accounting for age, sex, and education. Analyses were performed in R (v4.1.2(Team, 2013)).
Results: PD-MCI (0.702± 0.269) patients exhibited significantly lower accuracy on the motion discrimination task than HC (0.853 ± 0.241; p = *0.033*) and PD-NC (0.880 ± 0.208; p =*0.039*). A Group × Coherence interaction was identified in which several regions, including orbitofrontal, posterior parietal and occipital cortex, showed increased activation during High relative to Low coherence trials in the PD patient groups but not in the HC group. HC showed default mode deactivation and frontal-parietal activation during Low relative to High coherence trials that was not evident in the patient groups.
Conclusions: PD-MCI patients exhibited worse visuospatial performance on a motion discrimination task than PD-NC and HC participants and exhibited hyperactivation of the posterior parietal and occipital regions during motion discrimination, suggesting possible compensatory activation.

Categories: Neurodegenerative Disorders
Keyword 1: Parkinson's disease
Keyword 2: cognitive functioning
Keyword 3: neuroimaging: functional
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5 Midbrain Degeneration and Cognition in Parkinson's Disease

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Objective: Neuromelanin imaging is an emerging biomarker for PD as it captures degeneration of the midbrain, a process which is associated with the motor symptoms of the disease. Currently, it is unknown whether this degeneration also contributes to cognitive dysfunction in PD beyond dysfunction associated with fronto-subcortical systems, as quantitative examination of substantia nigra (SN) degeneration could not be studied until recently. In the current study, we examine whether neuromelanin signal is associated with broader cognitive dysfunction in PD patients with varying degrees of cognitive impairment: PD with normal cognition (PD-NC), PD with mild cognitive impairment (PD-MCI), and healthy controls (HC).
Participants and Methods: 11 PD-NC, 16 PD-MCI and 14 age and sex-matched healthy controls (HC) participated in the study. PD participants were diagnosed with MCI based on the Movement Disorders Society Task force, Level II assessment (comprehensive assessment). In addition, all participants underwent an MRI scan that included a T1-weighted sequence and a neuromelanin-sensitive (NM-MRI) sequence. Contrast-to-noise-ratio of the substantia nigra pars compacta (SNc) was calculated and a distribution-corrected z-score was used to identify the number of extrema voxels for each individual, suggestive of the number of voxels that have exhibited significant degeneration (extrema_count). An analysis of covariance (ANCOVA) was used to evaluate group differences between HC, PD-NC, and PD-MCI in the extrema_count accounting for age, sex, and education. A multiple regression for each cognitive variable with extrema_count as the dependent variable adjusting for age, sex, and education were conducted.
Results: A significant main effect of group ($F(2, 33) = 33.548$; $p < 0.001$) indicated that PD-NC (21.55 ± 12.57) and PD-MCI (43.64 ± 32.84) patients exhibited significantly greater extrema_counts relative to HC (3.36 ± 3.61; both $p < 0.001$). Regression results indicated that higher extrema_counts were associated with worse cognitive performance across cognitive domains, including working memory (Digit Span Backward; $R^2 = .357$, $F(1,20) = 5.295$, $p = .032$), (Hopkins Verbal Learning Test – Revised, Trials 1 to 3; $R^2 = .432$, $F(1,20) = 5.819$, $p = .026$).
Conclusions: PD patients (PD-NC and PD-MCI) exhibited decreased neuromelanin in the SNc relative to healthy controls, confirming the ability of the NM-MRI sequence to differentiate PD from HC. There was no significant difference in SNc neuromelanin levels between PD-NC patients and PD-MCI patients, however, this is likely due to the small sample size. In addition, significant SNc degeneration was associated with worse cognitive performances in tasks associated with working memory and executive functioning. These results warrant further

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examination of the role of SN in PD patients with differing levels of cognitive impairment.

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Keyword 3: neuroimaging: structural
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6 Association Between American Football Play and Parkinson's Disease: Analysis of the Fox Insight Data Set

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Objective: Parkinsonism and Parkinson's disease (PD) have been described as consequences of repetitive head impacts (RHI) from boxing, since 1928. Autopsy studies have shown that RHI from other contact sports can also increase risk for neurodegenerative diseases, including chronic traumatic encephalopathy (CTE) and Lewy bodies. In vivo research on the relationship between American football play and PD is scarce, with small samples, and equivocal findings. This study leveraged the Fox Insight study to evaluate the association between American football and parkinsonism and/or PD Diagnosis and related clinical outcomes.
Participants and Methods: Fox Insight is an online study of people with and without PD who are 18+ years (>50,000 enrolled). Participants complete online questionnaires on motor function, cognitive function, and general health behaviors. Participants self-reported whether they "currently have a diagnosis of Parkinson's disease, or parkinsonism, by a physician or other health care professional." In November 2020, the Boston University Head Impact Exposure Assessment was launched in Fox Insight for large-scale data collection on exposure to RHI from contact sports and other sources. Data used in this abstract were obtained from the Fox Insight database https://foxinsight-info.michaeljfox.org/insight/explore/insight.jsp on 01/06/2022. The sample includes 2018 men who endorsed playing an organized sport. Because only 1.6% of football players were women, analyses are limited to men. Responses to questions regarding history of participation in organized football were examined. Other contact and/or non-contact sports served as the referent group. Outcomes included PD status (absence/presence of parkinsonism or PD) and Penn Parkinson's Daily Activities Questionnaire-15 (PDAQ-15) for assessment of cognitive symptoms. Binary logistic regression tested associations between history and years of football play with PD status, controlling for age, education, current heart disease or diabetes, and family history of PD. Linear regressions, controlling for these variables, were used for the PDAQ-15.
Results: Of the 2018 men (mean age=67.67, SD=9.84; 10, 0.5% Black), 788 (39%) played football (mean years of play=4.29, SD=2.88), including 122 (16.3%) who played youth football, 494 (66.0%) played high school, 128 (17.1%) played college football, and 5 (0.7%) played at the semi-professional or professional level. 1738 (86.1%) reported being diagnosed with parkinsonism/PD, and 707 of these were football players (40.7%). History of playing any level of football was associated with increased odds of having a reported parkinsonism or PD diagnosis (OR=1.52, 95% CI=1.14-2.03, p=0.004). The OR remained similar among those age <69 (sample median age) (OR=1.45, 95% CI=0.97-2.17, p=0.07) and 69+ (OR=1.45, 95% CI=0.95-2.22, p=0.09). Among the football players, there was not a significant association between years of play and PD status (OR=1.09, 95% CI=1.00-1.20, p=0.063). History of football play was not associated with PDAQ-15 scores (n=1980) (beta=-0.78, 95% CI=-1.59-0.03, p=0.059) among the entire sample.
Conclusions: Among 2018 men from a data set enriched for PD, playing organized football was

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