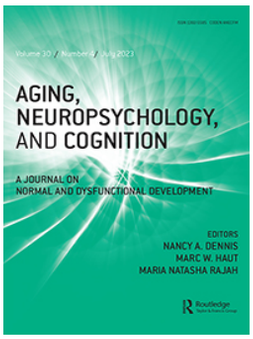

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Age-based stereotype threat and neuropsychological performance in older adults

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ABSTRACT

The current study investigated the effects of age-based stereotype threat on neuropsychological assessment outcomes in an older adult population. Community volunteers (n = 49) age 65 and older were screened for cognitive impairment, depression, and anticholinergic medication use. Screened individuals were randomly stratified into either an ABST or a Control group. All participants were administered a broad range of neuropsychological measures of cognition as well as a self-rating measure assessing subjective concern about cognitive ability. A main effect of ABST on subjective concern about cognitive ability was supported. Specifically, individuals in the ABST group were significantly more likely to attribute their memory errors to the onset of dementia ($F(1,41) = 5.334$, $p = .026$). However, results showed no significant difference between groups on objective neuropsychological performance measures. The current study discusses the importance of considering ABST effects in the context of neuropsychological assessment in older adult populations.

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Aging; stereotype threat; cognition; older adults; neuropsychological assessment; subjective cognitive concern

Age-based Stereotype Threat Exposure in Older Adults. As the population of older adults grows, negative perceptions of aging continue to inundate society, leading to increased ageism and age-based stereotype threat (ABST) exposure in older adults. Negative aging stereotypes are often culturally ingrained, and research demonstrates that older adults are consistently exposed to aging bias and age-based stereotype threat in daily living (Abrams et al., 2011; Levy & Banaji, 2002; Nelson, 2002). In addition, more recent research suggests negative aging stereotypes may be especially prevalent and impactful in neuropsychological assessment settings (Ben-David et al., 2018).

Definitionally, ABST occurs when negative stereotypes regarding older adult's competence result in their underperformance on physical and cognitive tasks (Lamont et al., 2015). Research suggests that eliciting ABST, through even subtle reminders of negative stereotypic aging expectations (i.e., cognitive and physical decline) can lead to cognitive and physical performance decrements (Armstrong et al., 2017; Shewach et al., 2019). In

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addition, exposure to negative aging stereotypes is shown to have far reaching health implications including increased stress and anxiety, decreased self-efficacy, and the initiation of physiological and biological changes in the brain consistent with the atrophy described in neurodegenerative disease (Levy et al., 2016).

As common age-based stereotypes include negative beliefs regarding cognitive functioning, understanding the impact ABST has on older adult's performance on cognitive tests used in clinical contexts is important for accurate evaluation, diagnosis, and treatment of neurocognitive disorders (Parker et al., 2020). This is especially pertinent in this day and age, given the substantial media attention on Alzheimer's disease and dementia, which continues to flood society. Even just engaging in negative, emotionally arousing social media has been shown to reduce dorsolateral prefrontal cortex activation and decrease performance on cognitive tasks (Tashjian & Galván, 2020). Thus, while public education of AD is imperative, the effect of ABST in age-related media on older adults' objective and subjective cognition is important to assess.

Age-based stereotype threat and neuropsychological performance in older adults

As context, age-based stereotype threat (ABST) is a subcategory of stereotype threat (ST) more generally, wherein exposure to stereotypes reduces the performance of members in the stereotyped group (Steele, 1997). While substantial research supports the significant effect of stereotype threat on performance in the context of ethnic, racial, and gender stereotypes (Aronson et al., 2002; Aronson et al., 1999) relatively limited research exists investigating the effects of aging stereotypes on performance in older adults.

In studies that do look at age-based stereotype threat in older adults, results demonstrate that ABST reduces performance on cognitive tasks (Hess et al., 2009). Most commonly, age-based stereotypes of cognitive aging include negative expectations of cognitive decline, especially expectations of poor memory ability (Fiske et al., 2002; Lamont et al., 2015). Yet, while most studies look at the effect of ABST on memory performance, limited evidence suggests ABST may also impact cognition more globally (Barber, 2017). Two known studies showed individuals in an age-based stereotype threat condition performed below cutoffs on a screening measure for dementia (Haslam et al., 2012; Mazerolle et al., 2016) while a third study showed decreases in screening scores that were not below normative measures (Barber et al., 2015).

However, while these results demonstrate how powerful the effect of ABST on cognitive performance may be, they do not provide evidence of ABST effects in the context of neuropsychological assessment. A study by Fresson et al. (2017), is the only published study that has looked at age-based stereotype threat in the context of cognitive performance on specific, clinically relevant, neuropsychological measures. They further looked at whether dementia worry moderated the role of age-based stereotype threat on clinical cognitive performance. Based on the cognitive domains mostly affected in AD, specific cognitive performance domains measured were memory, attention, and executive function. While they found no effect of stereotype threat on memory, attention, or subjective complaint measures, cognitively intact people with moderate-to-high dementia worry scored at pathological levels on executive measures.

The relationship between cognitive aging stereotypes and cognitive performance on neuropsychological measures across cognitive domains is important to consider given the frequent reliance of clinical decisions on such measures, especially in the context of neuropsychological assessment in older adults. Indeed, the majority of older adults who present for neuropsychological assessment do so because of concern regarding their cognitive abilities. The neuropsychologist is often tasked with determining whether these concerns are objective in nature. Indeed, neuropsychological assessment, which picks up on the subtle cognitive deficits that arise in AD prior to the emergence of clinical symptoms, is key in the evaluation of prodromal signs of age-related decline. As stated in the DSM-5, "Neuropsychological testing, with performance compared with norms appropriate to the patient's age, educational attainment, and cultural background, is part of the standard evaluation of NCDs and is particularly critical in the evaluation of mild NCD" (American Psychiatric Association, 2013, p. 607). Early identification of cognitive impairment is beneficial in that it allows for targeted interventions, increases patient time for cogent decision making, and aids dementia research. However, inaccurate interpretation of cognitive performance scores may have a number of adverse consequences including misdiagnosis of cognitive impairment.

The potential misdiagnosis of mNCD and Alzheimer's disease in older adults raises further concerns related to iatrogenic progression of disease pathology as negative expectations elicited by diagnosis could have detrimental effects on older adults (Régner et al., 2016). In fact, there is evidence that people who are knowingly diagnosed with dementia become worried to an extent that results in low self-esteem, self-stigmatization, and impaired quality of life (Cutler & Hodgson, 2013).

Age-based stereotype threat and cognitive performance

In summary, despite the far-reaching implications of ABST on older adult's cognitive performance, relatively few studies have looked at the relevance of ABST on older adult's performance on clinically relevant neuropsychological measures. As scores on neuropsychological measures are used to make dementia-related diagnostic decisions, understanding the effects of age-based stereotype on neuropsychological measures relevant to the assessment of older adults is fundamental for the accurate evaluation of cognitive performance in this vulnerable, growing population.

Furthermore, given that attention, executive function, processing speed, and memory performance are all indicative of mNCD and Alzheimer's disease disposition, it is essential that the effects of ABST on these domains is understood. The current study uses a novel ABST exposure paradigm that aims to reproduce public media representations of Alzheimer's disease and investigates how this exposure impacts older adult's cognitive performance on clinically relevant neuropsychological tests of memory, attention, executive function, and processing speed (Rabin et al., 2016).

Methods

Participants

Participants were recruited through an advertisement posted in a local community newspaper in the Northwest region of the United States. The participants were at least 65 years old. Participants were initially screened over the phone using the Telephone Interview for Cognitive Status (TICS) and excluded if they scored below 28, representing possible cognitive impairment. Participants were additionally screened in-person using a Demographic and Health Questionnaire (DHQ) and the Patient Health Questionnaire-8 (PHQ-8). Participants were excluded if they indicated current neurological disorder, scored 3 or higher on anticholinergic medication burden, or scored in the moderate-severe range of depression (10 or higher on the PHQ-8). Participation in this study was voluntary. All participants received ten dollars for their participation in the study.

After completing the DHQ, PHQ-8, and reading the experimental or control condition paragraph, all participants were administered a series of neuropsychological measures and self-report questionnaires. A total of 49 subjects participated in the research. Six participants were excluded from study analyses after failing to meet inclusion criteria on the anticholinergic burden scale or depression measure.

Materials

Demographic and health questionnaire

The demographic and health questionnaire was used to obtain participant information including age, gender, ethnicity, years of education, psychiatric and neurological history, and behavioral health habits.

Patient health questionnaire-8

The Patient Health Questionnaire-8 was used as a measure of depression. It is deemed a valid indicator of depressive symptoms. Participants with scores of 10 or higher, which is indicative of moderate or high levels of depressive symptoms, were excluded from this study. The PHQ-9 has a specificity of 88% and a sensitivity of 88% for major depression (Kroenke et al., 2001). The PHQ-8 includes all PHQ-9 items with the exception of an item regarding suicidal ideation (Kroenke et al., 2009). The PHQ-8 was administered to participants during the in-person screening evaluation.

Telephone interview for cognitive status

The Telephone Interview for Cognitive Status (TICS) is one of the most widely used cognitive screening measures in medium-large scale epidemiological studies and is believed to reliably distinguish between normal cognition, mild cognitive impairment, and dementia (Knopman et al., 2010). The TICS took less than 10 minutes to complete and was administered over the phone prior to participant scheduling. Those who scored under 28 were excluded from the

study. The TICS is highly correlated with the Mini-mental Status Exam ($r = .94$, $p < .001$) and has been found to have excellent sensitivity (94%) and specificity (100%) in differentiating normal elderly and those with Alzheimer's disease (Fong et al., 2009).

Anticholinergic burden scale

Medications with anticholinergic properties have been found to impact cognition in non-demented older adults (Risacher et al., 2016). The anticholinergic burden (ACB) scale was developed to assess the additive effects of specific drugs implicated in decreasing cognitive ability in older adults. Drugs listed on the scale are given a number between 1 and 3 depending on their cognitive impact with 1 being low and 3 being high. A total ACB score of 3 or more is considered clinically relevant. Participants who had an ACB score of 3 or higher were excluded from study analyses.

Experimental and control conditions

The age-based stereotype threat exposure used in the current study was designed to realistically represent common, ecologically relevant aging stereotypes while also providing a poignant and robust stereotype threat induction. The age-based stereotype threat condition for cognitive performance was developed in relation to meta-analytic data indicating the most salient forms of stereotype threat exposure (Lamont et al., 2015). The experimental condition was presented as a half page, large font, double spaced excerpt from a pseudo-journal on aging and incorporated explicit, fact-based stereotypes (i.e., "Many older adults will go on to develop Alzheimer's disease or other forms of dementia"), and implicit, ambiguous stereotypes(i.e., "as we age, our bodies and minds change") pertaining to aging. Multiple, different types of age-based stereotypes were utilized to increase the salience of the condition and to increase the likelihood of finding a true positive experimental effect. Further, experimental condition content was directly adapted from information provided on the National Institute of Aging website in order to ensure ecological validity. The control condition was a pseudo-journal article on ornithology of similar length and difficulty. Both conditions required participants to answer True/False questions about what they had read in order to enhance their attendance to the content presented. All participants were exposed to the same research conditions with the single exception of the pseudo-article condition they were randomly selected into.

Neuropsychological measures

Neuropsychological measures were determined based upon their common use in neuropsychological practice and their validity in assessing for memory, executive function, processing speed, and attention performance. According to a study evaluating test usage practices among clinical neuropsychologists, the Wechsler Adult Intelligence Scale (WAIS), the Trail Making Test (TMT), and the California Verbal Learning Test (CVLT) are three of the five most commonly used tests in neuropsychology. Further, in older adults specifically, the study

determined that commonly used and well-normed tests of executive function, attention, processing speed, and memory included the DKEFS Stroop, Trail Making Test, WAIS-IV Digit Span, and Coding subtests, and the California Verbal Learning Test (Rabin et al., 2016).

Neuropsychological measures of memory

California verbal learning test II

The California Verbal Learning Test II (CVLT-II) measures immediate and delayed recall of a list of 16 words read out loud a total of five times (CVLT-II, r = .94). Total words on immediate (0–80) and delayed recall (0–16) measures were used to assess general memory function. Total scores on immediate and delayed recall have been shown to have 87.6% and 86.5% respective accuracy in predicting the presence of mild cognitive impairment (CVLT-II; Delis et al., 2000; Lezak et al., 2012).

Neuropsychological measures of executive function

DKEFS Stroop

The DKEFS Stroop test was used as an outcome measure of executive function (r = .93). DKEFS Stroop appears specifically relevant to the executive function ability to resist or resolve interference from irrelevant information in the external environment. The DKEFS Stroop task assesses one's ability to inhibit an automatic response over a controlled response (Kane & Engle, 2003). DKEFS Stroop is timed and participants are given 45 seconds to read as many words, as fast as they can, in each of four different tasks. Each task varies in terms of demand with the first set pure word reading, the second pure color, the third color-word reading, and the fourth alternating color-word and word reading. Scores on color-word/word reading (trial 3) were used in the analysis of executive function (Stroop, 1935).

Trails B

Trail Making Test (TMT) Part B tests executive function by requiring subjects to plan and execute a drawing task while utilizing working memory to maintain appropriate task instructions (r = .55). Participants are given instructions to draw a line connecting alternating, sequential numbers and letters, as fast as they can. TMT B raw times, in seconds, were used for analysis of executive function (TMT; Reitan, 1992).

Neuropsychological measures of attention

Trails A

The Trail Making Test (TMT) A test asks participants to draw a line connecting a page of mixed-up numbers in sequential order from 1 to 25. TMT A raw times, in seconds, were used for analysis of attention (r = .74). Given the foundational importance of attention in other cognitive systems, understanding the effects of age-related expectations on

attention has significant potential to shape targeted interventions aimed at reducing the consequences of stereotype threat. Both TMT A and TMT B are shown to be sensitive to the progressive decline of dementia (TMT; Lezak et al., 2012; Reitan, 1992)

Wechsler adult intelligence Scale IV, digit span

The entire Wechsler Adult Intelligence Scale IV is a test of intelligence. Digit span (DS) is a subtest of the WAIS-IV, which measures attention. DS has three trials wherein participants are asked to repeat a list of numbers read aloud to them by the examiner verbatim, backward, and in sequential order. Total raw scores from all trials (0–27) were used for analysis of attention (WAIS-IV; Wechsler, 2008a, 2008b).

Neuropsychological measures of processing speed

Wechsler adult intelligence Scale IV, coding

Coding is a subtest of the WAIS-IV, which measures processing speed. Coding requires participants to translate numbers to symbols using a key and to complete as many translations as possible within 2 min. The total number of correct translations were used in the analysis of processing speed (WAIS-IV; Wechsler, 2008a, 2008b).

Wechsler adult intelligence Scale IV, symbol search

Symbol Search is a subtest of the WAIS-IV, which additionally measures processing speed. It requires subjects to scan multiple series' of symbols and identify whether or not each series has a symbol, which does or does not match a given target symbol. Participants are given 2 min to complete as many symbol searches as they can. The total number of correct symbol searches was used in the analysis of processing speed (WAIS-IV; Wechsler, 2008a, 2008b).

Manipulation check questionnaire

A manipulation check questionnaire was used to check participants' understanding of the age-based stereotype threat exposure instructions. The manipulation check asked participants a dichotomous yes or no question about whether they understood the statements they read prior to testing. Participants were also being asked to rank how much effort they put into the tasks, the perceived difficulty of the tasks, how much pressure they felt during the testing, and their perception of their performance on the tasks using a 9-point Likert scale adapted from (Suhr & Gunstad, 2002).

Dementia worry scale

The Dementia Worry Scale (Suhr & Isgrigg, 2011) is a validated measure assessing the construct of "dementia worry." Participants were asked to respond to 13 statements related to worrying about dementia and to indicate on a Likert scale ranging from 1 to 5 how typical of themselves each statement was ("not at all typical" of them = 1 to "very

typical" of them = 5). Items on the DWS include statements such as "I find it difficult to control my worries about developing dementia" and "When I forget a word that I want to say, my thoughts immediately turn to dementia."

Procedure

Study approval was obtained from the Montana Institutional Review Board prior to participant recruitment. Following recruitment, participants were screened over the phone using the TICS (a cognitive screening tool) and then scheduled for the in-person portion of the study. In-person, participants completed an additional screening evaluation that asked them to list their medications (for later scoring using the ACB scale, an assessment of potential medication-based reductions in cognition) and to complete the PHQ-8 (a measure of depression). Participants were excluded if they had a TICS score under 28, a PHQ-8 score greater than 10, or an ACB score of 3 or higher.

Prior to participants entering the clinic, the primary researcher created packets that contained the informed consent, demographic and health questionnaire, and either the control or experimental tasks. Packets were labeled according to age and gender and randomly mixed. Each new participant scheduled received a packet according to their associated age and gender label. In this way, the primary researcher and the trained research assistants who administered the study were blind to participant condition.

Participants completed the study in a designated assessment room within a university-based clinical psychology center. At the onset of the study, participants were provided with the introductory packet, which included the informed consent form, indicating the nature and potential risks of the study. Participants were informed that they could voluntarily withdraw from the study at any time, without penalty. Assessment was conducted by the researcher and by trained research assistants. Scoring was performed by trained research assistants who had no involvement in instruction packaging nor who had administered the tests they scored. Following control or experimental task completion, cognitive tests were administered in semi-randomized order to each participant. All participants began testing with the CVLT-II immediate recall task. All other tests were administered in randomized order within the 20 minute CVLT-II delay period. If participants did not complete all other tests within the 20 minute delay they were administered following the CVLT-II delayed recall task. At the conclusion of testing, participants completed the dementia worry scale and a manipulation check. Administration of these measures was followed by debriefing.

Data analysis

Cognitive performance was evaluated using raw scores on each measure within each cognitive domain. Each cognitive domain was constructed of two dependent variable measures. Data was analyzed using separate between groups MANOVAs on each cognitive domain with the group status (experimental or control) as the between groups measure. The construct of Memory was measured using total word scores on immediate and delayed CVLT II recall, attention was constructed using total seconds scores of TMT A and total number scores of WAIS-IV Digit Span, Processing Speed was constructed using total correct scores from WAIS-IV Coding and Symbol Search, and Executive Function was

constructed using Trial 3 scores from DKEFS Stroop and total seconds scores from TMT B. A separate one-way ANOVA was used to assess whether significant differences existed between groups education.

Overall, the following sample means and sample mean vectors were compared:

(1) Control and experimental sample mean vectors of scores on Memory measures (Immediate and Delayed CVLT-II raw word scores).
(2) Control and experimental sample mean vectors of scores on Attention measures (TMT A and WAIS-IV Digit Span time and total raw scores).
(3) Control and experimental sample mean vectors of scores on Executive Function measures (TMT B and DKEFS Stroop time and interference score).
(4) Control and experimental sample means of scores on Processing Speed measures (WAIS-IV Coding and Symbol Search total correct scores).

Results

Power

An a priori power MANOVA analysis using G Power statistical software indicated that a sample size of 42 total participants would be needed for sufficient power (1-beta = .95) to detect an expected moderate effect size (d = .3). The effect size was conservatively determined based on existing literature demonstrating moderate to large stereotype threat effect sizes. Forty-three participants were included in the analyses.

Demographic Information

Demographic information is provided in Table 1. A total of 49 subjects completed the neuropsychological measures and questionnaires. Of these, five were excluded on the basis of depression, as measured by the PHQ-8 cutoff of 10 or higher, and one was excluded on the basis of anticholinergic burden, as measured by an ACB scale score of 3 or higher. Forty-three participants were therefore included in the analyses.

Of these participants 14 (33%) were male and 29 (67%) were female. Forty-two participants identified as Caucasian (97.7%) while 1 (2.3%) identified as Asian. Participants ranged in age from 67 to 89. Nine (20.9%) participants were 65–70, 11 (25.6%) were 71–75, 12 (27.9%) were 76–80, 10 (23.3%) were 81–85, and 1 (0.02%) was 89. The mean number of completed years of education was 17.65 with a standard deviation of 2.47. The chi-square analysis for gender revealed no significant differences between the two groups, $\chi 2$ (1, $N = 43$) = 0.011, $p > .05$. Group differences for age and education were analyzed using two separate one-way ANOVAs. There was no significant difference found for Age, F(1,

Table 1. Demographic Characteristics of the Study Groups.

Variable	Control Group (N = 21)	ABST Group (N = 22)	Significance
Age	M = 75.38 (SD = 5.54)	M = 76.41 (SD = 6.18)	p = .569
Raw Education	M = 18.14 (SD = 2.15)	M = 17.18 (SD = 2.70)	p = .918
Male	Percent = 33.3%	Percent = 31.8%	p = .206

41) = 0.329, $p > .05$ or Education, $F(1, 41) = 1.655$, $p > .05$. No participants included in the analyses reported a current psychiatric illness, neurological illness, or substance use issue.

Performance on neuropsychological measures

Memory. Performance on the cognitive domain of Memory was analyzed using total scores on the CVLTII immediate and delayed recall. Table 2 shows the means and standard deviations for immediate and delayed recall scores in ABST and Control groups. MANOVA was used to analyze group differences in Memory using CVLTII immediate and delayed recall scores as dependent variables and group condition as the between groups measure. Individuals in the ABST condition did not perform significantly differently than individuals in the Control condition on Memory, $F(1, 41) = .109$, $p > .05$ (*Partial Eta Squared = .005*; Table 3).

Attention. Performance on the cognitive domain of Attention was analyzed using total score on WAIS-IV Digit Span and total seconds on Trail Making Test Part A. Table 2 shows means and standard deviations for total DS and TMTA seconds scores in ABST and Control groups. MANOVA was used to analyze group differences in Attention using total DS and total TMTA seconds scores as dependent variables and group condition as the between groups measure. Individuals in the ABST condition did not perform significantly differently than individuals in the Control condition on Attention, $F(1, 41) = .973$, $p > .05$ (*Partial Eta Squared = .046*; Table 3).

Executive Function. Performance on the cognitive domain of Executive Function was analyzed using total seconds on TMTB and total seconds on the inhibition trial (trial 3) of DKEFS Stroop. Table 2 shows the means and standard deviations for total TMTB and DKEFS Stroop Trial 3 seconds scores in ABST and Control groups. MANOVA was used to analyze group differences in Executive Function using TMTB and DKEFS Stroop Trial

Table 2. Means and Standard Deviations of Neuropsychological Measures by Condition.

Neuropsychological Domain	Control Group (N = 21)	ABST Group (N = 22)	p value (Cohen's d)
Memory	M (SD)	M (SD)	
CVLT II Immediate Recall	47.00 (10.36)	46.86 (12.80)	0.910 (0.012)
CVLT II Delayed Recall	9.70 (3.11)	9.41 (3.46)	0.879 (0.088)
Attention			
Trails A	29.60 (6.69)	34.55 (12.86)	0.217 (0.25)
Digit Span Total	28.25 (5.89)	26.18 (5.48)	0.285 (0.18)
Executive Function			
Trails B	83.05 (36.06)	86.05 (29.20)	0.755 (0.44)
DKEFS Trial 3	63.45 (19.33)	67.95 (14.05)	0.471 (0.13)
Processing Speed			
WAIS IV Coding	62.95 (12.61)	54.50 (14.11)	0.054 (0.63)
WAIS IV Symbol Search	27.00 (6.18)	25.27 (8.62)	0.418 (0.23)

CVLT II = California Verbal Learning Test II, WAIS IV = Wechsler Adult Intelligence Scale-IV.

Table 3. MANOVA Results.

Neuropsychological Domain	*df1*	*df2*	*F*	η^2	*p*
Memory	1	41	0.109	0.005	0.897
Attention	1	41	0.973	0.046	0.387
Executive Function	1	41	0.274	0.014	0.761
Processing Speed	1	41	2.055	0.093	0.141

3 seconds scores as dependent variables and group condition as the between groups measure. Individuals in the ABST condition did not perform significantly differently than individuals in the Control condition on Executive Function, $F(1, 41) = .274$, $p > .05$ (*Partial Eta Squared = .014*; Table 3).

Processing Speed. Performance on the cognitive domain of Processing Speed was analyzed using total seconds on WAIS-IV Coding and Symbol Search subtests. Table 2 shows the means and standard deviations for total WAIS-IV Coding and Symbol Search seconds scores in ABST and Control groups. MANOVA was used to analyze group differences in Processing Speed using Coding and Symbol Search seconds scores as dependent variables and group condition as the between groups measure. Individuals in the ABST condition did not perform significantly differently than individuals in the Control condition on Processing Speed, $F(1, 41) = 2.055$, $p > .05$ (*Partial Eta Squared = .093*; Table 3).

Ratings on the manipulation check questionnaire

Independent sample t-tests were used to analyze whether or not group conditions differed on self-report measures of how hard participants tried during testing, how difficult they found the tests, how much pressure they felt during the testing, and how confident they were in their testing performance. Participants in the ABST group did not differ significantly from participants in the Control group with regards to how much self-rated effort they put into taking the tests, $t(43) = 1.606$, $p > .05$, how difficult they found the tests, $t(43) = -0.09$, $p > .05$, how much more pressure they felt during the testing, $t(43) = -0.901$, $p > .05$, or how confident they were in their performance, $t(43) = 1.202$, $p > .05$ (Table 4). All participants indicated they understood the instructions given at the beginning of the study.

Ratings on the dementia worry scale

Independent sample t tests were used to evaluate group differences on self-rated dementia worry at item-specific levels. Participants in the ABST group differed from those in the control group in regards to the following question: "When I find myself making a mistake with my memory, I tend to think of having dementia as the cause." Specifically, those in the ABST group were significantly more likely to attribute their memory mistakes to having dementia ($F(1,41) = 5.334$, $p = .026$; Table 5).

Table 4. Posttest Ratings on the Manipulation Check Questionnaire by Group Condition.

Self-Report Ratings	Control Group (N = 21) M (SD)	ABST Group (N = 22) M (SD)	p value (Cohen's d)
Effort	12.10 (2.49)	10.95 (1.94)	0.116 (0.47)
Difficulty	6.31 (1.86)	6.36 (2.08)	0.929 (0.03)
Pressure	4.38 (2.54)	5.14 (2.93)	0.373 (0.28)
Confidence	6.17 (1.20)	5.64 (1.65)	0.236 (0.37)

*All ratings are scaled with higher values representative of higher levels of effort put forth on testing, higher levels of perceived test difficulty, higher pressure felt during testing, and higher confidence in testing performance

Table 5. ABST Exposure is Related to Internal Attribution of Memory Errors.

Dementia Worry Item Measure	*df1*	*df2*	*F*	*P value*
"When I find myself making a mistake with my memory, I tend to think of having dementia as the cause"	1	41	5.334	0.026

Discussion

Results suggest that exposure to age-based stereotypes does not significantly reduce cognitive performance on neuropsychological tests used to assess memory, attention, processing speed, and executive function in older adults. However, results do suggest that older adults who are exposed to ABST may be more likely to rate their subjective memory mistakes as causally linked to dementia. Results indicate that while brief ABST exposure in older adults may not significantly affect objective performance scores on neuropsychological tests, it may lead to an increase in older adults' subjective concern about having dementia.

Of note, results are inconsistent with previous study findings in the ABST literature by (Barber et al., 2015; Haslam et al., 2012), and (Mazerolle et al., 2016), all of which showed reductions in cognitive performance on dementia screening tests after various ABST inductions. This difference in findings from the current study may indicate that neuropsychological tests, which aim to measure precise cognitive constructs, are more robust to ABST than global screening measures.

It is also possible that the current study results differed from previous research results due to important study design factors. Indeed, in each of the four known previous studies of ABST effects on cognitive performance, researchers used different types of exposures and outcome measures. Furthermore, certain authors found that the effects of ABST on cognitive performance were dependent on other related factors (Fresson et al., 2017; Haslam et al., 2012).

In the first related study, Haslam et al. showed that 70% of the older adults who expected declines in memory and self-categorized as "older" performed below predementia cutoffs on the Addenbrookes Cognitive Examination-Revised (ACE-R). A key difference between the current study and the Haslam et al. study; however, is that experimenters assessed participant expectations regarding cognitive decline in addition to exposing them to self-categorization based ABST. Thus, those that performed worse were expecting to do so.

Literature suggests that negative expectations in and of themselves may decrease performance and increase threat salience (Suhr & Gunstad, 2002). Thus, it may be conjectured that, while ABST may increase negative expectations, the expectations themselves may be what impact cognitive performance. In future studies, assessing participant's expectations of performance prior to test administration and ABST induction, as well as after ABST induction, is recommended to determine whether a negative change in performance expectations moderates the effect of ABST on cognitive performance.

In the second related study, Barber et al. showed that participants in their ABST condition performed significantly lower on the ACE-R than participants in their positive control group. However, this effect did not change the proportion of participants who met diagnostic criteria for predementia. In contrast to the current study, Barber et al. used

a threat condition and a reduced threat condition but did not include a true control condition. This may have increased the difference in performance scores between threat and reduced threat conditions more so than in the current study.

In the third relevant study, Mazerolle et al. looked at how ABST affects the Mini-Mental Status Exam (MMSE) and Montreal Cognitive Assessment (MoCA) screening measures for dementia. Results from their study showed that ABST significantly lowered performance on both measures, resulting in 40% of ABST group participants meeting screening criteria for predementia in comparison to 10% of control participants. Such inconsistent results may be related to the difference in education level between the Mazerolle et al. study population and the current study population. Indeed, the current study population had an average education level of 17 years while the average education level of participants in the Mazerolle et al. study was 8 years. While higher education is thought to increase stereotype threat saliency, it may be that more highly educated people experience greater chronic ABST relative to those with lower levels of education (Hess et al., 2009).

While not studied, chronic ABST could be described as the long-term exposure of older adults to culturally embedded stereotypes of aging. Those with higher education would likely have greater chronic ABST exposure due to their potentially higher levels of media consumption on topics related to aging and dementia. Additionally, more highly educated individuals may experience more susceptibility to ABST due to their higher presumed use of cognition in occupational and other settings. Indeed, if more highly educated individuals rely on cognition in work settings more than less educated individuals, a minor decrease in cognitive ability may be of greater actual and perceived threat to their livelihood. In this way, sociocultural ABSTs, elicited both externally and internally, may have desensitized the current study population to the brief, experimental ABST exposure. Relatedly, current study results could suggest that chronic, cultural ABST is salient enough that brief exposure to ABST in a laboratory setting is insignificant as an experimental condition in this population. In order to examine the contribution of culturally embedded ABST on older adults neuropsychological performance, future research should work to develop a measure of ABST to use to test ABST levels across conditions.

Taking all of this in account, if certain older adults are, as we suggest, highly exposed to ABST within the American culture, it may be pertinent to investigate how long-term ABST exposure impacts cognition longitudinally. Further, it may be especially interesting to know how long-term ABST exposure specifically impacts other non-neurological variables such as worry, anxiety, distractibility, and confidence; as these variables may have significant downstream effects on cognition and performance in the context of neuropsychological assessment.

In the executive interference model, these worry-related factors are thought to decrease working memory capacity, thereby decreasing executive control and performance on executive function measures. Many general ST studies have supported this model and a couple studies of ABST support this model as well. For instance, Mazerolle et al. showed that the executive function subtests on the Mini-mental Status Exam (MMSE) and the Montreal Cognitive Assessment (MoCA) were the most significantly affected by ABST. Additionally, Fresson, Dardenne, Geurten, and Meulemans, showed that ABST specifically reduced performance on the DKEFS Stroop executive function measure in participants high in dementia worry.

Our study result demonstrating that ABST exposure increased internal attribution of memory mistakes to dementia could suggest that ABST paves the path toward increased subjective cognitive worries. As subjective cognitive concern in and of itself can reduce objective cognitive performance, this is important to consider. It may be that as ABST exposed older adults go through normal aging, and experience a normal increase in memory errors, their emotional reaction toward these errors may contribute to objective cognitive impairments later on.

Interestingly, it is not far-fetched to imagine that psychological variables, such as subjective cognitive worry serves to mechanize ABST effects. In fact, one theory of stereotype threat mechanisms suggests thought suppression, physiological arousal, and cognitive monitoring – all features of worry – work to decrease cognitive performance in individuals exposed to such threats (Johns et al., 2008). In the literature, this mechanism is specifically referred to as the "executive interference" model of stereotype threat.

In clinical neuropsychology practice, this type of subjective cognitive worry in otherwise cognitively healthy individuals is referred to as the "worried well" phenomenon. While the "worried well" are often believed to have no neurological problems, research supports that those who are "worried well" may genuinely suffer cognitive, affective, and physiological consequences of such worrying, which could lead to impairments in cognitive performance (Fornazzari & Fischer, 2022). Overall, this potential process of ABST leading to downstream psychological factors, which then affect neuropsychological performance is an important area for future study.

Limitations

Limitations of this study include selection bias, confounding, and condition salience. Due to the voluntary nature of this study and the use of newspaper recruitment, selection bias may have occurred. Though study participants were equally represented in age, gender, and education across groups, the sample overall included more women, more Caucasians, and more highly educated individuals than the national average. Importantly, given the known impacts of race-based and gender-based stereotype threat, future studies are recommended to assess whether or not such factors compound age-based stereotype threat in the assessment of cognition in older adults.

This study also had a potential for confounding in that participation in the study required older adults to engage in neuropsychological assessment, which may have exposed control participants to inherent, self-imposed age-based stereotype threat. Often, older adults coming in for testing are worried about their cognition and have negative expectations pertaining to their performance already. Indeed, observations noted during the course of the study indicated that many individuals who participated expressed concern about their memory during testing, independent of group condition (e.g., "I am not good with memory," "I'm not going to be able to remember, I'm too old").

Another potential limitation in this study was exposure saliency. In trying to balance the realistic nature of the ABST exposure so as to allow culturally relevant research results, the exposure may not have been at a high enough dose for effects to be captured experimentally.

Indeed, given the prevalence of media attention on Alzheimer's disease and cognitive aging, as well as the high average education level of study participants, this exposure may not have been salient above and beyond what participants are exposed to in daily life.

An overarching limitation in this study, which applies to stereotype threat research more generally, is that our sample size may have been too small to capture the ABST effect. While an a priori power MANOVA analysis was used in order to determine the sample size, this was based on a moderate (d = .30) effect size in accordance with the reported ABST literature, which reports ST effect sizes around .42. However, according to a meta-analysis of ABST research, if unpublished research on ABST is included in the overall effect size calculation, the reported size is reduced from .42 to .28. In addition, the effect size can vary significantly depending on the type of stereotype threat manipulation used, with stereotype-based manipulations estimated to have a .52 effect size and fact-based manipulations estimated to have a .09 effect size (Lamont et al., 2015). Of note, the largest meta-analysis of stereotype threat to date found that publication bias exists in the stereotype threat literature, and they "believe the largest cause of publication bias is null-result suppression in the form of failure to publish nonsignificant findings" (Shewach et al., 2019). In light of this, and in accordance with our own study findings, it is recommended that future studies be designed in accordance with lower effect size estimations and include larger sample sizes to account for known publication bias in the field.

Conclusions

The current study examined how exposure to age-related stereotypes impacts cognitive performance on neuropsychological measures in an older adult population. The findings of this study suggest that brief ABST exposure on its own does not significantly reduce cognitive performance on measures of memory, attention, executive function, or processing speed. Authors suspect the lack of significant findings may reflect the high level of cultural exposure to ABST and age-related information in the study population overall. Results demonstrating an increase in the internal attribution of memory errors to dementia following ABST exposure suggest that while ABST may not immediately result in decreased objective performance scores, it may lead to an increase in dementia worry factors. The authors posit that downstream effects of chronic ABST exposure, such as increased aspects of dementia worry, may significantly impact older adult's cognitive performance abilities over time; however, this deserves future study.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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