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Age-expanded normative data for the Ruff 2&7 Selective Attention Test: Evaluating cognition in older male

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Abstract

The Ruff 2&7 Selective Attention Test's (RSAT) current scoring data are relatively limited for older adults because persons over the age of 70 years were not included in the normative sample. Prior evidence suggests that changes in attention skills, such as those evaluated by the RSAT, may distinguish normal cognitive aging from pathologic cognitive decline. Thus, normative data for older individuals on this measure increases its utility in diagnosing Mild Cognitive Impairment (MCI) and dementia, and enhance its potential use in clinical and research settings. Data from 415 male volunteers (mean age = 69.5 ± 5.7 years) in the PREADViSE clinical trial were used in the current investigation. Analysis of covariance (ANCOVA) shows statistically significant effects of

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age, race, and education on RSAT Speed measures. Results indicate that age-expanded norms will provide a more accurate reflection of the typical performance of older individuals on the RSAT.

INTRODUCTION

The Ruff 2&7 Selective Attention Test (RSAT) is a paper and pencil cancellation task developed by Ruff and colleagues (Ruff, Evans, & Light, 1986; Ruff, Niemann, Allen, Farrow, & Wylie, 1992; Ruff & Allen, 1996) to expand upon prior investigations of "cross-through" tests for the assessment of brain damage. The final published version of the RSAT lays much of its theoretical foundation on a substantial literature based on the work of Logan and colleagues (Logan, 1988; Logan & Klapp, 1991; Logan & Stadler, 1991). The authors designed the RSAT to measure selective attention through a comparison of accuracy and speed responses to visual information. Within each trial target stimuli (i.e., 2s and 7s) are intermingled among alphabetic or numeric distracters. Thus, targets and distracters from both the same stimulus category (Controlled Search processing) and a different stimulus category (Automatic Detection) are presented within the same test, where prior studies of this concept used only targets from the same stimulus category. The 20 trials are "quasi-randomly" ordered, with 10 Automatic Detection trials and 10 Controlled Search trials. Participants are allowed 15 seconds for each trial, with total administration time being 5 minutes.

The creators of the RSAT suggest that it demonstrates important improvements over prior measures of selective and sustained attention for several reasons (Ruff & Light, 1996). Of importance, in the Automatic Detection condition of the RSAT, target numbers are easily distinguished from distracters (letters). The recognition of numbers and letters is an over-learned skill, even in semiliterate individuals, so this task is relatively effortless. Controlled Search, on the other hand, requires that the participant employ strategic selection procedures to identify the target numbers from the distracters, which are also numbers. The primary concept behind the RSAT is that reaction times in the condition of identifying targets from the same stimulus category would be slower compared to different stimulus categories (Ruff, Evans & Light, 1986). In addition, the RSAT was also developed to tap sustained attention due to the longer duration of the test (5 minutes) as compared to measures incorporating attention that had been available previously but were much shorter in duration; e.g., Digit Symbol (Wechsler, 1981; Wechsler, 1997) is 90 or 120 seconds.

Normative data for the RSAT are presented in the Ruff 2&7 Selective Attention Test Procedures Manual (Ruff & Allen, 1996). The normative sample consisted of 360 normal volunteers, residing in California (65%) and in Michigan (30%), with the remainder of the group from the Eastern seaboard. It is reported that the sample's racial composition was similar to the 1980 U.S. Census proportions, but no specific information by race was provided by the authors. The participants in the normative sample were given the RSAT as part of a larger study that included additional neuropsychological testing with a subsample (n=99) being retested after 6 months to explore the temporal stability of performance. Participants ranged in age from 16–70 years and denied history of psychiatric hospitalization, chronic dependency on alcohol or drugs, or suffering from a neurological disorder. Participants were stratified by age category, gender, and educational attainment level. The statistical methodology outlined in the procedures manual for the RSAT does not, however, specify how many individuals from the normative sample are in each strata. However, if participants are distributed equally across the strata (n = 24), only relatively small numbers of participants are contributing to the normative materials for the procedure (360 subjects/24 strata = 15 subjects per strata). This alone argues for a reassessment of this procedure's normative data.

Statistical Findings for the Ruff 2&7 Selective Attention Test

Results of factor analyses conducted by Ruff & Allen (1996) suggest that the RSAT has the ability to capture selective attention (factor loading called Planning and Flexibility) and sustained attention (as seen by Speed scores). Factor analysis shows three main factors for the RSAT in healthy adults: Speed of Processing (Controlled Search Speed, Automatic Detection Speed), Controlled Processing (Speed Difference, Accuracy Difference, Controlled Search Accuracy), and Automatic Processing (Automatic Detection Accuracy, Accuracy Difference; Ruff & Allen, 1996). Alpha coefficients and split-half coefficients for the normative sample are high, suggesting good internal reliability (all coefficients ranging from 0.80–0.97 for split-half; ranging from 0.81–0.97 for Alpha). However, the test-retest reliability coefficient was low for Accuracy scores (r=0.59 for Automatic Detection Accuracy; and r=0.63 for Controlled Search Accuracy, with adequate stability coefficients of 0.76 and 0.82 respectively). Test-retest reliabilities for Speed scores were strong (Automatic Detection Speed r=0.89, stability coefficient r=0.92; Controlled Search Speed r=0.89, stability coefficient =0.93).

LeMay and colleagues (2004) studied the test-retest reliability of attentional and executive tests in middle-aged to elderly French-Canadian subjects. They found that reliability was low for all RSAT Accuracy scores and was only modest for Processing scores over repeated sessions (14-day intervals between administrations). The authors concluded that while the RSAT has good psychometric qualities and can be used in repeated evaluations, utilizing Accuracy scores in interpretation of longitudinal performance should be avoided and that further research on the significance of Accuracy scores on the RSAT is needed.

Attention and Aging

The effect of selective attention at encoding on repetition priming in young adults, normal older adults, and Alzheimer's disease (AD) patients for objects presented visually or haptically has been examined in an investigation by Ballesteros, Reales, Mayas, and Heller (2008). Results found reliable priming for young adults and healthy older adults for visually presented pictures and haptically presented objects. Results suggest that perceptual facilitation is maintained in normal aging. Patients with AD did not show priming for either attended or unattended stimuli presented visually or haptically. The authors suggest that early deficits in selective attention may be an initial indicator of AD.

Cognitive aging in attention and perceptual tasks was examined in other research literature (Mapstone, Dickerson, & Duffy, 2008). Healthy older adults show significantly poorer performance on a heading discrimination (determining the direction of a stimulus or of self-movement) task than younger adults. However, healthy older adults' mean processing speed and variance were about the same as those found for younger adults. In younger adults processing speed tended to limit heading discrimination, yet older adults did not follow this pattern. For healthy older adults heading discrimination was related to an independent measure of attention. Thus, this investigation does not support the assertion that older adults become slower, and that this is responsible for poorer performance in important tasks. Rather, older adults appear to be limited by attentional capabilities in both selective and divided attention.

Evidence from prior investigations suggests that older adults differ significantly from younger adults in their attentional capabilities, even in normal aging. As it is likely that younger adults will perform better on tests of attention than older adults, the current RSAT normative data are vulnerable to distorting the performance of older adults age 55 and over because, as it stands, all are scored using the same test standards. Further, given that no normative data are available for evaluating individuals over age 70, the current standards are

limited in their ability to describe performance in the upper age ranges. If it is the case that selective attention holds promise as an early indicator of cognitive decline in aging, and incidence of cognitive dysfunction (specifically AD) significantly increases after age 70 (Ganguli, Dodge, Chen, Belle, & DeKosky, 2000; Kawas, Gray, Brookmeyer, Fozard, & Zonderman, 2000), normative data for ages above 70 would increase the utility of the RSAT in clinical and research settings, particularly in the diagnosis of Mild Cognitive Impairment and AD. Given the differences in performance on attentional tasks seen in normal aging and in AD, normative data for the RSAT that more fully cover the range of older ages would be beneficial.

Study Objectives

The current investigation utilizes data from the Prevention of Alzheimer's Disease by Vitamin E and Selenium (PREADViSE) clinical trial (Caban-Holt, et al., 2006; Kryscio, Mendiondo, Schmitt, & Markesbery, 2004) to develop additional normative data for the RSAT. The aims of the current investigation are to expand the current normative data to include ages above 70, add to the available normative data for ages 60–70, and assess the effect of race on RSAT performance.

METHODS

Participants and Procedure

Data for the current study were collected for the PREADViSE study, a National Institute on Aging sponsored clinical trial. The primary goal of PREADViSE is to determine whether vitamin E and selenium (alone or in combination) will reduce the incidence of AD in a group of men age 62 and older (age 60 and older if African American or/and Hispanic). Participants in the PREADViSE study were recruited exclusively from the participant pool of the Selenium and Vitamin E Cancer Prevention Trial (SELECT; Klein, 2004). SELECT is sponsored by the National Cancer Institute to examine the potential of selenium and vitamin E to prevent prostate cancer. SELECT had a total of 35,553 male participants at 420 research sites in the United States, Canada, and Puerto Rico (Lippman, et al., 2009), ages 55 and older (50 or older if African American). For eligibility criteria for the SELECT trial refer to Appendix A. All SELECT sites were offered the opportunity to become a PREADViSE study site during SELECT semi-annual meeting breakout sessions, as well as via emails and written correspondence. As a result, 125 sites successfully obtained approval from their respective Internal Review Boards (IRB) and were trained, during meeting breakout sessions and with accompanying videos on CD-ROM, on the administration of PREADViSE procedures. Subsequent to training and approval from the PREADViSE coordinating center, sites began recruiting SELECT participants into the PREADViSE study. The PREADViSE study was described to all eligible SELECT participants at approved sites. Inclusion and exclusion criteria for PREADViSE are listed in Appendix B. Written consent to participate in PREADViSE was obtained from men interested in the trial, and the Memory Impairment Screen (MIS) was then administered to rule out potential pre-existing memory problems. Individuals with passing scores on the MIS were enrolled into PREADViSE. The enrollment period began in June 2002 and ended in September 2009 with 7,547 participants. At baseline, participants' current health history and family history of dementia were also recorded.

Screening Procedure

The MIS (Buschke, et al., 1999) is a two-minute, four-item delayed free and cued recall memory test with controlled learning. A cut-score of four was suggested by the creators of the measure because it provided a high level of sensitivity (0.80), specificity (0.96), and Positive Predictive Value (>0.69) for most base rates of dementia. The MIS was

administered to all PREADViSE participants at enrollment and all PREADViSE study visits.

Normal Aging Sub-study

In an effort to validate the MIS and assess cognitive changes in normal aging, the 15 highest enrolling PREADViSE study sites were also invited to participate in the validation study. Some sites were unable to overcome local Internal Review Board issues, or encountered difficulty getting sufficient staff trained to administer the validation sub-study. Of these, 8 sites (refer to Appendix C for site regions) ultimately contributed to the Normal Aging (NAG) validation sub-study. A subgroup of PREADViSE participants at these sites who met the cut score on the MIS agreed to undergo more extensive annual testing. The NAG assessment comprised the Consortium to Establish a Registry for Alzheimer's Disease (CERAD; Morris, et al.,1989) battery of tests—Category fluency (animals), Boston Naming Test, Constructional Praxis, Mini-Mental State Exam (MMSE), 10-item word list with immediate and delayed recall and recognition trials--supplemented by the RSAT (Ruff & Allen,1996), New York University paragraph recall (Kluger, Ferris, Golomb, Mittleman, Reisberg, 1999), WAIS-III Digit-Symbol (Wechsler, 1997), phonemic verbal fluency (Eslinger, Damasio, Benton, & VanAllen, 1985), and the National Adult Reading Test-Revised (NART; Nelson, 1982; NAART; Spreen & Strauss, 1991), which was only administered at baseline. Data in the current investigation were taken from baseline visits only.

RSAT Scoring Procedures

All RSAT protocols were scored according to the guidelines specified in the professional manual (Ruff & Allen,1996; pp. 5–7). Scores derived from the RSAT were:

- Automatic Detection Speed (ADS; the sum of all "letter distracter" hits)
- Automatic Detection Accuracy (ADA; "letter distracter" hits / "letter distracter" hits + all "letter distracter" errors)
- Controlled Search Speed (CSS; the sum of all "digit distracter" hits)
- Controlled Search Accuracy (CSA; "digit distracter" hits / "digit distracter" hits + all "digit distracter" errors)

Participants

The normative sample consists of 415 cognitively intact male volunteers (mean age = 69.5 ± 5.7 years, range 60 – 90) in the NAG sub-study of the PREADViSE trial (Table 1).

Participants without an RSAT (n = 55) or with a baseline MMSE score below 26 (n = 37), history of depression (n = 45), or cerebrovascular accident (n = 11) were excluded from the sample (refer to Figure 1). As stated previously, the participant sample is taken from diverse geographic regions of the United States.

Statistical Analysis

Raw scores were transformed to T scores with a mean of 50 and standard deviation of 10 in order to normalize the response variables and to facilitate the generation of normative tables. The relationship between the mean T-score for each of the four endpoints (ADS, ADA, CSS, CSA) and two predictors—age as a continuous variable and education level (high school or less, some college, and college plus)—was assessed with an analysis of covariance (ANCOVA) using PROC GLM in SAS 9.2® software. Although Ruff & Allen did not include race as a factor in their analysis, because African-Americans were over-sampled in

the NAG sub-study, we performed several additional analyses to determine the effect of including a factor for race (African-American versus Caucasian) as well as its interactions with age and education in the ANCOVA. The possible interaction between age and education, without race in the model, was also assessed. Additional analyses were also performed to determine whether changing the age intervals or education categories affected RSAT scores. Statistical significance was determined at the α=0.05 level.

Overlapping cells methodology was used in preparing the normative tables in order to maximize the available data (Pauker, 1988; Duff, et al., 2003; Malec, et al., 1992). The data were divided into four overlapping age ranges with midpoints at 65, 70, 75, and 82.5. The age range for the oldest participants was set at 15 years instead of 10 years due to the low number of participants over the age of 85 (n = 6). ANCOVAs restricted to the participants in each of the four overlapping cells were used to estimate the mean demographically adjusted T scores for the education levels within each age range (at the midpoint age), which were then shifted to 50. That is, if the demographically adjusted mean T-score for a given group was 48, a two-point correction was necessary to bring the mean to 50.

Normative tables were then constructed by calculating the unadjusted T-score equivalents for all raw scores, and then adjusting those scores for age and education level by adding or subtracting the appropriate correction factor. Raw scores corresponding to the T scores associated with Ruff & Allen's clinical interpretations were then identified and placed in the table. Rates of impairment in the existing versus the age-expanded norms were compared using McNemar's test.

RESULTS

Participants were similar in age across educational attainment groups (F=0.12, 2 df, p=0.89). Participants with less than a college education tended to be disproportionately African-American, who account for only 13.5% of the college plus group but 26.0% of the entire sample (χ^2=47.5, 2 df, p<0.0001).

ANCOVA results indicated mean CSA T scores were independent of both age and education level, mean ADA T scores were dependent on only education level, and mean ADS and CSS T scores were dependent on both (Table 2). We note that the effect sizes associated with age are greater than those associated with education for both ADS and CSS, and that although education is significant for the ADA model, the effect size is modest (Table 2). A college education or higher was associated with significantly higher Speed scores than high school or less, regardless of age, while increased age was associated with lower Speed scores regardless of education (Table 2).

Only the three factor ANCOVA model for ADA-T produced a significant result for race (semipartial ω^2 = 0.03; Cohen's d = 0.44). The adjusted mean ADA T-score for African-Americans is 46.8 ± 0.9 and is 51.1 ± 0.6 for non-African-Americans; both mean scores reflect average performance (based on suggested clinical interpretation of Ruff & Allen. 1996).

DISCUSSION

The goals of this investigation were to expand the current normative data to include ages above 70 years, add additional information to the available normative data for ages 60–70, and to include a race category in the demographic parameters analyzed.

RSAT data from 415 PREADViSE participants ages 60 – 90 were included in the current analyses. This is an important increase in the number of older adult participants analyzed as

compared to the original group (360 participants; ages 16–70) used to develop the normative data in the professional manual. These data expand the age range for which the RSAT can be utilized to draw clinical conclusions. As the current group covers a much more narrow range of older ages, there is greater likelihood that the data for this group are an accurate reflection of the functioning of older adults on this measure. Further, because the PREADViSE participants included in this investigation are from geographically diverse regions, the results of this investigation may be generalized to the various populations across the United States.

ANCOVA was used to determine whether age and education influence RSAT scores in the NAG sample. Current results generally fall in line with those found by Ruff and Allen (1996). In general, a college education or more was associated with higher RSAT scores, while increasing age was associated with lower scores. Specifically, while ADS-T scores and CSS-T scores were dependent on both age and education level, CSA-T scores were found to be independent of both age and education level, and ADA-T scores were dependent on only education level. Like the current investigation, results of original standardization procedures for the RSAT also found significant main effects of age and education for ADS and CSS-T scores. A steady and linear decline in ADS and CSS was observed with increasing age; greater education resulted in an increase in Speed scores. Taken together, these findings support research by Mapstone, Dickerson, & Duffy (2008) that suggest that attention and the processing speed of older adults is significantly negatively correlated. In addition, as in the current analyses, the original normative procedures did not find significant main effects of gender, age or education on CSA-T scores. However, interestingly, the analysis in the current investigation found that ADA was dependent on education (higher education was associated with increased Accuracy), a finding that was not present in the original normative research. In the RSAT procedures manual Ruff and Allen (1996) note that in their sample there was a relatively low base rate of errors in the performance of normal individuals on the RSAT. They posit that correlations between Accuracy scores and demographic variables may be higher in other populations that have higher error rates on the procedure. Though the original normative sample includes a range of education levels from 7 to 22 years, the average education level for the sample was not reported. It may be that the PREADViSE sample has a more evenly distributed range of education levels (and range of error rates), which has elucidated the association between education and RSAT Accuracy scores.While race was shown to have a significant effect on ADA, the difference between the mean scores for African Americans and non-African Americans is not likely to be clinically meaningful. The difference in ADA performance, which corresponds to less than a 2% difference in raw scores, would not likely lead a clinician to shift the clinical impression of a patient or research participant. Further, there is no apparent explanation for why African American participants performed differently than non-African Americans on this parameter of the RSAT. For example, rates of co-morbidities of African Americans and Caucasians, which would have been a reasonable explanation for the score difference, were examined and found to be similar for both groups (data not shown).

Of particular interest for the current investigation, the clinical interpretation of scores on the RSAT may change for some participants when the age-expanded norms derived in this research are used in place of the existing norms. Due to the limitations in the age span of the normative data in the professional manual, all PREADVISE participants' scores were initially standardized (T-score and percentile score) utilizing the age group of 55–70 years prior to the re-analysis for this investigation. Figure 2 illustrates the concordance of existing and age-expanded norms.

Determination of "impaired" status was determined by the suggested guidelines for clinical interpretation of T scores provided in the procedures manual (Ruff & Light, 1996). T scores of 39 and below are interpreted as being at least mildly impaired. Figure 2 shows that for one of the Accuracy indices, CSA (McNemar's S=4.0, p=0.046), and both of the Speed indices, ADS (McNemar's S=14.2, p=0.0002) and CSS (McNemar's S=35.0, p<0.0001), the age-expanded normative data classify significantly fewer individuals over the age of 70 as being impaired than the existing norms. The greatest discrepancy between the existing and age-expanded norms was observed with CSS (31.8% impaired with existing norms, 13.2% impaired with age-expanded norms), where both attention and speed skills, which are thought to be negatively affected in normal aging, are maximally utilized in this test procedure. Thus, it is unsurprising that individuals over the age of 70 would be misclassified as impaired most often on this measurement when compared to younger adults rather than their older adult peers. The finding that one of the RSAT Accuracy scores (CSA) was found to be significantly associated with education is a novel finding that was not seen by Ruff and Allen (1996). This may be evidence that confirms their suggestion that because their sample had a low base rate of errors that demographic effects on RSAT Accuracy scores could not be detected. It may be that the older adult male population commits more errors on the RSAT than younger adults, thus allowing Accuracy differences to be determined. However, because base rates for errors are not provided in the procedures manual, this supposition is merely speculation.

To facilitate the usefulness of the results of this investigation in clinical settings and clinical trials (e.g., Schmitt, et al., 1988; Regine, et el., 2004), tables for determining clinical interpretations of raw scores for ADS, CSS, ADA, and CSA are provided in Appendix D. These tables will allow clinicians to easily cross-reference performance of older adults on this measure. Of note, the ADA table is referenced only by educational level as age and ADA-T scores were independent in the ANCOVA analysis. CSA-T scores were independent of both age and education level, thus the table for CSA is based only on the unadjusted T scores.

While this investigation adds to the currently available data for the RSAT, there are some limitations. First, the current sample excludes women due to the participants being drawn from a prostate cancer trial. Thus, potential sex differences in performance could not be addressed. Second, though we note a relatively large proportion of African Americans in the sample (over 25%), there is not a substantial representation of other races or ethnicities in this study. Third, although the current analysis includes participants up to age 90, there are relatively few participants over age 80. Thus, the results for those between ages 80 and 90 may be less robust than for those age 60 to 80.

A final limitation to be addressed is the fact that the data from this investigation is taken from a subset of sites (n = 8) from the total sample of 125 PREADViSE sites. Invitation to participate in the NAG sub-study was based on high PREADViSE enrollment. Because NAG site staff required additional training on administration of NAG procedures and resources (e.g., testing and training materials, time of PREADViSE staff to provide verbal and written feedback, etc.), it was important that resources be used judiciously and provided to those sites with the greatest probability of securing the participants needed for validation (i.e., those with the highest enrollment). The 8 NAG sites account for 37.3% of the total PREADViSE participants, a sizable proportion of the sample despite the limited number of sites. Additional comparisons were conducted to determine whether the NAG participants are different from the general PREADViSE sample. In terms of age, participants at NAG sites tend to be slightly younger at enrollment (67.3 ± 5.3 vs 67.7 ± 5.2, $p = 0.0008$), which is statistically but not practically significant. Participants at NAG sites were also slightly better educated (15.2 ± 2.5 vs 14.8 ± 2.8, $p < 0.0001$). Again, not a practically important

difference though statistically significant. There is no difference between NAG and non-NAG participants with regard to family history of dementia ($p = 0.23$). The NAG sites do have a different distribution of race—16.3% of men at the NAG sites are African American vs 7.0% of men at the non-NAG sites ($p < 0.001$). However, this was by design as NAG was aiming to oversample African Americans. We contend that, in general, the NAG site participants are quite similar to their counterparts who are not in NAG and likely achieve test performance that is similar to the overall group.

Overall, due to the expansion of the normative data to an older age range, relatively large proportion of African Americans sampled, removing individuals with potentially confounding co-morbidities and low MMSE scores from the sample, and by providing clinical interpretations that can be easily cross-referenced to raw scores, this investigation improves the clinical utility of the RSAT in examining selective attention in older adult populations and adds to the literature in the field of attention and aging.

CONCLUSIONS

These analyses point out the importance of having age-expanded normative data when classifying older individuals' cognitive status. In the case of the RSAT, comparing the performance of individuals over the age of 70 to those 55–70 years of age places the older individuals at a disadvantage in terms of clinical interpretation of their scores and increases the likelihood that they will be viewed as having a cognitive impairment when in fact their performance is average compared to others in their age group. The clinical interpretation tables provided in Appendix D should promote the use of the RSAT in neuropsychological evaluations of older adults, particularly of those with suspected MCI, as declines in attention may be an early indicator of cognitive decline. Future directions for this research include addressing issues of longitudinal performance on the RSAT such as those posed by LeMay and colleagues (2004), who found that reliability for RSAT Accuracy scores to be low and modest for processing speed over repeated sessions. Ultimately, they caution against using RSAT Accuracy scores in the interpretation of longitudinal performance. Subsequent analysis of the longitudinal NAG dataset will attempt to provide some resolution as to whether the RSAT is a useful measure in the longitudinal follow-up of older individuals.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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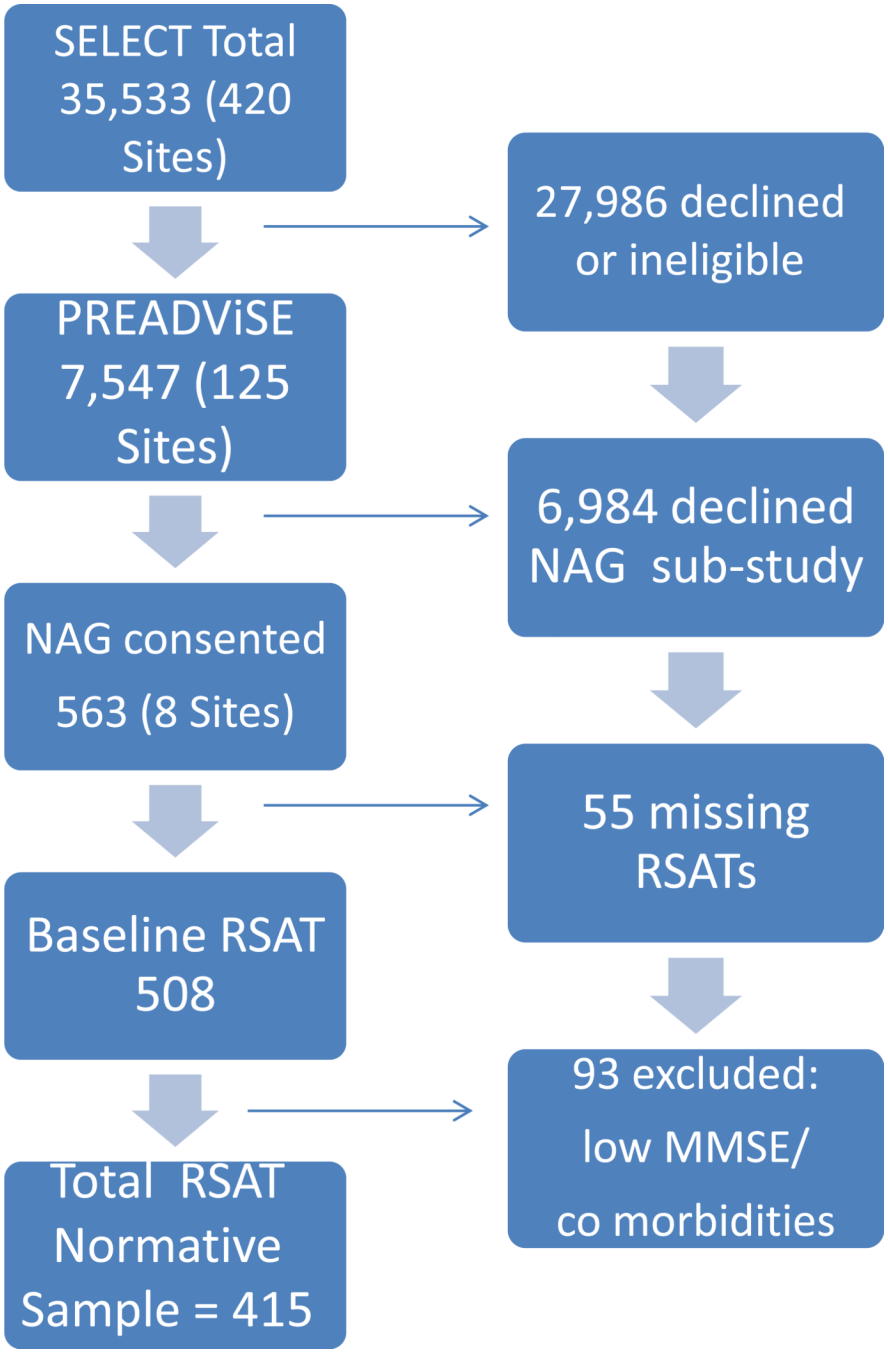

Figure 1.
Flow diagram of RSAT sample

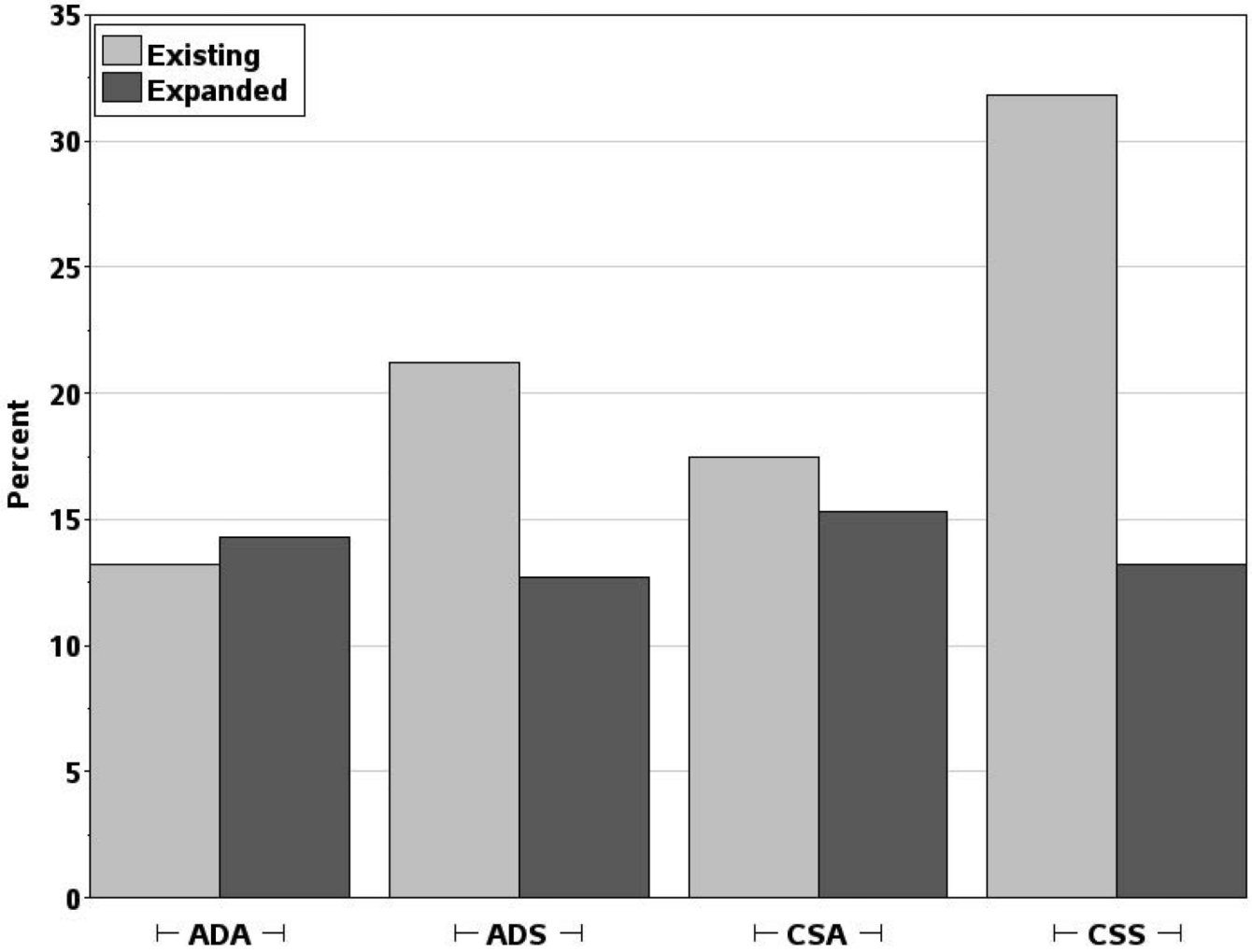

Figure 2.
Percent classified as impaired by existing and age-expanded normative data
ADA=Automatic Detection Accuracy, ADS=Automatic Detection Speed, CSA=Controlled Search Accuracy, CSS=Controlled Search Speed

Table 1

Demographic characteristics of the normative sample

	Total Sample	**Age Ranges**			
	60–90	60–70	65–75	70–80	75–90
N	415	263	267	174	80
Midpoint Age	75	65	70	75	82.5
Mean Age	69.6±5.6	66.1±2.7	69.3±3.0	73.6±3.2	78.5±3.4
Education (n)					
High School or less	78	52	46	32	15
Some College	113	67	76	51	20
College or more	224	144	145	91	45
Race/Ethnicity (n)					
African-American	106	68	57	41	18
Hispanic	10	5	7	7	1
Caucasian	284	182	191	119	57
Other/Unknown	15	8	12	7	4

Table 2

ANCOVA results

Endpoint	Variable	df	F	p	Semipartial ω^2(95% CI)
ADS-T	Age	1	47.66	<0.0001	0.098 (0.0052–0.16)
	Education	2	9.25	0.0001	0.035 (0.0088–0.079)
ADA-T	Age	1	0.18	0.67	0.00 (0.00–0.013)
	Education	2	3.49	0.031	0.02 (0.00–0.05)
CSS-T	Age	1	33.19	<0.0001	0.071 (0.033–0.13)
	Education	2	2.99	0.0511	0.0089 (0.0000-0.040)
CSA-T	Age	1	0.21	0.65	0.00 (0.00–0.01)
	Education	2	0.69	0.50	0.00 (0.00–0.02)

ADS-T = Automatic Detection Speed T-score; ADA-T = Automatic Detection Accuracy T-score;

CSS-T = Controlled Search Speed T-score; CSA = Controlled Search Accuracy T-score