Movement Disorders
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RESEARCH ARTICLE

Factor Analysis of the Apathy Scale in Parkinson's Disease

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ABSTRACT: Background: The Apathy Scale (AS), a popular measure of apathy in Parkinson's disease (PD), has been somewhat limited for failing to characterize dimensions of apathy, such as those involving cognitive, behavioral, and emotional apathy symptoms. This study sought to determine whether factors consistent with these apathy dimensions in PD could be identified on the AS, examine the associations between these factors and disease-related characteristics, and compare PD patients and healthy control (HCs) on identified factors.
Methods: Confirmatory (CFA) and exploratory factor analysis (EFA) were conducted on AS scores of 157 nondemented PD patients to identify AS factors. These factors were then correlated with important disease-related characteristics, and PD and HC participants were compared across these factors.
Results: Previously proposed AS models failed to achieve an adequate fit in CFA. A subsequent EFA revealed two factors on the AS reflecting joint cognitive-behavioral aspects of apathy (Motivation-Interest-Energy) and emotional apathy symptoms (Indifference). Both factors were associated with anxiety, depression, health-related quality of life, and independent activities of daily living, with Indifference associated more with the latter. In addition, only the Indifference factor was associated with cognitive functioning. PD patients reported higher levels of symptoms than HCs on both factors, with the group difference slightly larger on the Motivation-Interest-Energy factor.
Conclusion: The AS can be decomposed into two factors reflecting Motivation-Interest-Energy and Indifference symptoms. These factors are differentially associated with clinical variables, including cognition and independent activities of daily living, indicating the importance of evaluating apathy from a multidimensional perspective.

Apathy is among the most common psychiatric symptoms in Parkinson's disease (PD). Prevalence estimates of apathy in PD range from 17% to 62%. Although there is a substantial overlap between apathy and depression (e.g., common symptoms of lack of energy, fatigue, and loss of interest), a growing body of literature suggests that symptoms of apathy and depression are dissociable in PD, with 5% to 33% of individuals reporting apathy in isolation from any other psychiatric symptom.[1–8] This is likely attributed to nonoverlapping symptoms, such as diminished initiation and interests in the absence of affective evaluation in apathy as opposed to depression.[9] Apathy is associated with diminished quality of life,[10] a reduction in activities of daily living,[2,11] and may be a predictor of future executive dysfunction and global cognitive decline.[4,5,12]

Marin[13] provided an early and highly influential definition of apathy, describing it as "a lack of motivation characterized by diminished goal-oriented behavior and cognition and reduced emotional expression." Subsequent researchers have similarly operationalized apathy along these three dimensions of behavioral, cognitive, and emotional symptoms.[1,9] More recently, Robert and colleagues[14] proposed diagnostic criteria for apathy to facilitate its identification in neuropsychiatric disorders, which maintained a similar triadic structure. Drijgers and colleagues[15] validated these criteria in PD, reporting that cognitive and behavioral symptoms of apathy were more common among PD patients than emotional symptoms (95% and 86% vs. 52%, respectively).

Rating scales are the most common approach to measuring apathy in PD. At present, there is no gold standard for measuring

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apathy in PD, and several scales exist for the purpose of assessing apathy in this population.[16] For instance, a single item can serve as a simple screening for apathy symptoms (i.e., an item on the UPDRS[17]) whereas other scales were developed to specifically assess apathy symptom domains (i.e., Lille Apathy Rating Scale [LARS][18]). In a past review, the International Parkinson and Movement Disorder Society (MDS) Task Force recommended only the Apathy Scale (AS)[19] to assess apathy in PD,[20] although other, more recent reviews have shown other scales as having perhaps better psychometric properties.[16] Nevertheless, the AS has shown adequate face validity, internal consistency, inter-rater reliability, and test-retest reliability[19] as well as adequate convergent and known-groups validity.[21] However, this scale has been criticized for only providing a total score capturing global apathy symptoms, rather than characterizing a profile of symptoms across apathy symptom subdomains.[22]

More recently, two studies have attempted to identify AS dimensions in PD using principal components analysis (PCA) or factor analysis (FA)[23,24] Based on past conceptual definitions, these studies hypothesized a three-factor structure to the AS separately reflecting cognitive, behavioral, and emotional dimensions. Pedersen and colleagues[23] administered the AS to 194 nondemented newly diagnosed PD patients. PCA identified two distinct apathy dimensions reflecting cognitive-behavioral aspects of apathy and general apathetic symptoms, the latter of which were largely characterized by reduced emotional responsivity. Alternatively, an exploratory FA conducted by Kay and colleagues,[24] in a sample of 226 nondemented PD patients, revealed a three-factor structure to the AS, which paralleled cognitive, behavioral, and emotional apathy subdomains. Notably, Kay and colleagues[23] reported evidence supporting both two- and three-factor models.

Given the popularity of the scale, the MDS Task Force's recommendation, and the lack of consensus on the AS factor structure, we sought to further evaluate the appropriateness of the AS in characterizing specific dimensions of apathy in PD. There were three aims of this study: (1) to clarify the AS factor structure; (2) to extend previous research by determining whether these factors were differentially associated with important clinical variables; and (3) to evaluate whether specific AS dimensions were elevated in PD relative to healthy control (HC) participants. Based on previous research, we hypothesized that the AS would consist of two dimensions reflecting joint cognitive-behavioral and emotional aspects of apathy[23]; these dimensions would be associated with distinct clinical variables; and PD participants would have significantly higher ratings on cognitive-behavioral, but not emotional, aspects of apathy relative to HCs.[15]

Patients and Methods

Participants

Participants consisted of a PD group (n = 157) and a healthy older adult control (HC) group (n = 76). PD participants were diagnosed using the UK Brain Bank Criteria[25] by a board-certified neurologist specializing in movement disorders. The PD group was recruited from the Movement Disorders Clinic at the University of California San Diego and the Veterans Affairs San Diego Healthcare System (VASDHS). Participants were determined to be nondemented using the Diagnostic and Statistical Manual of Mental Disorders-IV[26] criteria, defined in Emre and colleagues,[27] and a cut-off score of ≥123[28] on the Mattis Dementia Rating Scale[29] (MDRS). PD participants were assessed on their normal dosages of medication. Table 1 depicts descriptive characteristics of PD and HC groups. Measures of apathy, depression, state and trait anxiety, and overall cognition exhibited non-normal distributions as evidence by significant Shapiro-Wilk tests (*P*s all <0.001); therefore, nonparametric Mann-Whitney U tests were used to compare differences in these measures across groups. The local ethics committee approved this retrospective study, and all participants provided written informed consent.

Materials and Procedure

Participants completed the AS.[19] The AS includes 14 items rated on a 4-point Likert scale (0 = "Not At All" to 3 = "A Lot"). Total scores range from 0 to 42, with higher scores representing greater levels of apathy.

In addition, participants completed several self-report measures of mood and quality of life. Depression was measured using the Geriatric Depression Scale,[30] anxiety with the State-Trait Anxiety Inventory,[31] and health-related quality of life with the Parkinson's Disease Questionnaire-39 (PDQ-39).[32] Measures of cognition (MDRS[29]), independent functioning (Lawton and Brody Independent Activities of Daily Living Scale[33]), levodopa equivalent dosage (LED[34]), disease stage (Modified H & Y Scale[35]), and motor function (Finger Tapping Test[36]) were also analyzed.

Statistical Analyses

Confirmatory FA (CFA) was conducted in the PD group to explore the fit of Pedersen and colleagues'[23] two-factor and Kay and colleagues'[24] three-factor AS models. Both of these studies highlighted Item 3 as potentially problematic. Therefore, we evaluated Pedersen and colleagues'[23] model with and without this item. This item was excluded in Kay and colleagues'[24] model, and thus we did not need to evaluate a revised version of this model. However, in Kay and colleagues'[24] model, there were only two indicators on the latent behavioral apathy factor. Consequently, we imposed equality constraints on the factor loadings of these indicators to achieve model identification.

None of the previous models exhibited acceptable fit. Consequently, we conducted exploratory FA (EFA) to evaluate alternative AS factor models. EFA was initially conducted on 13 items from the AS, excluding Item 3, and relied on an oblique rotation (i.e., Geomin) owing to significant correlations among factors (r = 0.562). Factor extraction was based on scree plot visual analysis and the Kaiser-Guttman criterion (eigenvalues >1.0), and theoretical interpretability of extracted factors. Items were removed that exhibited nonsignificant loadings on any

TABLE 1 *Demographic and disease-related characteristics for healthy controls and individuals with PD*

	PD Group (n = 157)	HC Group (n = 76)	Test Statistic
Age (years)	67.64 (8.27)	66.95 (8.73)	$t_{(231)} = 0.59$
Education (years)	16.54 (2.36)	16.00 (2.42)	$t_{(231)} = 1.63$
Sex (M/F)	107/50	34/42	$\chi^2(1, N = 233) = 11.75$**
FTT—dominant hand	39.84 (13.16)	46.63 (11.13)	$t_{(228)} = -3.87$***
FTT—nondominant hand	40.10 (13.19)	44.75 (10.03)	$t_{(227)} = 2.97$**
Modified H & Y stage	0.0 to 5.0		
Stage 0	1.3%		
Stage 1	24.3%		
Stage 1.5	1.3%		
Stage 2	50.7%		
Stage 2.5	7.9%		
Stage 3	11.2%		
Stage 3.5	0.7%		
Stage 4	2.0%		
Stage 5	0.7%		
LED (mg/day)	747.83 (756.77)		
Disease duration (months)	66.14 (61.62)		
AS total score	11.59 (5.36)	9.21 (4.67)	Z = 3.60***[1]
GDS total score	6.27 (5.21)	3.01 (3.94)	Z = 5.49***[1]
State anxiety total score	34.77 (10.00)	28.17 (8.82)	Z = 5.26**[*1]
Trait anxiety total score	34.79 (9.40)	28.68 (8.62)	Z = 5.13***[1]
PDQ-39 total score	148.12 (98.77)		
MDRS total score	138.48 (3.88)	140.46 (3.24)	Z = −4.37***[1]
iADLs total score	14.18 (2.11)		

[1] Test statistic reflects Mann-Whitney U test attributed to non-normal distributions.
*$P < 0.05$;
**$P < 0.01$;
***$P < 0.001$.
FTT, Finger Tapping Test (T Score); GDS, Geriatric Depression Scale.

single factor or significant cross-loading on multiple factors to achieve simple structure (i.e., items significantly loading on one and only one factor). Significant item-factor loadings were defined as those ≥0.32.[37] Internal consistency of FA derived AS subscales was analyzed by Cronbach's alpha.

Multiple goodness-of-fit indices were evaluated to determine model fit.[38,39] These indices included the model chi square, root mean square error of approximation[40] (RMSEA), Bentler Comparative Fit Index[41] (CFI), Tucker-Lewis Index[42] (TLI), and standardized root mean square residual (SRMR). Acceptable fit was determined by the following criteria: RMSEA close to 0.06 or below; SRMR close to 0.08 or below; CFI close to 0.95 or greater; and TLI close to 0.95 or greater.[43] Given that there are only four response categories on AS items, items were treated as categorical and robust weighted least squares estimation was used.[44]

Correlations were calculated to determine whether the EFA-derived AS subscales were differentially associated with disease-related variables in PD. Because of non-normality in EFA-derived factor distributions (Shapiro-Wilk test of normality <0.001 for both factors), Spearman's rho was used. Differences in correlation coefficients across AS subscales were evaluated using Wilcox's percentile bootstrapped test of dependent robust correlations. This test yields a 95% confidence interval (CI) of the bootstrapped estimate of the difference in correlation coefficients. CIs that do not overlap with 0 indicate statistical significance.

A robust 2 (Group) × 2 (AS subscale) mixed-design analysis of variance (ANOVA) was performed to explore how PD and HC groups differed on AS dimensions. Owing to non-normality in EFA-derived subscale distributions, this ANOVA used M-estimators and bootstrapping. Sex and global cognition were statistically controlled for because of differences across groups. Significant interactions were followed up with robust independent-samples *t* tests that used trimmed means and bootstrapped samples.

Results

Factor Analysis

Kay and colleagues'[24] three-factor model failed to achieve convergence (Table 2). This was attributed to an estimated latent factor correlation exceeding 1 between the cognitive and behavioral latent factors. This indicates that these factors are indistinguishable, suggesting that this model suffers from factor overextraction. Both Pedersen and colleagues'[23] original and the revised models were able to achieve convergence; however, both of these models exhibited unacceptable fit, as indicated by low CFI and TLI values despite significant overall chi-square indices of model fit. Inspection of modification indices did not indicate theoretically justifiable modifications that could be made to either of these models to improve model fit. Thus, neither of the previously proposed factor models exhibited adequate fit, indicating a need to evaluate alternative AS factor models using EFA.

EFA revealed three factors that had eigenvalues >1.0. However, scree plot visual inspection indicated a two-factor solution (see Supporting Information Fig. S1). The two-factor solution was

TABLE 2 *Goodness-of-fit indices for previously proposed AS factor models*

Model	X^2	df	CFI	TLI	RMSEA (90% CI)	SRMR
Pedersen et al. (2012)[1]	106.456*	76	0.918	0.901	0.051 (0.025-0.072)	0.058
Pedersen et al. (2012)[2]	88.458**	64	0.903	0.882	0.059 (0.034-0.081)	0.059
Kay et al. (2012)[3]	NA					

[1] Including Item 3.
[2] Excluding Item 3.
[3] Model failed to achieve convergence because of excessively high factor correlation.
*$P < 0.05$;
**$P < 0.01$;
NA, not applicable; df, degrees of freedom; CFI, Comparative Fit Index; TLI, Tucker-Lewis Index.

theoretically interpretable whereas the three-factor solution was not. Moreover, the third factor in the three-factor solution consisted of two positively loading indicators and one negatively loading indicator, suggesting that this factor possessed poor internal consistency. Given the previously described difficulties in modeling an AS three-factor solution in CFA, the lack of theoretical interpretability and poor internal consistency of the third factor, and the indication of an AS two-factor structure through visual inspection of the scree plot, we opted to extract two factors from the AS. All 13 items significantly loaded on at least one factor; however, items 13 and 14 exhibited significant cross-loading on both factors (Supporting Information Table S1). These two items were subsequently removed to achieve simple structure. Table 3 presents the final two-factor model after removal of items 13 and 14. Although this model possessed a significant model chi square (χ^2 [34; N = 157] = 60.2; $P = 0.004$), all other indications of model fit were in acceptable ranges (CFI = 0.970, TLI = 0.952, RMSEA = 0.070 [90% CI = 0.040–0.099], and SRMR = 0.068). Given that all indices of model fit were in the acceptable range, we deemed this factor structure acceptable.

Overall, the two-factor model accounted for 54.1% of indicator variance, with Factor One accounting for 40.9% and Factor Two an additional 13.2% of variance. Seven items loaded on Factor One, termed Motivation-Interest-Energy, and the majority of these items represented the cognitive-behavioral aspects of apathy (items 1, 5, 6, and 7). Four items loaded onto Factor Two, termed Indifference, which represented symptoms of reduced emotional responsivity and lack of concern (items 9, 10, and 11).

The 11 AS items included in the EFA had acceptable internal consistency ($\alpha = 0.77$). The Motivation-Interest-Energy dimension demonstrated acceptable internal consistency ($\alpha = 0.74$); however, the Indifference subscale was slightly below acceptable internal consistency ($\alpha = 0.65$). Given that the Indifference subscale consists of only four items and Cronbach's alpha is highly sensitive to scale length, the somewhat low internal consistency of this scale is likely more attributable to its short length than to the extent of covariance among scale items. Notably, all intercorrelations among items composing both the Indifference and Motivation-Interest-Energy subscales were in the same positive direction, indicating that these items are suitable for subscale summation.

Subscale Correlations With Demographic, Clinical, and Disease-Related Characteristics

Both AS dimensions were significantly associated with depression, anxiety (state and trait), independent activities of daily living (iADLs), and health-related quality of life. Tests of the difference in correlation coefficients revealed that the Indifference subscale was more strongly correlated with cognition and iADLs than Motivation-Interest-Energy. Neither dimension was correlated with age, education, disease duration, disease stage, finger tapping, or LED (see Table 4). In contrast, only the Indifference factor was uniquely associated with cognition, with greater elevations on this subscale associated with lower MDRS total scores.

TABLE 3 *Final rotated pattern matrix*

Item	Description	Factor 1 Motivation-Interest-Energy	Factor 2 Indifference
1	Are you interested in learning new things?	**0.52**	0.15
2	Does anything interest you?	**0.73**	-0.04
4	Do you put much effort into things?	**0.55**	-0.01
5	Are you always looking for something to do?	**0.32**	-0.03
6	Do you have plans and goals for the future?	**0.68**	0.03
7	Do you have motivation?	**0.95**	0.01
8	Do you have the energy for daily activities?	**0.72**	-0.01
9	Does someone have to tell you what to do each day?	-0.27	**0.76**
10	Are you indifferent to things?	0.13	**0.67**
11	Are you unconcerned with many things?	0.01	**0.59**
12	Do you need a push to get started on things?	0.16	**0.57**
Eigenvaules		4.50	1.45
% of variance		40.92	13.21

Significant factors loadings indicated by bold-faced font.

TABLE 4 *Pearson bivariate correlations with subscales and PD-related characteristics*

	Factor 1 Motivation-Interest-Energy	Factor 2 Indifference	95% CI
Age	−0.10	0.07	−0.32 to 0.01
Education	−0.01	−0.08	−0.11 to 0.24
Disease duration (months)	−0.06	−0.02	−0.21 to 0.10
H & Y stage	0.06	0.15	−0.23 to 0.09
FTT–dominant hand	−0.04	−0.12	−0.10 to 0.22
FTT–nondominant hand	0.03	−0.09	−0.06 to 0.26
LED (mg/day)	0.08	0.13	−0.19 to 0.13
GDS total score	0.49**	0.48**	−0.13 to 0.19
State anxiety total score	0.34**	0.42**	−0.23 to 0.06
Trait anxiety total score	0.41**	0.44**	−0.21 to 0.11
PDQ-39 total score	0.39**	0.41**	−0.14 to 0.15
MDRS total score	−0.02	−0.30**	0.13 to 0.42**
iADLs total score	−0.18*	−0.34**	0.03 to 0.36*

*$P < 0.05$;
**$P < 0.01$.
FTT, Finger Tapping Test (T Score); GDS, Geriatric Depression Scale.

Group Differences on AS Subscales

A robust mixed-design ANOVA, controlling for sex and global cognition, revealed only a significant main effect of Group (Ψ = 0.42; P = 0.002). Follow-up t tests demonstrated that, on average, the PD group (mean [M] = 5.41; standard deviation [SD] = 3.04) reported significantly higher Motivation-Interest-Energy symptoms than the HC group (M = 3.80; SD = 2.99; T_y = 4.00; $P < 0.001$). In addition, the PD group (M = 3.21; SD = 2.25) reported significantly greater Indifference symptoms than the HC group (M = 2.18; SD = 1.83; T_y = 2.36; P = 0.02).

Discussion

The current study had three aims: (1) to explore the AS factor structure; (2) to evaluate correlates of AS factors in PD; and (3) to explore mean level differences on AS factors between PD and HC groups. Regarding the first aim of this study, previously proposed AS factors models[23,24] failed to achieve adequate fit in the current sample. Therefore, we conducted an EFA of the AS, which demonstrated that this scale was best characterized by a two-factor structure, although removal of items 3, 13, and 14 was necessary in order to achieve a simple structure.

The majority of items on the first factor, Motivation-Interest-Energy, represented cognitive-behavioral apathy symptoms. Notably, the Motivation-Interest-Energy factor was not a purely apathetic dimension, and characteristics of this factor overlapped with associated symptoms of depression (i.e., interest and energy). The second factor, Indifference, captured features of the affective presentation of apathy, including diminished affective motivation characterized as reduced emotional responsivity and lack of concern. The Motivation-Interest-Energy subscale had acceptable internal consistency, whereas the Indifference subscale had marginal internal consistency, although this latter finding is likely attributed to the short length of this subscale (four items) rather than low intercorrelations among items, per se.

The failure to replicate prior AS models[23,24] is likely attributed to methodological differences across studies. Specifically, Pedersen and colleagues[23] implemented PCA in their analyses as opposed to FA, which was used in the current study. FA is the preferred method for identifying latent factors within scales, because it differentiates between common and unique sources of variance, whereas PCA is more appropriate as a simple data reduction technique.[38,45] In addition, Pedersen and colleagues[23] retained Item 3 in their study, although these researchers noted that this item might be potentially problematic. Retention of this item may have slightly distorted the factor loadings of other AS items in their study. Conversely, Kay and colleagues'[24] three-factor model appeared to suffer from factor overextraction, as revealed by the inability of this model to achieve convergence in CFA in the present study. Kay and colleagues[24] reported ambiguity in the precise AS factor structure, and, ultimately, their third factor possessed an eigenvalue <1.0. Finally, the current study implemented an estimation technique not used in these previous studies—namely, robust weighted least squares estimation—which is recommended for scales in which items possess less than five response categories.[44] This estimator may have led to slightly different factor loadings across studies.

Despite the failure to replicate previous studies, there are similarities between our EFA and past AS models.[23,24] Similar to Pedersen and colleagues,[23] our EFA identified a two-factor AS model, with one of these factors characterized by joint cognitive-behavioral apathy symptoms. Additionally, the pattern of item factor loadings was similar across the current study and that of Pedersen and colleagues,[23] with the exception of items 13 ("Are you neither happy nor sad, just in between?") and 14 ("Would you consider yourself apathetic?"). Our EFA is also similar to that of Kay and colleagues[24] insofar as our Indifference factor closely paralleled these researchers' emotional apathy factor.

At the conceptual level, the inability of the AS to capture distinct cognitive and behavioral apathy factors in PD raises questions about the distinction between these dimensions in this

disease. For instance, recent research in geriatric[46] and early PD[47] samples has reported that cognitive and behavioral apathy symptoms may manifest together as a single dimension that is difficult to disentangle. Alternatively, dopamine reduction, the major neurochemical feature of the disease, may underlie discrepancies in apathetic symptom presentation and subsequently identifiable dimensions particularly in the early stages of PD when apathy symptoms may be responsive to L-dopa treatment.[48]

A recent review reexamined the appropriateness of several rating scales to assess apathy symptoms in PD, including the AS and LARS.[16] Despite adequate psychometric properties of the AS, the LARS was reported to have favorable psychometric properties for use in PD populations. It is possible that the quality and quantity of factors identified would have differed had other scales been examined. Similarly, the factor structure of the AS may be more sensitive to sample composition and methodological approach given that the scale was originally developed as a unidimensional, rather than a multidimensional, measure.

Our correlational analyses found that both AS subscales were associated with worse outcomes on measures of anxiety, depression, and health-related quality of life. This is consistent with previous research, which has also demonstrated associations between overall apathy and these three symptom areas.[8] In addition, the AS subscales were differentially associated with important clinical variables in the PD group. Specifically, the Indifference dimension was uniquely associated with worse cognitive functioning. Previous research has also found a negative association between cognitive function and global apathy.[8] We expanded on this previous research by demonstrating that the Indifference dimension of the AS largely drives this association. Additionally, we found that the Indifference dimension was more strongly associated with worse iADLs than the Motivation-Interest-Energy dimension. Taken together, these findings lend further validity for the distinction of Motivation-Interest-Energy and Indifference dimensions in PD. Last, we found that PD patients reported greater Motivation-Interest-Energy and Indifference apathy symptoms relative to HCs. Despite a lack of significance, there was a tendency for PD patients to report greater symptoms of Motivation-Interest-Energy than Indifference.

Overall, this study suggests that although there may be a greater frequency of Motivation-Interest-Energy symptoms in PD patients, there may be greater clinical implications associated with Indifference symptoms. In line with this possibility, the current study has important clinical implications for use of the AS. For example, PD patients with greater Indifference symptoms may be at greater risk for cognitive and functional decline whereas those with greater Motivation-Interest-Energy symptoms may respond well to behavioral treatments.

There are limitations to this study. First, our sample size was small and mainly white, male, highly educated, and, on average, reported low depression and anxiety levels. Therefore, replication in larger samples differing in demographic and mood symptom severity is recommended. Second, not all patients in our PD sample reported clinically significant apathy levels. Nonetheless, based on an AS total score[19] cutoff of ≥14, 36% of our sample reported clinically significant apathy levels, which is close to the meta-analytic apathy prevalence estimate in PD of 40%.[8] Thus, the apathy levels in our sample are fairly representative of the general population of PD patients and provides adequate coverage of apathy across the spectrum of this construct. Third, rather than examine the AS factor structure against an external measure that separately measures dimensions of apathy, such as Robert and colleagues'[14] formal apathy diagnostic criteria, the current study relied on self-reported apathetic symptoms, which are vulnerable to bias.[49] Such an approach may provide further evidence for the validity of an AS two-factor structure in PD.

The findings of the current study demonstrate that the AS captures two distinct dimensions of apathy symptoms in PD despite its original development as a unidimensional measure and overlap with ancillary symptoms of depression (i.e., interest, fatigue, and energy). Although these findings may provide insight into the nuanced differences in clinical profiles of patients with PD presenting with apathy, future research should investigate the AS factor structure longitudinally to determine the course, stability, and predictive utility of AS dimensions. Also, future work should explore further developing the AS by adding new items that can further delineate apathy symptom subtypes in PD, as well as subtracting those items that have proven to be ambiguous and not contributing to any one specific apathy factor. The present findings, as well as those that address the future aims mentioned above, may assist in determining the clinical suitability of the AS as a measure sensitive to different dimensional characteristics of apathy in PD.

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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.

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

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. The VASDHS ethics committee approved this retrospective study, and all participants provided written informed consent (IRB Protocol #: H130079).

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Supporting Information

Supporting information may be found in the online version of this article.

Table S1. Initial rotated pattern matrix

Figure S1. Scree plot of the final factor model.