Accuracy

Pearson product-moment correlations (where alpha = .05) were run between accuracy scores in Experiment 1 (i.e., the accuracy with which participants' self-reported emotion matched the target emotion of the trial) & Experiment 2 (i.e., how accurately the raters were able to judge the emotion that participants in Experiment 1 reported experiencing). These correlations were conducted according to the valence of the stimuli used to evoke the scores (positive or negative). The goal of these correlations was primarily to explore how the valence of experienced emotion (Experiment 1) contributed to its expression (as indexed by accuracy rates in Experiment 2). Additionally, these scores from Experiment 1 and 2 were correlated with the global social judgment scores in Experiment 3, to explore the relationship between valence of emotional stimuli, the degree to which its expression was accurately perceived, and social correlates relating to Experiment 1 participants' expression. Correlations were run separately according to the group of target participants (PD, HC). We found a significant, large negative correlation between accuracy scores for the HC group on negative valence trials in Experiment 1 and raters' accuracy at perceiving the emotion of these negative trials in Experiment 2 ($r(18) = -.54$, $p = .02$). In other words, for trials in which HC participants reported experiencing the target negative affect with high accuracy, this negative affect was not accurately perceived by raters. We found a marginally significant medium strength positive correlation for the PD group's correlation for positive valence trials between Experiments 2 and 3 ($r(15) = .47$, $p = .056$). All other accuracy correlations between the three experiments were non-significant. Please see Table 2.7 for full results.

Intensity

Pearson product-moment correlations were run between intensity scores that were self-reported by subjects in Experiment 1 and intensity scores perceived by expressivity raters in Experiment 2 (which corresponded to the same participants as in Experiment 1) to explore whether subjective intensity of emotion was perceived differently by raters according to group status. Additionally, intensity scores from Experiment 1 and 2 were correlated with global social judgment scores (Experiment 3) to learn how intensity of subjective experience, intensity of perceived facial expression, and resulting social judgments may have differed according to group status. These correlations were calculated according to the valence of the stimuli used to evoke the ratings (positive or negative). Correlations were run separately by group (PD, HC). There were no significant correlations between the intensity ratings in the three experiments. There was a marginal, medium-strength correlation between Experiment 1 and Experiment 2 negative valence trials for the HC group ($r(18) = .42$, $p = .065$). Please refer to Table 2.7 for full results.

Table 2.7
Pearson product-moment correlations between data from Experiment 1 (self-report), Experiment 2 (expressivity) and Experiment 3 (social judgment)

Correlated experiments, by group					
		Accuracy		Intensity	
Group	Experiments	Positive trials	Negative trials	Positive trials	Negative trials
PD	1 & 2	-0.26	-0.23	0.34	0.08
	2 & 3	0.47	0.08	0.23	0.18
	1 & 3	0.13	0.14	0.13	0.00
HC	1 & 2	-0.27	*-0.54	-0.12	0.42
	2 & 3	0.27	-0.31	0.22	-0.12
	1 & 3	-0.15	0.12	-0.07	-0.20

*$p < .05$

Intensity (Experiment 1) to Accuracy (Experiment 2) Correlations

We ran Pearson product-moment correlations in order to see whether there were any group differences in correlations between the intensity with which subjects in Experiment 1 reported experiencing emotion and the corresponding accuracy with which raters in Experiment 2 were able to perceive the emotion felt by subjects in Experiment 1. All correlations, across both groups, were not significant (all $|r|$'s <.40, all p's >.12).

Correlations between patients' CPIB scores and Global Social Judgments

We ran Pearson product-moment correlations on PD patients' CPIB score, which assesses their self-perceived level of spoken communicative competency in daily life, and raters' global social judgment scores. The correlation was non-significant (r = .28, p = .27).

Discussion

In this experiment, 20 age-peers performed social judgments on a series of 10-second samples of video clips edited from Experiment 1. Unlike the silent edited video clips that served as the stimuli for Experiment 2, the video clips in Experiment 3 contained both auditory and visual cues. In the current experiment's video clips, subjects in Experiment 1 described their responses to film clips that were neutral, positive, or negative in valence. After watching each video, social judgment raters assigned the person they had just observed a score, on a scale of 0-6, that corresponded to how friendly, optimistic, caring, involved, interested, intelligent, attentive, and physically attractive raters perceived subjects to be. These social judgments were made on the basis of audiovisual cues available in the approximately 10 second film clips which presented subjects from Experiment 1 describing a movie clip they had just seen.

For social attributes where significant group differences were seen, with only two exceptions[2], the more negative social judgment was consistently attributed to the PD group. This echoes the growing body of literature indicating that PD patients garner more negative social impressions when rated by young adults, both those trained in the health professions as well as members of the general public, on the basis of silent video footage (Pentland, Gray, Riddle, & Pitcairn, 1988; Pentland et al., 1987) and recorded vocal samples (Jaywant & Pell, 2010; Pitcairn et al., 1990). In light of evidence suggesting there may be age-related declines in emotion processing and social perception (Ruffman et al., 2008; Sullivan & Ruffman, 2004), we similarly employed young adult raters for our expressivity task in Experiment 2. However, our goal in Experiment 3 was to assess the ramifications PD might have on subjects' social lives, and as such, we were interested in the social judgments of age-peers. To the best of our knowledge, only one study has hitherto explored social perception of PD patients by age-peers, however this study by Hemmesch et al. (2009) was concerned with how social desirability of PD patients was affected by degree of facial masking. As such, Hemmesch and colleagues did not include a control group of healthy adults. However, in much the same way age-peers in the study by Hemmesch et al. (2009) rated those with less facial masking (and therefore, those that were presumably responding more like healthy adults) as more desirable social partners, the older adult raters in our experiment indicated a clear social preference for healthy control participants over our PD participants.

[2] PD patients were rated as more caring and more intelligent than HCs when responding to negative valence stimuli only.

It appears that the negative social judgments attributed to subjects with PD may stem primarily from disease-related changes in emotionally expressive communication. We observed no significant group differences or valence differences for the social judgment of physical attractiveness in our experiment, which suggests that the more negative social judgments attributed to members of the PD group are due to disease-induced changes in aspects of communication, not due to changes in physical appearance alone. Hemmesch et al. (2009)'s raters formed their social judgment on the basis of video footage with audio content that had been filtered to preserve nonverbal qualities of the speech while masking the verbal content. When Jaywant & Pell (2010) asked raters to provide separate judgments of the linguistic content of the vocal samples (e.g., amount of detail included, comprehensibility, coherency, how interesting it was, etc.) and holistic, social judgments of the speaker of the vocal samples, PD and control groups were not rated differently with respect to linguistic content, but only with respect to overall social perceptions. Taken together, these findings indicate that it is likely the emotional aspects of PD patients' expressive communication that are responsible for the negative social impressions. To the best of our knowledge, ours is the first study to explore raters' social perceptions of PD subjects using unaltered, multi-modal audiovisual samples.

On the basis of the increased negative expressivity we observed in the PD group of our Experiment 2, we propose that PD patients may have difficulty down-regulating their intense negative affect in a manner that is socially appropriate. Given that the same fronto-striatal circuitry that is responsible for conscious inhibition of emotion has been shown to be impaired in PD (Cools et al., 2002; Cropley et al., 2006; Owen, 2004), it would follow that PD patients may have difficulty controlling their affect. As a result, PD patients who display more negative emotion than is socially expected might lead healthy peers to perceive individuals with PD as less suitable social partners.

While we propose that this negative social perception is occurring due to patients being unable to consciously adjust their emotional response, Pitcairn, Clemie, Gray, & Pentland (1990) offered a parallel reason for the negative social perception, implicating the same faulty neural circuitry: Pitcairn et al. (1990) suggest that the negative social impressions may be due to the appearance of overly-conscious control of emotion. Pitcairn and colleagues analyzed silent video footage of PD and healthy control subjects being interviewed, using a simplified version of Ekman & Friesen's Facial Affect Coding System (1978). They found that PD patients were exhibiting significantly more "posed" smiles that appear phony or insincere, while the control group displayed many more spontaneously "happy" smiles. They proposed that such changes in emotional presentation may lead social partners to judge PD patients as being "false". This, combined with other PD-induced changes such as facial masking and decreased gesture and body movement, might lead to a perception of PD patients being cold, withdrawn, and less trustworthy or likeable than a healthy person.

Pitcairn et al. (1990)'s "posed smiles" hypothesis and our own "impaired emotional inhibition" hypothesis both implicate the same impaired neurological process. Rinn (1984) notes that spontaneous facial expressions require different neural circuitry than do posed expressions. Volitional expression requires the pyramidal system, which is largely spared in PD, whereas spontaneous facial expression relies on the extra-pyramidal, largely subcortical system, which is compromised by the disease (Rinn, 1984). Pitcairn et al. (1990) suggest that PD patients must compensate for the lack of spontaneous facial expression with consciously controlled expressions that appear posed, and, as such, may feel inauthentic to viewers, leading to the sense that individuals with PD are less friendly and more deceptive and aloof than healthy individuals.

Our proposition that patients with PD experience difficulty masking displays of negative emotion does not contradict the proposal set forth by Pitcairn et al. (1990), as there is evidence that different brain regions are associated with the expression and processing of positive and negative emotion (Beraha et al., 2012; Sackeim et al., 1982). Indeed, in Experiment 2, we found that the relative degree of expressivity differed according to valence, with PD patients expressing less positive, and more negative, emotion relative to healthy controls. It may be that the social challenges patients with PD face are due to a detrimental combination of decreased ability to display genuine positive affect as well as a decreased ability to mask or down-regulate negative affect (Simons et al., 2003; Pitcairn et al., 1990). While not explored in the current experiment, it is entirely possible, given the well-documented challenges PD patients have processing emotion (Gray & Tickle-Degnen, 2010) and being able to understand others' experiences (Freedman & Stuss, 2011; Mengelberg & Siegert, 2003; Monetta, Grindrod, & Pell, 2009; Poletti et al., 2011), that PD patients' real-life interactions are further compromised by patients being unable to read others effectively and respond in an appropriate manner. Taken together, the existing body of evidence clearly demonstrates that patients face significant social barriers as a result of disease-induced changes in their communication abilities.

There are several approaches for mitigating the social communication challenges these patients face. Greater awareness, on the part of caregivers, physicians, and friends of people with PD, should be paid to understanding that PD patients' outward displays of emotion do not accurately reflect their emotional reality. As a result, those interacting with PD patients should take the time to ask patients for verbal explanations of their experience, as studies have shown that despite changes in the presentation of statements (e.g., more unfilled pauses, (Pitcairn et al., 1990)), linguistic, semantic content does not appear to be affected by the disease (Breitenstein et al., 2001; Jaywant & Pell, 2010). Future neuroimaging studies could beneficially explore the effect PD has on the ability to modulate one's negative affect in a manner that conforms to social norms. Should our hypothesis be correct and PD patients, due to the degradation of frontal-striatal circuitry, be unable to down-regulate their negative affect, educational efforts could be made to promote social understanding.

General Discussion

The goal of this project was to explore, on subjective, expressive, and interpersonal levels, how emotional meaning is affected by Parkinson's disease. In Study 1, we developed and validated 11 film clips that could reliably evoke happiness, tenderness, sadness, fear, and a neutral affective state in older adults. These film clips served as the basis for Study 2, Experiment 1, which sought to determine how subjective emotional experience may be altered by PD. In Study 2, Experiment 2, we examined how spontaneous, dynamic emotional facial expression differed between groups, when judged on a holistic basis by female young adult raters were naïve to subjects' group status. Finally, in Study 2, Experiment 3, we collected social impressions, on the basis of audiovisual interview segments, of the same set of healthy control and PD subjects from their age peers. Our results provide strong evidence of a disconnect between PD patients' emotional experience and their ability to express that experience.

While the intensity and the accuracy with which PD subjects reported feeling the target emotions in Study 2, Experiment 1 did not differ from that of healthy controls, patients' emotional expression (Experiment 2), and the resulting social impressions (Experiment 3), were significantly affected by the disease. Our findings of preserved subjective emotional intensity in PD subjects are in keeping with the existing body of literature, both in studies that have similarly used video clips to elicit emotion (e.g., Simons et al. (2004), Smith et al. (1996) and Vicente et al. (2011)), as well as in those that have used picture stimuli (Miller et al., 2009) and those that have asked participants to reflect on their emotional responses and complete questionnaires indicating their typical experience of emotional intensity (Mikos et al., 2009). Similarly, the results of Experiment 3, showing that PD patients are perceived more negatively than their healthy peers, echoes what has been reported in previous studies based on auditory-only, visual-only, and combined audiovisual expressivity samples from PD patients (Jaywant & Pell, 2010; Pentland et al., 1987; Pitcairn et al., 1990; Tickle-Degnen & Lyons, 2004). However, our findings from Experiment 2 ran counter to the vast majority of results on PD expressivity when we observed that PD patients, with the exception of happiness were rated as significantly *more* emotionally facially expressive than their healthy peers. This finding deserves particular attention, as we propose that by using thin-slice silent video samples of spontaneously elicited emotion to provide an approximation of the type of emotional expressivity produced in everyday interactions, our methodological approach may have provided insight on PD expressivity not previously captured by studies that relied upon facial muscle action units as the basis for expressivity analysis.

The main differences in our methodological approach to studying expressivity and that of other studies that reported decreased facial expressivity in PD patients hinged upon our choice to use *spontaneously* elicited emotion samples, as well as our decision to have raters provide an overall impression of expressivity, as scored on Likert scales. With the exception of one article by Brozgold et al. (1998), we were unable to find other studies that have used spontaneously elicited emotion combined with an impression-based (as opposed to a muscle action unit-based) analysis to understand how expressivity may be affected by PD. It is believed that different neural systems are required for spontaneous, as compared to posed, emotional expressions (Rinn, 1984), and, while still debated, evidence from previous studies has indicated that PD may differentially affect the two neural systems in such a way that spontaneous emotional expression, associated with the extrapyramidal system is hampered while posed expression, attributed to the pyramidal system may be preserved (Rinn, 1984). Given that the majority of everyday social interactions are likely to demand spontaneous emotional expression, instead of posed responses, it seems necessary to explore PD patients' spontaneous emotional displays in order to understand how PD is likely to affect real-life social interactions.

However, as Motley & Camden (1988) note, in order for spontaneous emotion samples, which are less intense and more ambiguous than posed expressions, to truly approximate real-life emotional expressions, sufficient contextual information must be present to inform observers of the expression's meaning. Motley & Camden (1988) explain that this situational context guides our understanding of another's emotional response in a manner that compensates for the lack of specificity in the expression itself. The lack of situational context in our experiment significantly limits the extent to which we may extrapolate our findings to real-world situations. While we do not believe this lack of contextual cues would have had any effect on the group differences we observed, as samples from both the PD and HC participants in our study were equally impoverished, we believe that this lack of context was responsible for the extremely low accuracy rates we observed, which were comparable to those reported in Motley & Camden (1988) for their spontaneously elicited emotion condition. As a result, in order to better understand the accuracy with which conversation partners are able to read emotion in PD subjects in real-life situations, future studies should situate spontaneous emotion samples within a contextual environment that more closely approximates real-life decoding conditions. For example, in our own study, if we had first shown raters the various film clips that were used to evoke the facial expressions they observed in subjects, we expect that recognition accuracy would have greatly increased as raters could have better linked the expression they observed to the type of stimuli likely to elicit it.

While we were interested in exploring the relationship between PD patients' self-perception of communicative competency and raters' impressions of patients' expressivity and social persona, our study was chiefly concerned with emotional communication, and as such, the experimental design limited the extent to which we could explore this relationship using the Communicative Participation Item Bank (CPIB; Baylor et al., 2013). For example, our second experiment judged emotional expressivity on the basis of nonverbal cues, while the CPIB assesses patients' perceptions of *spoken* communicative competency. As a result, it is possible that a patient who felt they were significantly impaired in their spoken ability may not have presented as similarly impaired in their facial expressive ability. Given the extreme heterogeneity of the disease (Foltynie et al., 2002) and the absence of studies that have directly assessed symptoms on an individual subject basis, it is currently unclear whether an individual PD patient's expressive impairments in the vocal and facial realms may covary or whether the two modalities may be differently affected within the same person. In our third experiment, which did include spoken content, we did not find a correlation between patients' CPIB scores and raters' global perceptions of patients' social desirability. However, it is possible that existing correlations may have been masked when social judgment scores for a single participant were averaged across raters. Future research would be needed to determine to what degree patients' self-perception of communicative difficulty relates to peers' perceptions of social desirability.

Additionally, future studies that pay close attention to the disparity between *expected* expressive responses and PD versus HC differences in actual responses may bring us closer to pinpointing the manner in which PD patients deviate from healthy controls in their emotional expression. These differences are likely extremely subtle, and may require a methodological approach that combines holistic impressions with more quantitative measures of expressivity, such as the computer imaging analysis employed by Bowers et al. (2006) which can assess changes in movement on a level not perceptible by the human eye. We expect, based on our own evidence and that of Brozgold et al. (1998), that such studies will reveal a marked difference in the expressive content between PD and HC subjects, with PD subjects displaying a heightened frequency and intensity of negative expressive responses.

Our prediction of increased expressivity of negative affect in PD subjects is informed by two factors: a specific underreported PD symptom we will refer to as "emotionalism", and evidence from neuroimaging studies of the disease's deleterious effect on brain structures required to modulate negative emotion. While difficulty controlling emotional outbursts is a symptom that has been associated with PD, there has been surprisingly little research exploring the prevalence of this symptom and the significant psychosocial repercussions of it that patients must face. The symptom is currently referred to by a number of overlapping terms, ranging from "emotionalism" (House et al., 1989; Madeley et al., 1992) to "emotional hyperreactivity" (Houeto et al., 2002), "emotional lability" (Marsh, 2000; Narme et al., 2013), and "pseudobulbar affect" (Siddiqui et al., 2009), among others. This breadth of terms may be contributing to the lack of consensus on the prevalence of this symptom. As a result of these parallel studies that have yet to be united under a common term or meta-analysis, the symptom's relevance to patient quality of life may well be underappreciated.

The few studies that have reported variations of this symptom indicate that its prevalence may be alarmingly high; a study by Houeto et al. (2002) reported its presence in 15 out of the 24 PD patients they tested, or 62.5% of their sample. Madeley et al. (1992) reported increased tearfulness since disease onset in 38% of their sample of 47 PD patients. In our sample of 17 PD patients, only one had this symptom identified in her medical records, however over the course of the testing sessions, the first author observed symptoms of extreme emotionality (in the form of uncontrollable crying in response to both tender and sad film stimuli) in a total of 5/17 PD patients, or 29% of our patient sample. While some of the healthy control subjects also became tearful during the tender and sad film clips, their tears were of a perceptively different nature; the PD patients' crying consisted of sobbing uncontrollably, whereas the HC subjects' tears were of the restrained type that would normally be expected in a public movie theater during an emotional movie. Our findings suggest the need for future research on how PD affects patients' ability to regulate the expression of their emotional affect.

Neuroimaging studies that have examined the brain structures involved in modulating the intensity of negative emotion, on an experiential level (via suppression or reappraisal tasks) have implicated that the dorsolateral prefrontal cortex, which is known to be impaired by PD (Cools et al., 2002; Cropley et al., 2006; Owen, 2004), is involved in the conscious suppression of negative emotion (Levesque et al., 2003). While it has been shown that PD patients have difficulty consciously masking a negative expression with a positive one (Simons et al., 2003), to the best of our knowledge, no studies have yet directly investigated how well PD patients are able to regulate the expression of their negative affect in the manner that would correspond with what is expected during normal social interactions. The inability to modulate affect in a socially acceptable manner may be at the crux of the negative social impressions that associated with PD (Brozgold et al., 1998).

Studies on social interaction in children have indeed found a close link between the ability to regulate one's emotional displays and social competence (Hubbard & Coie, 1994; Jones, Abbey, & Cumberland, 1998). We are socialized to adhere to certain emotional display rules, which are learned in childhood (Saarni, 1979). Research has shown that older adults are more effective than younger adults at down-regulating negative emotion (Gross et al., 1997; Scheibe & Blanchard-Fields, 2009; Urry & Gross, 2010). As a result, it would be expected that older adults, such as our PD patients, who violate these emotional display norms would take their interlocutors by surprise, making the social interaction feel uncomfortable. This discomfort would likely lead social partners to choose to engage less with individuals who emote at a high level. Instead, healthy older adults may choose to seek out more socially appropriate conversation partners.

The social repercussions associated with the inability to effectively express one's emotions cannot be overstated. Older adults are known to prune their social networks as they age, maintaining fewer relationships than younger adults (Carstensen, Fung, & Charles, 2003). If PD is negatively affecting social interaction, as our study, as well as a host of other studies (e.g., Hemmesch et al., 2009; Jaywant & Pell, 2010; Pentland et al., 1987; Pitcairn et al., 1990) indicate it does, the cost of these disease-induced communicative changes may be social isolation. A first step towards improving patient quality of life will be to better isolate the disease-induced changes in pragmatic communication that are contributing to the negative social perception of patients with PD (Hemmesch et al., 2009; Jaywant & Pell, 2010; Pentland et al., 1987; Pitcairn et al., 1990). Our hope is that this study may serve as a first step towards research that will mitigate the social costs of PD by (a) more closely examining to what degree PD patients' ability to regulate the expression of negative emotion is impaired, (b) developing a unified term within the PD research community for the symptom of poor regulation of emotional affect, in order to begin developing a body of literature regarding the prevalence and intricacies of this affliction and (c) employing methodology, such as the use of contextually-informed, spontaneously evoked emotion excerpts, that is more closely representative of real-life interactions. These approaches will allow us to more closely evaluate the social challenges PD patients are encountering on a daily basis. We are hopeful that, through future research and educational efforts, the social barriers PD patients currently face can be significantly reduced.

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