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The Power of Personality in Discriminating Between Healthy Aging and Early-Stage Alzheimer's Disease

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This study examined differences in personality in the earliest stages of dementia of the Alzheimer type (DAT) relative to healthy aging, and the power of personality in discriminating healthy aging from early-stage DAT. Four groups of participants (middle-aged controls, older controls, persons with very mild DAT, and persons with mild DAT) and their families were administered Costa and McCrae's NEO Five-Factor Inventory. On the basis of both self-report and informant report, there was an increase in neuroticism and a decrease in conscientiousness in persons with very mild DAT relative to healthy individuals without it, and in persons with mild DAT relative to those with very mild DAT. Moreover, informant reports of neuroticism and conscientiousness capture substantial unique variance in discriminating healthy aging and very mild DAT, above and beyond standard neuropsychological tests. Discussion focuses on the importance of personality traits as a noncognitive indicator of early-stage DAT.

THERE has been considerable interest in the ability to diagnose dementia of the Alzheimer type (DAT) in the earliest possible stage of the disease. This early diagnosis is critical to families and clinicians in planning the management of the disease in terms of possible drug treatment and behavioral interventions. The diagnosis of early-stage DAT is difficult to make; it relies on the detection of subtle changes in cognitive function over time and a reliable informant who can document such changes (Carr, Gray, Baty, & Morris, 2000). The elusive nature of the clinical detection of early-onset DAT has been supported in longitudinal studies in presumed healthy older adults (e.g., Morris et al., 1996; Price & Morris, 1999; Rubin et al., 1998). In a recent study of 97 healthy control individuals who were clinically assessed approximately 1 year prior to death, between 39% and 47% received a neuropathological diagnosis of Alzheimer's disease (AD) at autopsy (Morris et al., 2004). Thus, preclinical markers of the disease appear to be present in some older individuals who appear to be clinically "normal," underscoring the need to reliably identify more specific changes that could serve as additional early markers for DAT. Because of the emphasis on memory and cognitive changes in dementia, research efforts have primarily focused on identifying aspects of cognition that discriminate healthy aging from early-stage DAT and that predict the progression of the disease (Morris, 2003).

In an attempt to increase sensitivity for early detection, various noncognitive risk factors for DAT have also been identified in the literature. For example, depressive symptoms have been reported in the preclinical stage of AD and have been linked to an increased risk of dementia (Berger, Fratiglioni, Forsell, Winblad, & Backman, 1999; Wetherell, Gatz, Johansson, & Pedersen, 1999; Wilson et al., 2002). Ringman and colleagues (2004) found higher levels of depression in a group of nondemented women at risk for AD as a result of mutations in the presenilin-1 gene compared with their nonmutation female family members, all of whom were unaware of their genetic status. Mutation status significantly predicted Beck Depression Inventory scores after education, age, scores on the Mini-Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975), and subjective memory complaints were controlled for. Ringman and colleagues argued that depressive symptoms may serve as an early indicator of the onset of DAT, rather than being a consequence of the disease, and may be linked to the neuropathology underlying the disease process.

Wilson and associates (2003) found a link between "proneness to distress" and increased risk for AD. They measured proneness to distress prospectively at baseline by using the Neuroticism Scale from the NEO Five-Factor Inventory (Costa & McCrae, 1992) in a sample of healthy control individuals from the Religious Orders Study. Individuals with the highest distress proneness (90th percentile) were twice as likely to develop AD as were individuals with the lowest distress proneness (10th percentile), when other risk factors such as age, education, and depressive symptoms were controlled for. In addition, distress proneness was related to a decline in episodic memory but not other cognitive factors. However, distress proneness was not related to common measures of AD pathology. These results are particularly interesting in light of other evidence for a link between chronic stress and hippocampal structural and functional changes (e.g., Baker & Kim, 2002; Margarinos, Verdugo, & McEwen, 1997). Wilson and associates argued that exposure to chronic stress may produce changes to the hippocampal formation, thereby rendering the individual more susceptible to lower levels of neuropathology. Thus, disposition to experience stress, as measured by a stable personality factor (i.e., neuroticism), may serve as a potentiating variable for the development of the clinical manifestations of AD.

Changes in personality with diagnosed DAT have been well documented in the literature. Caregivers report that individuals with DAT show increased neuroticism and decreased extraversion, openness, and conscientiousness after diagnosis (e.g.,

Siegler, Dawson, & Welsh, 1994; Strauss & Pasupathi, 1994). However, these studies are somewhat limited because the DAT individuals are not in the very mild stages of the disease. In a prospective study, Smith-Gamble and colleagues (2002) found that informant reports of personality change in nondemented individuals at baseline predicted dementia status 2 years later, suggesting that personality changes may precede cognitive decline in DAT. Although these latter results are intriguing, there are some limitations in the specificity of the assessment of personality. The researchers assessed personality change by means of six yes–no questions from the Cambridge Examination of Mental Disorders of the Elderly (known as CAMDEX; see Roth et al., 1986). Clearly, it is important to extend this work to include a more detailed assessment of personality characteristics.

A recent study by Balsis, Carpenter, and Storandt (2005) provides further support for this latter notion. In this study, personality changes on the Blessed Dementia Scale (BDS) were reported by an informant for a group of 108 nondemented individuals upon entry into a longitudinal study. Over time, 68 participants received a clinical diagnosis of DAT after entry into the study (i.e., converters; average 3.68 years after entry). The remaining 40 participants died and went to autopsy with a clinical diagnosis of no dementia; however, 14 of these 40 individuals received a neuropathological diagnosis of AD at autopsy (i.e., preclinical AD; average 7.97 years after entry) and 26 received a neuropathological diagnosis of no dementia (i.e., nondemented; average 4.12 years after entry). The results indicated that only 23% of the nondemented participants showed some personality change at their last clinical assessment, whereas twice as many converters (47%) and preclinical DAT participants (50%) showed personality change before their diagnosis of DAT or before their last clinical assessment, respectively. Even though the preclinical participants were not showing enough cognitive decline for a clinical diagnosis of DAT, they were showing the same magnitude of personality change as the converters. In particular, the latter two groups showed increased rigidity, apathy, egocentricity, and decreased emotional control. Balsis and associates argue that personality changes may actually *precede* the cognitive changes that form the basis for the diagnosis of DAT, and thus personality change should be considered as another marker for the early onset of the disease. However, they also point out the need for a more systematic exploration of personality changes in DAT beyond the questions on the Blessed Dementia Scale.

Our purpose in the present study was to (a) identify personality differences in the earliest detectable stages of DAT relative to healthy aging; (b) examine the degree to which personality discriminates between healthy aging and early-stage DAT compared with cognitive performance; and (c) determine whether personality adds to the discrimination of healthy aging versus early-stage DAT, above and beyond cognitive performance. We assessed personality traits with the five-factor model of personality (Costa & McCrae, 2000; McCrae & John, 1992). According to this framework, personality traits can be organized into five basic dimensions: neuroticism, extraversion, openness, conscientiousness, and agreeableness. Research indicates that these five dimensions of personality generalize across several diverse cultures (McCrae & Costa, 1997), may be biologically based (McCrae et al., 2000), are relatively gender invariant (Costa, Terracciano, & McCrae, 2001), and remain relatively stable across age, especially in middle and old age (Costa, Herbst, McCrae, & Siegler, 2000; Costa & McCrae, 1993, 2006; and Weiss et al., 2005; however, see Roberts, Walton, & Viechtbauer, 2006).

The inclusion of four groups of participants in this study (i.e., middle-aged and healthy old individuals, and persons with very mild DAT or mild DAT) afforded the comparison of personality traits as a function of healthy aging (middle-aged vs healthy old persons), early-stage DAT (healthy old persons vs those with very mild DAT), and progression of the disease (persons with very mild vs those with mild DAT). The Clinical Dementia Rating (CDR) scale is used to identify individuals at the earliest detectable stages of DAT and is derived without knowledge of any independent cognitive testing. The power of the CDR scale in early diagnosis was recently illustrated by Storandt, Grant, Miller, and Morris (2006), who compared the rate of progression of individuals who initially at enrollment met standard criteria for mild cognitive impairment (MCI; which presumes no dementia), and individuals with a CDR of 0.5 (very mild DAT) who initially did not meet standard criteria for MCI. Surprisingly, the rate of decline was reliably greater for the MCI group compared with the CDR 0.5 DAT group, with the use of both a psychometric composite and time to reach a more advanced stage of DAT (i.e., CDR 1) as outcome measures. This study indicates that it is possible to detect very mild DAT with the CDR scale at an even earlier stage than what is considered to be MCI without dementia. Because we address personality traits in the CDR 0.5 group, we investigate differences in the earliest detectable stages of DAT, unlike much of the literature, which has typically focused on individuals well into the disease process. In addition, the comparison of a well-characterized group of healthy control persons versus individuals in the very earliest stage of the disease will further address the issue of the predictive power of personality traits as a marker for the onset of DAT, above and beyond cognitive measures.

Methods

Participants

A total of 287 individuals participated in this study. We recruited all participants from the Washington University Alzheimer's Disease Research Center (ADRC). We had all ADRC participants originally screened for depression, untreated hypertension, reversible dementias, and other disorders that could potentially produce cognitive impairment. The inclusionary and exclusionary criteria for DAT are consistent with the criteria set forth by the work group of the National Institute of Neurological and Communicative Disorders and Stroke/Alzheimer's Disease and Related Disorders Association (McKhann et al., 1984). We staged the severity of dementia according to the Washington University CDR scale (Berg, 1988; Hughes, Berg, Danziger, Coben, & Martin, 1982; Morris, 1993).

According to this scale, CDR scores of 0, 0.5, 1, 2, and 3 represent no dementia, very mild dementia, mild dementia, moderate dementia, and severe dementia, respectively. The CDR is based on a 90-minute interview that both assesses the

Table 1. Neuropsychological Test Means and Standard Deviations as a Function of Participant Group

Test	Middle-Aged	Healthy Old	Very Mild DAT	Mild DAT
Wechsler Memory Scale				
Logical Memory	10.67 (4.63)	9.88 (3.19)	5.82 (3.51)	2.68 (2.32)
Digits Forward	6.92 (1.16)	6.72 (1.19)	6.32 (1.18)	5.92 (1.30)
Digits Backward	6.00 (.85)	5.06 (1.26)	4.22 (1.16)	3.63 (1.07)
Associate Learning	16.04 (5.02)	14.14 (3.76)	9.72 (4.03)	5.53 (3.83)
Animal Fluency	23.33 (5.84)	18.47 (5.79)	14.00 (5.22)	7.53 (5.06)
Word Fluency S-P	40.42 (11.6)	30.07 (10.4)	26.24 (11.5)	14.99 (9.45)
Wechsler Adult Intelligence Scale				
Information	21.17 (5.56)	20.79 (4.50)	16.74 (5.14)	11.50 (6.21)
Block Design		31.31 (8.60)	24.56 (9.73)	16.11 (11.7)
Digit Symbol	55.50 (20.5)	46.20 (11.0)	34.59 (12.0)	20.38 (14.9)
Similarities	25.86 (4.75)	25.15 (4.25)	20.32 (5.79)	14.37 (8.14)
Trail Making Test				
Part A	38.14 (41.3)	37.45 (17.5)	55.44 (28.4)	92.59 (46.9)
Part B	59.36 (22.1)	86.86 (38.4)	107. 40 (53.1)	137.88 (60.8)
Boston Naming Test	56.25 (4.45)	55.40 (4.58)	41.49 (17.0)	32.70 (17.9)
Selective Reminding Test Free Recall	31.33 (5.91)	29.31 (7.18)	18.29 (9.25)	7.95 (7.14)

Note: The Wechsler Adult Intelligence Scale Block Design is not available for the middle-aged group. Standard deviations are shown in parentheses. DAT = dementia of the Alzheimer type.

participant and also relies on information from the family member concerning the participant. This interview assesses the participant's cognitive abilities in the areas of memory, orientation, judgment, and problem solving, community affairs, home and hobbies, and personal care. Details regarding the assessment and recruitment procedures have been previously described in the literature (Berg et al., 1998; Morris et al., 2001). Both the reliability of the CDR (Burke et al., 1988) and the validation of the diagnosis (based upon autopsy) by the research team have been excellent (93% diagnostic accuracy) and well documented (e.g., Berg et al.). It should be noted that the validity study was based almost entirely on cases concerning individuals who were initially diagnosed at the very mild (CDR 0.5) or mild (CDR 1) stage of the disease, although many had progressed to more severe dementia by the time of death.

Of the 287 participants, 36 were middle-aged healthy control individuals (age, $M = 52.2$, $SD = 4.86$; education, $M = 15.1$, $SD = 2.85$; MMSE score, $M = 29.6$); 131 were healthy older control individuals (age, $M = 75.1$, $SD = 10.2$; education, $M = 14.9$, $SD = 3.98$; MMSE score, $M = 29.0$); 74 were classified as having very mild DAT, with a CDR of 0.5 (age, $M = 75.2$, $SD = 9.38$; education, $M = 14.3$, $SD = 3.18$; MMSE score, $M = 26.9$); and 46 were classified as having mild DAT, with a CDR of 1 (age, $M = 77.9$, $SD = 8.93$; education, $M = 14.1$, $SD = 3.23$; MMSE score, $M = 21.2$).

Neuropsychological Testing

Each participant was administered a 2-hour standard neuropsychological battery in a separate testing session, by an examiner who was unaware of the participant's CDR score. We assessed memory with the Logical Memory, Forward and Backward Digit Span, and Associate Memory subtests from the Wechsler Memory Scale (Wechsler & Stone, 1973) and the with Selective Reminding Test (Grober, Buschke, Crystal, Bang, & Dresner, 1988). We assessed general intelligence with Information, Block Design, Digit Symbol, and Similarities subtests of the Wechsler Adult Intelligence Scale (WAIS; Wechsler, 1955). We assessed visual perceptual-motor performance with Parts A and B of the Trail Making Test (Armitage, 1946). We administered the Boston Naming Test (Goodglass & Kaplan, 1983a), the Word Fluency Test S-P (Thurstone & Thurstone, 1949), and the Animal Naming Test (Goodglass & Kaplan, 1983b) as tests of semantic or lexical retrieval.

The means and standard deviations for the neuropsychological measures for each of the groups are presented in Table 1. A series of one-way analyses of variance (ANOVAs) with group as a between-subject factor indicated that performance on all of the measures was significantly different among groups (all $ps < .05$). Post hoc comparisons between the healthy control versus very mild DAT groups and the very mild DAT versus mild DAT groups indicated decreasing cognitive performance with increasing dementia severity (all $ps < .04$; see Table 1). There were also differences in performance as a function of healthy aging (i.e., middle-aged vs older controls), primarily for speeded–attention measures (Digit Symbol, Trails B, $p = .06$; Animal Fluency, Word Fluency, Digits Backward).

Materials and Procedure

The examiner gave all participants the NEO Five-Factor Inventory (NEO-FFI; Costa & McCrae, 1992) to fill out. The NEO-FFI is a shortened version of the Revised NEO Personality Inventory (NEO-PI-R) that measures the five factors of neuroticism, extraversion, openness, agreeableness, and conscientiousness. There are 60 items rated on a 5-point scale from strongly agree to strongly disagree. Administration of the scale takes about 10 to 15 minutes. This shortened scale has correlations of .77 to .92 with the five factor scales from the NEO-PI-R, and internal consistency values range from .68 to .86 (Costa & McCrae). Participants filled out the form at the time of their clinical visit. If participants were unable to fill out

Table 2. NEO Self-Report and Informant Report as a Function of Group

Factor	Middle-Aged	Healthy Controls	Very Mild DAT	Mild DAT
Self-report				
Neuroticism	15.4 (6.91)	13.8 (6.86)	16.9 (7.51)	17.2 (6.28)
Extraversion	30.8 (6.25)	30.1 (6.49)	29.4 (5.45)	27.9 (4.11)
Openness	30.0 (4.68)	27.6 (5.62)	25.0 (5.27)	22.7 (4.23)
Agreeableness	35.6 (4.30)	34.6 (4.80)	34.0 (5.66)	33.2 (4.72)
Conscientiousness	36.1 (5.98)	34.3 (6.22)	33.0 (5.88)	32.5 (4.73)
Informant report				
Neuroticism	13.8 (7.59)	13.0 (7.36)	18.1 (7.57)	21.4 (8.89)
Extraversion	32.3 (6.96)	30.4 (7.87)	27.3 (7.51)	24.7 (6.91)
Openness	26.9 (4.53)	26.0 (5.51)	23.4 (5.98)	21.5 (5.98)
Agreeableness	35.0 (6.27)	36.0 (7.12)	32.5 (8.08)	33.4 (6.27)
Conscientiousness	39.1 (6.35)	37.7 (7.50)	32.0 (7.85)	25.8 (7.67)

Note: DAT = dementia of the Alzheimer type; NEO self-report or informant report = assessment of the personality traits of neuroticism, extraversion, openness, agreeableness, and conscientiousness, according to the NEO Five-Factor Inventory, by the participant or an informant.

the form on their own, a trained research assistant orally administered the questionnaire. Finally, because of the concern regarding the self-report of personality in demented individuals, informants also independently filled out the NEO inventory at the time of the clinical visit. The informant (i.e., typically a spouse or adult child) filled out the NEO in reference to the participant's current state. It should be noted that there tends to be good agreement between self-report and other-report ratings for individuals with AD (Rankin, Baldwin, Pace-Savitsky, Kramer, & Miller, 2005).

Results

We first present the NEO self-report and informant-report data as a function of subject group to examine whether aspects of personality differ as a function of healthy aging and very-early-stage DAT. Next, we present analyses that examine whether specific personality traits add to the discrimination of healthy aging versus early-stage DAT, above and beyond cognitive performance.

NEO Self-Report and Informant Report

The NEO raw scores for each of the five personality traits as a function of group and self-report versus informant report are presented in Table 2 and Figure 1 for the entire sample. Overall, there are clear differences in some of the personality factors across groups, and these differences appear larger for the informant ratings than they do for the self-report ratings. It should be noted that the mean raw scores for both self-report and informant report for the middle aged and healthy older controls are very consistent with the NEO-FFI norms (Costa & McCrae, 1992), with slightly lower neuroticism and slightly higher extraversion in the current sample.

NEO Self-Report.—The self-report data are presented on the left side of Figure 1. We performed a series of one-way ANOVAs on the self-report data for each of the five personality dimensions with group as the between-subjects factor. There was a significant effect of group for neuroticism, $F(3, 283) = 4.56$, $MSE = 22.62$, $\eta^2 = .05$, $p = .004$; openness, $F(3, 283) = 17.58$, $MSE = 478.32$, $\eta^2 = .16$, $p < .001$; and conscientiousness, $F(3, 283) = 3.48$, $MSE = 120.66$, $\eta^2 = .04$, $p = .016$. Neither extraversion, $F(3, 283) = 2.09$, $MSE = 72.28$, $\eta^2 = .02$, $p = .10$, nor agreeableness, $F(3, 283) = 1.78$, $MSE = 43.96$, $\eta^2 = .02$, $p = .15$, yielded a significant group effect. We used post hoc t tests, utilizing a Bonferroni correction ($p = .016$), to further explore the locus of the group differences for the reliable main effects. The results of the post hoc tests are indicated in Figure 1. The self-report data indicate that there is a difference in neuroticism in the very mild DAT group compared with the healthy control groups. There is relatively little difference in extraversion, agreeableness, and conscientiousness across the groups. Openness does decrease between the very mild and mild dementia groups in these self-report ratings.

Informant Report.—The informant-report data are shown on the right half of Figure 1. The results from the one-way ANOVAs on the informant-report data yielded main effects for all five factors: neuroticism, $F(3, 283) = 16.81$, $MSE = 999.27$, $\eta^2 = .15$, $p < .001$; extraversion, $F(3, 283) = 10.09$, $MSE = 571.49$, $\eta^2 = .10$, $p < .001$; openness, $F(3, 283) = 10.56$, $MSE = 331.55$, $\eta^2 = .10$, $p < .001$; agreeableness, $F(3, 283) = 4.08$, $MSE = 215.69$, $\eta^2 = .04$, $p = .007$; and conscientiousness, $F(3, 283) = 35.84$, $MSE = 2009.97$, $\eta^2 = .28$, $p < .001$. Thus there are strong differences in each of the personality measures across groups. We used post hoc t tests to further explore the locus of the group differences for the reliable main effects. The results of the post hoc tests are indicated in Figure 1. There was an increase in reported neuroticism in the very mild DAT group compared with the healthy control groups. There was a decrease in extraversion, openness, and agreeableness in the very mild DAT group compared with the healthy control groups. Conscientiousness decreased substantially with dementia onset and dementia severity.

NEO Scores and the Discrimination of Healthy Aging Versus Early-Stage DAT

We also examined whether specific personality traits add to the discrimination of healthy aging versus early-stage DAT, above and beyond cognitive performance. Given that the informant ratings were more sensitive to group differences, we included only informant ratings in these analyses. We performed a series of stepwise logistic regressions to determine whether any of the NEO traits significantly contributed to the discrimination between healthy aging (CDR 0) versus very mild DAT (CDR 0.5) after a general cognitive factor score was entered into the regression equation. We computed z scores for each subject by using the means and standard deviations from the healthy older group for each of the following neuropsychological measures: Logical Memory, Digits Forward, Digits Backward, WAIS Information, Digit Symbol, Trails B, Animal Fluency, Word Fluency, Associate Learning, and Block Design subtests. We chose these measures to maximize the sample of subjects to be included in this set of analyses (healthy old, $n = 91$; very mild DAT, $n = 51$). We created a general cognitive factor score by averaging these z scores for each subject.

First, we performed a logistic regression with the general cognitive factor to determine how well cognitive performance

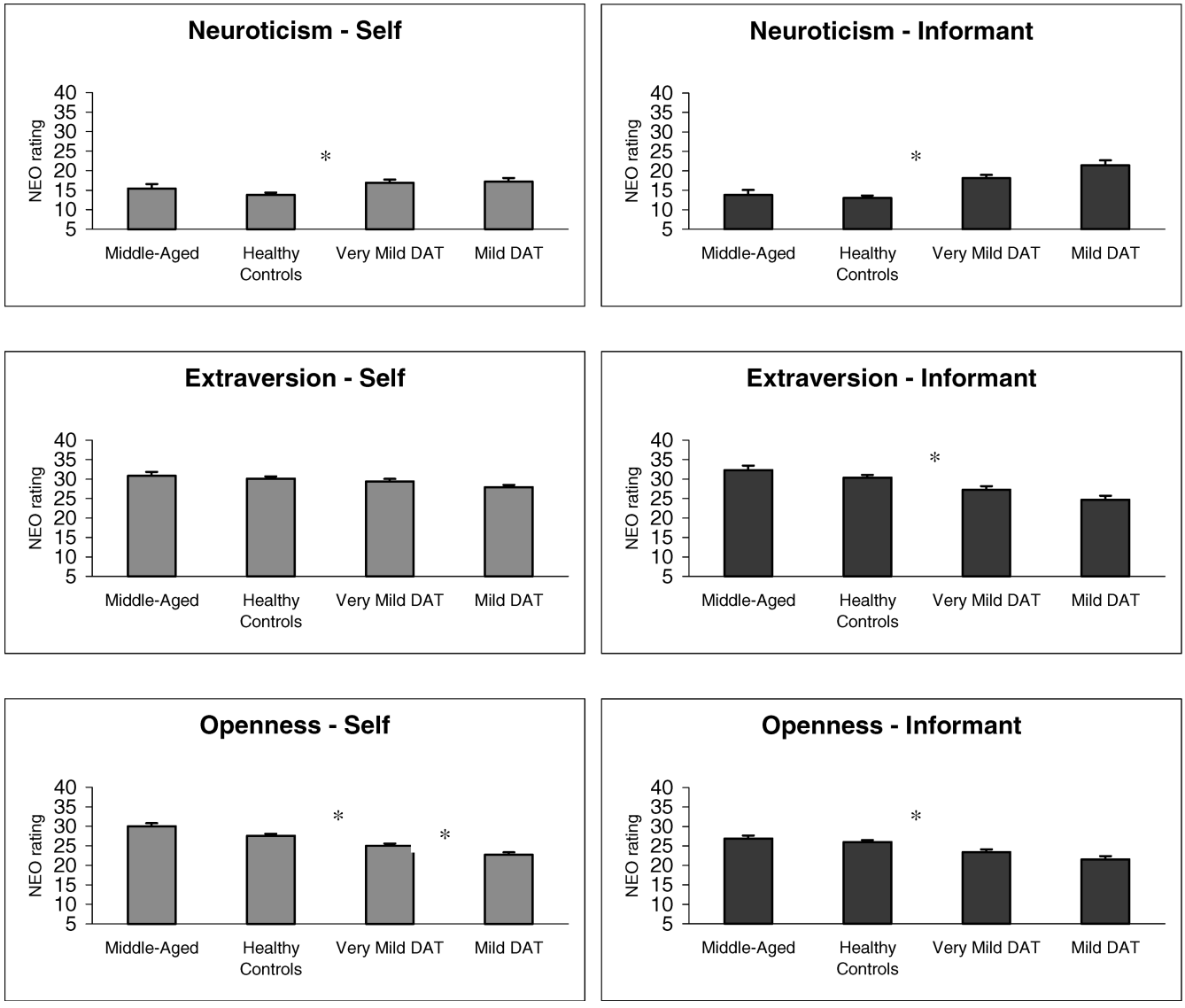

Figure 1. Mean self- and informant-report ratings on the five factors of neuroticism, extraversion, openness, agreeableness, and conscientiousness as a function of group. (The asterisks signify a Bonferroni correction; $p < .016$.)

discriminates the CDR 0 versus the CDR 0.5 groups. The results of this analysis indicated that indeed this general factor significantly contributed to the discrimination between the healthy control group and the CDR 0.5 group, $p < .001$. The general cognitive factor alone correctly classified 70.4% of cases (43.1% sensitivity; 85.7% specificity). Then, we performed a logistic regression in which we entered only the five NEO factors into the equation. The results of this analysis indicated that both the informant report of neuroticism ($p = .006$) and conscientiousness ($p = .01$) significantly discriminated the groups, now correctly classifying 75.4% of cases (49% sensitivity; 90.1% specificity). Hence, the results from these analyses suggest that the differences in personality were as powerful at discriminating between healthy aging and the earliest detectable stages of DAT, as a general factor measure reflecting cognitive performance.

Next, we performed a logistic regression in which we entered the general cognitive factor first, followed by the informant report of neuroticism and conscientiousness. The results of this analysis indicated that the informant report of neuroticism ($p = .036$) and conscientiousness ($p = .001$) significantly contributed to the discrimination of the groups, above and beyond the general cognitive factor. With the addition of the informant report of neuroticism and conscientiousness, correct classification increased to from 70.4% to 77.5% (58.8% sensitivity; 87.9% specificity).

Finally, we performed a logistic regression in which we used an episodic memory factor (Logical Memory, Associate Learning, SRT Free Recall, Animal Fluency) as a more targeted cognitive factor for discriminating the control group from the CDR 0.5 group, given that memory is often considered the hallmark symptom for the disease. The episodic memory factor

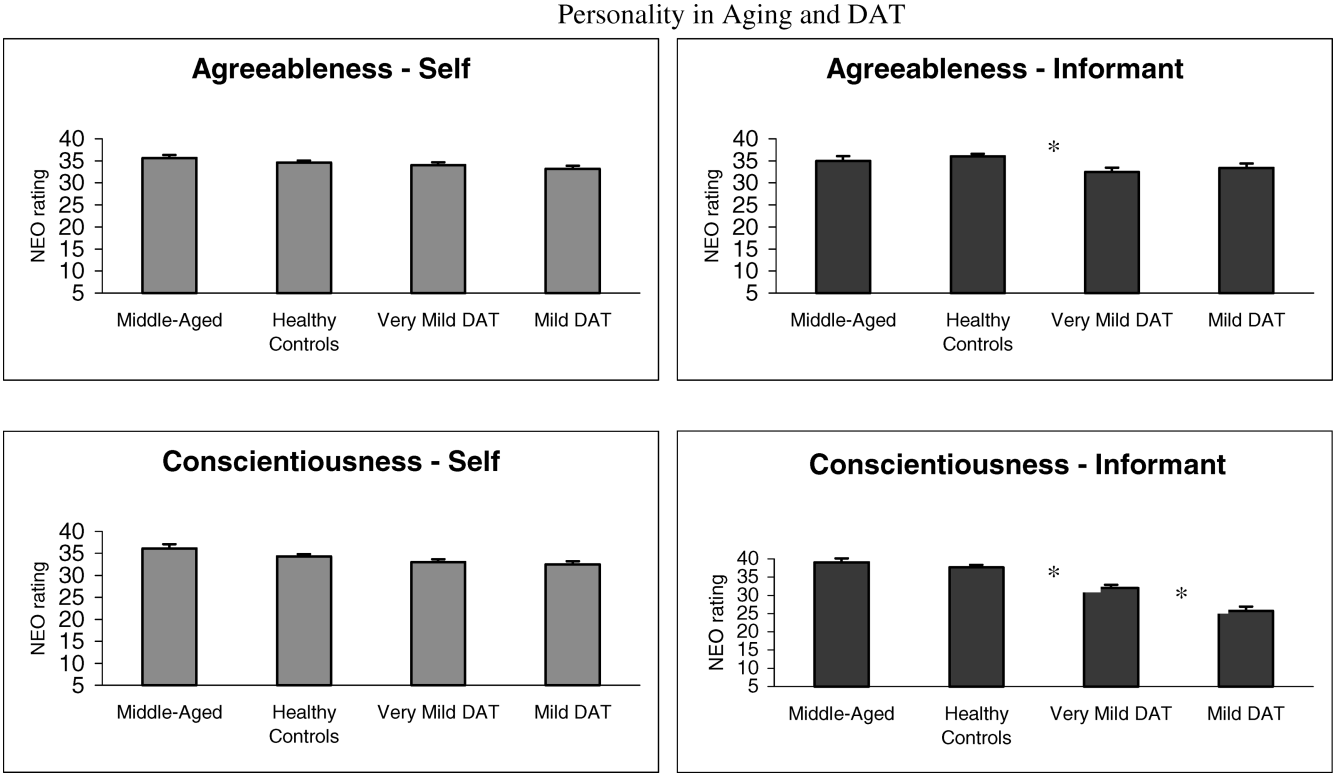

Figure 1. Continued.

was entered first, followed by the informant report of neuroticism and conscientiousness. The results of this analysis indicated that the episodic memory factor significantly discriminated the groups ($p < .001$), with 76.1% correct classification (56.9% sensitivity; 86.8% specificity), which is remarkably similar to the correct classification produced by only neuroticism and conscientiousness (i.e., 75.4%). In the multiple-step logistic regression, the informant report of conscientiousness contributed to the discrimination of the groups, above and beyond the episodic factor ($p < .001$), increasing classification to 79.6% (66.7% sensitivity; 86.8% specificity). Neuroticism no longer contributed to the discrimination ($p = .139$). Thus, both the informant report of neuroticism and especially conscientiousness appear to be powerful predictors of early-onset DAT.

It should be noted that we also performed a logistic regression in which we used only the self-report ratings. The results indicated that only the self-report of neuroticism ($p = .02$) significantly discriminated the groups, correctly classifying only 68.3% of cases (vs 75.4% with the informant reports). Furthermore, the self-report of neuroticism did not add significantly to the discrimination, after we entered either the general cognitive factor score ($p = .19$) or the episodic memory score ($p = .24$). Thus, the informant reports of personality factors appear to be more sensitive predictors of early-onset DAT.

Discussion

Our purpose in the present study was to (a) identify personality differences in very-early-stage DAT relative to healthy aging; (b) examine the power of personality in discriminating healthy aging from the earliest stages of DAT; and (c) examine whether personality adds to the discrimination of healthy aging versus early-stage DAT, above and beyond cognitive performance.

Personality Differences in Early-Stage DAT

There clearly are large differences in personality traits in both self-reports and informant reports in the healthy older controls versus very mild DAT groups. Regarding the self-report data, there were higher levels of neuroticism reported in the very mild DAT group compared with the healthy older controls, along with decreased openness. These differences in personality traits as a function of DAT are consistent with the literature. The important aspect of the present study is that these differences are based on the self-reports of healthy adults versus individuals at the earliest detectable stages of dementia, rather than informant reports for individuals that are in more advanced stages of the disease, as typically reported in the literature (e.g., Balsis et al., 2005; Dawson, Welsh-Bohmer, & Siegler, 2000; Siegler et al., 1994; Smith-Gamble et al., 2002; Strauss & Pasupathi, 1994). Thus, individuals in the very mildest stage of the disease do appear to have insight into aspects of their own personality that are consistent with informant reports.

The informant report data were also consistent with the literature in showing personality differences in DAT (e.g., Siegler et al., 1994). The current study appears to be unique in that it provides a comparison of a group of well-characterized

individuals in the earliest detectable stages of AD with a group of healthy older controls, free of any cognitive impairment. The use of the CDR scale in this study afforded the detection of very mild AD at an even earlier stage than what is considered to be MCI without dementia (Storandt et al., 2006). Informants reported higher neuroticism and lower extraversion, openness, agreeableness, and conscientiousness in individuals with very mild DAT compared with healthy control individuals without it. Lower conscientiousness was also reported between the very mild and mild DAT groups according to informant reports.

In general, there appears to be relatively good agreement between the self-report and informant ratings. It is not surprising that the agreement between self-report and informant ratings is highest in the two healthy control groups ($r = .38$–$.68$) and lowest for the two DAT groups ($r = .12$–$.53$). Specifically, informants report lower levels of extraversion, agreeableness, and conscientiousness compared with participants' self-report in the very mild DAT group. Thus, informants are overall reporting *more* differences in personality traits between the healthy older control group and the very mild DAT group than are seen in the self-report ratings.

Of course, one might expect that the informants would have more insight into personality differences than the DAT participants themselves. However, it is also possible that the marked increase in neuroticism, and the decrease in conscientiousness in particular, in the very mild DAT group may not be a function of the onset of the disease per se, but rather the informants' reaction to the initial diagnosis of DAT in the participant. In order to address this issue, we examined the physicians' notes regarding feedback to the informant from the clinical interview for the CDR 0.5 participants for whom this information was available ($n = 54$). Depending on the circumstances, participants and informants are not always given a diagnosis of DAT in this very mild DAT group. On the basis of this feedback, we categorized participants as having either received a "diagnosis of DAT" ($n = 16$) or "no clear diagnosis" ($n = 38$). There was no significant difference in informant reports of neuroticism ($p = .56$) or conscientiousness ($p = .37$) between these latter two groups. There were also no significant differences in informant reports of extraversion ($p = .80$), openness ($p = .44$), or agreeableness ($p = .42$) between these two groups. Thus, it does not seem that the reported differences in neuroticism or conscientiousness for the healthy control groups versus the very mild DAT group are due to the informants' reaction to the clinical diagnosis of DAT. Instead, these differences may potentially reflect real changes that the informant has seen in the participant with the early onset of the disease.

Personality as an Early Independent Indicator of DAT

One of our primary purposes in the present study was to determine whether personality traits add to the discrimination of healthy aging versus early-stage DAT, above and beyond cognitive performance. As expected, performance on neuropsychological measures was not highly correlated with the personality measures of neuroticism, extraversion, agreeableness, or conscientiousness, which ranged from $r = .02$ to $r = .28$; larger correlations, not surprisingly, occurred between openness and cognitive performance, ranging from $r = .30$ to $r = .41$ (see DeYoung, Peterson, & Higgins, 2005). Thus, personality may afford a unique additional leverage in the discrimination between individuals with early-stage DAT and healthy controls.

As we previously discussed, this can be a difficult discrimination to make (e.g., Morris et al., 2004), and various noncognitive risk factors for the onset of DAT have been identified in the literature in an attempt to further refine this discrimination (e.g., Ringman et al., 2004; Smith-Gamble et al., 2002; Wilson et al., 2003). The results from the current study clearly indicated that the informants' report of neuroticism and conscientiousness did significantly add to the discrimination of healthy aging and early-stage DAT beyond a general measure of performance on standard neuropsychological tests (77.5% vs 70.4%). In fact, neuroticism and conscientiousness alone (part of a 10- to 15-minute questionnaire) discriminated the healthy control and very mild DAT groups slightly better than did the general cognitive factor (75.4% vs 70.4% classification, respectively) as based on a 2-hour battery of neuropsychological tests. Furthermore, the informant report of conscientiousness also significantly added to the discrimination of healthy aging and early-stage DAT beyond a more targeted measure of episodic memory performance (79.6% vs 76.1%). It should also be noted that neuroticism did not add to the discrimination between healthy aging and early-stage DAT, beyond conscientiousness in this latter analysis. Informants appear to be particularly sensitive to aspects of conscientiousness and neuroticism in the earliest stages of the disease. The conscientiousness factor is composed of items that are related to setting and accomplishing goals, being organized, following through on tasks, and being dependable and reliable. The neuroticism factor is composed of items that are related to depression, anxiety, and tension. These behaviors appear to be particularly salient to caregivers in the very earliest detectable stages of DAT.

In this light, it is interesting that Pearman and Storandt (2004, 2005) have found that conscientiousness was the primary predictor of subjective memory complaint in healthy older adults, above and beyond depression, anxiety, and actual memory performance. Specifically, the conscientiousness facet of self-discipline explained the most variance in subjective memory complaints. Because the NEO-FFI represents a shortened version of the NEO-PI-R, we were unable to explore the specific facets of these personality traits as they relate to healthy aging and early-stage DAT. Because subjective reports are critical in the diagnosis of the earliest stages of the disease, these results underscore the importance for understanding the role of personality differences as an early marker for the disease.

Indeed, these results do suggest that differences in personality traits may serve as an early marker for the onset of AD; specific traits, such as conscientiousness and neuroticism, as reported by an informant may serve to further refine the early discrimination between DAT and healthy aging, beyond more traditional measures of cognitive performance. These data lend credence to the arguments made by Smith-Gamble and colleagues (2002) and Balsis and associates (2005) that personality changes may potentially precede the cognitive changes that typically signal the initial diagnosis of DAT. Given that informant reports of neuroticism and conscientiousness discriminated the healthy older control individuals from the very mild DAT subjects slightly *better* than did general cognitive performance, it is important that the assessment of personality be included in the initial diagnosis of DAT.

This study also supports the importance of the informant report in making the early diagnosis of DAT. The determination of dementia and assignment of the CDR in the present study is based solely on clinical information that is obtained in a semi-structured interview with both the participant and informant, without reference to performance on standard neuropsychological measures (see Morris et al., 2001 for a more complete description). The information that is derived from the informant is particularly useful in determining if the participant has experienced a gradual onset and progressive decline in memory and other cognitive abilities relative to the individual's previous state of functioning. In fact, Carr and associates (2000) found that informant-reported memory problems were a better predictor of the diagnosis of DAT than were self-reported memory problems.

The current study further illustrates the need for clinicians, in making the diagnosis of early-stage DAT, to query informants about personality characteristics and potential personality changes that may have occurred over time. Of course, a limitation of the current study is that only cross-sectional data of personality ratings were available in our sample. Thus, it is unclear whether the group differences in neuroticism and conscientiousness reflect *changes* in personality with the onset of the disease or whether these personality traits (i.e., higher neuroticism and lower conscientiousness) were present before the onset of DAT and thus merely predispose individuals to AD. The literature appears to be mixed on this account. For example, Balsis and colleagues (2005) reported greater personality *change* in individuals who later converted to AD relative to nondemented controls. However, Wilson and associates (2003) reported that individuals high in neuroticism at baseline were more likely to later develop AD, thus supporting the notion that premorbid personality traits may be predictive of AD. In either case, personality appears to be an important noncognitive risk factor for the onset of DAT. There is clearly a need for future prospective, longitudinal studies to carefully track whether there are personality changes with the initial onset and progression of AD. We are indeed currently engaged in such a study.

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