Highlights

- Parkinson's disease (PD) has been connected to a burst of artistic creativity.
- PD patients' perception and evaluation of art is compared against healthy controls.
- No evidence for PD-related differences in liking or beauty ratings.
- PD patients showed significantly higher ratings on assessed "emotionality."
- This is potentially related to the tie between PD, DA pathways, and emotion/reward.

Parkinson's disease and changes in the appreciation of art: A comparison of aesthetic and formal evaluations of paintings between PD patients and healthy controls

Jon O. Lauring, [a†*] Matthew Pelowski,[b†] Eva Specker,[b] Tomohiro Ishizu,[b,c] Steven Haugbøl,[d] Barbara Hollunder,[b] Helmut Leder,[b] Johan Stender,[d] Ron Kupers,[a]

[a] Department of Neuroscience and Pharmacology, BRAINlab, University of Copenhagen, Blegdamsvej 3B, DK-2200 Copenhagen, Denmark

[b] Faculty of Psychology, Department of Basic Psychological Research and Research Methods, University of Vienna, Liebiggasse 5, A-1010 Vienna, Austria.

[c] Faculty of Biosciences, Cell and Developmental Biology, University College London, Gower Street, WC1E 6BT, London, UK

[d] Department of Neurology, Copenhagen University Hospital Bispebjerg, Bispebjerg Bakke 23, DK-2400 Copenhagen, Denmark

* Correspondence concerning this article should be addressed to Jon O. Lauring, Department of Neuroscience and Pharmacology, BRAINlab, University of Copenhagen, Blegdamsvej 3B, DK-2200 Copenhagen, Denmark. E-mail: jonolauring@gmail.com

† These authors contributed equally.

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Abstract

Parkinson's disease (PD) is a progressing neurodegenerative disease predominantly involving the loss of dopamine producing neurons with hallmark symptoms of motor disorders and cognitive, motivational, emotional, and perceptual impairments. Intriguingly, PD can also be connected—often anecdotally—with a sudden burst of artistic creativity, motivation, or changed quality/style of produced art. This has led to growing empirical interest, promising a window into brain function and the unique neurological signature of artists. This topic also fits a growing interest from researchers in other areas, including Alzheimer's or other dementia, which have suggested that specific changes in art production/appraisal may provide a unique basis for therapy, diagnosis, or understanding of these diseases. However, whether PD also shows similar impacts on how we perceive and evaluate art has never been systematically addressed. We compared a cohort of PD patients against age-matched healthy controls, asking participants to rate paintings using scales of liking and beauty and terms pertaining to artworks' formal and conceptual qualities previously designed to provide a rubric for symptom identification. We found no evidence for PD-related differences in liking or beauty. However, PD patients showed higher ratings on assessed "emotionality," potentially relating to the tie between PD, dopamine pathways, and emotion/reward.

Keywords: Parkinson's disease; art viewing; aesthetic appraisal; brain damage; emotion; perception

1 Introduction

Parkinson's disease (PD) is a devastating diagnosis with, however, extremely intriguing aesthetic and creative implications. At present, PD constitutes the world's second leading neurodegenerative disorder, affecting roughly 0.3% of the population, rising rapidly to 3% over the age of sixty-five (Gillies Pienaar, Vohra, & Qamhawi , 2014; Mhyre, Boyd, Hamil, & Maguire-Zeiss, 2012). It progressively impacts brain cells' ability to produce, release, or re-uptake the neurotransmitter dopamine (DA), leading to a number of symptoms including loss of motor control, impaired cognition, language processing, emotion regulation, sensory and visual function (Chaudhuri, Healy, & Schapira, 2006; Sveinbjornsdottir, 2016; Lauring et al., 2019 for review). Thus, in conjunction with an aging world population, PD marks an increasingly pressing target for clinical and brain research.

At the same time—and despite, or, perhaps even because of, motor and cognitive changes—an emerging collection of case studies report a sudden burst of artistic output, visual creativity, or even passion for visual art (as well as music, dance, novels, poetry/writing, etc.). A recent survey by Joutsa, Martikainen, and Kaasinen (2012) suggests this may touch upwards of 20% of patients; it can occur with established artists (Forsythe, Williams, & Reilly, 2017) and with individuals who have never before shown artistic interest (Lhommée et al., 2014; Inzelberg, 2013). Case studies also report changes in style, theme, color, technique, or even in the aesthetic quality—often argued to be improved—of produced images (Lauring et al., 2019).

This phenomenon provides an intriguing window for a better understanding of both the symptomatic and neurophysiological bases for PD and of our artistic or aesthetic experiences. Linking neurobiological changes, brought about via specific patterns of disease, to their behavioral consequences holds the potential to gain a better idea about the human capacity to engage in the arts. This may also be useful for understanding general brain function (Boot, Baas, van Gaal, Cools, & De Dreu, 2017) and offers important empirical evidence for causative study as a necessary counterpart to brain imaging (Zaidel, Nadal, Flexas, & Munar, 2013). This also

follows a recent trend in neuroscience that has attempted to tie patterns of damage—with dementia, stroke, and Alzheimer's disease (AD)—to changes, or non-changes, in appraisal of art (Chatterjee Bromberger, Smith, Sternschein, & Widick, 2011; Chaudhuri et al., 2015; Graham, Stockinger & Leder, 2013; Gretton & Ffytche, 2014), with results potentially providing a basis for early diagnosis and rehabilitative or even neuroprotective therapy (Chaudhuri et al., 2015; Lim, Fox, & Lang, 2009; Martinez-Martin, Rodriguez-Blazquez, Kurtis, & Chaudhuri, 2011). However, despite the interest and emerging findings regarding making art (Lauring et al., 2019), the impact of PD on how we *view* art or on aesthetic appreciation—arguably much more general tasks across the human population—has not been investigated.

In this paper, we offer a first systematic study of PD and art viewing. We compare a cohort of PD patients against age-matched healthy controls (HCs), asking participants to rate a number of paintings for both hedonic scales of liking and beauty as well as using a previously-designed standardized battery of assessments pertaining to formal factors designed to identify functional connections to damage in the brain (Chatterjee, Widick, Sternschein, Smith II, & Bromberger, 2010). This is preceded by a discussion of PD's neurological and symptomatic basis, especially as this relates to perception, cognition, and brain function, as well as aspects of clinical assessment or severity scoring and previous art-related studies. We conclude with implications and future directions for PD and aesthetic research.

2 Theory: PD neurobiology, symptoms, and potential relation to art perception

The reason for PD's onset is still unknown, and most probably involves a number of genetic and environmental factors (Kalia & Lang, 2015). It is, however, a neurodegenerative disease involving diminishment or damage to specific areas of the brain, which may follow a generally specific pattern, and thus providing a basis for matched behavioral or diagnostic assessments.

2.1 Main PD-related brain regions, symptoms, and treatments

Most notably, PD involves again loss of the brain's ability to produce DA. This acts as a neurotransmitter, primarily evoking action potentials in postsynaptic neurons, and is thus a major component of brain functioning and interconnectivity. As shown in Figure 1, which depicts main PD-related brain areas and potential overlap with evidence relating to art, the main site of PD-related DA production is in the substantia nigra pars compacta (vSNc), a region in the midbrain (Cameron, Watanabe, Pari, & Munoz, 2010). The vSNc is functionally connected, via the nigostriatal DA pathway to the basal ganglia, a diverse set of subcortical nuclei—including the substantia nigra, pallidum, subthalamic nucleus; caudate/striatum—situated at the base of the forebrain and with a primary function involving action selection, habit formation, and regulation of motor/premotor areas (Grahn, Parkinson, & Owen, 2008). Neuronal depletion has been identified in the ventral tegmental area (VTA) and associated areas along both the mesolimbic and the mesocortical DA pathways. The mesolimbic pathway connects the VTA to the ventral striatum (primarily nucleus accumbens, NAcc), associated with motivation and reward. This also projects to the hippocampus—memory formation, navigation, emotion (anterior regions)—as well as to the ventromedial prefrontal cortex (vmPFC), associated with motivation, reward response, introspection, self- awareness, and to the orbitofrontal cortex (OFC), a key site of reward processing (Elliott, Dolan, & Frith, 2000; Takeuchi et al., 2010). The mesocortical pathway transmits DA from the VTA to the prefrontal cortex (PFC), especially dorsolateral regions (dlPFC), and is related more to executive functions, motivation, emotion, and judgment. Beyond the main target of dopamine systems and the brain, neuropathological alterations can also concern the central and autonomic nervous systems, and also noradrenergic, serotonergic, and cholinergic systems (Braak et al., 2003; Hawkes, Del Tredici, & Braak, 2010; Lim et al., 2009).

<Figure 1>

The PD-related neurobiological changes lead to a range of symptoms. The disease is usually diagnosed by motor symptoms—slowed/impaired movement, rigidity, tremor (Okun,

2012). These are accompanied, or even preceded by up to twenty years (Hawkes et al., 2010), by a range of non-motor symptoms (Chaudhuri et al., 2006; Jellinger, 2014; Martinez-Martin et al., 2011; Simuni & Sethi, 2008;), often progressing in severity with the disease (Hawkes et al. 2010). Notable among these are cognitive and emotional symptoms, which may include deficits with attention, memory, language, or reduced motivation/conation as well as increased apathy, anhedonia (Connolly & Lang 2014; Grover, Mansi, Santhosh, & Ajit, 2015; le Bouc et al., 2016), or reduced ability to distinguish emotional information, especially in social situations (Enrici et al., 2015). Sensory symptoms include impaired olfaction and vision (Bayulkemand & Lopez, 2011; Chaudhuri, et al., 2006; Sveinbjornsdottir, 2016). Notably, among the latter, researchers suggest blurred or double vision, reduced contrast sensitivity, color discrimination (Alenicova, Likhachev, & Davidova, 2017; Müller, Woitalla, Peters, Kohla, & Przuntek, 2002; Oh et al., 2011), motion detection and perception of space (Davidsdottir, Cronin-Golomb, & Lee, 2005), and selective attention or visual recognition (Bodis-Wollner 2009). These are most often connected to electrophysiological and morphological evidence of disruption of retinal structure and function (e.g., Bodis-Wollner et al., 2014), but may also tie to damaged visual cortices or ventral and dorsal pathways or visual association-related areas in the brain (Archibald, Hutton, Clarke, Mosimann, & Burn, 2009; Bodis-Wollner, 2009; Diederich et al., 2014). Psychiatric symptoms include depression, anxiety (Bayulkemand & Lopez, 2011; Connolly & Lang, 2014; Grover et al., 2015), hallucinations (Connolly & Lang, 2014; Diederich, Stebbins, Schiltz, & Goetz, 2014; Fénelon et al., 2010), and compulsive or repetitive behaviors.

PD also often involves treatments, which may themselves contribute to behavioral changes (Tarsy, 2016). The most common initial therapy involves DA-replacement, typically via oral levodopa. This is also often augmented by DA agonists, which increase receptivity of brain areas to DA. Especially agonists may have side effects that include heightened or addictive pleasure, insomnia, hallucination, and impulse control disorders (ICD). Medical doctors may also utilize a range of other medications as well as deep brain stimulation (DBS, see Connolly &

Lang, 2014). Note however, due to inconsistent impacts from DBS in previous art and creativity studies, this was an excluding factor in the present study.

Finally, to assess and document symptoms, medical doctors and researchers most often use the Unified Parkinson's Disease Rating Scale (UPDRS, Fahn & Elton, 1987), updated to the MDS-UPDRS (Goetz et al., 2007), with a reported score often used as a shorthand for disease severity (as also used in the present paper). The most common means of describing PD stages, based on the assessment of symptoms, involves the Hoehn and Yahr (HY) scale (Hoehn & Yahr, 1967). The Braak stages of lesions (Braak et al., 2003), have been the standard means of organizing specific damage to the brain. The above factors can also be combined into a general description of PD progression (Hawkes et al., 2010; Skorvanek et al., 2017; Zhao et al., 2010). This suggests a general timespan of around forty years: with the first twenty years involving subtle changes in especially non-motor regions and eventual cognitive and emotional symptoms, typically from three years before diagnosis, followed by onset of motor symptoms, diagnosis, treatment (HY Stage 1, Braak Stage III), and then followed by up to 20 years of increasing cognitive, emotional, and visual symptoms (HY Stage 3-5) in diagnosed PD.

2.2 Hypotheses and outstanding questions for the impact of PD on aesthetic appreciation

Within the above PD symptoms and stages, researchers have begun uncovering intriguing indication for impact on art or aesthetic processing/experience (see again also Figure 1). This is noted primarily in case studies or anecdotal reports involving art production and changes in the output of artists (Inzelberg, 2013; Lauring et al., 2019), and may suggest at least potential reciprocal effects on art viewing or aesthetic appreciation.

Previous studies have typically considered individuals in the early diagnosed stages of PD, but with a generally wide-timespan (with a Mean of 10.9 years; HY Stages 1 to 4 (Lauring et al., 2019; see also Lakke, 1999), and involve two main findings: (1) Case studies have documented novices to art production who suddenly show a burst of artistic interest, felt creativity, and even urge or need to make art (e.g., Chatterjee, Hamilton, & Amorapanth, 2006; Lakke, 1999; Pinker,

2002). Evidence suggests connections to increased felt reward, heightened impulsivity and creativity, or lowered inhibition, with patients reporting feeling freer, more spontaneous (Chatterjee et al., 2006; Lhommée et al., 2014; Pinker, 2002; Walker, Warwick, & Cercy, 2006), and often reporting a needed outlet for their creative expression (Kulisevsky, Pagonabarraga, & Martinez-Corral, 2009). This is also supported by some empirical comparisons using standardized visual and non-visual/verbal measures (Canesi, Rusconi, Isaias, & Pezzoli, 2012, Canesi et al., 2016), with such changes typically suggested to relate to DA-related or other functional changes throughout the mesolimbic reward and prefrontal mesocortical regions (Lauring et al., 2019).

(2) Reports also document individuals who were artistically active before diagnosis with PD, and who may also show certain artistic changes. These may involve, once again, increases in felt motivation or creativity, as well as modifications in form, style, or themes (e.g., Forsythe et al., 2017; Lakke, 1999; Pinker, 2002; Shimura, Tanaka, Urabe, Tanaka, & Hattori, 2012). Research suggests, for example, increased emphasis on abstraction or impressionism (Chatterjee et al., 2006; Kulisevsky et al., 2009; Pinker, 2002), with looser brush strokes, as well as emphasis on mood or emotional expressivity (Canesi et al., 2012; Kulisevsky et al., 2009; Lakke, 1999; Shimura et al., 2012). Authors report more vibrant colors after PD/therapy (Pinker, 2002) or an emphasis on color and light rather than shape/detail (Kulisevsky et al., 2009). A review across previously published case studies showed some evidence for more use of blue/green and also orange, as well as higher color saturation (Lauring et al., 2019).

A common finding also involves more technical changes such as compositional imbalance (Lakke, 1999), lack of or less fluid vertical lines, and crosshatching (Chatterjee et al., 2006). A recent study by Forsythe et al. (2017), which utilized artworks from across the lifespans of two famous artists diagnosed with PD—Salvador Dali and Norval Morrisseau—also found evidence for a U-shaped pattern in fractal dimension, argued to indicate formal complexity, which peaked in the period presumably where an individual might display the early stages of PD.

Although compelling, the above evidence reveals numerous outstanding questions and issues that might especially be considered in study with art viewing. These changes might, for example, suggest modulations in general taste or in attention to formal features which would manifest in both art production and, perhaps even more saliently, in viewing. However, it is unclear which, if any, of these might translate from art production to viewing or to general aesthetic attention. Even aspects such as a move to abstraction or impressionism are not presently straightforward (e.g., see Shimura et al., 2012 for an artist who appeared to move in style in the opposite direction and become less creative).

More generally, there is a question of the underlying neurobiological, pharmaceutical, or other (i.e., contextual) basis for changes, which might be partially addressed through a consideration of viewing (Lauring et al., 2019). Some factors—e.g., strokes, crosshatching—might tie primarily to motor symptoms (stemming themselves from diminished functionality in the nigrostriatal DA areas). As the resulting impact on art production might be expected to tie to the task itself of physically producing mark making, these may not necessarily relate to art viewing. This could also explain the change to more impressionistic or abstract styles, and increased complexity, which again may not relate to changed taste in art itself. Similarly, changed blue-yellow color discrimination is noted as a common issue with PD (Alenicova, et al., 2017; Birch, Kolle, Kunkel, Paulus, & Upadhyay, 1998; Müller et al., 2002; Oh et al., 2011), perhaps causing artists to ignore certain colors or to overuse them, explaining the more saturated or vibrant use of color, as could reduced contrast sensitivity. On the other hand, the above factors *could* also tie to more complex changes in other brain regions and altered cognitive and perceptual processes, which might impact viewing. Color focus or even interest in abstraction, for example, could relate to a heightened seeking of reward, changed interests or perception of mood and the environment, etc., and may thus manifest in both making and viewing/rating art.

Moving to other emotional and cognitive processes, studies have also focused on PD patients' ability to manage emotional information, which could also coincide with color or

abstraction changes. PD has been tied to lowered proficiency in perceiving and classifying emotions depicted in the environment (Assogna, Pontieri, Caltagirone, & Spalletta, 2008; Enrici et al. 2015; Gray & Tickle-Degnen, 2010; Lima, Garrett, & Castro, 2013; Serranová et al., 2011). These symptoms are suggested to tie to damage/change in one or more key emotion-processing areas and have been found to be independent of cognitive and perceptual abilities in general, as well as to ability to identify emotions in the self (Enrici et al., 2015). PD artists might use their art as a way of exploring emotion specifically due to their felt ambiguity, thus explaining the heightened emotionality.

The impairment of emotion processing may also suggest that art viewing would show different results. An early study by Bowers et al. (2006), which showed aversive pictures coinciding with a white noise burst, reported lower startle response in medicated PD patients versus HCs, which they attributed to a blunting in receptivity or awareness of emotions. Van Tricht et al. (2010), in a study with music clips, also found that medicated PD patients (on levodopa and primarily on DA agonist) showed impairments in recognition of fear and anger (but not sadness and happiness). Lima et al. (2013), on the other hand, found diminished recognition of music-related happiness and peacefulness in similarly medicated PD patients, as compared to controls, but found no difference in sadness and fear. In a similar study, Saenz et al. (2013) found impaired recognition of fear and sadness—however this occurred with viewing faces, whereas recognition in music did not differ from controls. Vicente et al. (2011) found no difference between early and later stage PD and control participants in reported intensity of a number of emotions when viewing film clips. These results suggest that previous findings may be highly tied to the specific conditions of the study, or there may be unique disassociations between modalities—raising the need for a study with visual art.

Questions may also relate to motivation and art-related interest. The above finding in art production studies of increased desire for art making and felt reward or even compulsivity, may tie to PD-related changes in DA reward pathways (specifically mesolimbic DAergic circuits

connecting to ventral striatum/NAcc, as well as medial OFC (mOFC) or even default mode network (DMN) areas such as the vmPFC and posterior cingulate cortex (PCC), see also below). As art is often suggested to be a rewarding experience (Lauring et al., 2019), we might expect—if changes relate to the reward areas of the brain—similar increased general interest or liking and enjoyment of others' art as well, especially styles that evoke positive feelings (e.g., Schwingenschuh, Katschnig, Saurugg, Ott, & Bhatia, 2010).

On the other hand, it is also possible that motivation changes may be partially or even predominantly driven by other factors such as premorbid latent talent or personality (Bachner-Melman et al., 2005; Canesi et al., 2012; Zaidel, 2014), or that a pursuit of artistic pleasure or art making only relates to one's own making, and does not impact artistic taste in general. Art viewing, as opposed to making, may also show evidence for anhedonia (Grover et al., 2015; le Bouc et al., 2016; Connolly & Lang 2014), suggesting again the need for a comparison of effects from art perception as well.

Similar arguments can be made for the tie between reward/motivation and pharmacological treatment accompanying PD. It is broadly suggested—in addition to any other explanation—that one key component in sudden artistic behavior change involves DAergic pharmacotherapy (Chatterjee et al., 2006; Inzelberg, 2013; Kulisevsky et al., 2009, Lhommée et al., 2014; Shimura et al., 2012; Walker, Warwick, & Cercy, 2006). Levodopa and especially DA agonists were noted in several of the case studies pertaining to the general aspects of reward, creativity and inhibition. This factor was recently posited by Lauring et al. (2019) to combine with PD-related brain changes, leading to increased activity in key areas—dorsal striatum (compulsivity), NAcc, mOFC, and vmPFC (impulsivity and reward seeking)—perhaps accentuating many of the aesthetic changes noted above (see also Kulisevsky et al., 2009; Lhommée et al., 2014; Weintraub, & Nirenberg, 2013). PD medication may enhance DAergic receptivity within areas such as the PFC tied to high cognitive functions (Ellamil, Dobson, Beeman, & Christoff, 2012). This is also supported in DBS studies, which often coincide with lowered medication following

surgery and have shown a loss of art interest and subjectively felt urge toward making art (Canesi, et al., 2012; Drago et al., 2009a; Lhommée et al., 2014) as well as lowered nostalgia, wonder, and joy in patients' subjective reports from, for example, music (Trost et al., 2018; see also Vicente et al., 2009). Kulisevsky et al. (2009) also connected higher emotionality to DA therapy—all again findings that might be hypothesized to plan a role in art viewing.

The only known empirical study that has considered PD and art-viewing itself points to the need for more systematic study of this domain. Drago et al. (2009a), assessed the case of a single professional painter with a 20-year history of PD, who had received a DBS implant (Left STN). The patient rated ten paintings by the artist Stephen Duren, half while receiving DBS stimulation, and half while "off". Ratings were made on 10-point scales based on six "artistic qualities": beauty, completeness, originality, rendering quality, demonstrated skill, and strength of induced feelings or thoughts. These were further compared against ratings by a group of HCs (no report of art training/experience). With DBS "off," the patient's ratings did not differ from the controls. With DBS "on," assessed painting completeness, artistic skill, and evocative impact ("How strongly does the painting induce feelings or thoughts?") were significantly lower than mean ratings of the controls. The patient's general creativity (measured by the Abbreviated Torrance Test for Adults, Goff & Torrance, 2002) was lowered as well.

This study obviously is rather limited in terms of inference-making. It involves only one individual with DBS, again often linked to a reduction of felt visual creativity or artistic interest (Lhommée et al., 2014), and with an actual neurobiological effect that is still under debate (Apetauerovaet al., 2006; Moro & Lang, 2006), to the extent that DBS is often an excluding factor for the above types of empirical research, as again is the case in this present paper. The patient's PD-age (20 years) also placed her rather outside the typical window for assessed artistic changes (typically 0 to 10 years from diagnosis), while the explanations for why changes were detected raise questions in themselves. The authors suggest these may be related to deactivation of the right hemisphere mediating visuospatial skills or global attention, but DBS may have also

coincided with worsening PD and reduced medication (see Lauring et al., 2019 for this argument). Interestingly, the same patient was also assessed in a parallel paper (Drago et al., 2009b), which considered her art making, and which did consider earlier, pre-DBS periods. An assessment of the patient's artworks (assessed by nine judges using the same above scales) showed that rendering and skill *improved* initially from early pre-presymptomatic to later presymptomatic periods, followed by a decline after DBS. Beauty and evoked thoughts/feelings also declined significantly after the DBS. The patient herself also noted that DBS interfered with her artistic creativity and, most intriguing, with her *appreciation of others' art* as well.

2.3 Present Study

The present study assessed potential impact from PD on the appraisal of art or aesthetic experience. This was done by comparing ratings, made on a number of scales, between PD patients and an age- and gender-matched control. Due to its novelty, this study was treated as a largely exploratory first step in this direction, utilizing batteries of questions previously employed in brain damage research and also derived from specific discussion of PD.

In our design, we follow a recently created methodology and line of research that has shown the efficacy for connecting aesthetic perception to specific damage or changes in the brain. Although still rare, the relation of neurodegenerative disease or other brain damage and aesthetic perception has recently been investigated with stroke, forms of dementia, and AD, showing the efficacy for such approaches (see for example, Wijk, Berg, Sivik, & Steen, 1999 who detected changes in patients' color perception and assessments of beauty). Notably, for the purpose of this analysis, we follow the work of a group of studies by Chatterjee and colleagues (2010), which involved the development and use of the Assessment of Art Attributes battery (AAA). This is a group of rating scales for visual art designed by the authors to investigate functional connections to brain damage. It provides a set of 24 paintings from the Western canon, which participants are asked to judge with respect to six "formal-perceptual" attributes ("balance" or visual harmony or rightness of the image; "color saturation"; "color temperature"

or relative use of warmer, reds/yellows or cooler/bluish colors; "pictorial depth" or relatively more 2D/3D image; visual "complexity"; loose/tight control of "brushstrokes") and six "content-representational" attributes (depictive accuracy" or relative photographic realism by which content is depicted; "abstractness"; "animacy" or more or less sense of the images being alive; "emotional expressivity"; "symbolism"; relative "realism" or fantasy of themes in the image).[1]

Bromberger, Sternschein, Widick, and Smith (2010, 2011) conducted two studies, each involving a group of right hemisphere stroke patients with lesions in frontal, temporal and parietal lobe, as well as in the insula or angular gyrus, while comparing them to age-matched HCs (17 patients and 30 age-matched normal controls in Bromberger et al., 2010; 20 patients and 30 age-matched HCs in Bromberger et al., 2011). Results of the individuals with specific lesion locations (based on voxel-based lesion symptom mapping) were compared against the controls. Both studies revealed deviations from controls in attributes such as depth, abstractness/depictive realism, animacy, and symbolism. Bromberger et al. (2010) additionally found differences for color temperature. In the present study we used the same AAA scales and procedure. Our investigations targeted a cohort of individuals affected by PD, which we similarly compared to an age-matched HC group. They viewed a subset of the same paintings as provided in the AAA (Chatterjee et al., 2010), with results contrasted between patients and controls to assess potential general differences in the scales.

In addition, we also included a separate assessment with a larger number of abstract and representational artworks involving hedonic appraisals for liking and beauty. This too was designed to build on the above literature review—potentially revealing changes in general art interest or felt pleasure as well as enjoyment of certain styles. This also was meant to address the stability of these appraisals. Notably, both Bromberger et al. (2010, 2011) studies did not observe

[1] Note, in our opinion, the AAA suffers from a rather pronounced, persistent ambiguity between how certain scales are labeled by the authors and the actual explanation for what was being assessed as communicated to the participants. The above descriptions are therefore based on our attempt at disambiguation and may not always exactly reflect the original naming.

differences between the two groups in terms of art preferences or interest, nor did the color study by Wijk et al. (1999). Halpern. Ly, Elkin-Franklin, and O'Connor (2008), who assessed liking ratings of representational and abstract paintings by early-staged AD patients at two time points, also showed that, despite explicit memory performance in AD patients dropping to chance levels (as assessed by a second distractor image recall task), patients did not have significant change between early-staged AD and control group for preference consistency of all art types. Further, there were there significant differences in type of preference between the two groups. In a similar study, Graham, Stockinger, and Leder (2013) also found no significant differences between AD patients and control groups for preference consistency of portrait and landscape paintings and landscape photographs. These results broadly suggest that despite cognitive capacities and explicit memory fade, the aesthetic sense—at least for specific categories of aesthetic objects—may remain intact.

We also focused on individuals at the early to moderate stages of PD (e.g., HY staging of 1-3), matching most previous art making studies, and considered all individuals on both levodopa and DA agonists. For ethical reasons we were not able to take individuals off of their pharmacotherapy. However, by using medicated patients we therefore provide a generally close match to the conditions of making studies with the most salient observed changes. We further report extensive patient background, PD staging, and drug regimen in order to provide a maximally systematic and controlled study.

3. Material and Methods

3.1 Participants

The study included a final sample of 21 PD patients (17 females, M_{age} = 64.61 years, *SD* = 7.58; range = 48 to 78 years; Mean PD duration = 7.86 years, *SD* = 4.31, range = 3 to 17). These were matched against a control group of 23 age and gender matched HC participants (17 females; M_{age} = 64.35 years, *SD* = 6.43; range = 48 to 73 years). The PD participants were recruited from the University of Copenhagen Bispebjerg Hospital where the majority were

patients and had been previously diagnosed with PD, as well as from a PD Facebook group and from ads in the Parkinson Society members' magazine. Control participants were recruited through volunteer test-subject databases. None of the participants from either group was a professional or semiprofessional artist or had an art related profession; all had normal or corrected-to-normal vision, no colorblindness; both groups did not receive monetary or other compensation.

See Table A.1 of the Appendix for PD patient symptom severity, and treatment/medication information. Full background information was indicated in the table in cases where the individual was a patient of the Copenhagen Bispebjerg Hospital. In the case of five patients, the individual was receiving treatment elsewhere and thus a full rundown of time since diagnosis and specific medication/dosage information could not be obtained. However, it was confirmed by a medical doctor (one of the paper authors) that all patients were suffering from PD (either from a clinical examination or, in the case of two individuals who refused an examination, via confirmation with their primary care physician with patient consent). It was also confirmed that all were receiving Levodopa and DA agonists. No patients were receiving DBS. All received their usual antiparkinsonian pharmacotherapy throughout the study.

In addition, all patients, with the exception of two individuals who refused the examination, were assessed upon visiting the study location for symptom severity (by the same medical doctor), with scores assigned using the Unified Parkinson's Disease Rating scale (UPDRS III) (Fahn & Elton, 1987) and the Modified Hoehn and Yahr rating scale (HY) (Goetz et al., 2004). All PD patients showed mild to moderate symptoms and PD timespan, aligning with most previous art-making case reports. No cognitive deficits were detected (as assessed via the Montreal Cognitive Assessment test *7.0* (MoCA; Nasreddine et al., 2005). Patients were also assessed via the Beck Depression Inventory II (BDI-II; Beck, Steer, Ball, & Ranieri, 1996), see *Results* section for further discussion.

Note also, the original PD sample included 23 patients, with one excluded due to severe cognitive deficits followed by a stroke, and one excluded due to the presence of DBS implant. Before participating, informed written consent was obtained from all participants. The study was approved by the Regional Committee on Health Research Ethics for Copenhagen, Denmark.

3.2 Procedure

Participants completed the main study individually and separately in a quiet room, while seated at a desk, viewing artworks or survey questions on a monitor (SONY LED / 43" screen) placed in front of them. Participants recorded all rating answers in pencil on a paper evaluation form. This method was selected due to difficulty had by some participants in using a keyboard. Before test onset, participants were instructed that they would be shown a series of paintings and were asked to evaluate each individual work on a number of scales. The tasks were performed at BRAINlab, INF, University of Copenhagen. Neuropathological tests of the PD patients were also performed individually, at a separate date, and administered by a neurologist at the University of Copenhagen Bispebjerg Hospital.

3.2.1 Part 1: Assessment of formal art attributes (AAA).

For the first artwork rating task, participants conducted a modified version of the AAA test for formal features of visual art (Chatterjee et al., 2010). Procedure followed that of Chatterjee et al. (2010). Before test onset, participants were instructed that they would be shown a new set of paintings and were asked to evaluate each based on the set of attributes. Scales included the six "formal-perceptual attributes" (1-6 below) and six "content-representational attributes" (7-12, note text in brackets refers to accompanying explanation given to participants as part of the pre-study training, see below): (1) Balance [Visual harmony or visual "rightness"], (2) Color saturation [Calm (more pastel) or vibrant (brighter) color palate], (3) Color temperature [Warm (reds, oranges, yellows) or cool (blues, purples) color palate], (4) Depth [Flat [(two-dimensional) or depth (sense of three dimensions)], (5) Complexity [Simpler (contained fewer elements) or more complex], (6) Stroke [Loose or tightly controlled brush strokes], (7)

Abstraction [Abstract or concrete (representational) images], (8) Animacy [More or less sense of the objects being alive], (9) Emotion [More or less emotional expressivity], (10) Realism [Realistic or fantastic images (e.g., horse versus unicorn)], (11) Depictive accuracy [Degree of depictive realism (how much like a photograph)], (12) Symbolism [Literal or symbolic content]. All ratings used a 5 point Likert-type scale (following Chatterjee et al., 2010).

Participants were first trained in the meaning/use of the scales with three example artworks, and then evaluated the target paintings. Participants were first presented with a dark grey screen (using Microsoft PowerPoint slideshow), displayed for two seconds. This was followed by a painting, centered on the screen with dark grey background, and the participants asked to make an evaluation for all scales on a paper form with no minimum or maximum viewing time. Following the answer to all scales for one artwork, participants advanced to the net image until the entire set was completed. Painting size was standardized across images to leave one inch borders on both the screen top and bottom.

The painting set included 15 paintings taken from Chatterjee et al. (2010), and reduced from the original 24 due to difficulty shown by the PD patients in pilot tests regarding concentrating for long time periods. All paintings were examples from the Western canon of art history (see Supplementary Materials Table S1 for a full list), and balanced between formal-perceptual and content-representational attributes according to the original Chatterjee et al. (2010) paper.

3.2.2 Part 2: Liking/beauty ratings.

Following Part 1, participants completed a second rating task employing a different set of artworks, which they assessed for their own liking and for the relative beauty of each image. Stimuli consisted of 60 paintings (listed in Table S2, Supplementary Materials), from a set of 19th–21st century art previously used in empirical study by our team (Lauring et al., 2016). The set was balanced between representational (landscape, still life, or portrait) and abstract works, and was selected to represent images/artists previously unknown by lay participants (verified in

the study), in order to minimize conflation from highly personal references to the stimuli or from previous exposure effects (e.g., Jacobsen, Schubotz, Höfel, & von Cramon, 2006). The painting set was further selected to have a uniform distribution of quality from generally negative to positive liking (based on previous pilot testing with a larger set of 314 paintings, reported in Lauring et al., 2016), with 30 of those scoring highest for liking and 30 of the lowest scoring paintings chosen, maintaining the abstract/representational balance.

Participants in the present study were again presented with a dark grey screen (using Microsoft PowerPoint slideshow), displayed for two seconds, followed by a painting, centered on the screen with dark grey background, and displayed individually for seven seconds, during which time participants were asked to view the work. The painting was then replaced by a screen with a smaller version of the painting and scale, prompting participants to record first, their degree of "liking," using a 200-point Likert-type scale (*-100 = dislike very much, 0 = neither like nor dislike, +100 = like very much*), and second for "beauty" (*-100 = not very beautiful, 0 = neither not-beautiful nor beautiful, +100 = very beautiful*). Answers could be recorded by making a vertical line at any point on the scale, which, in addition to the three text anchors above, had numerical anchors marked at 10-point increments.

"Liking" was selected because it is a general measure of personal preference or hedonic/aesthetic judgment (Leder, Augustin, & Belke, 2005; Reber, Schwarz, & Winkielman, 2004). "Beautiful" was selected in order to detect possible differences in judgment from liking, especially relating to more formal/objective aspects. Participants were also instructed to announce if they were previously familiar with the artwork by circling the entire scale in the booklet and then writing one/both of the artist's name and the name of the artwork (included as a verification of true prior knowledge). Once participants had made their ratings, they were asked to press a key to advance to the next artwork. This was repeated for the entire artwork set.

3.2.3 Demographics and art interest.

Finally, participants filled out a questionnaire regarding demographic background, previous art-related experience (following Chatterjee et al., 2010)—e.g., number of previous art studio or theory classes, time spent making art—and regarding overall art interest (following Pelowski et al., 2017).

4. Results

The mean UPDRS III score was 8.25 (*SD* = 4.60; range = 2 to 19 of 70 possible points). The mean HY score (PD stage), was of 1.9 (*SD* = 0.9) with a range of one to three of the 7-Stage scale (score information on two patients was not available, see note in Table A1, and thus not included in the above mean). Mean duration after PD diagnosis was 7.69 years (omitting five patients for whom an exact number could not be obtained). Note, only one patient (number 20 in Table A1) showed a HY score above 2.5 (in this case, 3). Assessment of the patient's individual answers, however, suggested that they were well within one standard deviation of the group means, while comparisons of the following analyses both including and excluding this individual did not show any material differences in the reported results. Thus, this individual was included in the following analyses.

The mean MoCA cognitive impairment score was 27.35 (SD = 3.00; score of over 26 considered to be normal, Rosenzweig & Chaves, 2018). The patients' mean score in depression symptoms, as measured by BDI-II (Becket al., 1996), corresponded to the low end of mild depression, however, with a relatively high variance among participants (M = 12.25, *SD* = 10.29). (Score information on two patients not was available).

Participants' art interest and experience answers showed no significant differences between the HC and the PD sub-groups (as assessed via independent t-tests). Overall, the participants showed generally moderate levels of interest (HC Mean = 3.23; PD Mean = 3.44; $F(1, 44) = .29$, $p = .59$), and had taken very few art classes (HC Mean = 1.1 classes in lifetime; PD

Mean = 1.7; F (1, 44) = 1.05, p = .31), aligning with typical "lay viewer" in current empirical art study research. Groups also showed no differences in general level of education.

4.1 PD versus HC Artwork rating Comparison—AAA

Overall, the AAA scales showed a generally even spread across the artworks, although trending toward either the higher or lower end of certain scales for specific art images, but with no outliers detected. Thus, again, all artworks were used for the following analyses.

The mean ratings for the AAA scales across the artworks, comparing between the HC and PD cohorts, are shown in Figure 2. To assess potential between-group differences in ratings of the art, we conducted a series of linear mixed models (LMM), for each of the 12 scales, separately. The LMMs were conducted with the lme4 package (Version 1.1-8; Bates, Machler, Bolker, & Walker, 2015) in R (Version 3.1.0; R Development Core Team) applying Satterthwaite approximation for p-values (lmerTest, version 2.0-32; Kuznetsova, Brockhoff, & Christensen, 2016). We included a contrast for group (HC minus PD patients) as a fixed between-subject factor and random by-image intercepts and random by-participant intercepts with a random slope for group. This approach offered the benefit of including individual artwork and viewer instances in the analysis, rather than collapsing certain types or conditions into means, as in a typical ANOVA. Thus, we could both consider how individual artworks' ratings might change across conditions and also build the natural variance of both artworks (which of course are themselves different and not always rated similarly) and individual participants into the model. This inclusion of variance is particularly important for relatively heterogenous stimuli, such as art.

<Figure 2>

Results and statistics for the PD and HC group comparisons are reported in Table 1. Due to the exploratory nature of the study, the significance values are reported without correction for multiple pairwise comparisons. However, for the reader interested in such a correction, we have also reported the adjusted minimum alpha following a familywise Bonferroni correction (e.g.,

taking into account all 12 AAA scales) in the table notes. Significance values that would survive such a correction are also shown in bold in the table.

Table 1
Results of LMMs assessing PD versus HC group differences in artwork ratings for formal/visual qualities

Scale	Group Mean (SD)		*β*	SE	*t (df)*	*p*
	PD	HC				
AAA--formal-perceptual attributes						
balance (visual harmony)	38.4 (10.1)	39.6 (10.5)	1.14	1.13	1.01 (38.9)	.318
color saturation	36.8 (9.8)	34.7 (10.4)	-2.24	1.52	-1.48 (29.2)	.151
color temperature	33.1 (10.8)	32.3 (10.7)	-0.88	1.14	-0.77 (36.2)	.444
depth	31.5 (11.8)	31.2 (12.5)	-0.44	1.15	-0.38 (40.9)	.703
complexity	32.8 (11.9)	31.8 (11.5)	-0.86	1.24	-0.69 (41.6)	.494
brushstrokes (loose/controlled)	33.3 (12.5)	34.0 (12.0)	0.54	1.47	0.37 (36.7)	.717
AAA-content-representational attributes						
abstraction	34.2 (13.7)	35.3 (15.5)	1.03	1.02	1.01 (39.0)	.321
realistic/fantastic	31.0 (14.2)	30.9 (14.8)	-0.25	1.26	-0.20 (29.1)	.842
animacy	33.2 (13.6)	33.4 (15.9)	0.082	0.95	0.09 (19.6)	.932
objective accuracy	29.5 (12.7)	28.2 (12.7)	-1.55	1.69	-0.92 (39.2)	.364
symbolic/literal content	28.8 (13.1)	26.7 (13.3)	-2.36	1.87	-1.26 (38.6)	.214
emotional expressivity	32.0 (12.4)	28.5 (12.9)	-3.78	1.55	-2.44 (36.8)	.019*

Note. Results based on linear mixed models (LMMs) conducted separately for each scale (conducted with lme4 package Version 1.1-8 (Bates, Machler, Bolker, & Walker, 2015) in R Version 3.1.0, applying Satterthwaite approximation for p-values (lmerTest, version 2.0-32; Kuznetsova, Brockhoff, & Christensen, 2016). LMMS include a contrast for group (HC minus PD patients) as a fixed between-subject factor and random by-image intercepts and random by-participant intercepts with a random slope for group. * denotes significance at $p < .05$, uncorrected for multiple comparisons. Note, if one were to apply a familywise Bonferroni correction for multiple comparisons, the adjusted alpha would be $p = .0042$ (12 scales). Results that would maintain significance following such correction are shown in bold.

The initially most striking finding was the general level of agreement between HC and PD groups. Among all "formal-perceptual" AAA factors (balance, color saturation and temperature, depth, complexity, brushstroke control) and among all but one "content-representational" AAA factors (abstraction, realism, animacy, objective accuracy, symbolic content) we found no group differences. Inspection of PD versus HC group means for each individual painting also suggested quite uniform ratings for each instance between groups, with no notable trends regarding differences.

The only significant difference detected involved emotional expressivity. In this case, the PD patients rated the paintings as more emotionally expressive than did the HCs. Although not significant, note also that assessed symbolism and color saturation did show at least a trend whereby PD participants rated them higher on both scales.

4.2 PD versus HC Artwork rating Comparison—Liking/beauty

The mean ratings of liking and beauty, comparing between HC and PD patient cohorts, are shown in Figure 3, further displaying scores for both every individual artwork, dividing also between representational and abstract images, and the combined general means.

As can be seen, the liking and beauty ratings across all individual artworks showed an even more homogenous spread from generally liked and/or beautiful and generally disliked and/or not beautiful, again with no outliers. Correlation between the individual liking/beauty ratings across all artworks and participant combinations was quite low (r = .084), suggesting that the ratings were treated as independent. Once again, to assess for PD/HC group differences, LMMs were conducted for both liking and beauty scales, separately, using the methodology reported above (fixed between-subject factor = group, HC minus PD patients, contrast coded; random by-image intercepts and random by-participant intercepts with a random slope for group). In addition, we included artwork style as (abstract, representational) as another fixed factor, contrast coded.

Results are reported in Table 2. Among both hedonic scales we again found no significant effects of group. A significant main effect was found for style, with both PD and HC groups having lower ratings for abstract images, thus matching several past studies with generally novice participants. No significant effects were found for the group x style interaction.

Table 2
Results of LMMs assessing PD versus HC group differences in artwork ratings for Liking and Beauty

Scale	Group Mean (SD)		*β*	SE	*t (df)*	*p*
	PD	HC				

Liking[a]						
Group (PD vs. HC)	-3.8 (59.0)	0.54 (55.1)	6.38	7.77	0.82 (44.7)	.416
Style (PD, abstr. vs. rep)			26.32	8.17	3.22 (83.6)	**.002***
Style (HC, abstr. vs. rep)			30.79	8.09	81.2 (81.3)	**.0003***
Group x Style			-4.47	8.33	-0.54 (45.7)	.594
Beauty						
Group (PD vs. HC)	-0.4 (57.0)	0.59 (51.0)	2.84	5.95	0.48 (44.2)	.635
Style (PD, abstr. vs. rep)			3.19	7.70	0.42 (58.0)	.680
Style (HC, abstr. vs. rep)			6.95	8.52	0.82 (58.0)	.418
Group x Style			-3.75	3.60	-1.04 (58.1)	.302

Note. Results based on linear mixed models (LMMs) conducted separately for each scale (lme4 package Version 1.1-8 (Bates, Machler, Bolker, & Walker, 2015) in R Version 3.1.0, applying Satterthwaite approximation for p-values (lmerTest, version 2.0-32; Kuznetsova, Brockhoff, & Christensen, 2016); fixed between-subject factor for group (HC minus PD patients, contrast coded); fixed within-subject factor for artwork style (abstract, representational; contrast coded); random by-image intercepts and random by-participant intercepts with a random slope for group. * denotes significance at $p < .05$, uncorrected for multiple comparisons. A familywise Bonferroni-based adjusted alpha would be $p = .025$ (2 scales). Results that would maintain significance following such correction are shown in bold.

<Figure 3>

4.3 PD severity (HY Staging) and ratings

Finally, we considered the potential impact of PD severity on the above hedonic and formal ratings of art. Due to the smallish sample and lack of prior hypotheses, this was treated as a purely exploratory ad hoc assessment, however, this was included as a potential indication for future research. The analysis was done via another set of LMMs, again conducted individually for each of the above scales, and including the physician-assigned HY score as a fixed between-subject factor (treated as an ordered factor with scores of 0 (HC), 1, 1.5, 2, 2.5; 3 was omitted due to only one individual being assigned to this group), and testing for polynomial patterns (both linear or quadratic trends) across the ordered increments. Note, this approach provided the benefit of considering potential patterns in the use of assessment scales as a relation to increasing PD "severity" while also not violating assumptions that the individual HY levels themselves would have *uniform* differences in their nature or their increments (i.e., as would be the assumption if the scores had been coded as a continuous factor).

Results are reported in Table 3, with familywise Bonferroni correction information shown in the table footnote. Notable scales are also shown as scatterplots in Figure 4. The analyses suggested a significant linear trend for brushstrokes, with a movement toward art rated as having looser style as HY stages increased, as well as both a significant linear and quadratic (although both appeared to be quite similar, visually) trend for color temperature, with participants tending to rate the art as more cool (blueish) as HY stage increased. We also detected a quadratic trend for both complexity, which tended to increase through HY stages, and for beauty, which appeared to peak with very early stages of PD (HY 1-1.5) and then decrease below the HC mean. However, visual inspection of the scatterplots suggested that effects were quite small, with especially the beauty finding suggesting a rather large spread between participants with a trend that might be expected to survive a larger sample-based study. Only the linear trend for brushstrokes survived the Bonferroni correction. Also of note, emotional expressivity, although non-significant, showed a pronounced trend of linear increase across the HY stages (p = .075).

Table 3
Results of LMMs assessing linear or quadratic polynomial patterns in ratings for formal/visual qualities of artworks as a function of PD severity (HY score)

Scale	Pattern type	β	SE	t	p
Hedonic Scales					
Beauty	Linear	-4.38	3.01	-1.34	.179
	Quadratic	-11.11	3.29	-3.37	.007*
Liking	Linear	-3.88	3.19	-1.21	.224
	Quadratic	4.97	3.50	1.42	.155
AAA--formal-perceptual attributes					
balance (visual harmony)	Linear	0.89	2.09	0.43	.671
	Quadratic	1.64	1.91	0.86	.391
color saturation	Linear	0.97	1.99	0.49	.624
	Quadratic	-1.85	1.82	-1.01	.311
color temperature	Linear	5.16	1.98	2.60	.009*
	Quadratic	5.49	1.81	3.03	.003*
depth	Linear	1.42	2.33	0.64	.524
	Quadratic	0.43	2.05	0.21	.835
complexity	Linear	-3.49	2.26	-1.54	.123
	Quadratic	-6.32	2.07	-3.06	.002*

brushstroke (loose/controlled)	Linear	-7.60	2.24	-3.39	**.0007***
	Quadratic	-3.77	2.05	-1.84	.066
AAA-content-representational attributes					
abstraction	Linear	-0.92	2.60	-0.35	.723
	Quadratic	-0.96	2.39	-0.40	.687
realism/fantastic	Linear	-5.03	2.75	-1.83	.068
	Quadratic	-2.48	2.52	-0.98	.325
animacy	Linear	-1.76	2.64	-0.67	.505
	Quadratic	-1.35	2.42	-0.56	.577
objective accuracy	Linear	-3.70	2.54	-1.46	.146
	Quadratic	-4.41	2.33	-1.89	.059
symbolic/literal content	Linear	1.89	2.40	0.79	.432
	Quadratic	-3.47	2.20	-1.57	.116
emotional expressivity	Linear	4.59	2.57	1.78	.075
	Quadratic	0.56	2.36	0.24	.813

Note. Results based on linear mixed models (LMMs) conducted separately for each scale (lme4 package Version 1.1-8 (Bates, Machler, Bolker, & Walker, 2015) in R Version 3.1.0, applying Satterthwaite approximation for p-values (lmerTest, version 2.0-32; Kuznetsova, Brockhoff, & Christensen, 2016); fixed between-subject factor for group (HC minus PD patients, contrast coded); fixed between-subject factor for PD severity (physician-assigned HY score plus HC, treated as an ordered factor with scores of 0 (HC), 1, 1.5, 2, 2.5) testing for polynomial patterns (both linear or quadratic trends) across the ordered increments. * denotes significance at $p < .05$. uncorrected for multiple comparisons. Note, if one were to apply a familywise Bonferroni correction for multiple comparisons, the adjusted alpha would be $p = .0036$ (14 scales, limited to only linear or quadratic assessments); or $p = .0018$ (14 scales x 2 pattern types). Results that would maintain significance following the latter correction are shown in bold.

<Figure 4>

5. Discussion and Conclusion

This study was a first systematic test of the impact of PD on the aesthetic appreciation and formal perception of visual art. It was argued that by looking to potential differences in how individuals rate and perceive paintings following diagnosis with PD, and following a series of similar emerging studies with other neurodegenerative disease, we might provide a beginning for future diagnosis, art-related therapy, and understanding of symptoms and changes from this disease. Even more, by comparing these art viewing results to past evidence on intriguing PD-related behavioral changes in art making, we might gain important new insights into these case studies and the neurological basis of aesthetic perception or the interaction between art and the human brain.

Of course, it is also important to reiterate that, at this point, our findings, and their discussion can only be speculation. This was a first test study, without clear data-driven hypotheses for what we would detect nor specifically why we might find such changes. Rather, we were first and foremost addressing the question of whether/what changes might be found. However, the study does provide intriguing overlaps with much existing PD or neuroaesthetic study, and, when considered in this vein, provide an interesting direction for much future research.

In turn, our comparison—again, focusing on individuals at the early to moderate HY stages and on levodopa and DA agonist therapy, providing a close match to the conditions of most previous art making or aesthetic perception studies—provided two notable findings: (1) The results largely suggested a general lack of change as a result of PD across most scales. This included all formal/perceptual scales of the AAA battery of Chatterjee et al. (2010), as well as hedonic assessments of both liking and beauty, in this case also with no differences for either representational or abstract paintings, and most content/representational scales as well. (2) At the same time, we did find one major change, suggesting that the PD group tended to rate art as more emotionally expressive than HCs. The degree of emotion expressivity also tended to increase, albeit only moderately, with the severity of PD as measured by HY stage. Although very much an ad hoc exploration, when considering changes in relation to PD severity (HY score), trends were also detected for increasing perceived coolness (blueish hues) of color in the art, perceived looser mark-making style, higher complexity, and a peak and then decrease in perceived beauty in progressively more severe PD stages. We walk through the potential implications of our results, and their potential tie to brain function and cognitive processes below.

5.1 General stability in art ratings after PD

Beginning with the general stability in most rating scales, this finding in itself is quite interesting. This seems to be contrary to past art making and general perception studies that might have anticipated certain change. Here in fact, what was most notable was that scales

showed a marked consistency between the PD and the HC groups; and a similar consistency within individual stimuli as well. Especially with general liking or preference, DA in general and related systems (especially the mesolimbic and perhaps mesocortical DA pathways and involved regions) have been tied, at least to some degree, to regulating reward processing (Berridge & Kringelbach, 2013, 2015). Imaging results have also tied activity in these regions to art viewing (Cela-Conde & Ayala, 2014) and making ratings of liking (e.g., NAcc, Wassiliwizky et al., 2017; Zatorre & Salimpoor, 2013) or beauty (OFC, Ishizu & Zeki, 2011). Changes in these systems, due to functional changes relating to PD or a combination with DA pharmacology, have been tied to case evidence for increased desire and enjoyment for making art. It might have been expected that in viewing as well we would find general higher ratings.

It could of course be that our task could not detect such changes—again lack of statistical significance is not proof of lack of effect—or that related changes are not manifest in individuals at an early PD stage. However, this study did follow an established paradigm (from Chatterjee et al., 2010) that has detected changes in similar between-participants designed with other cases of stroke/brain damage or disease. Our sample also included individuals with generally the same early to moderate PD stages as patients included in most art making or general case studies. On the other hand, this finding does fit into an emerging body of evidence that suggests a general aesthetic rating stability, even following neurodegenerative disease. This was noted in the introduction, for example, with AD patients showing no difference in ratings of beauty between individuals with progressively higher disease severity scores and between patients and HCs (Wijk et al., 1999). Similar results have been reported with patients and 'liking,' also in the appraisal of paintings (Halpern et al., 2008), as well as portraits and art photographs (Graham, Stockinger, & Leder, 2013). See also Bromberger et al. (2010, 2011), Devinsky (2003), and Lipson, Sacks and Devinsky (2003) for similar consistency in patients with stroke or other lesions.

These results may broadly suggest that despite other changes in cognitive capacities, the aesthetic sense—at least for specific objects—may be less susceptible to change. In conjunction with the above DA and neurobiological aspects connected to PD, this may also mean that appraisals of what art one tends to like is detached from a basic feeling of reward. The above findings could also tell us something about the felt reward in art in general. The drive to produce art, as found in several previous case reports, and the concomitant pleasure reported by several of the case artists may be tied to one's actual making actions or the fulfillment of the creative drive itself—for example, a limbic system-connected reward feedback from creating something by oneself (Canesi et al., 2012) or through novelty seeking (Schwingenschuh et al., 2010)—and not to any "aesthetic pleasure" one gets from viewing and interacting with finished art products per se. This must be followed up in future research.

5.2 PD and increased assessed emotionality of art

Moving to the other main finding, in this case of PD-related change, the aspect of emotionality, found to increase both between PD patients in general and the HCs, and then to further progressively increase with HY stages, can also be connected to a good deal of supporting discussion. It also raises an intriguing disparity with previous art making case studies.

Interestingly, evidence from most general PD studies would have suggested a *decrease* in emotion perception. PD has again been tied to lowered proficiency in emotion recognition (Assogna, Pontieri, Caltagirone, & Spalletta, 2008; Enrici et al., 2015; Gray & Tickle-Degnen, 2010; Serranová et al., 2011), or perceiving and classifying emotions depicted in the environment (Lima, Garrett, & Castro, 2013; Mattei, Rodriguez, & Bassuner, 2013; van Tricht, Smeding, Speelman, & Schmand, 2010). These symptoms are suggested to tie to damage/change in one or more emotion-processing brain regions—ventral striatum, OFC, anterior cingulate cortex (ACC), PFC. As noted in the introduction, this has also been found to be independent of cognitive and perceptual abilities in general, and well as ability to identify emotions in the self (Enrici et al., 2015), and is also supported by past perception studies, for example, with

photographs (Bowers et al., 2006), or music (Van Tricht et al., 2010; Lima et al., 2013). Although, especially the latter 'aesthetic' studies have shown quite mixed results (e.g., Saenz et al., 2013).

At the same time, when looking to previous PD studies, especially with visual artists, there is supporting evidence for increased emotionality. Several case study authors report artists who changed their focus to moods and emotion expression, often in tandem with a greater emphasis on colors and abstraction (Canesi et al., 2012; Kulisevsky et al., 2009; Lakke, 1999; Shimura et al., 2012; Lauring et al., 2019 for review). It has been suggested that the turn towards emotion might be due to artists overcompensating or increasing the emotion signal in their art in the face of diminished discernment of specific emotions. Note also that the previous empirical evidence with music and photographs noted above did not assess emotionality itself, but rather perception of specific emotion types, themselves finding shifting results depending on the paradigm and study. PD artists might use their art as a way of exploring emotion specifically due to their felt ambiguity. Therefore, the present evidence suggests that we may also find a similar reaction in perception of finished visual art where, for example, the very fact that emotional content or signs may be less clear as to the actual valence or type, causes the feeling of emotionality to become more salient.

Emotional perception could also be somewhat domain specific. For example, many existing studies of diminished emotion perception have used music. On the other hand, Vicente et al. (2011) found no difference between early and later stage PD and control participants in reported intensity of a number of emotions when viewing films. Emotionality could also interact with expectations for stimuli type or processing mode. It may be that when individuals expect an "aesthetic" visual object (such as painting or film) they do focus on emotion. This may itself be connected to introspection or reward. Studies with healthy perceivers have connected viewing art, or perception tasks in which an individual is primed with an aesthetic context (for example telling individuals that what they are about to see is a work of art from a museum as opposed to a

computer-generated object, e.g., Kirk et al., 2009) to activations in reward systems. This could explain the findings by Bowers et al. (2006), which used photographs, but which may not have been seen as art. Similarly, taking an aesthetic focus can also tend to blunt felt negative content but allow more enjoyment or awareness of emotions with a happy valence (Gerger, Pelowski, & Leder, 2017). Salimpoor, Benovoy, Larcher, Dagher, and Zatorre (2011) also recently connected DAergic release in NAcc to the experience of peak emotional responses to music, and DAergic release in the caudate to the anticipation of such an emotional experience.

These papers suggests that previous findings may be highly tied to the conditions of both stimuli and perhaps PD patients. There may also be unique disassociations between modalities, or even classes of visual or auditory stimuli relating to the nature of processing expectations or approach. One limitation of the present study, and a clear future target, involves emotion valence or even specific types of emotions. The AAA test (Chatterjee et al, 2010) was not designed to assess what individuals themselves mean by "emotionality" in their assessments—this could refer to both perceived emotional signs or content, or actual felt affective experience. Future studies controlling for different varieties of emotional stimuli could clarify this.

It is also possible that the emotionality increase could tie to DA pharmacology. Taking levodopa and DA agonist, especially in early PD stages, may again tend to overmedicate especially reward-related frontal regions (see Lauring et al., 2019) leading to hyperfunctioning and contributing to changes in artistic drive, or inhibitions and higher cognitive functions seen with artists. This might also be supported by the one existing study of PD and rating art. Again, albeit with only one rather atypical patient, Drago et al. (2009a) report that when "on" DBS assessed painting completeness, artistic skill, and evocative impact ("How strongly does the painting induce feelings or thoughts?") were significantly lower versus HCs. DBS surgery is often linked to a reduction of felt visual creativity or artistic interest (Lhommée et al., 2014), perhaps due to lowering of DA medication. However, in the above case, when "on" DBS no change in ratings from the HC group was found. A parallel study assessing the same individual's

art productions also found that beauty and evoked thoughts/feelings declined significantly from late presymptomatic to after-DBS periods. If one were to expect a medication argument, we might also expect to find corresponding changes in felt liking or beauty in our sample as well. Again, this was not found.

One other possibility may be that increased emotionality perception could be tied to PD impact on the default mode network (DMN). The DMN, including vmPFC and especially PCC, has been demonstrated to play a role in affective and visceroceptive evaluation or introspection (Ellamil et al., 2012; Jung, Mead, Carrasco, & Flores, 2013; Shulman & Fiez, 1997). Typically, it is found to be activated when one is not performing a task requiring outward attention (however, see Vatansever, Menon, & Stamatakis, 2017). At the same time, it is also suggested to be active in certain cases where one is savoring or aware of one's own emotional or affective response (Pelowski et al., 2017), which may interact especially with art. In an fMRI study on "intense aesthetic experience," Vessel et al. (2012) found activations in left SN, mPFC, PCC, in addition to other frontal and subcortical regions when individuals perceived paintings rated as the most moving, whereas if paintings were rated as less moving, they found typical deactivations. They suggest that this may tie to DA processes. "rais[ing] the possibility that the efferent DAergic connections from the substantia nigra to the striatum offer a mechanism by which hedonic responses to the most highly moving images might be modulated" (p. 10; see also Limb & Braun, 2008 who reported higher DMN activation in jazz improvisation; however, Saggar et al., 2015).

In PD patients, similar lack of deactivations are reported. van Eimeren, Monchi, Ballanger, and Strafella (2009), in a study with patients taken off antiparkinsonian medication before scanning (type/regimen not reported), showed that while performing an executive task the mPFC normally deactivated, whereas PCC and precuneus failed to deactivate. Studies with PD patients on levodopa, both alone or in combination with DA agonists, also show failure of deactivation in the vmPFC while performing a sequence learning task (Argyelan et al., 2008),

and in both the vmPFC and PCC during resting state (Tinaz, Lauro, Hallett, & Horovitz, 2008; however, see Delaveau et al., 2010). The PCC may also be a candidate for more direct changes brought about by PD pathology, for example increasing the resting receptivity to DA (see also Nagano-Saito, Liu, Doyon, & Dagher, 2009; Tomasi et al., 2009). This suggests intriguing future assessments, involving our response especially to art. It also demands future study of patients on and off of medication, which may help to further resolve these findings. In any case, emotionality assessment does seem to be a compelling candidate for future research or even a tool for diagnosis.

5.2 Other notable trends—abstraction and severity related evidence

Finally, our results, when considering further subdivisions between types of art and across individuals with differing PD severity, also raise interesting other possibilities for future research. Primarily, these are compelling for what they may suggest for our interpretations and the functional neurobiological underpinnings regarding existing art making evidence.

First, another change that was hypothesized, but not born out in the data, involved the specific appraisal of abstract art. As noted above, one of the most salient changes noted in art making case studies is a move away from realism and toward abstraction or impressionistic works (Chatterjee et al., 2006; Kulisevsky et al., 2009; Pinker, 2002). This is argued to potentially relate to one or a combination of PD aspects involving for example a reduced inhibition, increased spontaneity or felt reward (potentially tied to brain areas such as the OFC, dlPFC or other mesolimbic regions), as well as increased emotionality or perhaps emphasis on colors and feelings rather than mimetic content. Alternatively, this could also be tied to general changes in motor control, also tied to increased use of crosshatching. As such, if changes could be attributable to especially the reward or spontaneity processing aspects of the brain, we also expected similar changes might manifest in art ratings. We again did not find this.

Both groups favored the representational paintings, however, with no difference in abstract ratings related to PD. This result might provide an important counterpoint to past art

making studies, suggesting that the move to abstraction could relate more to loss of motor control rather than any higher level cognitive change in the brain—i.e., just because artists start making abstract artworks about the time that they start to show symptoms of PD, this does not necessarily mean that they will increase their preference for abstract paintings from other artists in general. This finding also tends to support the above main finding of an absence of difference between PD patients and controls in terms of other hedonic liking and beauty ratings.

Second, when further analyzing the art ratings building in HY severity as a factor, we do add intriguing other possibilities that we will at least entertain for future studies. Notably, our data suggested that with increasing PD severity, individuals may tend to perceive paintings as having looser mark making. This of course is a symptom in PD artists, related again to the move to abstraction and probably reduced motor control. However, it is not immediately clear to ourselves why this would manifest in viewing other's paintings. It may be that this finding ties to higher cognitive function, or suggests a relation that can be found between art production and reception in relation to making aspects, thus calling for future research.

Another overlap with previous making evidence involves perception of complexity, which once again showed an increase across stages of PD. Interestingly, an increase, especially in early PD stages, was found in case studies of famous artists by Forsythe et al. (2017), using computer analysis of Fractal Dimension. Similar results were also detected in Lauring et al. (2019) analysis, using the same methods, of artworks from nine published case studies. In relation to making evidence, it was suggested that increased complexity could be the result of simple loss of motor control—leading to more cross-hatching or haphazard mark making, and thus more visual complexity on the page. However, the present study suggests again that complexity, as with the looseness of brush stroke evidence, may relate to other factors tied to PD. For example, higher complexity perceived in paintings might be an artifact of changes in more complex cognitive processing, for example, working memory, leading to more difficulty processing artistic scenes and thus higher perceived complexity of the scene. A similar result

might also be given for looser perceived mark making. Similarly, inhibitions in selective attention (i.e., as related to the dlPFC) may also lead to difficulty in focusing on specific artwork elements. Such an argument might—again very speculatively—also explain why artists would produce more complex art as well, and suggests most of all, the need for future study.

Perception of color also showed an interesting trend. As noted above, PD is associated to modulated color discrimination (Alenicova, et al., 2017; Birch, Kolle, Kunkel, Paulus, & Upadhyay, 1998; Müller et al., 2002; Oh et al., 2011), and in case studies of art production there is some evidence for increased color emphasis (Kulisevsky et al., 2009; Pinker, 2002), and especially use of 'coolers' blues and greens (Lauring et al., 2019). Interestingly, although we again do not find a general (across all PD patients) change, the ad hoc assessment of art ratings taking into account the HY scoring did suggest a similar potential progressive change toward viewing art as having cooler colors.

This finding once again raises intriguing questions for the previous art making studies. As noted in the introduction, it was suggested that color changes, which are often connected to deficiencies in the retina rather than the brain, might be explained by artists beginning to ignore certain colors or to overuse them, and/or increase their intensity due to difficulty in perception. Especially blue is often difficult for PD patients to perceive (Alenicova et al., 2017). However, it is rather counterintuitive that individuals with difficulty perceiving blue might not only over-use this color in art making, but perceive others' artworks as overall more blue as well. Thus, this once again raises need for future research, perhaps suggesting that changed color perception—at least in the domain of art—may relate more to higher cognitive aspects such as emotionality. Future study might especially combine aesthetic perception, production, as well as general color processing ability within-participants.

5.3 Caveats and other avenues for research

Of course, this study comes with other caveats and multiple demands for future research. This constitutes a first analysis, with a relatively small sample of individuals in early PD stages.

Future study should aim to replicate these findings with more individuals and potentially other types of art. The present analysis focused on individuals in early PD stages, due specifically to our interest in both duplicating the conditions of most previous art-involved PD assessments and also due to our main interest in assessing what main changes might demarcate those with or without a PD diagnosis. However, it is also possible that individuals at later stages could show more pronounced or different changes from HCs—indeed there was some tentative evidence for this in the HY stage comparisons reported. It would be interesting for future studies to offer a more expansive comparison between individuals from varying PD stages in order to test some of these indications further. Future study could also utilize, for example, hemisphere laterality (e.g., see Drago, Foster, Skidmore, & Heilman, 2009; however see Joutsa et al., 2012a; Lauring et al., 2019 for lack of empirical support with making art). Within-participant comparison 'on' and 'off' medication or pre and post DBS, as well as within-participant comparison of art making and viewing, or even art and general perception batteries would also be interesting.

That said, this study provides compelling evidence for both the lack of changes or relative stability in art perception after PD, as well as some key differences that might occur, involving especially assessed emotionality, which themselves should be a basis for much future research.

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Appendix

Table A1

PD symptom and pharmacotherapy information of participants

PD Patient	Gender	Age	PD Duration	BDI-II	MoCA	UPDRS III	HY	PD Pharmacotherapy (Regimen)
1	f	64	--	13	26	16	2.5	Levodopa; DA agonists (--)
2	m	64	--	5	28	7	1	Levodopa; decarboxylase inhibitor (100 mg/25 mg, 1 + 1 + 0.5 x day); DA agonists (2.1 mg x day)
3	f	48	--	3	29	2	1	Levodopa; DA agonists (--)
4	f	56	3	3	29	12	2	Levodopa; DA agonists (6 mg, 1 x day); Selegiline (10 mg, 1 x day)
5	f	56	7	7	28	3	2	Levodopa; decarboxylase inhibitor (100 mg/25 mg, 7 x day); DA agonists (10 mg + 8 mg x day)
6	f	75	17	14	28	7	2	Levodopa; decarboxylase inhibitor (100 mg/25 mg, 1+1.5 + 1.5 + 1.5+1); Pramipexole, hydrochloride monohydrate, DA agonists (0.78 mg 1 x day); MAO-B inhibitors (10 mg 1 x day)
7	f	61	6	47	30	10	2	Levodopa; decarboxylase inhibitor (50 mg/12.5 mg, 4 x day)
8	f	69	9	20	30	8	2	Levodopa; decarboxylase inhibitor (100 mg/25 mg, 6 x day); DA agonists (--)
9	f	67	5	13	29	8	1.5	Levodopa; decarboxylase inhibitor (100 mg/25 mg, 1 x day); Rasagiline, MAO-B inhibitors (1 mg, 1 x day)
10	f	51	--	7	27	4	1	Levodopa; DA agonists (--)
11	f	68	10	14	28	7	1.5	Levodopa; decarboxylase inhibitor (100 mg/25 mg, 1.5 + 1.5 + 1 + 1 x day); Pramipexole, DA agonists (1.05 mg, 1 x day)
12	f	69	--	--	--	--	--	Levodopa; DA agonists (--)
13	f	62	--	--	--	--	--	Levodopa; DA agonists (--)
14	f	67	4	12	28	16	1.5	Levodopa; decarboxylase inhibitor (100 mg/25 mg, 3 x day); Rasagiline, MAO inhibitors (1 mg, 1 x day)
15	m	66	4	15	30	9	2	Pramipexole, DA agonists (1.05 mg, 1 x day)
16	f	67	11	13	30	8	2.5	Levodopa; decarboxylase inhibitor (150 mg/37.5 mg/200 mg, 4 x day); Entacapone, DA agonist (16 mg, 1 x day)

17	f	68	16	3	24	6	2	Levodopa; decarboxylase inhibitor (50 mg/12.5 mg, 4 x day); Pramipexole, DA agonists (3.15 mg, 1 x day); Rasagiline, MAO inhibitors (1 mg, 1 x day)
18	F	60	6	5	29	3	2.5	Levodopa; decarboxylase inhibitor (50 mg/12.5 mg, 5 x day); DA agonists (0.52 mg, 5 x day)
19	M	65	6	6	29	10	2	Levodopa; decarboxylase inhibitor (100 mg/25 mg, 5 x day); DA agonists (2 mg, 5 x day); Rasagiline, MAO inhibitors (1 mg, 1 x day)
20	F	76	6	28	20	19	3	Levodopa-Carbidopa combination intestinal gel administered via portable pump. Quetiapine* (25 mg, 1 x day)
21	M	78	--	15	20	6	2	Levodopa; decarboxylase inhibitor (100 mg/25 mg, 4 x day)
Mean		64.61	7.86	12.79	27.47	8.47	1.89	
SD		7.58	4.31	10.51	3.03	4.61	0.56	

Note, all individuals with the exception of numbers 1, 3, 10, 12, 13 were patients of the study authors (Haugbøl, University of Copenhagen Bispebjerg Hospital) and thus a detailed clinical history could be compiled. Individuals with dashes (--) in specific columns indicate that the patient was recruited from a PD Facebook group and from ads in the Parkinson Society members' magazine, thus PD duration and specific medication and dosage information could not be obtained. All patients were confirmed to be receiving Levodopa and DA agonists. No patients were receiving DBS. All received their usual antiparkinsonian pharmacotherapy throughout the study. With the exception of patients 12 and 13 (refused the clinical examination) all patients were assessed by a medical doctor (Haugbøl, University of Copenhagen Bispebjerg Hospital) upon visiting the study location for symptom severity using the Unified Parkinson's Disease Rating scale, part III (UPDRS III) (Fahn & Elton, 1987), as well as Modified Hoehn and Yahr rating scale (HY) (Goetz et al., 2004), and the Montreal Cognitive Assessment test 7.0 (MoCA; Nasreddine et al., 2005), and Beck Depression Inventory II (BDI-II; Beck, Steer, Ball, & Ranieri, 1996).

* Quetiapine is an atypical antipsychotic also used for the treatment of schizophrenia, bipolar disorder, and major depressive disorder, etc.. However, the patient in question was using this as a sleeping in the treatment of PD, aid and did not exhibit psychotic or other symptoms related to the issues above.

Figures

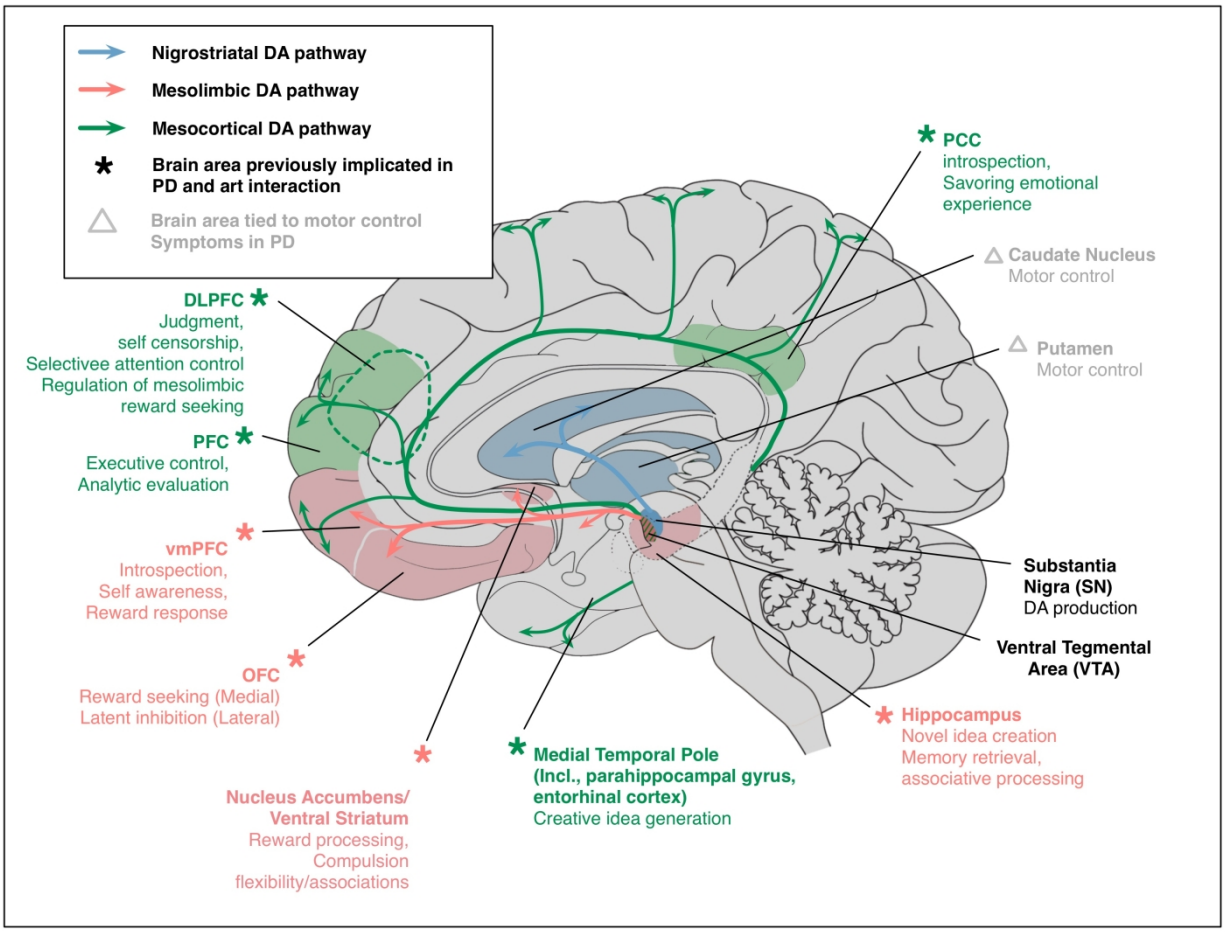

Figure 1. Main DA-pathways and brain regions as implicated in both art interaction and PD studies. (Figure based on Lauring et al., 2019)

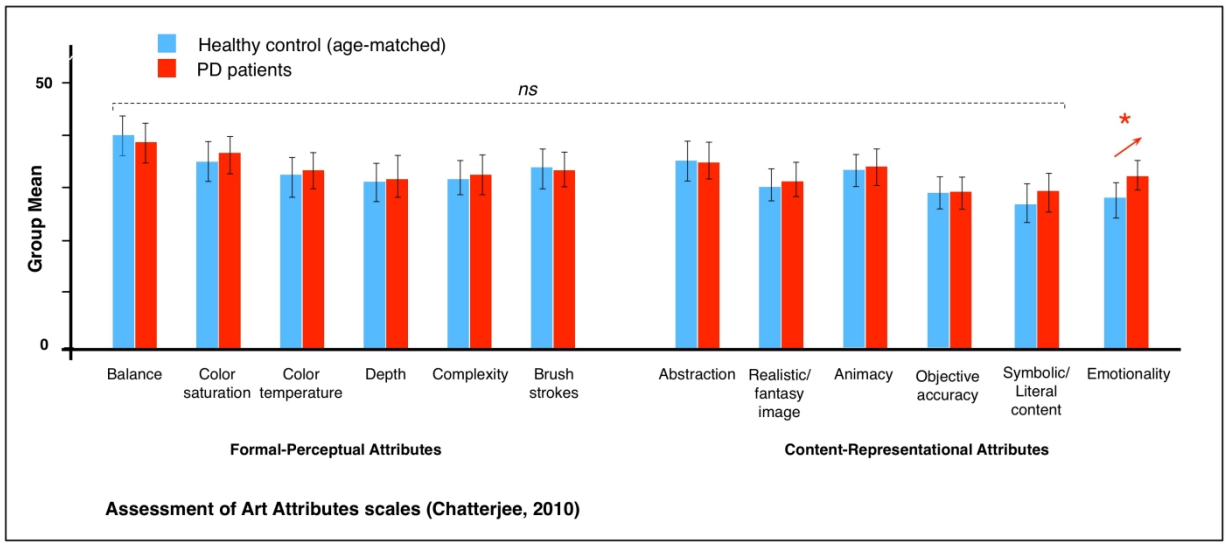

Figure 2. Comparison of PD patient and HC groups' mean ratings of ratings for formal-perceptual and content-representational attributes of visual artworks (paintings). Scales and artworks based on Chatterjee (2010). * denotes significant difference at $p < .05$ (based on LMM with Satterthwaite approximation for p-value, fixed between-subject factor for group (HC minus PD patients; contrast coded); random by-image intercepts and random by-participant intercepts with a random slope for group).

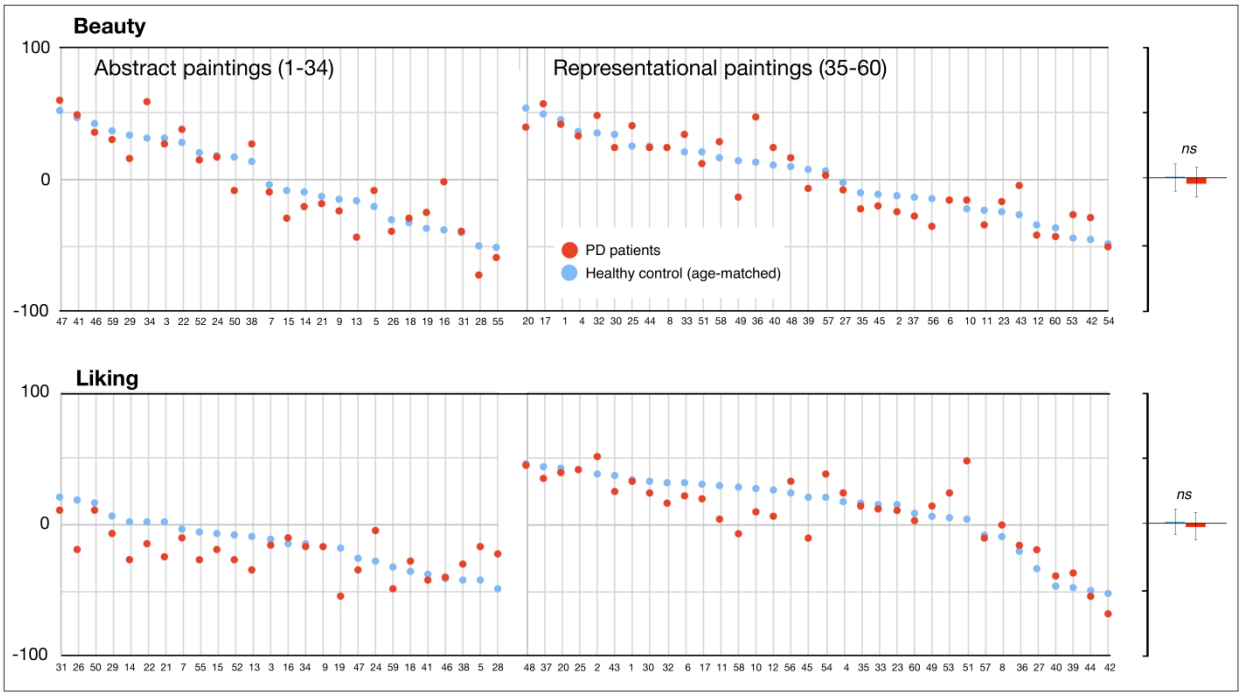

Figure 3. Comparison of PD patient and HC groups' mean ratings of individual paintings for liking and beauty. Significance assessment based on LMM with Satterthwaite approximation for p-value, fixed between-subject factor for group (HC minus PD patients; contrast coded); fixed within-subject factor for style (representational, abstract; contrast coded); random by-image intercepts and random by-participant intercepts with a random slope for group.

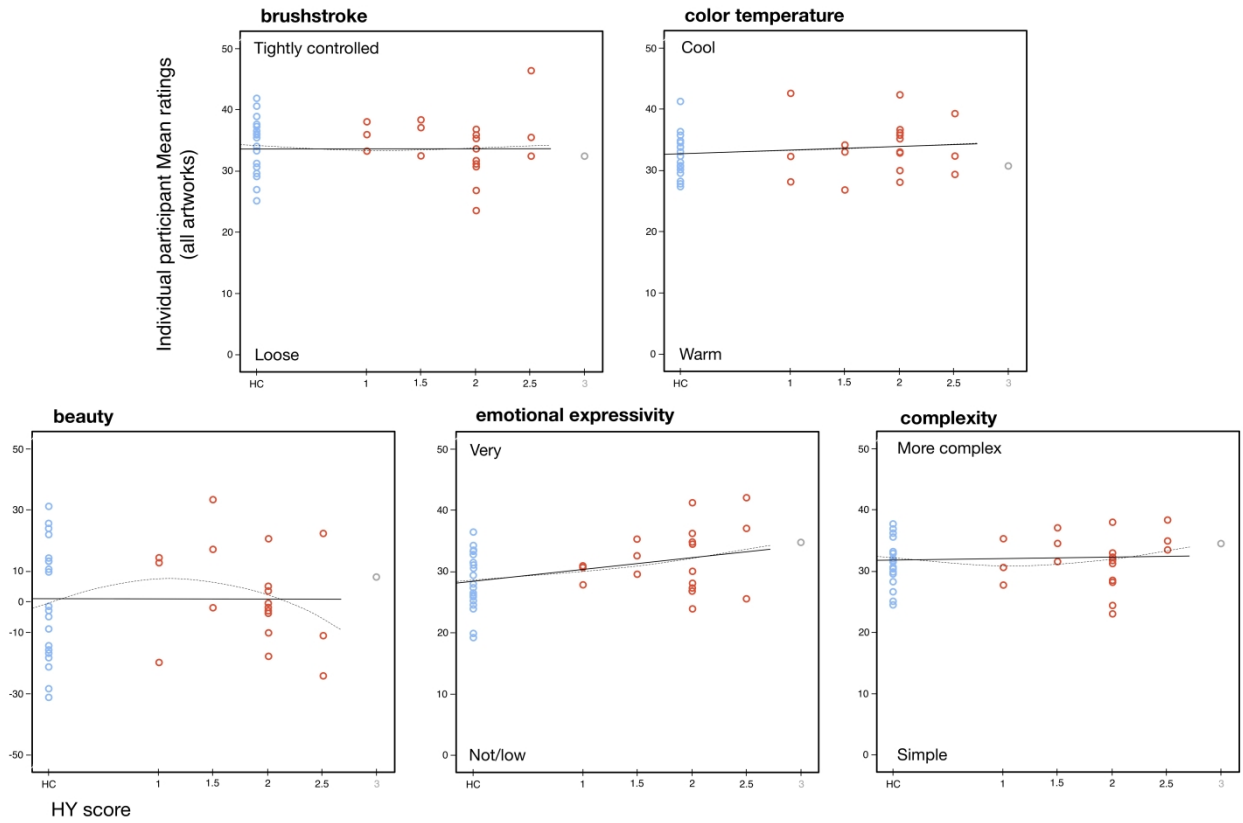

Figure 4. Scatterplots of relation between mean score of painting ratings by individual PD or HC participants and severity of PD symptoms (HY Stage). Bold line depicts linear regression line, dotted line depicts quadratic relation. (Note, HY score of 3 was omitted from the analyses due to only one individual being in this group. Shown for comparative purposes only).

Supplementary Materials

Table S1
List of Artworks (Paintings) Used in AAA Studies (from Chatterjee et al., 2010)

	Artist	Year	Title
1	Vermeer, Jan	1666	*The Letter*
2	Pollock, Jackson	1950	*Number One*
3	Cassatt, Mary	1873	*On the Balcony During Carnival*
4	Kahlo, Frida	1939	*Two Fridas*
5	Cézanne, Paul	1867-1869	*Still Life with Kettle*
6	Holbein, Hans	1533	*Portrait of Dirk Tybis*
7	Dali, Salvador	1944	*Gala and Tigers*
8	Ranson Paul	1891	*The Blue Room*
9	Rothko, Mark	1955	*Red and Orange*
10	Hopper, Edward	1940	*Gas*
11	Garsia, Stephanus	11c	*Apocalypse of Saint-Server*
12	Bruegel, Pieter, the Elder	1559	*Netherlandish Proverbs*
13	Newman, Barnett	1950	*Eve*
14	*de Kooning,* Willem	1950–52	*Woman*, I
15	Pissaro, Camille	1873	*Landscape with Flooded Fields*

Table S2
List of Artworks (Paintings) Used in Hedonic Judgment Studies

	Artist	Year	Title
1	Bellotto, Bernardo (Canaletto)	1758-1761	*Freyung Square from north-east, Vienna*
2	Friedrich, Caspar David	1819-1820	*Riesengebirge Landscape with Rising Fog*
3	Grosz, George	1917	*Explosion*
4	Buehr, Karl Albert	1913	*The Parasol*
5	Kelly, Walker	2002	*TWA Flight 800*
6	Ring, L. A.	1900	*Summers day at Roskilde Fjord*
7	Diebenkorn, Richard	1955	*Berkeley #57*
8	Picasso, Pablo	1968	*Nude Woman with Necklace*
9	Milhazes Beatriz	1996	*Succulent Eggplants*
10	Chagall, Marc	1969	*Bestiaire et Musique*
11	Degas, Edgar	1863	*Self Portrait*
12	Monet, Claude	1891	*The Four Trees Anagoria*
13	Murphy, William F.	2007	*Drilling for Eggs (MOBA)*
14	Mondrian, Piet	1911	*Gray Tree*
15	Guo-Qiang, Cai	2004	*The Age of the Eagle*
16	Cwynar, Sara	2014	*Contemporary Floral Arrangement 4*
17	Best, Kevin	Early 21c	*Untitled. Still life after Willem Kalf*
18	Riley, Bridget	1963	*Fall*
19	Unknown	2016	*Never Ending Story*
20	Henningsen, Erik Ludvig	1888	*Summer Holiday. Visitors Taking An Outing With the Local Fisherman*
21	Johns, Jasper	1961	*0 through 9*
22	Duchamp, Marcel	1912	*Nude Descending a Staircase, No. 2*
23	Ensor, James	1887	*Driven out Adam and Eve of the Paradise or Study of Light*
24	Rothko, Mark	1961	*Orange, Red, Yellow*
25	Hartley, Charles	2012	*Bahama Surf*
26	Kandinsky, Wassily	1923	*On White II*
27	*Close*, Chuck	1967-1968	*Big Self-Portrait*

28	Ellsworth, Kelly	1951	*Blue and White.*
29	Kobe, Martin	2009	*Untitled 2009*
30	Gude, Hans	1847	*Norwegian: Fra Hardanger*
31	Appel, Karel	1954	*People, Birds and Sun*
32	*Turner, William*	1842	*Snow Storm - Steam-Boat Off A Harbour's Mouth*
33	Delacroix, Eugène	1823–1824	*Orphan Girl at the Cemetery*
34	Unknown	Late 20c	Unknown (abstract)
35	Walsh, Nathan	2010	**Reichstag Dome**
36	Sir Landseer, Edwin	1851	*Monarch of the Glen*
37	*van Gogh,* Vincent	*1888*	*The Sower*
38	Unknown	20c	Unknown (abstract)
39	Freud, Lucian	1997	*Sunny Morning - Eight Legs*
40	Kinkade, Thomas	Late 20c/early 21c	*Everett's Cottage*
41	Twombly, Cy	1970	*Untitled*
42	MacLeod, Robert	Late 20c/early 21c	*Dissent from the Pedestal (MOBA)*
43	Pissarro, Camille	1897	*The Boulevard Montmartre at Night,*
44	Harris, Anne	Early 21c	Unknown (representational)
45	Bonheur, Rosa	1855	*The Horse Fair*
46	Unknown	Late 20c/early 21c	Unknown. (abstract, Jackson Pollock style)
47	Rauschenberg, Robert	1955	*Bed*
48	Hopper, Edward	1927	*Automat*
49	Veronese, Paolo	1573–1573	*The Feast in the House of Levi*
50	Richter, Gerhard	1990	*Abstract Painting (726)*
51	Xiaogang, Li	Early 21c	Unknown. (Representational, woman lying on a sheeted bed under a window)
52	Tomaselli, Fred	2000	*Echo, Wow, and Flutter,*
53	Magritte, René	1950	*The Empire of Light, II*
54	Seurat, George	1884	*Bathers at Asnières*
55	Malevich, Kazimir	1916	*Suprematist Composition*
56	*Tsitoghdzyan*, *Tigran*	*2012*	*Mirror*
57	Fragonard, Jean-Honoré	1755	*The Musical Contest*
58	Derain, André	1906	*Bridge over the Riou*
59	Kline, Franz	1950	*Chief*
60	Keathley, Mark	Late 20c/early 21c	*Simple Treasures*