Overcoming Age-Based Stereotypes to Optimise Cognitive Performance in Older Adults: A Systematic Review of Methodology and Existing Evidence

Abstract

Background and Objectives: Age-based stereotype threat (ABST) poses serious risks for the cognitive screening of older adults. This review aimed to identify and critically appraise the methodology and existing evidence of studies investigating the use of threat-removal (TR) strategies to overcome the effects of ABST on the cognitive performance of older adults. The types of strategies, their effectiveness in optimising cognitive performance, and factors influencing their effectiveness were examined.

Research Design and Methods: A systematic review was conducted following PRISMA guidelines. PsycINFO, PubMed, Embase, Web of Science, and Scopus were searched from 1st January 1995 to 6th November 2019. Two authors independently assessed article eligibility and appraised methodological quality of eligible articles using an adaptation of the STROBE guidelines. Narrative synthesis was used to summarise results.

Results: Thirty articles, reporting on 36 studies, were eligible and included. Overall, evidence for the effectiveness of TR was mixed and varied according to the explicitness of strategies and comparison conditions used. Studies examining blatant TR strategies, and those using a combination of blatant and subtle TR strategies, provided limited support for their effectiveness in overcoming ABST. However, studies evaluating subtle TR strategies provided preliminary support for their effectiveness in overcoming ABST.

Discussion and Implications: Existing studies provide limited evidence regarding the effectiveness of TR strategies in overcoming ABST due to methodological limitations. Recommendations are made for the design of future studies to differentiate the benefits of TR strategies from the detrimental effects of ABST, thus potentially informing their use in clinical practice.

Keywords: Stereotype threat; aging; cognitive assessment.

Challenging negative stereotypes regarding the cognitive and physical competence of older adults is crucial to the promotion of healthy aging (Nelson, 2016). Stereotypes are overstated beliefs or unchallenged myths that are widespread and entrenched within society (Allport, 1954). Most societies hold pervasive age-based stereotypes of older people as warm, albeit incompetent (Cuddy, Norton, & Fiske, 2005). Negative stereotypes of aging, such as advanced age being a time of cognitive decline, tend to be more prevalent than positive stereotypes of aging (e.g., wisdom and life experience; Hummert, 2011). Holding negative perceptions of aging has been associated with poorer long-term health outcomes, including greater cognitive decline, brain changes associated with Alzheimer's disease, and reduced lifespan (Levy et al., 2016; Robertson, King-Kallimanis, & Kenny, 2016). Moreover, there is now evidence that age-based stereotype threat can lead older adults to underperform on tests of cognitive ability (Lamont, Swift, & Abrams, 2015).

The cognitive performance of older adults can be affected by neuropathological changes, such as those that are characteristic of dementia, and the social context in which performance is assessed (Ben-David, Malkin, & Erel, 2018). It has been suggested that negative aging stereotypes (e.g., older adults are forgetful) implicitly permeate neuropsychological assessment settings. These could bias the expectations of older adults, as well as the expectations of clinicians, as to how well they will perform when assessed; potentially contributing to lower performance and increasing the risk of mild cognitive impairment and dementia diagnosis (Ben-David et al., 2018; Régner et al., 2016). Current practices in dementia care strive for earlier screening and diagnosis to better manage symptoms and their wider impact on daily living (Le Couteur, Doust, Creasey, & Brayne, 2013). With increasing numbers of older adults expected to be screened for dementia in the

future, it is important to understand how age stereotypes contribute to underperformance on cognitive testing, and how this might be mitigated.

Stereotype threat (ST) occurs when individuals face situations which place them at risk of confirming or being judged by a negative stereotype about a group they identify with, and consequently underperform on stereotype relevant tasks (Steele & Aronson, 1995). Individuals need not endorse the stereotype to be affected, but it must present a threat to their social identity (Steele, Spencer, & Aronson, 2002). The effects of ST were originally investigated on the intellectual test performance of African Americans and the mathematical achievement of women (Steele et al., 2002). Though, increasingly, research is focusing on the implications of age-based stereotype threat (ABST) for the cognitive test performance of older adults given widespread stereotypes about cognitive competence decreasing with age (Lamont et al., 2015). Attending hospitals or memory clinics to complete cognitive tests can be a stressful experience. Such contexts may also unintentionally serve as a reminder of an older adult's age and make salient the host of negative stereotypic expectations associated with aging (e.g., physical and cognitive decline; Haslam, Jetten, Cruwys, Dingle, & Haslam, 2018; Scholl & Sabat, 2008). This can have adverse effects on older adults, especially affecting their assessment performance.

Systematic reviews and meta-analyses investigating ABST have shown that older adults demonstrate performance decrements on memory and general cognitive ability tests, including those widely used in cognitive screening (e.g., Mini-Mental State Examination [MMSE], Montreal Cognitive Assessment [MoCA]), when negative age-based stereotypes are made salient (Armstrong, Gallant, Li, Patel, & Wong, 2017; Lamont et al., 2015). Performance decrements can even be present when subtle forms of ABST are experienced, as is likely in operational testing settings (Shewach, Sackett, & Quint, 2019). Indeed, the instructions for most memory tests understandably emphasise the memory component of the

task and such language can be sufficient to disadvantage older adults (Rahhal, Hasher, & Colcombe, 2001). Hence, it is easy to imagine how ABST could be elicited through standard instructions used to introduce older adults to memory assessment raising the risk of reduced performance during high-stakes testing (e.g., dementia assessment; Régner et al., 2016).

Research has identified factors that increase older adults' susceptibility to ABST. ABST appears to have greater impact on "young-old" adults (60-70 years) than "old-old" adults (71-82 years; Hess, Hinson, & Hodges, 2009). This could be due to increased salience and self-relevance of aging stereotypes for those entering older age compared to those more established in old age (Hess, Hinson, et al., 2009). However, Lamont and colleagues' (2015) meta-analysis suggested the effects of ABST are found across older age groups, and that women may be more vulnerable to its effects than men. ST effects also appear to become more marked as one's identification with the stereotyped domain increases (Steele & Aronson, 1995). Consistent with this are data showing greater impact of ABST on older adults who place greater value on their memory (Hess, Auman, Colcombe, & Rahhal, 2003) and are more educated (Hess, Hinson, et al., 2009). Other factors exacerbating performance decline include lower self-efficacy (Desrichard & Köpetz, 2005), external locus of control (Hehman & Bugental, 2013), and stronger age-group identification (Kang & Chasteen, 2009).

Evidence is mixed on the role of various mechanisms underlying ABST, such as increased test-related anxiety (Abrams, Eller, & Bryant, 2006), reduced performance expectations (Desrichard & Köpetz, 2005), and depletion of cognitive resources (e.g., working memory) to support performance (Mazerolle, Régner, Morisset, Rigalleau, & Huguet, 2012). Others have suggested that changes in one's regulatory focus may better account for the effects of ABST (Popham & Hess, 2015). This perspective contends that older adults exposed to ABST shift from a promotion focus (i.e., striving to perform their best) to a prevention focus (i.e., aiming not to perform their worst) in which they adopt more

cautious, risk-averse response strategies, slowing their performance and reducing test scores (Barber, 2017). Despite lack of consensus about mechanisms, there is general recognition that ABST has significant potential to compromise the validity of cognitive assessment as older adults may underperform relative to their true abilities and this may be incorrectly interpreted as evidence of pathological cognitive impairment (Ben-David et al., 2018; Régner et al., 2016). Consequently, it is imperative for research to investigate ways to promote resistance to ABST and facilitate optimal cognitive performance in older adults (Barber, 2017). However, the literature on ABST to date has largely focussed on performance decrements on memory and cognitive tests (Lamont et al., 2015) than ways of overcoming ABST.

Manipulations to induce or remove ST have been classified as "blatant" or "subtle" (Armstrong et al., 2017; Nguyen & Ryan, 2008). Blatant manipulations explicitly inform a stereotyped group that they are expected to underperform (or perform better) in a domain (e.g., stating that a test is diagnostic of ability and shows group differences in performance). In contrast, subtle manipulations indirectly increase (or decrease) the perceived relevance of a stereotype by manipulating features of the test environment (e.g., presenting a test as diagnostic [or non-diagnostic] of ability without reference to group differences, or referring to a positively [or negatively] stereotyped group; Nadler & Clark, 2011; Nguyen & Ryan, 2008). Blatant and subtle manipulations have also been conceptualised as "fact-based" (i.e., presenting statements about group differences grounded in purported evidence) or "stereotype-based" (i.e., alluding to widespread societal assumptions; Lamont et al., 2015), respectively. Hence, blatant threat-removal (TR) strategies for ABST could refer to a memory test as free of age bias (i.e., older adults perform just as well as younger adults). Conversely, subtle TR strategies may frame tests as non-diagnostic of impairment or provide descriptions favouring the performance of older adults (e.g., successful task performance requires life experience). Prior reviews on TR strategies in other stigmatised populations have revealed

mixed results (Nadler & Clark, 2011; Nguyen & Ryan, 2008). Specifically, Nguyen and Ryan (2008) found blatant TR strategies were more effective than subtle ones in the case of gender stereotypes, whereas the opposite was true for racial stereotypes. It is therefore unclear what effect blatant and subtle TR strategies will have in the context of ABST.

Lamont et al.'s (2015) meta-analysis found older adults showed greater performance decrements in response to stereotype-based (i.e., subtle; $d = 0.52$) than fact-based (i.e., blatant) ABST manipulations ($d = 0.09$). However, no difference was found between control conditions and those that attempted to nullify ABST. More recently, Armstrong et al. (2017) found that the effect of ABST was only significant when blatant manipulations were used with episodic memory tasks or when subtle manipulations were used with working memory tasks. However, neither review considered the effectiveness of TR strategies for overcoming ABST. Moreover, these reviews highlighted differences in the methodological design of studies investigating ABST; hence, conclusions regarding the effectiveness of strategies to overcome ABST must be interpreted in relation to the comparison conditions employed. To address these gaps, this review was conducted to identify and appraise studies investigating the use of TR strategies to optimise the cognitive performance of older adults in the context of ABST. The aims of the review were to: (a) identify the types of strategies employed to overcome the detrimental effects of ABST on cognitive performance in older adults; and (b) critically appraise the methodology and existing evidence of studies evaluating the effectiveness of TR strategies for optimising the cognitive performance of older adults and any factors influencing their effectiveness.

Methods

This review adhered to the Preferred Reporting Items for Systematic Reviews and Meta- Analyses (PRISMA) guidelines (Moher, Liberati, Tetzlaff, Altman, & The PRISMA Group, 2009; see Supplementary Table 1) and the protocol was registered with the

International Prospective Register of Systematic Reviews (PROSPERO, registration no. CRD42019118035).

Search Strategy

Articles were initially identified through title and abstract searches of PsycINFO, PubMed, Embase, Web of Science, and Scopus from 1st January 1995 (i.e., when the concept of ST emerged) to 7th December 2018. An updated search was conducted on 6th November 2019. A search strategy (see Supplementary Table 2) was developed in consultation with a health sciences librarian and used within each database. The strategy comprised three sets of search terms with variants related to population (e.g., "older adults"), manipulation (e.g., "stereotyp*"), and outcome (e.g., "cogniti*"). Subject headings, MeSH terms, and Emtree terms were applied as relevant to each database. Where permitted, database searches were restricted to articles on human subjects, written in or translated into English, and published in peer-reviewed journals. Limits related to sample age were also applied (e.g., "aged"), where possible. Backward and forward citation searches were conducted on all eligible articles and key reviews in the area (Armstrong et al., 2017; Barber, 2017; Lamont et al., 2015).

Study Selection

During initial screening, the first author independently screened the titles and abstracts for eligibility using Rayyan (Ouzzani, Hammady, Fedorowicz, & Elmagarmid, 2016). Articles were excluded if they did not meet preliminary criteria related to sample (i.e., not older adults), manipulation (i.e., not within the ST field), outcome (i.e., did not measure objective or subjective cognition), or publication type (e.g., review).

Full-texts of remaining articles were exported into EndNote X7 and screened independently by the first two authors according to the following eligibility criteria: (1) sample comprised healthy, community-dwelling older adults with at least one participant group with a mean age of ≥60 years (with a minimum participant age of 55 years); (2)

implemented a manipulation which sought to overcome the detrimental effects of ABST; (3) applied this manipulation through a conscious priming method; (4) the experimental procedure noted the age or stereotype relevance of the task(s); and (5) included at least one outcome measure of objective cognitive performance or subjective cognition, as both approaches are commonly used in a comprehensive cognitive assessment of older adults. TR strategies were conceptualised as manipulations which activated positive stereotypes of aging or negative stereotypes of younger adults, refuted negative aging stereotypes, or presented other manipulations that aimed to improve cognitive performance relative to an ABST or control condition. Objective cognitive performance included results of neuropsychological tests or laboratory-based tasks of cognitive abilities (e.g., memory, executive function, visuospatial construction; Lezak, Howieson, Bigler, & Tranel, 2012). Subjective cognition included results of self-report measures that assessed older adults' beliefs or judgements regarding their own cognitive abilities (e.g., metamemory). Studies that employed measures of motor performance, sensory perception (e.g., hearing), complex multi-skill activities (e.g., driving), or other independent activities of daily living were excluded.

Articles were excluded if the mean age of the participant group was <60 years, or if the sample was of continuous mixed age without subgroup analyses. Articles were also excluded if researchers made no attempt to overcome ABST, used a subliminal priming task, did not include age-based stereotypes, or activated stereotypes unrelated to cognition. Disagreement regarding the inclusion or exclusion of articles was resolved through consultation with the third author until consensus was reached.

Data Extraction and Quality Assessment

Details of study methodology and results were extracted and summarised for all articles. ABST manipulations and TR strategies were coded as involving subtle, blatant, or combined strategies (i.e., use of both blatant and subtle approaches) for activating or

removing threat. The results of analyses comparing ABST+TR, TR, and ABST or control conditions and those examining factors moderating or mediating the effects of TR strategies were recorded. The first author completed data extraction, with interpretation of findings confirmed by the second author. Effect sizes (i.e., Cohen's *d*) for predicted effects involving ABST+TR or TR conditions relative to an ABST or control condition, were extracted or calculated, where possible. Due to considerable variability in study design, manipulation types, and cognitive measures, meta-analysis was not used to synthesise the data. Instead, findings from each study are detailed in Table 1 and qualitative synthesis is provided.

The methodological quality of studies was examined using an adaptation of the STrengthening the Reporting of OBservational studies in Epidemiology (STROBE; von Elm et al., 2014) guidelines. Articles were rated against eight criteria regarding descriptive, internal validity, and statistical components (see Supplementary Table 3), scoring 0 (did not meet) or 1 (met), and those meeting a larger number of criteria were judged to be of stronger methodological quality for the purposes of this review. A random selection of 30% of articles was independently rated by the first two authors to assess consensus in rating methodological quality. Due to substantial agreement, the first author completed the risk of bias assessment for the remaining articles and discussed these collaboratively with the second author.

Results

Search Results

Overall, the database and backward and forward citation searches yielded 6125 articles (see Figure 1). This reduced to 3281 following duplicate removal. A further 3208 articles were excluded based on title and abstract, with 73 articles screened as full-texts. There was 89% agreement between the two independent raters concerning the inclusion or exclusion of these articles. This identified 30 eligible articles, which reported on 36 relevant studies. Table 1 outlines the study characteristics and key findings of the 30 eligible articles.

Quality Assessment

There was substantial agreement on the presence or absence of methodological quality criteria (κ = .70, p <.001), with disagreement resolved through discussion to yield final ratings. Most studies (≥75%) sufficiently outlined sample characteristics, design and procedure, variables and outcome measures, provided descriptive statistics on outcome measures, and employed statistical control methods (see Table 2). Over half (63%) outlined recruitment sources and eligibility criteria, and controlled for experimental bias. Conversely, only 20% justified their sample size. The mean methodological quality rating was 5.80, with a range of 4-8.

Experimental Design and Methodology

Sample Characteristics. In total, 2855 older adults were included in the 36 studies reported across 30 articles (n = 25-210 per study). Average age ranged from 61 to 76 years. Most articles (50%) reported on research conducted in the United States of America.

ABST Manipulations. Twenty-eight studies (78%) used blatant ABST manipulations, with the remaining eight employing subtle manipulations to induce ABST. Twenty-four studies activated ABST specific to memory ability, and 12 studies activated ABST related to general cognitive (e.g., intellectual performance) or multiple cognitive (e.g., memory and processing speed) abilities.

TR Strategies. TR strategies (see Table 3) were examined in 38 conditions across the 36 included studies; two studies (Barber, Seliger, Yeh, & Tan, 2019; Tan & Barber, 2020) included separate subtle and blatant TR conditions within the same experiment. Eight conditions (21%) involved subtle TR strategies. Examples included providing pre-test information referring to positive qualities stereotypically associated with aging (e.g., wisdom; Barber et al., 2019), providing a vignette of a counter-stereotypical older adult (e.g., "His memory is as good as ever"; Aisenberg et al., 2015), or priming older adults to self-categorise

as younger relative to others in the study (e.g., Haslam et al., 2012). Twenty-two conditions (58%) comprised blatant TR strategies. Examples included providing information about cognitive abilities that are preserved or improve with age (e.g., Fresson, Dardenne, Geurten, & Meulemans, 2017), providing pre-test information that explicitly favoured older adults' performance (e.g., Fernández-Ballesteros, Bustillos, & Huici, 2015), or presenting tests as free of age bias (e.g., Mazerolle et al., 2012). Eight conditions (21%) combined subtle and blatant strategies in the same manipulation (e.g., presented test as non-diagnostic of memory [i.e., subtle] and age-fair [i.e., blatant]). Interestingly, the explicitness of ABST manipulations and TR strategies did not match (e.g., blatant ABST was paired with subtle TR) in 36% of studies (i.e., 13 studies, including the eight using combined TR strategies).

Comparison Conditions. Of the 36 studies, 24 (67%) compared ABST conditions against TR conditions alone. A further seven studies (19%) included a control condition (Aisenberg et al., 2015; Alquist, Price, Hancock, Talley, & Cukrowicz, 2018; Andreoletti & Lachman, 2004; Fernández-Ballesteros et al., 2015; Hess et al., 2003; Swift, Abrams, & Marques, 2013). Four studies (11%) compared an ABST condition with a condition that included some type of TR strategy in addition to the ABST manipulation (i.e., an ABST+TR condition; Barber et al., 2019; Haslam et al., 2012; Liu, Zhao, Zhang, & Dang, 2017; Tan & Barber, 2020). Finally, one study (3%) included both an ABST+TR condition and a control condition (Abrams et al., 2008). Importantly, the 24 studies comparing ABST against TR conditions alone cannot address the second aim of the review as conclusions regarding the effectiveness of these TR strategies depend on the effectiveness of the ABST inductions. In other words, they do not allow one to distinguish the benefits of the TR strategy from the detrimental impact of the ABST manipulation. Hence, studies that included control and/or ABST+TR conditions are most relevant to understanding the effectiveness of TR strategies for optimising the cognitive performance of older adults. The five studies comparing ABST

and ABST+TR conditions directly address the second aim of this review and, as such, will receive greater emphasis in the synthesis of results.

Outcome Measures

Twenty-eight studies (78%) employed only objective cognitive measures. A further seven studies used both objective and subjective measures, and one study used a subjective measure alone. Of the studies using objective measures, 20 used memory tests exclusively (e.g., episodic or working memory), seven used a combination of memory and other cognitive tests, and eight used tests of other cognitive or executive functions (e.g., inhibitory control). Regarding subjective measures, three studies used a Remember vs. Know metamemory judgement task. Three studies employed subscales from the Metamemory in Adulthood questionnaire to examine potential mediators and/or moderators of ABST. Others included self-report measures of cognitive complaints, and beliefs or concerns about memory.

Synthesis of Results

Key findings from the 36 relevant studies, which reported on 38 TR conditions, are synthesised in the following sections according to the type of TR strategy used to overcome ABST. Although the methodology and key findings of all studies are initially summarised, greater emphasis is placed on the studies employing relevant comparison conditions when drawing conclusions regarding the effectiveness of TR strategies for optimising the cognitive performance of older adults.

Subtle TR Strategies

Eight studies included conditions which employed subtle TR strategies. One study only compared a TR condition with an ABST condition (Hehman & Bugental, 2013). Participants in the TR condition outperformed those in the ABST condition on visuospatial construction (Hehman & Bugental, 2013). However, as relevant to the second aim of this review, this study did not provide clear evidence about the effectiveness of TR in overcoming

ABST. Three studies compared TR conditions with control or neutral valence conditions (Aisenberg et al., 2015; Swift et al., 2013). TR conditions outperformed control conditions on inhibitory control (Aisenberg et al., 2015) and a crossword task (Swift et al., 2013). While Swift et al.'s (2013) TR condition also outperformed an ABST condition on crossword and problem-solving tasks, there was no difference between the TR and control conditions on problem-solving. However, this was in line with author predictions.

Four studies compared an ABST+TR condition with an ABST condition (Abrams et al., 2008; Barber et al., 2019; Haslam et al., 2012; Tan & Barber, 2020). Three provided evidence of participants in ABST+TR conditions outperforming those in ABST conditions on a mathematics test (Abrams et al., 2008), word list recall (Tan & Barber, 2020), immediate and delayed verbal memory, and global cognitive status on the Addenbrooke's Cognitive Examination-Revised (Haslam et al., 2012). This was mediated by lower test-related anxiety in Abrams et al.'s (2008) study. In contrast, Barber et al. (2019) did not find support for their subtle TR strategy in buffering ABST, with no significant difference between their ABST and TR+ABST conditions in recall of positive valence pictures on an affective picture recall test. Abrams et al. (2008) also found no significant difference between their TR+ABST and control conditions on math performance.

Overall, the evidence for studies investigating subtle TR strategies varied according to the comparison condition used. However, on balance, there was moderate evidence with three studies providing support for the effectiveness of subtle TR strategies relative to control conditions, and three studies supporting the effectiveness of subtle TR strategies in overcoming ABST (i.e., those comparing an ABST+TR condition with an ABST condition), with medium to large effect sizes (d = 0.46-1.63). Across all eight studies, effect sizes ranged from small to large (d = 0.25-1.63) and findings were significant across studies using tests of general cognition, executive function, and memory. Ratings of methodological quality for

articles reporting on subtle TR strategies ranged from 5-8/8 (M = 6.57). Most lacked sample size justification, except for Aisenberg et al. (2015) and Tan and Barber (2020), and failed to incorporate measures to address possible sources of experimental bias, such as use of a manipulation check (Abrams et al., 2008; Aisenberg et al., 2015; Barber et al., 2019). Three studies (Barber et al., 2019; Haslam et al., 2012; Tan & Barber 2020) used subtle TR to address blatant ABST. This inconsistency in matching the explicitness of the manipulations may have contributed to the different results obtained by Barber et al. (2019); their subtle TR strategy may have been insufficient to overcome blatant ABST in this study.

Blatant TR Strategies

Twenty-two studies included conditions which employed blatant TR strategies. Fifteen studies only compared TR conditions with ABST conditions. Participants in TR conditions outperformed those in ABST conditions on tasks of verbal memory (Barber & Mather, 2013b; Mazerolle et al., 2012; Plaks & Chasteen, 2013), working memory (Mazerolle et al., 2012; Plaks & Chasteen, 2013), eyewitness memory (Thomas, Smith, & Mazerolle, 2020), subjective metamemory judgements (Kalenzaga, Clarys, & Piolino, 2019; Mazerolle, Régner, Rigalleau, & Huguet, 2015), delay discounting (Alquist et al., 2018), and executive function (Fresson et al., 2017), and recalled more positive valence pictures on an affective picture recall test (Barber et al., 2019). Better performance in a TR condition was associated with lower pre-task worry (Plaks & Chasteen, 2013). Interestingly, participants in Fresson et al.'s (2017) TR condition had better executive function performance only when compared to those in the ABST condition who reported moderate-to-high fear of Alzheimer's disease. However, three studies (Chapman, Sargent-Cox, Horswill, & Anstey, 2016; Hess, Hinson, et al., 2009; Horton, Baker, Pearce, & Deakin, 2010) found no significant differences between TR and ABST conditions on their cognitive outcome measures. Moreover, some studies (Barber & Mather, 2013b; Thomas et al., 2020) found evidence of participants in

ABST conditions outperforming those in TR conditions on memory tests. For example, TR conditions outperformed ABST conditions when tests had a gain-based reward structure (i.e., poker chips earned for words recalled). Conversely, ABST conditions outperformed TR conditions when a loss-based reward structure was applied (i.e., poker chips lost for words forgotten; Barber & Mather, 2013a). However, as relevant to the second aim of this review, these studies do not provide evidence of the effectiveness of TR in overcoming ABST as they did not compare an ABST+TR condition with an ABST condition.

Four studies compared TR conditions with control conditions (Alquist et al., 2018; Andreoletti & Lachman, 2004; Fernández-Ballesteros et al., 2015; Hess et al., 2003). While TR conditions outperformed ABST conditions on verbal memory (Hess et al., 2003) and delay discounting (Alquist et al., 2018), with better performance mediated by participants subjectively feeling younger than their chronological age in Alquist et al.'s (2018) study, both studies found no significant difference in cognitive performance between TR and control conditions. Fernández-Ballesteros et al. (2015) found that the TR condition outperformed ABST and control conditions on memory recall, but only when those in the TR condition had negative self-perceptions of aging. Similarly, Andreoletti and Lachman (2004) reported a moderating effect of education, whereby only participants with high levels of education in the TR condition had greater recall than participants in ABST and control conditions.

Two studies compared blatant TR strategies with an ASBT condition as well as a subtle TR+ABST condition investigated within the same experiment (Barber et al., 2019; Tan & Barber, 2020). The blatant TR conditions outperformed ABST conditions on verbal memory (Tan & Barber, 2020) and recalled more positive valence pictures on an affective picture recall test (Barber et al., 2019). However, mixed findings were observed when comparing the blatant TR and subtle TR+ABST conditions. Participants in Barber et al.'s (2019) blatant TR condition outperformed those in the subtle TR+ABST condition, recalling

more positive valence pictures on an affective picture recall test, suggesting the blatant TR condition was more effective in optimising performance. Conversely, Tan and Barber (2020) found no significant difference between their blatant TR and subtle TR+ABST conditions, suggesting both were equally effective in optimising performance, relative to an ABST condition. While interesting to compare the findings of these studies, they did not provide evidence of the effectiveness of blatant TR in overcoming ABST.

Only one study investigating a blatant TR strategy compared an ABST+TR condition with an ABST condition. Liu et al. (2017) investigated whether priming multiple age-based stereotypic identities could buffer ABST. They induced ABST and presented participants with articles outlining advantages of being older (positive identity), disadvantages of being older (negative identity), or both advantages and disadvantages of being older (multiple identities) compared to being younger. No significant differences were reported between the ABST+positive identity condition and the standard ABST or ABST+negative identity conditions. However, the ABST+multiple identities condition outperformed the ABST and ABST+negative identity conditions on recognition memory.

Overall, the evidence for studies investigating blatant TR strategies was mixed and insufficient to address the second aim of this review due to the methodological designs employed. Of the 22 studies, only five were designed in ways that allow conclusions to be drawn regarding the effectiveness of blatant TR strategies. Evidence from the four studies incorporating control conditions was mixed, although these highlighted some interesting findings concerning the moderating effects of education, subjective age, and self-perceptions of aging on the effectiveness of TR. The one study (Liu et al., 2017) directly evaluating the effectiveness of blatant TR strategies in overcoming ABST, provided support for their TR strategy (i.e., priming multiple identities), with medium to large effect sizes (d = 0.65-0.77). Effect sizes across the 22 studies ranged from negligible to large (d = 0.07-1.47). The bulk of

studies examining blatant TR strategies used memory tests, as opposed to tests of other cognitive abilities. Methodological quality ratings for articles reporting on blatant TR strategies ranged from 4-8/8 (M = 5.72). Studies were limited by their failure to screen for participants' cognitive status or report education level (e.g., Alquist et al., 2018), justify sample size (e.g., Kalenzaga et al., 2019) and group allocation (e.g., Barber & Mather, 2013a, 2013b), report participant eligibility criteria (e.g., Hess et al., 2003), and include measures to address possible sources of experimental bias (e.g., Hess, Hinson, et al., 2009; Thomas et al., 2020). Two studies (Mazerolle et al., 2012, 2015) used blatant TR strategies to address subtle ABST. This inconsistency in the explicitness of their manipulations could have amplified their effects relative to studies that matched the nature of their TR and ABST manipulations.

Combined TR Strategies

Eight studies combined subtle and blatant TR strategies in the same manipulation. The content of these manipulations is summarised in Table 1. All eight studies compared TR conditions with ABST conditions alone; none included control or ABST+TR conditions. Participants in TR conditions outperformed those in ABST conditions on working memory (Jordano & Touron, 2017), associative memory (Brubaker & Naveh-Benjamin, 2018), and general cognition (MMSE and MoCA; Mazerolle et al., 2017). Findings from the other five studies were mixed. Hess, Emery, and Queen's (2009) TR condition outperformed the ABST condition on recognition memory and a subjective metamemory judgement task. However, this only applied when tasks required time-limited decisions. Interestingly, although participants in Popham and Hess' (2015) TR condition were faster on a letter-cancelling task, they were less accurate than those in the ABST condition. In line with their previous studies, Barber, Mather, and Gatz (2015) found that participants in the TR condition outperformed those in the ABST condition on the MMSE and a word list memory test when the tests had a gain-based reward structure, but not a loss-based structure. Moreover, when the reward

structure for a recognition memory test was loss-based, the ABST condition outperformed the TR condition on several aspects of task performance (e.g., words recalled, recall accuracy, and false alarm rate; Barber & Mather, 2013b). Finally, Marquet, Missotten, Dardenne, and Adam (2017) found no significant difference between TR and ABST conditions.

Overall, the evidence for studies using a combination of blatant and subtle TR strategies was mixed and insufficient to address the second aim of this review due to the methodological designs. Two studies provided support, four provided partial support, and two provided no support for the effectiveness of TR relative to ABST. Effect sizes across the eight studies ranged from negligible to large (d = 0.04-1.34), and results did not vary according to the type of cognitive test used. Ratings of methodological quality for articles reporting on combined TR strategies ranged from 4-6/8 (M = 5.38). Studies were limited by their failure to fully detail participant eligibility criteria (e.g., Barber et al., 2015) and the basis for group allocation (e.g., Hess, Emery, et al., 2009), as well as their failure to include experimental or statistical control methods (e.g., Brubaker & Naveh-Benjamin, 2018). Moreover, none of the studies justified their sample sizes. Critically, as none of these studies included control or ABST+TR conditions, they do not allow conclusions to be made about the effectiveness of TR in overcoming ABST. Finally, caution is needed when interpreting findings for combined TR strategies, as there was inconsistency in the explicitness of the ABST and TR manipulations across all eight studies.

Discussion

This review aimed to identify and critically appraise the methodology and existing evidence of studies investigating the use of TR strategies to overcome the detrimental effects of ABST on the cognitive performance of older adults. The types of TR strategies, their effectiveness in optimising the cognitive performance of older adults relevant to appropriate comparison conditions, and the factors influencing their effectiveness were examined. Thirty

articles, reporting on 36 studies and examining 38 TR conditions, were identified. The design and methodology of included studies differed in terms of the TR strategies employed and the comparison conditions used. Fewer studies evaluated subtle TR strategies than blatant ones, and few studies were designed in ways that permitted conclusions to be drawn regarding the effectiveness of TR in overcoming ABST. Most studies (24 studies or 67%) exclusively compared TR conditions against ABST conditions. This precluded differentiation of the potential benefits of TR strategies from the detrimental effects of the ABST manipulations. Nevertheless, seven studies (19%) included a control condition and five studies (15%) compared an ABST condition with a condition that included some type of TR strategy in addition to the ABST manipulation. These latter studies have greater utility for advancing knowledge of the effectiveness of TR strategies as relevant to the second aim of this review.

Overall, evidence for the effectiveness of TR strategies varied according to the explicitness of strategies and the comparison conditions employed. The evidence from studies examining blatant and combined TR strategies was mixed and, due to the methodological designs employed, did not permit conclusions regarding the effectiveness of TR strategies for overcoming ABST. As one exception, the study by Liu et al. (2017) which compared ABST and ABST+TR conditions provided support for a blatant TR strategy overcoming ABST, with medium to large effect sizes.

Evidence from the eight studies examining subtle TR strategies also varied according to the comparison condition used, but generally yielded more consistent empirical support. Three of the four studies comparing subtle TR and control conditions provided support for the effectiveness of TR. Moreover, of the four studies examining subtle TR strategies through comparison of ABST and ABST+TR conditions, three provided support for the effectiveness of TR in overcoming ABST, with medium to large effect sizes. Articles reporting on subtle TR strategies also typically met a higher number of methodological quality criteria, than

those examining blatant or combined TR strategies. Overall, the existing studies provided limited evidence regarding the effectiveness of TR strategies in overcoming ABST. As such, this review only provides initial support for the effectiveness of subtle TR strategies.

In providing preliminary support for the effectiveness of subtle TR strategies in overcoming ABST, the current findings are consistent with those of a previous review on the effectiveness of TR for overcoming racial stereotypes (Nguyen & Ryan, 2008). However, Nguyen and Ryan (2008) also found that blatant TR strategies were more effective than subtle ones in overcoming gender-based ST. Although there was insufficient evidence concerning the effectiveness of blatant TR strategies in the current review, a potential reason why these may be less effective in overcoming ABST is that blatant information regarding expectations for older adults' cognitive performance, even when positively framed, may still induce evaluative performance pressure and result in underperformance (i.e., "choking under pressure"; Baumeister, 1984).

Research examining blatant versus subtle methods for activating ST (Stone & McWhinnie, 2008) found support for a dual process model whereby blatant and subtle ST cues operate through independent mechanisms and detrimentally affect performance in different ways. Likewise, blatant and subtle TR strategies may have independent beneficial effects on performance. For example, blatant TR may increase efficiency, while subtle TR may improve accuracy. Importantly, as Shewach et al. (2019) note, it is unlikely people encounter blatant ST in real-world assessments due to ethical guidelines for conducting cognitive assessment; thus, targeting these may be counterproductive. Subtle ABST (e.g., mentioning that a test assesses memory) is likely more prevalent in these contexts and hence subtle TR strategies may have greater utility for mitigating its effects (Shewach et al., 2019).

Regarding factors influencing the effectiveness of TR relative to ABST or control conditions, performance varied according to test characteristics, including reward structure,

time-limits, and valence of stimuli (Barber et al., 2019; Barber & Mather, 2013a; Hess, Emery, et al., 2009), education level (Andreoletti & Lachman, 2004), self-perceptions of aging (Fernández-Ballesteros et al., 2015), and fear of Alzheimer's disease (Fresson et al., 2017). Further, reduced pre-task or task-related anxiety and younger subjective age mediated the effects of TR strategies on cognitive performance (Abrams et al., 2008; Alquist et al., 2018; Plaks & Chasteen, 2013). Therefore, a combination of test characteristics, participant factors, and emotional and subjective appraisal variables appear to influence the effectiveness of TR strategies.

Theoretical accounts of ST also provide some explanation as to the effectiveness of particular TR strategies. Steele et al. (2002) theorised people are less susceptible to the effects of ST when they distance themselves from or de-identify with the negatively stereotyped group. This would suggest that TR strategies that reduce identification with a group (e.g., older adults) or performance domain (e.g., cognitive ability) would have greater efficacy. Similarly, the strategy of encouraging individuals to maintain a positive self-identity through de-emphasising the salience of the domain to one's self-worth may also aid efficacy (Haslam et al., 2018; Steele et al., 2002). Consequently, when encountering negative stereotypes, ABST will have little impact if older adults do not self-categorise as older and instead focus on other identities (e.g., family or community roles).

Barber (2017) conceptualised ABST as a threat to self-integrity, rather than group-reputation, which can be addressed through affirming an older adult's worth in an alternative domain of personal importance (e.g., family, religion). Research within other stereotyped groups (e.g., women and mathematics performance) has shown that ST can be overcome by increasing the salience of other identities in the same domain (Rydell, McConnell, & Beilock, 2009) or by reminding people of multiple roles and identities (Gresky, Ten Eyck, Lord, & McIntyre, 2005). While Liu et al. (2017) found that priming multiple identities (e.g., the

advantages and disadvantages of being older compared to being younger) has positive effects on memory performance, these were domain-relevant. It would be beneficial for future research to investigate whether reminding older adults of multiple roles and identities unrelated to their cognitive abilities is helpful in overcoming ABST.

Limitations

This review identified that evidence regarding the effectiveness of TR in overcoming ABST is currently limited due to the small number of studies employing relevant comparison conditions. Studies examining ways of overcoming ABST have infrequently used control or ABST+TR conditions in evaluating the effectiveness of TR strategies. As a further design issue, 34% of studies were not consistent in matching ABST and TR conditions on the explicitness of their manipulations (e.g., blatant ABST paired with subtle TR). Some researchers have suggested that subtle TR may be insufficient to overcome performance decrements due to blatant ABST (Stone & McWhinnie, 2008), although this remains to be investigated. Hence, reported effects (or lack thereof) in the reviewed studies could be due not only to the design of the TR manipulation, but also the choice of ABST induction. To increase confidence in conclusions drawn regarding the effectiveness of TR strategies in overcoming ABST it is recommended that future studies ensure that the explicitness of TR and ABST manipulations is consistent and that ABST conditions are compared with ABST+TR conditions.

The current findings are based on a set of heterogeneous studies with variable methodological quality. There was considerable variability with respect to study design, type of ABST manipulations and TR strategies examined, and measurement of cognition. This limited quantitative meta-analysis or other statistical analysis to address methodological problems. A recent meta-analysis by Shewach and colleagues (2019) examining ST effects (but excluding ABST) on the cognitive ability testing of adults found that effects were

negligible to small when accounting for methodological problems. The effectiveness of TR strategies for overcoming ABST when controlling for methodological issues remains to be examined. Additionally, most studies were conducted in Western cultures and articles not published in English were excluded; hence, the relevance and effects of TR strategies for overcoming ABST in Eastern cultures requires further investigation.

Conclusion

Test performance affected by ABST can have a major bearing on interpretation and diagnostic decisions in the context of dementia assessment (Haslam et al., 2012). Given the significant diagnostic implications of underperformance on cognitive tests for this population, it is important that cognitive assessments of older adults are appropriately introduced, administered, and interpreted (Régner et al., 2016; Scholl & Sabat, 2008). In the context of increased cognitive screening of older adults, investigating ways to optimise their cognitive performance by overcoming the detrimental effects of ABST is a valuable research objective. This is the first review to evaluate the effectiveness of TR strategies for overcoming the effects of ABST on older adults' cognitive performance. Overall, existing studies provided limited evidence regarding the effectiveness of TR strategies in overcoming ABST. This was in part due to the lack of studies employing ABST+TR or control comparison conditions. Nonetheless, preliminary support from a small number of studies was evident for the effectiveness of using subtle TR strategies to overcome ABST. It is imperative that future studies employ designs that enable the benefits of TR strategies to be differentiated from the detrimental effects of ABST. Such research has the potential to inform regarding ways to overcome or mitigate ABST in clinical practice.

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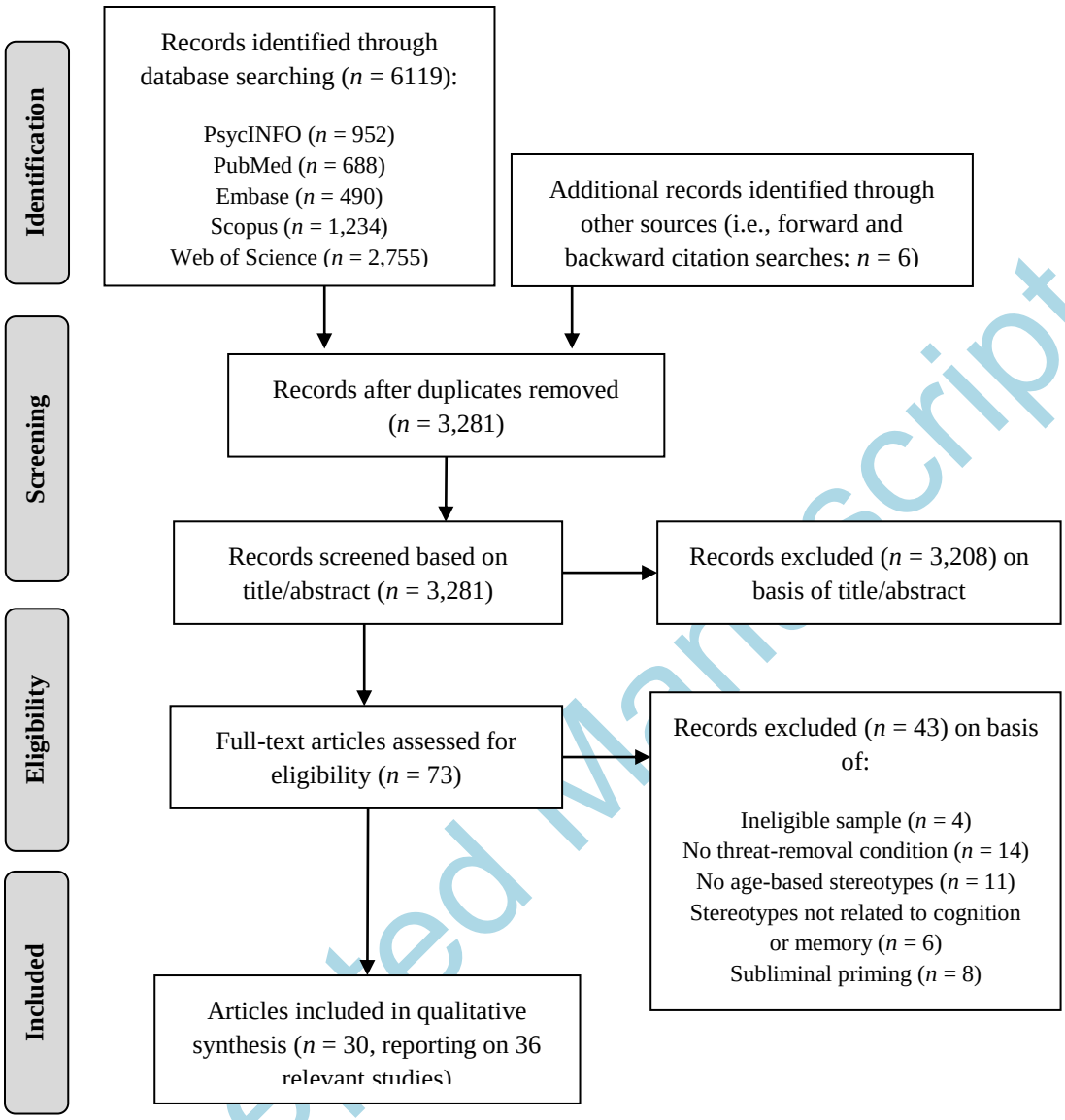

Figure 1. Flow chart of the article selection process, with reasons for exclusions.

Table 1. *Characteristics and Main Findings of Included Articles*

Study, Country	Participants	ABST Manipulation: Type/Stereotyped Domain	Comparison Condition(s): Type/Manipulation	Cognitive Outcome: Type/Measure(s)	Key Findings[a]
Abrams et al. (2008), UK	Exp 2: 84 OA (*M* age = 72.2 years, *SD* = 8.23), 34 males	Subtle/Intellectual performance	Subtle TR + ABST/ Imagined intergenerational contact + ABST Control/No ABST	Objective/Mathematics test	TR + ABST > ABST (*d* = 0.49), mediated by reduced test anxiety. TR + ABST = control condition.
Aisenberg et al. (2015), Israel	Exp 1: 48 OA (*M* age = 71.9 years, *SD* = 5.8); 45 YA Exp 2: 36 OA (TR: *M* age = 72 years, *SD* = 6.8; Neutral: *M* age = 73 years, *SD* = 6.2)	Exp 1: Subtle/ Memory and thinking speed Exp 2: No ABST	Exp 1 and 2: Subtle TR/ Vignette of counter-stereotypical exemplar Neutral/Vignette of neutral exemplar	Objective/The Simon task	OA demonstrated greater inhibitory control following TR, compared to ABST (Exp 1) and neutral (Exp 2) conditions.
Alquist et al. (2018), USA	Exp 1: 103 OA, 65-77 years (*M* = 67.7, *SD* = 2.12), 60.96% male Exp 2: 210 OA, 65–77 years (*M* = 67.7), 69.70% male	Blatant/Memory	Exp 1 and 2: Blatant TR/Articles on the maintenance of memory abilities across lifespan Exp 2: Control/Articles about nature	Objective/Delay discounting task	Exp 1: TR chose delayed rewards more frequently than ABST (*d* = 0.47). Exp 2: TR chose delayed rewards more frequently than ABST (*d* = 0.76), mediated by discrepancy in subjective and chronological age. TR = controls.
Andreoletti & Lachman (2004), USA	Mixed age sample (YA, middle-aged, and OA): 50 OA, 60-80 years (*M* = 69.38, *SD* = 5.46)	Blatant/Memory	Blatant TR/Test presented as age-fair Control/No ABST	Objective/Word list recall Subjective/Beliefs About Memory Ability and Concern About Memory Decline	No significant Age × Condition interaction or main effect of condition reported. Study focussed on recall by education and list trial. Across ages, those in TR with more education had greater recall than ABST and controls.
Barber & Mather (2013a), USA	Exp 1a: 56 OA, 60-79 years (*M* = 69.29, *SD* = 5.48), 61% male Exp 1b: 56 OA, 59-78 years (*M* = 65.61, *SD* = 5.18), 20% male	Blatant/Memory	Blatant TR/Articles on the preservation and improvement of memory with age	Objective/Sentence span task	TR > ABST with gain-based reward structure (*d* = 0.97). ABST > TR with loss-based reward structure. TR performance did not vary as a function of reward structure.
Barber & Mather (2013b), USA	Exp 1: 31 OA, 63-78 years (*M* = 70.42, *SD* = 4.76), 71% female Exp 2: 64 OA, 61-86 years (*M* = 70.85, *SD* = 5.82), 50% female	Blatant/Memory	Exp 1: Blatant TR/ Articles on the preservation and improvement of memory with age Exp 2: Combined TR/ Test presented as non-diagnostic	Objective/Word list free-recall and recognition	Exp 1: TR > ABST on word recall (*d* = 0.87); ABST > TR on recall accuracy. Exp 2: ABST > TR on recall accuracy and recall of loss-based items. ABST had more conservative response bias and fewer false alarms on recognition

Study, Country	Participants	ABST Manipulation: Type/Stereotyped Domain	Comparison Condition(s): Type/Manipulation	Cognitive Outcome: Type/Measure(s)	Key Findings[a]
			(Subtle) and age-fair (Blatant)		memory.
Barber et al. (2015), USA	80 OA, 61-80 years (*M* = 69.54, *SD* = 5.33), 53.7% female	Blatant/Memory and general cognition	Combined TR/Articles on cognitive abilities preserved with age (Blatant) and primed OA to self-categorise as younger (Subtle)	Objective/Word List Memory Test, ACE-R, and MMSE	TR > ABST on Word List Memory Test and MMSE with gain-based (*d* = 0.97-1.34) but not loss-based reward structure. A consistent pattern of results on the ACE-R was not significant.
Barber et al. (2019), USA	Exp 1: 49 OA, 57-88 years (*M* = 73.33), 33% female; 55 YA Exp 2: 90 OA, 60-79 years (*M* = 70.07), 50 females	Blatant/Memory	Exp 1 and 2: Blatant TR/Informed OA and YA perform equally well Exp 2: Subtle TR + ABST/Primed positive qualities associated with aging + ABST	Objective/Affective (positive or negative valence images) picture recall test	Exp 1: TR > ABST on recall of positive pictures (*d* = 0.38). No difference in recall of negative pictures. Exp 2: All conditions equivalent on recall of negative pictures. TR > ABST (*d* = 0.54) and TR + ABST (*d* = 0.70) on recall of positive pictures. ABST = TR + ABST on positive picture recall.
Brubaker & Naveh-Benjamin (2018), USA	Exp 1: 60 OA, 65-87 years, (*M* = 72.52, *SD* = 6.29), 23% male; 60 YA	Blatant/Memory	Combined TR/Test presented as non-diagnostic of memory (Subtle) and provided information favouring performance of OA (Blatant)	Objective/Item and associative memory recognition test (face-scene picture pairs and unrelated word pairs)	TR > ABST on associative memory, with greater accuracy (*d* = 0.29-0.35) and lower false alarm rate (*d* = 0.28-0.40). Item memory did not change as a function of condition.
Chapman et al. (2016), Australia	86 OA, 65-86 years (*M* = 73.58, *SD* = 6.08), 55% female	Blatant/Detection of driving hazards	Blatant TR/Provided information favouring performance of OA	Objective/Timed hazard perception task	No significant differences in hazard perception. Driving confidence reduced in ABST condition from pre- to post-test.
Fernández-Ballesteros et al. (2015), Spain	112 OA, 55-78 years (*M* = 61.72, *SD* = 5.26), 62% female; Controls: 34 OA, 55-78 years (*M* = 61.47, *SD* = 5.23), 61% female	Blatant/Memory	Blatant TR/Provided information favouring performance of OA Control/No ABST	Objective/Auditory verbal learning test	TR > ABST and controls when OA in TR condition had poorer self-perceptions of aging.
Fresson et al. (2017), Belgium	72 OA, 59-70 years (*M* = 64.04, *SD* = 2.87), 37 females	Blatant/Memory and general cognition	Blatant TR/Articles on the preservation of cognitive abilities with age	Objective/Attention (e.g., WAIS-IV Coding), memory (e.g., WAIS-III Digit Span), and executive tests (e.g., Stroop task) Subjective/Cognitive complaints	TR > ABST (*d* = 0.67) on overall executive function when ABST condition had moderate or high fear of AD. TR made fewer errors on Stroop task than ABST (*d* = 0.58). No differences in memory and attention performance, or subjective cognitive complaints.

Study, Country	Participants	ABST Manipulation: Type/Stereotyped Domain	Comparison Condition(s): Type/Manipulation	Cognitive Outcome: Type/Measure(s)	Key Findings[a]
				questionnaire	
Haslam et al. (2012), UK	68 OA, 60-70 years (*M* = 65.1, *SD* = 3.1), 33 females	Blatant/Memory and general cognition	Subtle TR + ABST/ Primed OA to self-categorise as younger + ABST	Objective/WMS-III Logical Memory and ACE-R	TR + ABST > ABST on all tests, contingent on aging expectations. OA who self-categorised as younger and expected memory decline had greater immediate (*d* = 1.13) and delayed recall (*d* = 1.12). OA who self-categorised as younger and expected general cognitive decline performed better on ACE-R (*d* = 1.63).
Hehman & Bugental (2013), USA	54 OA, 62-92 years (*M* = 75, *SD* = 8.22), 37 females; 81 YA	Subtle/General cognition (i.e., fast responses)	Subtle TR/Task description favoured qualities of OA	Objective/WAIS-III Block Design	TR > ABST (*d* = 0.86).
Hess et al. (2003), USA	48 OA, 62-84 years (*M* = 70.8), 27 females; 48 YA	Blatant/Memory	Blatant TR/Articles rejecting inevitability of memory decline Control/No ABST	Objective/Word list free-recall Subjective/MIA questionnaire (Memory Anxiety and Achievement subscales)	TR > ABST (*d* = 0.90). TR = control condition. No significant correlation between recall and value placed on memory ability in TR condition.
Hess, Emery, et al. (2009), USA	82 OA, 60-86 years (ABST deadline: *M* = 70.4, *SD* = 7.2; ABST unlimited: *M* = 70.1, *SD* = 6.8; TR deadline: *M* = 71.7, *SD* = 6.7; TR unlimited: *M* = 71.3, *SD* = 5.6), 43 females	Blatant/Memory	Combined TR/Test presented as non-diagnostic of memory (Subtle) and provided information favouring performance of OA (Blatant)	Objective/Word list recognition Subjective/Remember vs. Know metamemory task	TR > ABST when memory decisions were time limited. ABST deadline condition reported lower ratio of 'remember' (i.e., remembered learning words and recalled associated contextual details) to 'know' (i.e., words were identified as familiar, but no contextual details were recalled) responses.
Hess, Hinson, et al. (2009), USA	103 OA: 53 young-old – 60-70 years (*M* = 64.2), 26 females; 50 old-old – 71-82 years (*M* = 75.4), 25 females	Blatant/Memory	Blatant TR/Test presented as age-fair	Objective/Word list free-recall and computation span task	Young-old OA with higher education had poorer free-recall in ABST condition. Pattern reversed but not significant in TR condition.
Horton et al. (2010), Canada	96 OA (36 males: *M* age = 68.33, *SD* = 4.02; 60 females: *M* age = 66.33, *SD* = 5.04)	Blatant/Memory and physical ability	Blatant TR/Informed about the maintenance of memory and physical abilities with age	Objective/Word list recall Subjective/MIA questionnaire (Memory	No significant difference between conditions in recall performance. No significant correlation between recall and investment in memory ability.

Study, Country	Participants	ABST Manipulation: Type/Stereotyped Domain	Comparison Condition(s): Type/Manipulation	Cognitive Outcome: Type/Measure(s)	Key Findings[a]
				Achievement subscale)	
Jordano & Touron (2017), USA	90 OA, 60-75 years (*M* = 67.51, *SD* = 3.89); 30 YA	Blatant/Memory	Combined TR/Articles rejecting inevitability of memory decline (Blatant) and presented test as non-diagnostic of memory (Subtle)	Objective/Operation span task Subjective/MIA questionnaire (Memory Anxiety and Achievement subscales)	TR had greater recall accuracy (*d* = 0.61) and reported less task-related interference than ABST (*d* = 0.61).
Kalenzaga et al. (2019), France	25 OA, 66-80 years (*M* = 71.28, *SD* = 4.86); 25 YA	Blatant/Memory	Blatant TR/OA were informed the test was easy for their age group	Subjective/Remember vs. Know metamemory task Objective/Running-span and trail making	TR produced more 'remember' responses (*d* = 1.47) and fewer 'know' false alarms (*d* = 0.94) than ABST.
Liu et al. (2017), China	Exp 2: 95 OA >55 years (ABST: *M* = 68.83, *SD* = 4.26; ABST + positive identity: *M* = 67.83, *SD* = 5.14; ABST + negative identity: *M* = 67.36, *SD* = 5.96; ABST + multiple identities: *M* = 66.35, *SD* = 5.66)	Blatant/Memory	ABST + Blatant TR/ ABST + Article on advantages (positive identity) or advantages and disadvantages (multiple identities) of OA vs. YA ABST + negative identity/ABST + article on disadvantages of OA vs. YA	Objective/Word list recognition task	ABST + multiple identities > ABST (*d* = 0.77) and ABST + negative identity (*d* = 0.65). No significant differences reported between ABST + positive identity, ABST + negative identity, and ABST conditions.
Marquet et al. (2017), Belgium	58 OA, 57-83 years (ABST: *M* = 66.57, *SD* = 5.77; TR: *M* = 66.37, *SD* = 5.78), 38 females	Blatant/Memory	Combined TR/Test presented as non-diagnostic of memory (Subtle) and age-fair (Blatant)	Objective/Word list recall and Brown-Peterson task	No significant effect of condition on task performance.
Mazerolle et al. (2017), France	80 OA, 60-93 years (*M* = 75, *SD* = 8.31)	Subtle/Memory	Combined TR/Presented Test 1 as age-fair, and educated OA on ABST prior to Test 2 (Blatant); Test 2 presented as under construction (Subtle)	Objective/MMSE and MoCA	TR > ABST on cognitive screening tests (*d* = 0.81). Effects of ABST eliminated after OA debriefed and educated about ABST.
Mazerolle et al. (2012), France	110 OA (*M* = 69.01 years, *SD* = 5.67), 71 females; 110 YA	Subtle/Memory	Blatant TR/Test presented as age-fair	Objective/Reading span and word list cued-recall tasks	TR > ABST on working memory (*d* = 0.54) and controlled recollection in cued-recall (*d* = 0.07).
Mazerolle et al. (2015), France	38 OA, 60-83 years (*M* = 69.33, *SD* = 5.71); 40 YA	Subtle/Memory	Blatant TR/Test presented as age-fair	Subjective/Remember vs. Know metamemory task	TR reported more 'remember' responses (*d* = 0.67) and fewer 'know' responses (*d* = 0.55) than ABST.
Plaks &	Exp 3: 84 OA, 60-80 years	Blatant/Cognitive and	Blatant TR/Article rejecting	Objective/Word list	TR > ABST on free-recall (*d* = 0.52)

Study, Country	Participants	ABST Manipulation: Type/Stereotyped Domain	Comparison Condition(s): Type/Manipulation	Cognitive Outcome: Type/Measure(s)	Key Findings[a]
Chasteen (2013), Canada	(ABST: *M* = 69.64, *SD* = 0.98; TR: *M* = 68.9, *SD* = 0.82), 44 females	memory ability	inevitability of cognitive decline	free-recall and reading span tasks	and reading span (*d* = 0.52). Better performance in TR associated with lower pre-task worry.
Popham & Hess (2015), USA	63 OA, 65-83 years (TR: *M* = 70.8, *SD* = 4.2; ABST: *M* = 71.1, *SD* = 3.7), 31 females; 64 YA	Blatant/Cognitive ability and mental agility	Combined TR/Task description favoured qualities (Subtle) and performance of OA (Blatant)	Objective/Letter-cancelling and operation span tasks	TR faster on letter-cancelling (*d* = 0.63) but made more mistakes than ABST.
Swift et al. (2013), UK	Exp 2: 120 OA, 61-95 years (*M* = 76.16), 71 females	Subtle/Intellectual performance (i.e., math and spatial skills)	Subtle TR/Task description favoured qualities of OA Control/No ABST	Objective/Crossword and cognitive (i.e., problem-solving) tasks	TR > ABST on crossword (*d* = 0.98) and cognitive (*d* = 1.02) tasks. TR > controls on crossword task (*d* = 0.46). TR = controls on cognitive task.
Tan & Barber (2020), USA	107 Chinese OA, 55-84 years (*M* = 68.5), 56 females 85 American OA, 56-91 years (*M* = 71.76, *SD* = 6.39), 53 females	Blatant/Memory	Blatant TR/Test presented as age-fair Subtle TR + ABST/ Primed age-positive cultural values + ABST	Objective/Word list recall	TR > ABST for Chinese (*d* = 0.59) and American (*d* = 0.63) OA. For Chinese OA, TR + ABST > ABST (*d* = 0.59). TR = TR + ABST.
Thomas et al. (2020), USA	Exp 1: 62 OA (*M* age = 73.51), 38 females Exp 2: 66 OA (*M* age = 72.59), 51 females	Blatant/Memory	Blatant TR/Article describing research showing that some types of memory do not decline with age	Objective/Operation span (Exp 1), cued-recall eyewitness memory (Exp 1 and 2), and source monitoring tests (Exp 2)	Exp 1: ABST produced fewer correct responses (*d* = 0.77) and more omission errors (*d* = 1.06) than TR. Exp 2: ABST ≥ TR. TR less accurate than ABST on source monitoring.

Notes. ABST = age-based stereotype threat; ACE-R = Addenbrooke's Cognitive Examination-Revised; AD = Alzheimer's Disease; MIA = Metamemory in Adulthood; MoCA = Montreal Cognitive Assessment; MMSE = Mini Mental State Examination; OA = older adults; TR = threat-removal; WAIS-IV = Wechsler Adult Intelligence Scale – Fourth Edition; WMS-III = Wechsler Memory Scale – Third Edition; YA = young adults.

[a] Effect size reported when able to calculate on the basis of data reported. For consistency, effect sizes are all reported as Cohen's *d* (0.20 = small, 0.50 = medium, 0.80 = large) and were converted from partial eta-squared, when necessary.

Table 2. *Methodological Quality of Articles Included in Review*

Study	Sample characteristics	Participant recruitment and screening	Sample size justification	Study design and group allocation	Experimental control	Experimental variables and outcome measures	Descriptive statistics on outcome measures	Statistical control	Total
Abrams et al. (2008)	x	x		x		x	x	x	6
Aisenberg et al. (2015)			x	x		x	x	x	5
Alquist et al. (2018)			x	x		x	x		4
Andreoletti & Lachman (2004)	x	x		x	x	x	x	x	7
Barber & Mather (2013a)	x		x			x	x	x	5
Barber & Mather (2013b)	x				x	x	x		4
Barber et al. (2015)	x			x	x	x	x	x	6
Barber et al. (2019)	x	x		x		x	x	x	6
Brubaker & Naveh-Benjamin (2018)	x	x			x	x	x		5
Chapman et al. (2016)	x	x		x	x	x		x	6
Fernández-Ballesteros et al. (2015)	x	x		x	x	x	x	x	7
Fresson et al. (2017)	x	x	x	x	x	x	x	x	8
Haslam et al. (2012)	x	x		x	x	x	x	x	7
Hehman & Bugental (2013)	x	x		x	x	x	x	x	7
Hess et al. (2003)	x			x	x	x	x	x	6
Hess, Emery, et al. (2009)	x	x				x	x	x	5
Hess, Hinson, et al. (2009)	x			x		x		x	4
Horton et al. (2010)	x	x		x	x	x	x	x	7
Jordano & Touron (2017)	x	x		x		x	x	x	6
Kalenzaga et al. (2019)				x	x	x	x	x	5
Liu et al. (2017)		x		x	x	x	x	x	6
Marquet et al. (2017)	x	x		x	x	x		x	6
Mazerolle et al. (2017)		x		x	x	x	x		5
Mazerolle et al. (2012)	x			x		x	x		4
Mazerolle et al. (2015)		x		x		x	x	x	5
Plaks & Chasteen (2013)	x			x	x	x	x		5
Popham & Hess (2015)	x			x	x	x	x	x	6
Swift et al. (2013)	x	x		x	x	x	x	x	7
Tan & Barber (2020)	x	x	x	x	x	x	x	x	8
Thomas et al. (2020)	x	x	x	x		x	x		6

Table 3. *Stereotype Threat-Removal Strategies Included in Review*

Strategy	Studies
Subtle	
Framed test as non-diagnostic task (e.g., memory test as verbal comprehension task)	Barber & Mather (2013b); Brubaker & Naveh-Benjamin (2018); Hess, Emery, et al. (2009); Jordano & Touron (2017); Marquet et al. (2017)
Reduced evaluative performance pressure (e.g., informed participants the test they are about to complete is under construction)	Mazerolle et al. (2017)
Primed participants with positive qualities associated with aging or provided task description favouring performance of those with qualities associated with older age (e.g., wisdom, life experience, problem-solving)	Barber et al. (2019); Hehman & Bugental (2013); Popham & Hess (2015); Swift et al. (2013)
Manipulated age-based self-categorisation (i.e., primed participants to self-categorise as younger)	Barber et al. (2015); Haslam et al. (2012)
Primed older adults with age-positive cultural values (e.g., Confucian value of filial piety or respect for one's parents, elders, and ancestors)	Tan & Barber (2020)
Exposed older adults to an imagined intergenerational contact scenario	Abrams et al. (2008)
Provided vignettes, pictures, or videos of counter-stereotypical exemplars (i.e., older adults in positive or astereotypical roles)	Aisenberg et al. (2015)
Blatant	
Provided information on the preservation and/or improvement of cognitive abilities with age; presented information on the malleability of age-related cognitive change (i.e., induced a growth mindset); or rejected the inevitability of cognitive decline (e.g., "cognitive decline is preventable")	Alquist et al. (2018); Barber & Mather (2013a, 2013b); Barber et al. (2015); Fresson et al. (2017); Hess et al. (2003); Horton et al. (2010); Jordano & Touron (2017); Plaks & Chasteen (2013); Thomas et al. (2020)
Presented test as free of age bias or "age-fair" (i.e., younger and older adults perform equally as well)	Andreoletti & Lachman (2004); Barber & Mather (2013b); Barber et al. (2019); Hess, Hinson, et al. (2009); Marquet et al. (2017); Mazerolle et al. (2012, 2015, 2017); Tan & Barber (2020)
Provided research 'evidence' favouring the performance of older adults or stated older adults perform better than younger adults	Brubaker & Naveh-Benjamin (2018); Chapman et al. (2016); Fernández-Ballesteros et al. (2015); Hess, Emery, et al. (2009); Kalenzaga et al. (2019); Popham & Hess (2015)
Primed multiple identities relevant to one's age (e.g., positive and negative aspects of being older compared with being younger)	Liu et al. (2017)
Provided education or debriefed older adults about stereotype threat	Mazerolle et al. (2017)