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Psychometric Properties and Characteristics of the North-East Visual Hallucinations Interview in Parkinson's Disease

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Abstract: **Background:** Visual hallucinations (VH) are a common symptom experienced by individuals with Parkinson's disease (PD); however, a validated measure of VH has yet to be established for this population. The North-East Visual Hallucinations Interview (NEVHI), a promising VH measure, has not been well validated in patients with PD. The aim of this study was to evaluate the convergent and discriminant validity of the NEVHI as well as the proportional identification and characteristics of VH in PD.
Methods: One hundred seventeen individuals with PD completed the NEVHI along with evaluations of psychological, cognitive, motor, and visual functioning as measures of convergent and divergent validity. The hallucination items from the Neuropsychiatric Inventory (NPI) and the Movement Disorder Society-sponsored revision of the Unified Parkinson's Disease Scale (MDS-UPDRS) were used to assess convergent validity.
Results: The NEVHI identified 20.5% of patients who had PD with VH, which included all individuals identified by the MDS-UPDRS and NPI and 9 additional individuals who were not identified using the other measures. The NEVHI was strongly correlated with the MDS-UPDRS hallucinations item and weakly correlated with the NPI VH item. Weak to nonsignificant correlations were observed between the NEVHI and measures of psychological, cognitive, motor, visual, and demographic characteristics.
Conclusion: The NEVHI identified a greater number of individuals with VH than either the MDS-UPDRS or the NPI. The current results demonstrated good convergent validity between the NEVHI and a clinician-administered, patient-report measure of VH and excellent divergent validity, supporting the NEVHI as a valid and preferable measure for assessing the presence of VH in PD

Visual hallucinations (VH), defined as sensory misperceptions that occur in the absence of a visual stimulus, are common in Parkinson's disease (PD), with prevalence rates ranging from 8% to 40%.[1,2] VH have been associated with increased caregiver burden,[3] permanent nursing home placement,[4] increased mortality,[5] and cognitive decline.[6,7] Given the high prevalence and potentially detrimental impact of VH in PD, accurate VH assessment in this population is critical.

Despite the importance of evaluating VH in PD, there is no accepted gold standard of VH assessment. Many common VH measures are limited because they use only 1 item, fail to differentiate VH from other types of hallucinations, and/or are administered to informants rather than directly to patients.

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Although several scales have been validated to assess for psychosis in PD,[8,9] these measures are typically not specific to VH, nor do they assess for critical details such as VH type or qualitative characteristics.

The Movement Disorder Society-sponsored revision of the Unified Parkinson's Disease Rating Scale (MDS-UPDRS)[10] is one of the most frequently used assessments in PD.[11] Item 1.2 of the MDS-UPDRS, Part I evaluates both hallucinations and delusions using a clinician-administered, patient-report or informant-report measure on a rank-ordered scale. Although MDS-UPDRS item 1.2 has been validated for use in PD,[12] it is limited by the lack of differentiation between types of hallucinations (e.g., visual vs. auditory; for references, see Patients and Methods, below). Another commonly used scale, the Neuropsychiatric Inventory (NPI),[13] assesses VH as a distinct symptom but is administered to an informant without patient input (for references, see Patients and Methods, below). Informant reports have been identified as less reliable and capture fewer details associated with VH than those administered directly to the patient.[14] Although patient insight is often a concern, patients who have PD with cognitive impairment, including dementia, are frequently able to describe their VH in detail.[15]

Most VH measures, including the MDS-UPDRS and NPI, do not examine details regarding the patients' experience of VH. VH are often divided into 2 categories: simple and complex.[16] Simple VH consist of low-complexity visual features (e.g., flashes, swirls, patterns), whereas complex VH contain clearly defined images (e.g., animals, people, faces).[1,17] Assessing this phenomenology is important, because simple and complex VH may be associated with different pathophysiologic mechanisms[18] and thus may be valuable in terms of diagnostic and prognostic assessment.[19]

One of the more promising measures of VH is the North-East Visual Hallucinations Interview (NEVHI).[16] The NEVHI is a semistructured, clinician-administered, face-to-face interview designed to comprehensively assess VH in elderly patients with potential cognitive or visual impairments. The NEVHI is a 17-item measure that examines the frequency, intensity, and content of VH and is administered directly to the patient in less than 10 minutes. The NEVHI contains 3 screening items designed to identify individuals with VH using a variety of terminologies. However, to date, the validity and utility of the individual screening items has not been assessed. Moreover, the NEVHI also addresses the temporal course and onset of VH. Although the NEVHI has demonstrated good validity in older adults,[16] it still requires systematic validation in patients with PD.

Psychometric studies of the NEVHI in PD are very limited and primarily focus on informant-patient agreement using different versions of the NEVHI. A recent study conducted by Urwyler et al.[14] revealed poor-to-moderate inter-rater agreement between the NEVHI patient and informant reports. Moreover, the patient-report NEVHI resulted in a greater number of VH endorsements compared with the informant report. Likewise, Archibald et al.[18] found that informant-to-patient reliability on the NEVHI was low for patients who had PD with simple VH. However, validation studies comparing the patient-report NEVHI with other patient-report measures of VH are needed. Furthermore, there is a need to assess the discriminant validity of the NEVHI with other psychiatric measures as well as motor and visual symptoms, because these symptoms have been associated with VH in patients with PD.[20,21] Previous studies have also indicated that VH in PD can be associated with age, disease stage, disease duration, levodopa equivalent dosage (LED), and cognitive impairment.[22,23] Thus, examination of these variables in relation to the NEVHI will provide critical clinical as well as psychometric information.

The objectives of the current study were to examine the convergent validity of the NEVHI through a comparison with clinician-administered, patient-reported (MDS-UPDRS) and informant-reported (NPI) measures of hallucinations as well as the discriminant validity of the NEVHI. To examine validity, we used the multitrait-multimethod matrix approach,[24] which provides structured selection of convergent and discriminant measures stratified by content/trait (e.g., VH vs. psychiatric, motor, and visual symptoms) and assessment method (e.g., clinician administered vs. informant report). The qualitative characteristics of VH were examined as an exploratory aim. It was hypothesized that the NEVHI: (1) would identify a higher number of VH compared with the MDS-UPDRS and NPI; (2) would demonstrate weak convergent validity with the informant report (NPI) and strong convergent validity with the patient report (MDS-UPDRS); and (3) would have good discriminant validity through weaker correlations with measures of visual impairment, motor function, anxiety, and depression as well as demographic (e.g., age) and PD (e.g., disease severity) characteristics.

Patients and Methods

Participants

Participants included 117 individuals who met UK Brain Bank Diagnostic Criteria[25] for idiopathic PD, as diagnosed by a board-certified neurologist specializing in movement disorders. Participants were recruited from the Movement Disorders Clinics at the University of California, San Diego and the Veterans Affairs Healthcare System in San Diego, California. Exclusion criteria included a history of psychosis before the onset of PD. Visual acuity was measured using a Snellen chart and was translated to a decimal notation system (i.e., 1.0 visual acuity is 20/20 or perfect vision) ranging from 0.3 to 1.0. The Mattis Dementia Rating Scale (MDRS)[26] measured overall cognitive functioning and ranged from 127 to 144. All but 1 participant provided medication information. Participants were tested on their normal medication dosages in the on-medication state. In total, 136 patients with PD were identified as possible participants; however, 19 patients were unable to designate a primary caregiver to complete the NPI and thus were excluded from analyses. Caregivers consisted of 81% spouses, 13% family members (e.g., child, sibling, parent), and 6% friends. The local ethics committee approved this study, and participants provided

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TABLE 1 Demographic and clinical characteristics for sample, n = 117

Variable	Mean ± SD[a]
Age, y	68.9 ± 7.6
Sex: No./total no. of men/women	90/27
Education, y	16.2 ± 2.4
Duration of disease, y	6.1 ± 5.3
MDRS total score	137.8 ± 4.3
FTT-dominant hand, t score	40.3 ± 13.6
FTT-nondominant hand, t score	41.0 ± 13.6
Snellen visual acuity, raw	0.80 ± 0.18
Modified Hoehn & Yahr stage, %	
0	1.7
1	20.0
1.5	2.6
2	56.4
2.5	4.3
3	11.1
4	0.9
5	0.9
Levodopa equivalent, mg/d[b]	711.1 ± 574.4

SD, standard deviation; MDRS, Mattis Dementia Rating Scale; FTT, Finger Tapping Test.
[a]All values listed are the mean ± SD unless otherwise indicated.
[b]Levodopa equivalents were calculated using the formula published by Tomlinson et al.[27]

written informed consent before the initiation of study procedures. Table 1 displays participant demographics and clinical characteristics.[27]

Procedure

The NEVHI was administered to all patients in a clinical interview by a trained psychometrician, a method herein referred to as "clinician-administered." A second reviewer inspected all NEVHI responses for accuracy. The NEVHI consists of 3 sections. The first section contains 4 binary (yes/no) response questions. The first 3 screening questions (NEVHI-Q1–3) were designed to identify the presence of VH (Question 1: "Do you feel like your eyes ever play tricks on you?"; Question 2: "Have you ever seen something that other people could not see?"; Question 3: "Have you ever had visual hallucinations?"). The fourth question ("Have you ever had prior visual experiences?") was devised to assess for potential false-positive results. A confirmatory response to any of the first 3 screening questions elicits an interviewer prompt to describe the VH in an open-ended response followed by closed-ended questions about key features of VH (e.g., color, form, shape), which the interviewer categorizes as simple, complex, or both simple and complex hallucinations.[16] If a person endorses any of the first 3 items in Section 1, then VH are considered present, and the interviewer administers Section 2 (rank-ordered, qualitative, temporal aspects of VH). If VH within the last month are endorsed, then Section 3 (9 questions regarding emotions, cognitions, and behaviors associated with VH rated on a Likert scale ranging from 0 [never] to 4 [always]) is administered. The NEVHI is described in greater detail in the report by Mosimann et al.[16]

In accordance with the multitrait-multimethod approach, convergent validity was measured using the monotrait (i.e., VH)-heteromethod (i.e., clinician-administered vs. informant) correlations between NEVHI-Q1–3 and informant-administered (NPI Item B: Visual Hallucinations; NPI-VH) and clinician/psychometrician-administered (MDS-UPDRS-Part I item 1.2: Hallucinations and Psychosis; referred to herein as MDS-UPDRS-H) items. Discriminant validity was assessed with heterotrait (i.e., psychiatric, motor, visual symptoms)-heteromethod (i.e., clinician-administered vs. informant) correlations.

The MDS-UPDRS-H ("Over the past week, have you seen, heard, smelled, or felt things that were not really there?") was clinician-administered to the patient and rated on a 5-point severity scale ranging from 0 (normal) to 4 (severe), and these responses were bifurcated (i.e., normal vs. slight-severe) for comparison with the answers on NEVHI-Q1–3 (any yes vs. no on all 3 questions). No participants reported a severity level of 4, which is the only rating indicative of delusions. The caregivers completed a written version of the screening items from the NPI-Clinician,[13] referred to as an "informant report." The hallucinations item (NPI-VH), "Does she/he have hallucinations such as seeing false visions or hearing false voices? Does he/she seem to see, hear, or experience things that are not present?" was marked yes or no, and this binary response was used in analyses.

Discriminant validity for NEVHI-Q1–3 was measured by evaluating heterotrait-heteromethod correlations with visual acuity (Snellen chart total score) and motor function total t scores (the Finger Tapping Test)[28] as well as heterotrait-monomethod correlations with the individual Depressed Mood and Anxious Mood MDS-UPDRS-Part I items. In addition, the relationships between the NEVHI-Q1–3 answers and demographic (age, sex, education) and clinical characteristics (e.g., disease stage)[29] were also analyzed.

Statistical Analyses

The distribution of VH detected by each measure was examined with the χ^2 test. To evaluate the convergent and discriminant validity of the NEVHI, a φ coefficient was calculated to examine the relationship of the binary NEVHI-Q1–3 responses (yes/no) to the binary responses on the MDS-UPDRS-H, NPI-VH, MDS-UPDRS-Anxiety, and MDS-UPDRS-Depression items as well as sex (male/female). Participants were classified into groups based on the binary NEVHI-Q1–3 responses, and the Shapiro-Wilk test for normality was used to examine normality of the distributions of all continuous discriminant variables for each group. Point-biserial correlations were used to compare the NEVHI-Q1–3 answers to the normally distributed continuous variables (e.g., the Finger Tapping Test). Nonparametric statistics were used for all other continuous discriminant variables in which at least 1 of the groups exhibited a non-normal distribution. Rank-biserial correlations were used to compare correlations between NEVHI-Q1–3 and visual acuity, demographic information (e.g., age, education), and clinical characteristics (e.g., cognitive function, disease duration, disease stage, LED). Based on guidelines from Cohen's Statistical Power Analyses,[30] correlation coefficients were classified as strong (>

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0.5), moderate (0.3–0.5), or weak (<0.3). A sample size of 117 was used for all statistical analyses unless otherwise specified.

Results

The results revealed significant differences in the proportion of individuals identified with or without VH using the NEVHI-Q1–3 compared with the MDS-UPDRS-H (χ^2 [2, 117] = 57.858; $P < 0.001$) and the NPI-VH (χ^2 [2, 117] = 9.819; $P = 0.002$), such that more individuals endorsed VH on the NEVHI compared with the MDS-UPDRS-H and the NPI-VH (see Table 2). The NEVHI-Q1–3 identified all patients with VH who were identified by the MDS-UPDRS-H and the NPI-VH and also detected an additional 9 patients who were missed by both measures. Questions 1 and 3 identified all individuals (n = 24), and Question 2 (n = 15) did not identify any unique individuals that Questions 1 or 3 did not capture. Eight participants endorsed Question 4, and all of those individuals also endorsed both Questions 1 and 3.

Convergent Validity

As shown in Table 3, the relationship between the NEVHI-Q1—3 and the MDS-UPDRS-H was strong ($\varphi = 0.57$), whereas the relationship between the NEVHI-Q1–3 and the NPI-VH was weak ($\varphi = 0.10$). To explore the strength of convergence of each of the 3 NEVHI items independently with the MDS-UPDRS-H and the NPI-VH, correlations between each question on the NEVHI and the convergent measures were computed (see Table 3). Question 1 had a moderate correlation, Question 2 demonstrated a weak association, and Question 3 evidenced a strong correlation ($\varphi = 0.54$) with the MDS-UPDRS-H.

Discriminant Validity

The relationship between NEVHI-Q1–3 and the heterotrait-monomethod measure of depressed mood was significant but weak: the NEVHI-Q1–3 was not significantly related to anxious mood (Table 4). Heterotrait-heteromethod correlations of the NEVHI-Q1–3 with visual acuity and motor function revealed no significant relationships. Moreover, there were no significant relationships between the NEVHI-Q1–3 and patient demographic or clinical characteristics, including age, education, sex, disease duration, disease stage, and cognitive function, with the exception of a weak correlation between the NEVHI-Q1–3 and the LED (Table 4).

TABLE 2 Count of visual hallucinations detected using North East Visual Hallucinations Interview Questions 1 through 3 compared with the Movement Disorder Society-sponsored revision of the Unified Parkinson's Disease Rating Scale-Hallucinations Item, and the Neuropsychiatric Inventory-Visual Hallucinations Item

	MDS-UPDRS-H			NPI-VH		
NEVHI-Q1–3	+ VH	− VH	Total	+ VH	− VH	Total
+ VH	15	9	24	3	21	24
− VH	0	93	93	0	93	93
Total	15	102	117	3	114	117

MDS-UPDRS-H, Movement Disorder Society-sponsored revision of the Unified Parkinson's Disease Rating Scale-Hallucinations Item; NPI-VH, Neuropsychiatric Inventory-Visual Hallucinations Item; NEVHI Q1–3, North East Visual Hallucinations Interview Questions 1 through 3; +, raters endorsed visual hallucinations; −, raters did not endorse visual hallucinations; VH, visual hallucinations.

TABLE 3 Count and φ correlation coefficients of the North East Visual Hallucinations Interview questions, the Movement Disorder Society-sponsored revision of the Unified Parkinson's Disease Rating Scale-Hallucinations Item, and the Neuropsychiatric Inventory-Visual Hallucinations Item

NEVHI question Question no.	UPDRS-H		NPI-VH		
	Count	φ	Count	φ	Count
Q1−Q3	24	0.570*	15	0.102*	3
Q1	19	0.440*	12	0.136*	3
Q2	15	0.293*	9	0.010 (0.284)	1
Q3	19	0.536*	13	0.136*	3
Q4	8	0.254*	6	0.029 (0.067)	1

NEVHI, North East Visual Hallucinations Interview, MDS-UPDRS-H, Movement Disorder Society-sponsored revision of the Unified Parkinson's Disease Rating Scale-Hallucinations Item; NPI-VH, Neuropsychiatric Inventory-Visual Hallucinations Item.
*$P \leq 0.001$.

VH Characteristics

Of all participants who endorsed VH on the NEVHI, 7 (29%) reported only simple VH, 15 (63%) reported only complex VH, and 2 (8%) reported co-occurring simple and complex VH. The NEVHI identified 9 individuals who were not identified by the NPI or the MDS-UPDRS; and 7 of those individuals (78%) reported complex VH (without simple VH), whereas 2 (22%) reported simple VH (without complex VH). On Sections 2 and 3 of the NEVHI, the majority of participants endorsed VH that began more than 1 year ago and lasted up to 1 minute.

TABLE 4 Correlations between North East Visual Hallucinations Interview Questions 1 through 3 and measures of patient demographic and clinical characteristics

Measure[a]	Correlation[b]	*P*
MDS-UPDRS Part I, depression	(φ) 0.035	0.044[c]
MDS-UPDRS Part I, anxiety	(φ) 0.004	0.502
Sex	(φ) 0.015	0.183
Age, y	0.039	0.675
Education, y	−0.064	0.496
Duration of disease, y[d]	0.147	0.119
MDRS total score	−0.139	0.134
FTT-Dominant hand	(r_{pb}) 0.164	0.079
FTT-Nondominant hand	(r_{pb}) 0.093	0.319
Snellen visual acuity[d]	0.095	0.313
Modified Hoehn & Yahr stage	−0.029	0.757
Levodopa equivalent, mg/d	0.259	0.005[c]

MDS-UPDRS, Movement Disorder Society-sponsored revision of the Unified Parkinson's Disease Rating Scale; MDRS, Mattis Dementia Rating Scale; FTT, Finger Tapping Test.
[a]For all measures, n = 117 unless otherwise specified.
[b]Values are rank-biserial correlations unless specified: (r_{pb}) indicates point-biserial; (φ), φ correlations.
[c]This *P* value indicates a statistically significant difference.
[d]For this measure, n = 114.

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TABLE 5 Characteristics of visual hallucinations on the North East Visual Hallucinations Interview[a]

	No. of patients (%)
First hallucination[b]	
More than 1 y ago	17 (77.23)
1 y ago	4 (18.2)
Several mo ago	1 (4.6)
Duration	
Up to 1 min	17 (77.3)
From 1 min to 1 h	3 (13.6)
All the time	2 (9.1)
Last hallucination	
Within last 24 h	7 (31.8)
2–6 d ago	4 (18.1)
1–4 wk ago	3 (13.6)
1–11 mo ago	3 (13.6)
≥1 y	5 (22.7)
Hallucinations in last mo	
Daily	5 (22.7)
Weekly	6 (22.7)
Every 2 wk	2 (9.1)
Only once during the last mo	0 (0)
Never	8 (36.3)
Emotions/cognitions/behaviors, n = 13	
Nice/pleasant	9 (69.2)
Irritating	1 (7.7)
Frightening	3 (23.1)
Control start/content	1 (7.7)
Control end	7 (53.8)
Awareness	11 (84.6)
Act out	3 (23.1)
Common visual hallucinations	
Human figures	13 (54.1)
Animals	4 (16.7)
Nondescript movement, e.g., flashes/floaters	5 (20.8)

[a]Note that n = 22 for items from Sections 2 and 3 of the interview (i.e., those who endorsed the first 3 screening questions).
[b]Items are not mutually exclusive. Percentages denote the percentage of people who were administered the item that was endorsed.

For participants who reported VH in the last month, the majority of VH consisted of human figures and were considered pleasant (Table 5).

Discussion

The current results demonstrated that the NEVHI identifies a greater number of patients with PD who have VH compared with other standard measures while also demonstrating good convergent validity with a clinician-administered, patient-report measure of VH as well as excellent discriminant validity. The strong association between the NEVHI and the clinician-administered, patient-reported MDS-UPDRS-H relative to the weak association between the NEVHI and the informant-based NPI-VH was not unexpected, as informant reports of VH have been purported to be unreliable.[14,18]

In this study, 20.5% of patients with PD endorsed VH on the NEVHI, which is consistent with previously reported prevalence rates of VH in PD.[14,18] In contrast, only 12.8% individuals endorsed VH on the MDS-UPDRS-H, and 2.5% endorsed VH on the NPI-VH. The NEVHI detected all patients with VH who were identified by the MDS-UPDRS-H and the NPI-VH as well as 9 additional patients who were missed by both measures. Of these 9 participants who were uniquely identified by the NEVHI, 7 reported complex VH, and 2 reported simple VH. Thus, the evaluation of simple in addition to complex VH does not entirely account for the NEVHI's higher base rates of VH. Of the participants who endorsed VH on the NEVHI, 37.5% would have been missed by the MDS-UPDRS-H, and 87.5% would have gone undetected with the NPI-VH. These findings underscore the importance of using appropriate measures for detecting VH in patients with PD.

Our results confirm the utility of multiple/diverse questioning, because none of the 3 NEVHI screening questions alone identified all patients who reported VH. However, the first and third screening questions together captured all patients who reported VH, suggesting that the second question (*have seen something that other people could not see*) may not yield any additional information in the context of the first (*eyes play tricks*) and third (*visual hallucinations*) questions. In contrast, the first and third questions of the NEVHI appear to be critical, as they capture more patients than the individual items of MDS-UPDRS and the NPI. Although Question 1 may not seem to target VH per se, it is notable that only 4 individuals exclusively endorsed Question 1; and, of those, 2 endorsed "hallucinations" on the MDS-UPDRS and 1 endorsed complex VH upon further inquiry. Thus, Question 1 appears to be a viable line of questioning in the assessment of VH in PD. On the other hand, the fourth NEVHI question (*other visual experiences*) does not appear to function as intended (i.e., does not identify "false VH"), because all study participants who endorsed this item also endorsed both Questions 1 and 3. Given the tendency of patients with PD to underreport VH,[31] a lack of "false positives" was not inconsistent with expectations. However, future studies may benefit from including multiple independent VH interviews to elucidate any potential for false endorsement of VH.

Excellent discriminant validity was observed between the NEVHI and measures of visual acuity, motor function, depressed mood, and anxious mood, all of which had nonsignificant or very weak correlations identified (correlation coefficients <0.15). The lack of moderate or strong correlations between the NEVHI and other measures of psychological functioning suggests that the NEVHI preferentially assesses for VH and is not operating as a general measure of reported psychological functioning or distress. As predicted, the discriminant measure correlations were of similar magnitude to the informant-report convergent measure correlations, further supporting the importance of validation with other patient-report measures. Despite prior findings suggesting a relationship between VH and age, disease stage or duration, LED, and cognitive impairment in PD, our findings did not indicate any significant associations with any demographics or characteristics with the exception of a weak association with LED. This latter finding is consistent with previous studies that identified dopaminergic medications as a risk factor for VH.[23] Given that our sample was younger with shorter disease duration on average than in previous studies,[14,16,22] it is possible that these associations may

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become evident or stronger in a sample of older patients further in PD progression. Thus, future studies of the NEVHI in more advanced disease stages should be explored.

Unlike other commonly used VH measures, the NEVHI can gather qualitative information and differentiate between simple and complex VH. The majority of patients indicated that their VH began more than 1 year before evaluation and persisted for less than 1 minute, which is consistent with previous research.[1] Also in line with previous studies, the majority of patients with complex VH reported that VH consisted of human figures and animals, whereas patients with simple VH reported seeing flashes, floaters, or movement in the periphery.[14,17,32] Similar to Urwyler et al.,[14] the majority of the patients indicated that their VH were pleasant, and very few patients experienced frightening or irritating VH. Although complex VH often co-occur with simple VH in PD,[14,16,22,33] in the current study, only 2 participants reported more than 1 type of VH (i.e., simple or complex), whereas 92% reported 1 type of VH. Participants in the current study, on average, were early in the disease process (> 87% below stage III); thus, it is possible that, in later disease stages, complex and simple VH may co-occur at higher rates.

There are several limitations of this study worth noting. First, the majority of our participants were highly educated Caucasian individuals; therefore, generalization may be limited. Thus, future study of the NEVHI in PD samples with less education or from other ethnic backgrounds is suggested. In addition, the MDS-UPDRS was only administered to the patients (and not to the caregivers) in this study. Future studies may wish to explore convergent and incremental validity of the MDS-UPDRS administered concurrently to both patient and informant. Furthermore, the NEVHI is limited to the assessment of VH. Although the majority of the hallucinations reported by individuals with PD are visual in nature, previous studies have found that 8% to 10% of patients report co-occurring hallucinations in other sensory domains (e.g., auditory).[34,35] Thus, the utility and incremental validly of the multi-modal hallucination measures, such as the Psychosis and Hallucinations Questionnaire in Non-demented Patients with Parkinson's Disease,[36] should be explored for suitability in clinical care.

To our knowledge, this is the first study to assess the validity of the NEVHI and the efficacy of individual items compared with both patient-report and informant-report measures of VH in PD. In summary, our results revealed strong convergence of the NEVHI with the MDS-UPDRS clinician-administered patient report, which was in contrast to a weak relationship with the informant-based NPI. The NEVHI exhibited excellent divergence from measures of visual acuity as well as motor and psychological symptoms. Two of the 4 NEVHI screening questions captured all individuals detected by the MDS-UPDRS and NPI as well as 9 additional individuals. Taken together, our findings support the overall validity of the NEVHI for identifying and characterizing VH in PD. The ability of the NEVHI to detect a greater number of individuals with VH compared with the other commonly used measures of VH, as well as its thorough evaluation of the qualitative features of VH, suggest that this measure would be of great clinical benefit and provide a valid and preferable tool for improved care and assessment of VH in individuals with PD.

Author Roles: 1. Research Project: A. Conception, B. Organization, C. Execution; 2. Statistical Analysis: A. Design, B. Execution, C. Review and Critique; 3. Manuscript Preparation: A. Writing the First Draft, B. Review and Critique.

K.A.H.: 1A, 1B, 1C, 2A, 2B, 3A
E.P.T.: 1B, 1C, 2A, 2C, 3B
V.L.M.: 1A, 3B
J.V.F.: 1C, 3B
I.L.: 1C, 3B
S.L.: 1C, 3B
D.S.: 1C, 3B
D.M.S.: 1A, 1B, 1C, 2A, 2C, 3B

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Disclosures

Ethical Compliance Statement: We confirm that we have read the Journal's position on issues involved in ethical publication and affirm that this work is consistent with those guidelines.

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