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Characteristics of Healthy Older Adults that Influence Self-rated Cognitive Function

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Abstract

Objectives: We sought to clarify the nature of self-reported cognitive function among healthy older adults by considering the short-term, within-person association (coupling) of subjective cognitive function with objective cognitive performance. We expected this within-person coupling to differ between persons as a function of self-perceived global cognitive decline and depression, anxiety, or neuroticism. **Methods:** This was an intensive measurement (short-term longitudinal) study of 29 older adult volunteers between the ages of 65 and 80 years without an existing diagnosis of dementia or mild cognitive impairment. Baseline assessment included neuropsychological testing and self-reported depression, anxiety, and neuroticism, as well as self- and informant-reported cognitive decline (relative to 10 years previously). Intensive within-person measurement occasions included subjective ratings of cognitive function paired with performance on a computerized working memory (*n*-back) task; each participant attended four or five assessments separated by intervals of at least one day. Statistical analysis was comprised of multilevel linear regression. **Results:** Comparison of models suggested that both neuroticism and self-rated cognitive decline explained unique variance in the within-person, across-occasion coupling of subjective cognitive function with objective working memory performance. **Conclusions:** Self-ratings of cognition may accurately reflect day-to-day variations in objective cognitive performance among older adults, especially for individuals lower in neuroticism and higher in self-reported cognitive decline. Clinicians should consider these individual differences when determining the validity of complaints about perceived cognitive declines in the context of otherwise healthy aging. (*JINS*, 2018, *24*, 57–66)

Keywords: Dementia, Individuality, Self-report, Multilevel modeling, Cognitive aging, Working memory

INTRODUCTION

There is considerable debate regarding the meaning and clinical utility of self-reported cognitive decline in older adulthood. On one hand, subjective ratings of cognitive function have been used cross-sectionally to differentiate healthy older adults from those with mild cognitive impairment (MCI) (Farias et al., 2008), and in the prediction of which healthy, neuropsychologically intact individuals will show prospective decline to MCI or Alzheimer-type dementia (Glodzik-Sobanska et al., 2007). Conversely, population-level screening studies have shown that complaints about difficulties with cognitive functions are quite common among community-dwelling older adults (e.g., Cooper et al., 2011; Jonker, Geerlings, & Schmand, 2000), and often associated with traits such as neuroticism, anxiety, and depression (Comijs, Deeg, & Dik, 2002; Derouesné & Lacomblez, 1999; Dux et al., 2008; Jorm & Butterworth, 2004; Slavin et al., 2010). Providing further context to the debate, subjective cognitive decline (SCD), recently described as a possible prodrome to Alzheimer's dementia, is primarily ascertained using self-report of perceived cognitive decline in the context of apparently normal clinical functioning. As Jessen and colleagues (2014) note in their recent position paper on the classification of SCD, "the concurrent and longitudinal relationship between subjective and objective cognitive performance is a research topic of major interest" (p. 847).

Despite the recent focus on self-reported cognitive functioning as a candidate marker of early dementia pathology, few studies have examined its longitudinal, within-person

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relationship to objective cognitive performance. Studies that focus on cross-sectional measurement of cognitive performance and perceived functioning cannot differentiate within- from between-person sources of performance variance (cf., Hofer & Sliwinski, 2001; Molenaar, 2004), just as longitudinal studies of cognitive performance outcomes that consider subjective cognitive function at only a single measurement occasion (e.g., Rabin et al., 2012) cannot evaluate its within-person association with cognitive performance. Some research has investigated within-person coupling of subjective and objective cognitive performance through repeated measurement of both, usually with measurement intervals of days to weeks.

For instance, the explicit participant self-report of daily cognitive function has been linked to objective cognitive performance at the concomitant measurement occasion among younger adults (Brose, Schmiedek, Lövdén, & Lindenberger, 2012). Among older adults, this subjective-objective association appears to be dampened and qualitatively distinct (Brose et al., 2012); in some individuals the direction of the within-person association between perceived and actual performance may even be reversed (Brose, Schmiedek, & Molenaar, 2010). Eroding self-awareness of cognitive impairment has long been linked to increasing dementia severity (Reisberg & Gauthier, 2008). Thus, the relationship between a given individual's subjective and objective cognitive function might itself prove a useful early indicator of potential future problems. It may be the case that healthy individuals (like those in the present study) and those at the very earliest stages of dementia accurately perceive subtle signs of cognitive decline, but with worsening severity, self-assessment becomes progressively unreliable (Reisberg & Gauthier, 2008; Jessen et al., 2014).

These latter reports also demonstrate a broader implication that individual-level results can differ from those at the group-level in terms of both magnitude and valence (Robinson, 1950). Moreover, individuals often differ in their patterns of association among biological and psychological processes over time (Molenaar, 2004). This is obvious in the clinical assessment of a particular older adult, yet obscured by study designs that do not accommodate this fact; it speaks to the importance of accommodating hierarchically nested within- and between-person levels using a multilevel modeling framework (Borsboom, Mellenbergh, & van Heerden, 2003).

Multilevel models allow for the within-person association among repeated-measures variables to differ between individuals. As a result, occasion-specific departures (fluctuations) relative to a given person's typical level of self-rated function can be isolated as a predictor of cognitive performance at that same occasion. Because it is partially determined by a subjective rating, the magnitude and direction of the subjective-objective within-person coupling effect investigated in the present study was expected to differ as a function of between-person differences in the psychological dimensions of self-perceived cognitive decline and depression, anxiety, or neuroticism. Indeed, previous between-person/cross-sectional studies seem to suggest that the utility of self-report for the early identification of individuals at increased risk for dementia is complicated by its association with mood and personality (Comijs et al., 2002; Derouesné & Lacomblez, 1999; Dux et al., 2008; Jorm & Butterworth, 2004; Slavin et al., 2010).

The current study could refine the present understanding of self-reported cognitive function because it provides a within-person perspective on subjective and objective cognitive function, both of which are known to fluctuate over time and in concert with a myriad of intrinsic and extrinsic factors. Some older adults may provide reliable and valid subjective indications of subtle neurocognitive change long before clinically manifest declines are apparent. For example, in the case of SCD, Reisberg and colleagues (2008) have referred to a preclinical stage of dementia "when the patient knows but the doctor does not yet know," underscoring the predictive utility of self-reports of cognitive function even in the absence of objective clinical impairment. As such, the findings from the present study could improve screening protocols for pathological cognitive decline by identifying older adult characteristics that impact the reliability and validity of self-reported cognitive function.

In summary, the available literature suggests that the potential clinical utility of self-reported experiences of cognitive decline for dementia screening of healthy older adults is limited by (1) the relation of experiences of decline to other factors such as depression, anxiety, and neuroticism, and (2) a predominantly between-person perspective. To refine the construct of subjective cognitive function, the present study investigated potential sources of individual difference in the degree of within-person association between subjective and objective cognitive function assessed at four or five occasions separated by at least a day. We expected that between-person elevations in depression, anxiety, or neuroticism would confound the association of subjective with objective cognitive function. Thus we predicted that the degree of within-person, across-occasion subjective-objective coupling would show cross-level interaction with between-person differences in self-rated decline and depression, anxiety, or neuroticism.

METHODS

Participants

Study procedures conformed to the Declaration of Helsinki and were approved by the University of Victoria Human Research Ethics Board. Individuals were recruited from the Victoria, British Columbia, area. Recruitment messaging requested the participation of healthy older adults who either (1) had no concerns about their cognitive functioning, or (2) had some concerns about their cognitive functioning. A structured telephone interview (Rabin et al., 2007) was used to determine study eligibility. To be included in the study, participants had to be between ages 65 and 80 years, be free of significant neurological history (e.g., stroke, Alzheimer's, Parkinson's disease), report intact instrumental activities of daily living (Lawton & Brody, 1969), have access to an informant (friend or family member) who knew

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them well and who could accompany them to their first laboratory visit, and be willing and available to participate in all of the study activities.

Between April and July 2013, thirty-seven potential participants between ages 65 and 80 expressed interest in the study. Four were excluded due to positive neurological history, and four did not complete all assessments, leaving a sample of 29 participants eligible for inclusion in the present analyses. Material compensation afforded in exchange for participation in the study was limited to reimbursement for travel/parking expenses only. Data gathered during initial telephone screening interviews suggested that most participants were motivated to participate out of interest in and a desire to support scientific research related to aging and cognitive function.

Measures

Between-person

Cross-sectional assessment at a single timepoint (study baseline) was done using standardized instruments; these included self-report measures and neuropsychological test scores. Self-report scales included Everyday Cognition Scale (Farias et al., 2008; possible range = 39 to 156), Geriatric Depression Scale (Yesavage et al., 1983; normal range < 11), Adult Manifest Anxiety Scale-Elderly (Reynolds, Richmond, & Lowe, 2003; normal range T-score < 65), and the Neuroticism subscale of Big Five Inventory (John, Donahue, & Kentle, 1991; possible range = 8 to 40). Neuropsychological measures included the following: Test of Premorbid Function from the Wechsler Adult Intelligence Scale-Fourth Edition Wechsler, 2008; standard score mean = 100, *SD* = 15), Logical Memory and Visual Reproduction from the Wechsler Memory Scale-Revised (Wechsler, 1987; scaled score mean = 10; *SD* = 3), Boston Naming Test (Goodlass, Kaplan, & Barresi, 2001; scaled score mean = 10; *SD* = 3), Digit Span from the Wechsler Adult Intelligence Scale-Revised (Wechsler, 1981; scaled score mean = 10; *SD* = 3), California Verbal Learning Test – Second Edition (Delis et al., 2000; *Z*-score mean = 0; *SD* = 1), CLOX: An Executive Clock-Drawing Test (Royall, Cordes, & Polk, 1998; raw score normal range > 12), Mini-Mental Status Exam – Second Edition (Folstein & Folstein, 2001; raw score normal range > 22), Controlled Oral Word Association Test (Ivnik, Malec, Smith, Tangalos, & Peteresen, 1996; scaled score mean = 10; *SD* = 3), and Category Fluency Test (Lucas et al., 1998; scaled score mean = 10; *SD* = 3).

Total raw scores were used for all self-report measures except for the anxiety measure (Adult Manifest Anxiety Scale, Elderly Version; Reynolds et al., 2003) where raw total scores were converted to T-scores using test publisher norms. Raw scores from neuropsychological tests were referenced to MOANS (Mayo's Older Americans Normative Studies) norms (Ivnik et al., 1992, 1996; Lucas et al., 1998) whenever possible, and test publisher norms otherwise to adjust for differences due to age and education.

Within-person

Repeated self-report and computerized measurement sessions were conducted to assess dimensions expected to vary within persons, across testing occasions. At each occasion, participants completed two items adapted directly from a similar study that we sought to replicate and extend (Brose et al., 2012): *Today, I can concentrate on one activity for a long time if necessary*; and *Today, I can control my thoughts from distracting me from the task at hand*. Each item was rated on an 8-point scale from 0 (does not apply at all) to 7 (applies very well). The summed score from these two items was used to represent subjective control of attention (CoA) for that day (possible range = 0 to 14), and served as an index of subjective cognitive function as rated immediately before performing the computerized task on that day. In addition to providing useful information regarding one's perceived capacity for attention/concentration on a given day, rating subjective CoA before rather than following task performance also captures fluctuations in motivation/volition in relation to task engagement (Brose et al., 2012).

Following the self-report at each occasion, participants completed a battery of computerized tasks assessing cognitive control; the current report focuses on one particular working memory task, the *n*-back (performance on the other tasks was not examined). Our rationale for looking only at *n*-back performance for this study was based on an *a priori* plan to pair the subjective CoA rating to the clearest exemplar of "holding information in mind". The decision, taken before data collection began, to limit our analysis to a single performance outcome had the added benefit of controlling experiment-wise alpha in our small-sample study.

The *n*-back task involved the display of a string of single letters (approximately 1 per s) on the computer screen and required participants to determine if the presented letter matched the letter presented *n* trials previously (spacebar press) or not (withhold spacebar press). This version of the *n*-back, based on that created by Ladouceur and colleagues (2009), consisted of 12 blocks of 12 trials, with 4 target (response) and 8 non-target trials in each block. The individual blocks differed in terms of their difficulty (*n* = 0-, 2-, or 3-back) and the presence/type of distractor face stimuli flanking the stimulus letters (no, neutral, happy, or angry faces). In the 0-back condition, the participant pressed in response to a particular letter.

For the current analyses, daily cognitive performance was defined as response accuracy on 2- and 3-back trials from the "no face" (i.e., no distracting flankers) condition. Performance accuracy was quantified in terms of the *phi*, or Matthews, correlation coefficient (Matthews, 1975), which allowed both target and non-target trials to contribute to a single performance score. A score of 1.0 thus reflected perfectly accurate performance (responses to all target trials and non-responses to all non-target trials), while a score of –1.0 reflected perfectly inaccurate performance (non-responses to all target trials and responses to all non-target trials). To minimize practice effects, the order of the blocks and the trials within each block were varied to create five different

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versions of the *n*-back, which participants completed in sequence at each of their four or five visits.

Statistical Analyses

For the purposes of analysis, time in study was defined as zero for each participant's baseline (first) computerized assessment, with subsequent visits assigned time values equal to the number of days since the baseline assessment. Within the multilevel modeling framework, *n*-back performance accuracy was estimated as a function of linear time. The null model for the present analysis also included person-centered subjective CoA as a within-person predictor and person-mean of CoA (PMeanCoA) as a between-person predictor. This latter step was essential to isolate each participant's occasion-specific deviations from their own across-occasion mean, hence creating the opportunity to isolate within-person coupling between day-to-day fluctuations in self-rated CoA and *n*-back performance.

In this way, the between-person effect (represented by the person-mean CoA, β_{01}) and the within-person/coupling effect (represented by the person-centered CoA, β_{20}) can be represented as independent effects in the model; the former can be interpreted as the variation in person-mean *n*-back accuracy associated with a unit increase in person-mean CoA, while the latter can be interpreted as the variation in *n*-back accuracy on a particular occasion associated with a unit increase in CoA on that same occasion relative to the person's own mean (i.e., the coupled within-person covariation between CoA and *n*-back) (Hoffman & Stawski, 2009),

$$\text{Accuracy} = b_{0j} + b_{1j}(\text{Time}) + b_{2j}(\text{CoA}) + e_j \quad (1a)$$

$$\begin{aligned} b_{0j} &= \beta_{00} + \beta_{01}(\text{PMeanCoA}) + r_{0j} \\ b_{1j} &= \beta_{10} \\ b_{2j} &= \beta_{20} + r_{2j} \end{aligned} \quad (1b)$$

This null model of *n*-back response accuracy included level-1 (occasion-level) terms for intercept (b_{0j}), linear time slope (b_{1j}), and CoA slope (b_{2j}), as well as for the level-1 random effect, or residual term (e_j). At level 2 (person level), b_{0j} was modeled as a function of an intercept (β_{00}), the person-mean CoA (β_{01}), and a random term (r_{0j}); b_{1j} as a function of an intercept only (β_{10}); and b_{2j} as a function of an intercept (β_{20}) and a random term (r_{2j}). Subsequent analysis steps involved the addition of terms to (1) adjust the model intercept (b_{0j}) for between-person differences in standardized neuropsychological performance and informant-rated cognitive decline, and (2) assess the effects of self-rated cognitive decline and depression, anxiety, or neuroticism on the slope relating CoA to *n*-back performance accuracy (b_{2j}).

Although this study used a community-based sample without existing diagnoses of dementia or MCI, it is possible that some individuals had experienced undiagnosed declines in cognition that could predict between-person differences in overall *n*-back performance. The former model intercept (b_{0j}) adjustments were thus made to minimize this potential confound by diagnostic group differences; individuals with undiagnosed cognitive declines would be more likely to show borderline- or impaired-range neuropsychological test scores and/or elevations in informant-rated cognitive decline. As in clinical assessment scenarios informant-rated cognitive decline is of particular relevance for high-performing individuals, like many in the present sample, who may have declined relative to their own peak functioning but not relative to their age- and education-matched peers. The latter additions to the model addressed the main study questions with regard to differences in the within-person, across-occasion coupling of CoA with *n*-back performance (b_{2j}) as a function of self-perceived cognitive decline and depression, anxiety, or neuroticism.

Multilevel analyses were done *via* commercial software package (HLM 6, Scientific Software International, Inc., Skokie, IL) with full information maximum likelihood (FIML) estimation. FIML can result in downward bias of variance estimates (and hence coefficient standard errors and *p*-values), especially with small sample sizes. However, unlike restricted maximum likelihood (REML), FIML allows testing the contribution of multiple fixed effects simultaneously and for the computation of chi-square difference tests, contrasting log likelihood differences between nested models to ascertain relative increases in model fit (Hoffman, 2015). Because the comparison of nested models that differed in multiple fixed effects was central to testing our hypotheses, we opted to use FIML. Effects of individual predictors were evaluated *via* the Wald test.

RESULTS

Between-Person Analyses

Relevant sample characteristics are reported in Table 1. The sample was predominantly Caucasian, female, and highly educated, which is generally commensurate with the community

Table 1. Characteristics of participants enrolled in final study

	Mean (*SD*, min-max)
Age (y)	70.8 (3.82, 65–79)
Sex (M/F, n = 29)	7/22
Education (y)	17.4 (3.5, 8–22)
WAIS-IV Test of Premorbid Function	116.9 (10.5, 82–129)
MMSE Total Score	28.1 (2.4, 20–30)
Neuroticism	19.7 (5.1, 12–34)
AMAS-E Total	41.4 (10.3, 26–61)
Geriatric Depression Scale	3.3 (3.5, 0–12)
Everyday Cognition Scale – Self	52.8 (10.2, 39–76)
Everyday Cognition Scale – Informant	45.8 (9.3, 32–63)
Number of BIRS	0.66 (0.90, 0–4)
Proportion of participants with ≥1 BIRS	0.48

WAIS-IV = Wechsler Adult Intelligence Scale-Fourth Edition; MMSE = Mini-Mental Status Exam; AMAS-E = Adult Manifest Anxiety Scale-Elderly; BIRS = borderline- or impaired-range neuropsychological test scores (≥1.5 *SD* below reference mean).

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of origin. Of 29 participants, 23 scored at or above 28 on the MMSE-2. These scores are in the "no to mild" impairment range (Crum, Anthony, Bassett, & Folstein, 1993). The lowest observed MMSE-2 score was 20. Participant depression scores revealed that most were in the "no depression" range, with only two clearly falling in the "mild depression" range. Similarly, no participant had an anxiety score that fell in the clinically significant range based on test publisher recommendations (i.e., $T > 65$). Depression and anxiety scores were significantly associated with each other ($r = 0.63$; $p < .05$) and with neuroticism ($r = 0.58$; $p < .05$ and $r = 0.62$; $p < .05$, respectively). Depression and anxiety scores also showed significant association with self-rated cognitive decline ($r = 0.73$; $p < .05$ and $r = 0.64$; $p < .05$, respectively), whereas neuroticism was not significantly related to decline ($r = 0.26$; $p > .05$).

In the context of multilevel modeling, multicollinearity can yield unstable regression coefficients and artificially inflate the coefficient standard errors, leading to an increased chance of type II error (Shieh & Fouladi, 2003). This empirical result was in agreement with our *a priori* analysis plan to consider the effects of depression, anxiety, and neuroticism on subjective-objective cognitive coupling using separate multilevel models. While the restricted, non-clinical ranges of observed depression and anxiety scores suggested that findings involving these two measures should be interpreted with caution (if at all), we nonetheless proceeded with our plan in the interest of transparency and replicability (Button et al., 2013).

When common clinical neuropsychological cutoffs for borderline-range performance of 1.5 *SD*s below the reference sample mean were applied, 14 of 29 (48%) study participants had at least one neuropsychological test score in the borderline range or lower, with only 3 participants having >1 such score (observed range = 0 to 4). Analysis with independent samples *t* tests suggested that participants with borderline-range neuropsychological scores did not differ ($p > .05$) from those without in terms of age ($t(27) = 0.20$; $d = 0.08$), education ($t(27) = 0.45$; $d = 0.17$), premorbid function ($t(27) = 0.81$; $d = 0.31$), MMSE-2 ($t(27) = 0.01$; $d < 0.01$), neuroticism ($t(27) = 0.50$; $d = 0.19$), anxiety ($t(27) = 1.07$; $d = 0.41$), depression ($t(27) = 1.48$; $d = 0.57$), or self-reported decline ($t(27) = 1.12$; $d = 0.43$). However, those with borderline-range neuropsychological scores were rated by informants as higher in cognitive decline ($t(27) = 2.68$; $d = 1.03$).

Within-Person Analyses

Each of the 29 participants attended four or five repeated testing sessions that included self-ratings of subjective CoA as well as computerized *n*-back testing, with a total of 134 individual records available for the analysis. In terms of intraindividual (across-occasion) summary statistics, the average (*SD*, min–max) within-person mean was 5.19 (2.09, 1–9.25) for time in days between consecutive computerized testing occasions, 11.12 (2.08, 6–14) for subjective CoA (possible range = 0 to 14), and 0.59 (0.16, 0.0–1.0) for *n*-back accuracy (possible range = −1 to 1). The average within-person standard deviation was 1.05 (0.63, 0.01–2.70) for subjective CoA and 0.19 (0.06, 0.10–0.32) for *n*-back accuracy.

First, to illustrate the relative explanatory power of including a coupling parameter, we computed a measure of effect size that represented the relative reduction in unexplained level-1 (residual) variance in *n*-back score attained by a model that included the person-centered deviation in CoA compared to a model that was conditional on time only. Although calculating effect sizes in a multilevel modeling context is a contentious issue (e.g., Hoffman, 2015), however, the pseudo-R^2 (e.g., Singer & Willett, 2003) is broadly preferred and easily interpreted. This demonstrated that, relative to the time-only model, including a term for the day- and person-specific deviation in CoA reduced the level-1 residual variance by approximately 3.6%. This suggests that day-to-day fluctuations in self-rated CoA explained only a small proportion of the overall day-to-day fluctuations in *n*-back performance; however, this effect size is nearly identical (3.5%) to that reported in the study whose basic findings we intended to replicate (Brose et al., 2012).

Next, results from the null coupling model (Eqs. [1a/b]), reported in the first column of Table 2, revealed that the person-mean of subjective CoA was not significantly associated with *n*-back performance at baseline. This result is akin to a between-person/cross-sectional finding of a lack of association between subjective and objective cognitive function. Across the entire sample, the within-person coupling between *n*-back accuracy and subjective CoA was also not significantly different from zero ($p > .05$).

Next, three separate alternative models containing between-person predictors of interest were constructed and compared to the null coupling model. All model intercepts were adjusted for between-person differences in neuropsychological performance, as indexed by the presence/absence of borderline-range neuropsychological scores, and informant-rated cognitive decline. The three alternative models differed in terms of which person-level indicator (depression, anxiety, or neuroticism) was included, along with self-rated cognitive decline, as a cross-level moderator of the within-person coupling of subjective with objective cognitive function. All models converged and standard errors for the estimated coefficients did not appear inflated relative to the null coupling model. The regression coefficients, standard errors, and significance levels for parameters in these models are reported in Table 2. In general, coefficients can be interpreted as the increase in *n*-back accuracy associated with a 1-unit increase in that predictor above the grand mean (with all other predictors in the model at grand mean values).

Across all models, the presence of borderline-range neuropsychological scores consistently emerged as a unique predictor of baseline *n*-back performance (i.e., the model intercept). Coefficients indicated that individuals without borderline-range neuropsychological scores obtained an average accuracy score of 0.56 at baseline. For those with one

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Table 2. Summary of multilevel model coefficients

	Null model			Depression model			Anxiety model			Neuroticism model		
Fixed effect	*b*	*SE*	*P*	*b*	*SE*	*P*	*b*	*SE*	*P*	*b*	*SE*	*P*
Inercept												
Intercept	0.50	0.04	<.01	0.56	0.04	<.01	0.56	0.04	<.01	0.56	0.04	<.01
PMCoA	0.01	0.01	.45	–0.01	0.02	.69	<0.01	0.02	.80	<0.01	0.02	.79
BIRS	—	—	—	–0.15	0.06	.02	–0.13	0.05	.03	–0.14	0.06	.02
ECog-Informant	—	—	—	–0.19	0.12	.11	–0.12	0.11	.30	–0.18	0.11	.13
ECog-Self	—	—	—	0.02	0.16	.92	0.15	0.14	.28	0.04	0.12	.77
Depression	—	—	—	<0.01	0.01	.97	—	—	—	—	—	—
Anxiety	—	—	—	—	—	—	–0.01	<0.01	.11	—	—	—
Neuroticism	—	—	—	—	—	—	—	—	—	<0.01	0.01	.71
Time slope												
Intercept	0.01	<0.01	<.01	<0.01	<0.01	<.01	0.01	<0.01	<.01	<0.01	<0.01	<.01
CoA interaction slope												
Intercept	–0.02	0.01	.14	–0.02	0.01	0.10	–0.02	0.02	.14	–0.03	0.01	.07
ECog-Self	—	—	—	0.13	0.08	0.11	0.15	0.08	.07	0.11	0.05	.04
Depression	—	—	—	<0.01	0.01	0.53	—	—	—	—	—	—
Anxiety	—	—	—	—	—	—	<0.01	<0.01	.20	—	—	—
Neuroticism	—	—	—	—	—	—	—	—	—	–0.01	<0.01	.07
Model Deviance	*−49.95*			*−59.09*			*−63.64*			*−62.48*		
−2ΔLL (df = 4)	—			*9.14*			*13.69*			*12.53*		

Note. *b* = unstandardized regression weight (slope); BIRS = Borderline- or impaired-range neuropsychological test scores; ECog = Everyday Cognition Scale; CoA = Subjective control of attention; PMCoA = Person-mean centered subjective control of attention; -2ΔLL = difference in model -2 log-likelihood (-2LL or deviance) is approximately chi-square distributed, with degrees of freedom (*df*) equal to the difference in the number of parameters between the null and alternative models. The critical chi-square value is 9.49 for *df* = 4 and alpha = 0.05.

or more borderline-range scores, there was a performance reduction at the first computerized assessment of approximately 0.14 units for an estimated baseline accuracy score of 0.42. Informant- and self-rated decline, as well as depression, anxiety, and neuroticism, were all unrelated to baseline *n*-back performance. There was a significant effect of time, such that each additional day in the study beyond baseline was associated with an increase of 0.01 in *n*-back accuracy. This small but reliable learning effect reflects the difficulty of the task, even after multiple exposures, consistent with anecdotal feedback from participants.

Self-rated cognitive decline emerged as a significant, unique between-person moderator of the within-person coupling of subjective and objective cognitive function only in the neuroticism model. Neuroticism was also a marginally significant unique moderator of the same coupling effect. Again, although our findings with respect to the effects of both anxiety and depression were not significant, the validity of these particular findings may be undermined by the issues with low/restricted range already mentioned. Coefficients in the neuroticism model suggested that, across the entire sample, the relationship of subjective to objective cognitive performance was negative; a 1-unit increase (relative to a person's own across-day average) in subjective CoA on a given day was associated with a decrement of 0.03 in *n*-back accuracy on that day.

Furthermore, the *n*-back performance decrement associated with a unit-increase in subjective CoA was disproportionately enhanced in those higher in neuroticism, by 0.01 units for every 1-unit elevation in neuroticism above the grand mean. Conversely, each unit of self-rated cognitive decline above the grand mean was associated with a significant improvement in daily *n*-back accuracy of 0.11 per unit-increase in subjective CoA on that day, suggesting that those higher in self-rated decline and lower in neuroticism provide subjective reports of cognitive function that are more congruent with subsequent working memory performance.

DISCUSSION

Despite its potential importance for understanding the earliest stages of pathological cognitive aging (Jessen et al., 2014), few studies have examined the within-person, across-occasion association of self-perceived cognitive function with objective cognitive performance among healthy older adults. Our sample of non-demented, community-dwelling older adults showed individual differences in the within-person, across-occasion covariance of subjective with objective cognitive function. Moreover, both neuroticism and self-reported cognitive decline moderated this within-person association, albeit in opposite directions.

Prior literature has shown that self-perceived cognitive function and neuroticism are positively related at the between-person level among non-demented older adults, and shared variance in these two constructs is often presumed to undermine the clinical utility of self-reported cognitive function for early dementia-risk screening. Comijs and colleagues (2002) indeed found that memory complaints were

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more common in non-demented, non-declining older adults higher in neuroticism, but were more likely to co-occur with physical health problems in those lower in neuroticism. The present study showed that self-perceived cognitive decline and neuroticism, although having a weak positive association between-persons, predict distinct and divergent profiles of within-person covariation of subjective with objective cognitive function. This finding highlights the inadequacy of using between-person (group-level) findings to infer within-person relationships (i.e., the ergodicity assumption; Molenaar, 2004), and demonstrates that self-reported cognitive function does not have a universal meaning among healthy, high-functioning older adults.

Consistent with previous findings (Comijs et al., 2002) the present study suggests that older adults lower in neuroticism provide self-reports of day-to-day cognitive functioning that more closely corroborate objective cognitive performance. Other researchers have similarly noted that mood and personality factors can obscure older adults' self-perception of their own cognitive status (Dux et al., 2008; Jonker et al. 2000; Weaver-Cargin, Collie, Masters, & Maruff, 2008), and that subgroups of older individuals show distinct patterns of association among mood, personality, and self-perceived cognitive function (Kliegel & Zimprich, 2005). For these reasons, some have recently advocated including measures of mood and personality alongside self-ratings of cognitive function in the comprehensive assessment of possible pre-clinical dementia (Rabin et al., 2015).

We found that the coupling effect was moderated in opposite directions by self-rated decline and neuroticism. This suggests that there may be multiple interacting sources of individual difference in the quality and degree of coupling between subjective and objective cognitive function. That those higher in self-rated cognitive decline provided self-ratings of attentional control that showed greater agreement with their actual performance across days may reflect an enhanced motivation to accurately report cognitive function in those with a greater sense of decline, or that cognitive successes/failures are more salient for those with more self-perceived decline. Emerging longitudinal research suggests that certain types of complaints about perceived cognitive decline are indeed a marker of increased risk for prospective MCI and dementia (Amariglio, Townsend, Grodstein, Sperling, & Rentz, 2011; Mitchell, Beaumont, Ferguson, Yadegarfer, & Stubbs, 2014).

On the other hand, older adults scoring higher in neuroticism are wont to report higher levels of perceived stress (Hooker, Monahan, Shifren, & Hutchinson, 1992) and heightened negative affect in response to stressful events (Mrozcek and Almeida, 2004; Mrozcek, Spiro, Griffin, and Neupert, 2006), and may have been more likely to perceive the challenging cognitive task used in the study as a threat (Mrozcek et al, 2006) resulting in reduced motivation to engage with the demanding computer test battery. At least one previous investigation has considered the impact of neuroticism on within-person covariation across days: Neupert, Mroczek, & Spiro (2008), showed that neuroticism moderated the coupling of daily self-reports of stressor occurrence with self-reported memory failures, where individuals higher in neuroticism showed an increased rate of subjective memory failures in response to perceived stressors.

Proneness to experiences of stress and negative affect impacts older adult cognitive performance and may bias or obscure the perception of day-to-day fluctuations in cognitive functioning. This effect has been hypothesized to underlie other instances of "neurocognitive hypochondriasis," for example, following mild traumatic brain injury (Boone, 2009). The inverse coupling of self-rated attentional control with cognitive performance reported herein could represent a general tendency, exaggerated in those higher in neuroticism, to use the self-rating of cognitive function to mitigate the perception of threat or the negative affect associated with the challenge of repeated cognitive testing (Charles & Carstensen, 2010). Clinical assessments of healthy older individuals who may be at increased risk of cognitive decline should, therefore, account for the relative meaning of "cognitive complaints" in relation to the relevant person-context (personality and the subjective experience of decline) to conceptualize and intervene appropriately.

The occurrence of a small number of borderline- or impaired-range scores on standardized neuropsychological tests is expected in healthy older adults and is not necessarily a sign of cognitive dysfunction (Binder, Iverson, & Brooks, 2009; Mistridis et al., 2015; Schretlen, Munro, Anthony, & Pearlson, 2003). Nonetheless, baseline *n*-back performance differed between participants in the current study when grouped according to the presence or absence of borderline-range neuropsychological test scores. Perceived cognitive decline was also uniformly low in this sample, in the *no decline* to *questionable decline* range, consistent with scores of healthy older adults in other samples (Farias et al., 2008). Consideration of data from future study waves will help to determine whether differences in perceived decline will manifest as differences in long-term, prospective decline in performance on either computerized or standardized clinical neuropsychological tasks.

The present study had several strengths, but also several limitations. Although our *a priori* plan involved parsing the influences of depression, anxiety, and neuroticism, the narrow and sub-clinical observed ranges on the two former measures call the findings related to anxiety and depression into question. We recommend that any interpretation of those findings be done with caution, and that further research is needed. For instance, clinical (as opposed to community-based) samples could be useful for capturing a broader range of anxiety and depression scores, and thus advancing knowledge in this area. It should also be reiterated that in the current, as in previous, studies (e.g., Brose et al., 2012), the subjective CoA rating was made before performing the computerized task; asking participants to make post-performance ratings may well reveal different patterns of association.

Another clear limitation of this study was the relatively small and demographically homogeneous sample, indicating

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the need for replication in larger, demographically diverse samples. The limited number of participants was a necessary practical offset to the multi-method, intensive-measurement nature of the study design. In this vein, it is important to consider that statistical power is not only a function of sample size, but also of the density of within-person assessments (Brandmaier, von Oertzen, Ghisletta, Hertzog, & Lindenberger, 2015); our data collection and analysis protocols were designed with this in mind.

The intensive measurement design of the present study moreover allowed for a statistical model that simultaneously considered diverse sources of clinically available information such as self-report, informant-report, standardized neuropsychological assessment, and repeated computerized cognitive testing. The robustness of the current findings were borne out by the results: all of our models converged, and coefficients and standard errors from the final models were comparable to those derived from the null model (see Table 2), suggesting that the estimated solutions were stable. Finally, it must be stated that the patterns of within-person subjective-objective cognitive function covariance reported herein may differ from those at briefer (within-day) or longer (across-year) measurement intervals.

CONCLUSION

There is to date no single method of sufficient sensitivity and specificity—self-report, neuropsychological, imaging-based, biochemical, or otherwise—that permits early identification of individual older adults at heightened risk for MCI and dementia. As a result the potential variety of initial clinical presentations of insidious cognitive decline remains relatively unknown. Although a higher level of self-perceived decline in study samples has been linked to an increased risk of prospective cognitive decline, the use of subjective cognitive function ratings for assessment is confounded by its between-person relationship to depression, anxiety, and neuroticism. Rather than operationalize subjective and objective cognitive performance as time-invariant, short-interval repeated measurement permits the characterization of cognitive performance relative to a person's own typical level as well as to that of their peers. Ultimately, this type of approach will aid in the characterization of distinct trajectories of healthy and pathological cognitive aging as they unfold across multiple hierarchical dimensions of time.

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