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# On Working Memory Capacity and Implicit Associations between Advanced Age and Dangerous Driving Stereotypes

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*Summary: Despite a large literature on implicit stereotypes, no one has scientifically documented the stereotype that older adults are dangerous drivers, even though its existence may impact older adults' driving performance through stereotype threat. The present studies are the first to use implicit tests to document the stereotype that older adult drivers are dangerous drivers. Experiment 1 (N = 159) documented a negative stereotype of older adult drivers in young and older adults by using a novel driving and age Implicit Association Test (IAT). Experiment 2 (N = 216) demonstrated that individual differences in working memory capacity moderate the degree to which young adults can willfully change this IAT score such that higher working memory capacity was associated with greater control of this negative stereotype of age and driving. This finding illustrates the potential utility of working memory capacity in interventions designed to reduce the impact of implicit stereotypes and negative attitudes. Copyright © 2013 John Wiley & Sons, Ltd.*

Older adults in the USA perceive the possession of a driver's license as the key to independence and an integral part of their personal and social identity (Eisenhandler, 1990). Using a qualitative focus group approach to discuss aging and driving with older adults, Yassuda, Wilson, and von Mering (1997) found that driving cessation was the most frequently discussed theme, accounting for 40% of the discussions. Within this theme, conversation focused on driving management and reluctance to give up driving. As described by one focus group member, 'they will pry my cold dead hands off the wheel before I stop driving' (p. 534). Anecdotal evidence in popular media suggests that older adults' desires to retain driving privileges seem to conflict with stereotypes about their driving abilities. For example, in a television episode of *South Park*, when a senior center meeting is adjourning, a character runs through town yelling, 'Get off the streets! Old people driving!' Another example is an online blog, automoblog.net, which recently posted a discussion about whether older adults should be banned from driving. In his blog, Burdick (2010) stated, 'I know *for a fact* that old people are a danger on the roads'. These anecdotal examples suggest that poor driving ability may comprise a component of ageism in our society.

Ageism, a phenomenon similar to sexism or racism, involves negative attitudes, stereotyping, and behaviors directed toward older adults based solely on their perceived age (Richeson & Shelton, 2006). This form of prejudice has been studied in terms of its applied manifestation explicitly and implicitly. For example, explicit ageism in the work place has affected seniors in the form of mandatory retirement ages (Hedge, Borman, & Lammlein, 2006). Implicitly, ageism can affect seniors in terms of health care decisions that are made by medical professionals that may be based on their negative attitudes and stereotypes toward older adults rather than objective measures of health (Adelman, Greene, Charon, & Friedmann, 1992). Specific stereotypic trait components of older adults have also been examined (Hense, Penner, & Nelson, 1995; Nosek, Banaji, & Greenwald, 2002). Within the laboratory, investigations of older adult stereotypes have often focused on identifying stereotypic traits such as 'traditional', 'conservative', and 'lonely' and more recently the trait of 'forgetfulness' (Brewer, Dull, & Lui, 1981; Hess & Hinson, 2006; Horton, Baker, Pearce, & Deakin, 2008). However, despite the wide circulation of anecdotal evidence for a poor driving component of the older adult stereotype, little attention has been paid to this possibility by the scientific community.

Two studies have alluded to stereotypes of older adult drivers, but these studies focused on positive aspects of their driving, such as less aggressive driving tendencies (Branaghan & Gray, 2010; Davies & Patel, 2005). Branaghan and Gray demonstrated that priming of the older adult stereotype caused young adult participants to drive slower and to take longer to reach their destination. Davies and Patel collected ratings of aggressiveness for hypothetical drivers of different ages and genders. Older adult women were rated least aggressive followed by older adult men. Taken together, these studies suggest that older adult drivers are stereotypically viewed as slower and less aggressive behind the wheel, but they do not rule out the possibility of negative implicit stereotypic associations between older adults and driving safety. Further, negative implicit associations would not necessarily contradict the driving traits of older adults reported in these studies. For example, driving slower than posted speed limit signs can disrupt traffic flow. Further, national statistics clearly show that older adults are disproportionately involved in traffic-related fatalities (National Highway and Traffic Safety Administration, 2008). Older adults represent 13% of the population but account for 15% of traffic fatalities and 18% if pedestrian fatalities. These more negative observations may also be reflected in cultural stereotype of older adult drivers. Thus, empirically examining stereotyped associations between advanced age and driving safety would help to shed light on the possibility that cultural stereotypes of older adult drivers may be quite complex.

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Research on the structure and function of stereotypes has demonstrated that they can be explicitly endorsed, implicitly held, or both. Implicit measurement techniques show that individuals who explicitly refuse to endorse social stereotypes may still carry stereotypical associations. Notable among these techniques is the Implicit Association Test (IAT), which measures the strength of an association between a target and an attribute (Greenwald, McGhee, & Schwartz, 1998). For example, white participants respond more quickly when the category *black* is paired with *unpleasant* than when the category *white* is paired with *unpleasant*, and more slowly when *black* is paired with *pleasant* than when *white* is paired with *pleasant*. This pattern persists even when participants do not explicitly endorse negative stereotypes of black people (Nosek et al., 2002). IATs have been widely used to assess implicit attitudes across many social domains including attitudes toward aging. In their large, web-based study, Nosek et al. created an IAT (as well as nine other IATs) aimed at examining positive and negative implicit associations of older and younger adults. In this IAT, participants sorted images of older and younger adult faces and positive and negative words (e.g., *happy*, *awful*) into categories of *old*, *young*, *good*, and *bad*. They found that most participants responded more quickly when the categories *old or bad* and *young or good* were paired than when the categories *old or good* and *young or bad* were paired, thereby showing an automatic preference for young over old. For the purposes of the present study, it is important to note that no previous IAT has been developed to specifically assess attitudes toward aging and driving safety. Therefore, by using a novel driving and aging IAT, Experiment 1 assessed implicit associations between *old* and *young* with *safe* and *dangerous*, respectively, while also collecting explicit measures of the stereotype in both young and older adults. We hypothesized that young and older adult participants would produce IAT effects consistent with the stereotype that older adult drivers are dangerous. Regarding the explicit measures, we hypothesized that young adults would be more likely than older adults to explicitly endorse negative stereotypes of older adult drivers given that young adults are not themselves members of the stigmatized groups.

## EXPERIMENT 1

### Method

#### *Participants*

One hundred and seven University of Utah undergraduates (age range 18–30 years, $M = 21.34$ years) participated in exchange for course credit. Fifty-two community-dwelling older adults (age range 61–89 years, $M = 72.52$ years) participated and were compensated with $15.

#### *Materials and apparatus*

The IAT (Greenwald et al., 1998) is a reaction time task that measures the strength of association between two concepts. Associations are considered to be implicit because they can be activated automatically and measured outside of conscious awareness. The task involves comparing reaction times for classifying pairs of stimuli thought to be more strongly associated (e.g., *fear* and *heights*) than ones thought to be less associated (e.g., *fear* and *flowers*). When the pairing represents a strong implicit association, participants classify stimuli more quickly.

In our IAT, modeled after the seven-block version described by Lane, Banaji, Nosek, and Greenwald (2007), participants sorted words as belonging to the categories of *safe* or *dangerous* and faces as belonging to the categories *old* or *young* (Figure 1). Verbal stimuli that were related to the concepts of safe and dangerous driving were compiled from the Nelson, McEvoy, and Schreiber (1999) word association norms as well as from the AARP Driver Safety Program participant workbook. These lists, in addition to safety-relevant (but not necessarily driving specific) and safety-irrelevant words (as a baseline), were then rated by undergraduate students at the University of Utah in terms of the strength of their relationship to the concepts of safe and dangerous driving without any mention of aging. This was done to verify that our stimuli differed from positively and negatively valenced verbal stimuli used in other aging IATs (see Appendix for a complete list of driving-relevant stimuli used in our IAT). Importantly, the present stimuli were rated to be specifically driving relevant (e.g., *crash*, *observant*).[1] Images of young and older adults were taken from a previous IAT that examined associations between *young/old* and *good/bad* categories (Nosek et al., 2002).

We also included an altered version of the feeling thermometer (based on Greenwald et al., 1998) that asked participants to describe their general level of warmth or coolness toward two target concepts: older adults' (≥60) driving and others' driving (<60). Participants indicated warmth or coolness by circling an answer on a scale from 0 (*very cold*) to 10 (*very warm*). This measure indexed participants' explicit attitudes toward older drivers.[2]

#### *Procedure*

All participants sat in front of a computer monitor for the IAT. As shown in Figure 1, category pairings appeared in the upper left and right corners of the computer screen. Words and images appeared in the middle of the screen. There were 16 words (eight positively valenced and eight negatively valenced). There were six images of older adults' faces (three women and three men) and six images of young adult faces (three women and three men). Our IAT was a classic seven-block IAT. The first two blocks were practice blocks. In block 1, the category headings were *old* and *young*, and the to-be-sorted items were images of older and young adult faces. In block 2, the category headings were *safe* and *dangerous*, and the to-be sorted items were words

[1] IAT safety-relevant stimuli, non-IAT safety-relevant words, and baseline non-safety-relevant words were rated by 70 undergraduates on their relatedness to the concepts of safe and dangerous driving. IAT stimuli were judged to be significantly more related to the concepts of safe and dangerous driving than non-IAT safety-relevant and baseline words.

[2] There was some concern that the category of *young adult drivers* could be interpreted as *teenage drivers* in these experiments because teenagers may also be stereotyped as dangerous drivers. In our IAT, visual images of young adult faces made this distinction clear. However, because no such images were presented in the feeling thermometer, we used the anchors *older adults* and *others* as opposed to *older adults* and *young adults* in order to reduce the possibility that some participants would interpret the *young adult* category as representative of teenage drivers.

 

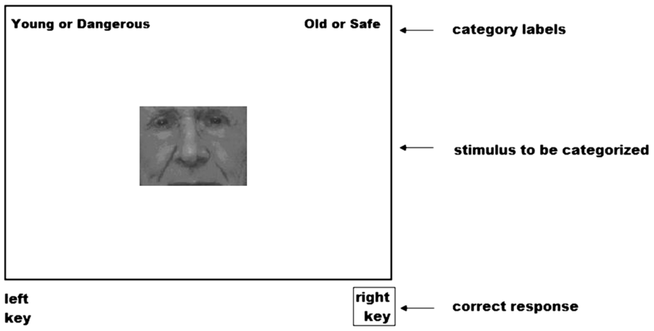


Figure 1. Sample IAT trial for which the participant's task is to categorize the image as *old* when the category is paired with *safe* by pressing a key on the right side of the keyboard. *Note*. Participants classify the stimulus by using either the right or left key. This trial represents a category pairing that is inconsistent with negatively valenced associations between driving and advanced age

related to safe and dangerous driving. Blocks 3 and 4 were critical conditions where the two category headings were combined (e.g., category pairings of *old* or *safe* on the left and *young* or *dangerous* on the right), and to-be-sorted items were words related to safe and dangerous driving, and images of older and young adult faces. Block 5 was another practice block where the category headings were *safe* and *dangerous*, and the to-be-sorted times were words related to safe and dangerous driving. Finally, blocks 6 and 7 were critical conditions where the two category headings were again combined (e.g., category pairings of *old* or *safe* on the left and *young* or *dangerous* on the right), and to-be-sorted items were words related to safe and dangerous driving, and images of older and young adult faces. Within each block of the IAT, words, images, or both appeared individually in a random order in the center of the screen, and participants sorted them according to the correct category label by pressing a key on the keyboard that corresponded to the spatial location of the correct category. Thus, if the category pairings were *old* or *safe* on the left and *young* or *dangerous* on the right, then participants correctly sorted the word *crash* by pressing the key on the right side of the keyboard. Responses were considered incorrect if a 'dangerous' word was categorized under the paired heading that contained 'safe', if a 'safe' word was categorized under the paired heading that contained 'dangerous', if an image of an old face was categorized under the paired heading that contained 'young', or if an image of a young face was categorized under the paired heading that contained old. The IAT took approximately 10 minutes to complete. For critical blocks 3, 4, 6, and 7, stimuli pair order was counterbalanced across participants so that half of the participants first sorted stimuli according to the categories pairing *old* with *safe* and *young* with *dangerous* in block 3 (and then the pairing orders alternated for blocks 4 through 7) while the other half first sorted stimuli according to the categories pairing *old* with *dangerous* and *young* with *safe* in block 3 (and then the pairing orders alternated for blocks 4 through 7). Stimuli remained on the screen until participants responded. Each stimulus presentation was separated by a 500-millisecond interstimulus interval (ISI) for trials in which the participant responded correctly. If the participant responded incorrectly, a screen indicating an error appeared for 500 milliseconds in place of the standard 500-millisecond ISI. We hypothesized that participants would be slower to categorize negatively valenced, driving-relevant stimuli such as crash when safe was in the same spatial location as old compared with when dangerous and old were paired together.

## Results

IAT *D* scores were calculated for each individual by using the improved IAT scoring algorithm as described by Lane et al. (2007). This *D* score represents the difference in mean reaction time between critical conditions (dangerous or old/safe or young, and safe or old/dangerous or young) divided by the standard deviations across conditions. Consistent with the results of Greenwald, Nosek, and Banaji (2003), trials with reaction times greater than 10,000 milliseconds were removed from the data set prior to *D* score calculations. No participants' data were deleted because of unusually fast reaction times (i.e., $<300$ milliseconds). Consistent with the IAT scoring algorithm, error trials were not removed from analyses. Thus, within this scoring system, *D* scores above zero indicate stronger associations between the *young-safe* and *old-dangerous* category pairings than *young-dangerous* and *old-safe*, which could be interpreted as novel empirical evidence for a negatively valenced stereotype of aging and driving. Scores below zero indicate the opposite, which could be interpreted as additional empirical evidence for a positively valenced stereotype of aging and driving (cf., Branaghan & Gray, 2010; Davies & Patel, 2005). As predicted, both young and older adults exhibited stronger associations between the *young-safe* and *old-dangerous* category pairings than *young-dangerous* and *old-safe* [young $t(106) = 18.25$, $p < .001$, $d = 1.79$; old $t(51) = 8.73$, $p < .001$, $d = 1.12$]. More specifically, young adults' IAT *D* score was 0.43; whereas older adults' IAT *D* score was comparable at 0.37. Indeed, an independent samples *t*-test showed these two groups' *D* scores were not significantly different from one another, $t(157) = 0.3$, $p = .12$, $d = 0.05$, suggesting that the implicit association strength and the negative stereotype of older adult driving may persist with age, even in members of the stigmatized group.

We also calculated a feeling thermometer difference score by subtracting each participant's rating on item 1 (older adults' driving) from their rating on item 2 (others' driving). Thus, positive scores indicated greater feelings of warmth toward others' driving than older adults' driving, and negative scores indicated the opposite. As anticipated, young adults reported greater feelings of warmth toward others' driving than older adults' driving (2.6) whereas the opposite was true for older adults ($-0.01$). One samples *t*-test confirmed that young adults' mean difference score was significantly greater than zero, $t(106) = 11.56$, $p < .001$, $d = 1.06$; however, older adults' mean difference score was equivalent to zero, $t(51) = -0.31$, $p = .76$, $d = 0.05$. Therefore, only young adults explicitly felt colder toward older adults' driving than others' driving. An independent samples *t*-test comparing these two groups' difference scores on the explicit measure also showed that young adults reported warmer feelings toward others' driving than older adults', $t(157) = 7.00$, $p < .001$, $d = 1.12$. Neither young $r(105) = -.01$, $p = .90$ nor older $r(50) = -.06$, $p = .68$ adults' IAT *D* scores correlated with their explicit attitudes.

## Discussion

While using a newly developed IAT measure, the results of Experiment 1 clearly demonstrated that both young and older adults hold implicit associations between age and dangerous driving, even though older adults do not explicitly endorse this attitude. To our knowledge, this is the first empirical evidence of a negative stereotype of older drivers, verifying that, in Western culture, stereotypes of older drivers are more complicated than has been suggested by prior research on positive aspects of this stereotype. Converging evidence suggests that performance on IAT measures, like the one used here, may be related to attentional control as measured by a computation span task (Hofmann, Gschwendner, Friese, Wiers, & Schmitt, 2008) an anti-saccade task (Payne, 2005) and a Stroop color naming test (Richeson & Shelton, 2003). Attentional control, which requires working memory capacity, refers to one's ability to maintain task goals when confronted with sources of interference or other distractions (Engle, 2002). Many have argued (see Engle, 2002; Hester & Garavan, 2005; McCabe, Roediger, McDaniel, Balota, & Hambrick, 2010 for examples) that attentional control and working memory comprise the crux of executive function or those cognitive processes that allow us to control our thoughts and actions. These abilities are particularly important in situations where one must override an automatic response in favor of a task-appropriate response. As such, working memory capacity has been shown to predict performance on many cognitive tasks that require goal maintenance and inhibitory control. Specifically, individual differences in working memory capacity have been shown to predict performance on lab standards such as Stroop color naming (Kane & Engle, 2003), dichotic listening (Colflesh & Conway, 2007; Conway, Cowan, & Bunting, 2001), and associative false memories elicited by the Deese, Roediger, and McDermott paradigm (DRM; see Gallo, 2010, for a recent review). Moving beyond these traditional lab tasks, individual differences in working memory capacity have also been shown to relate to performance in more applied domains such as driving, reading comprehension, ability to follow directions, vocabulary learning, note taking, writing, reasoning, bridge playing, and learning to write new computer programs (Engle, 2002; Watson & Strayer, 2010).

Perhaps most relevant for the purposes of the present discussion, Watson, Bunting, Poole, and Conway (2005) reported that the relationship between working memory capacity and susceptibility to associative memory illusions was particularly salient when participants were actively encouraged to avoid producing false memories. More specifically, within the DRM paradigm, lists of semantic associates (e.g., *bed*, *rest*, and *tired*) are presented to participants for a later episodic memory test. During that subsequent test, participants often falsely recall a semantically associated but non-presented critical word (e.g., *sleep*). This memory illusion is thought to occur, in part, because of an automatic spreading of activation from the semantically associated list items to critical words (Anderson, 1983; Roediger, Watson, McDermott, & Gallo, 2001). Thus, overcoming this illusion may require one to adopt the task goal of overriding this automatic process with a strategic one that more closely monitors the source of activation for critical words. Consistent with this argument, when participants were forewarned about the tendency of DRM lists to elicit false memories for non-presented critical words, Watson et al. (2005) found that those higher in working memory capacity were less susceptible to associative false memories. Watson et al. concluded that warning instructions equipped participants with a specific goal to help them control and avoid these automatic false memories, and individuals higher in working memory capacity were better able to actively maintain that task goal.

Returning to the potential implications of individual differences in working memory capacity for altering IAT performance, if there are strong implicit associations between *old* and *dangerous* driving that one is instructed to control, successful goal maintenance may require overriding a tendency to respond more quickly while sorting stimuli when the categories *young-safe* and *old-dangerous* are paired together. Carrying this logic forward, successful goal maintenance may also require overriding the tendency to respond more slowly when the categories *young-dangerous* and *old-safe* are paired together. Fiedler and Bluemke (2005) and Cvencek, Greenwald, Brown, Gray, and Snowden (2010) recently demonstrated that some participants could successfully 'fake' their IAT scores by intentionally slowing their reaction time when category pairings were consistent with their true implicit associations, and hastening their reaction time when category pairings were inconsistent with these associations. In these studies, the faking instructions explained how the IAT is a measure of implicit associations and provided participants with a specific goal to alter their responding in a manner that would contradict their automatically activated attitudes. In this light, mechanistically, successful faking on the IAT would appear to be reliant on one's ability to successfully maintain and implement a goal. If so, given the similarities between the current experimental design and that of Watson et al. (2005), individual differences in working memory capacity should predict the ability to regulate the underlying, automatic, negative associations that exist between age and driving safety. To test this hypothesis, in Experiment 2, we used the same IAT measure as in Experiment 1; however, we incorporated additional instructions where some participants were warned about the possibility of a negative stereotype of age and driving as indexed by our novel IAT. Akin to the earlier finding on the strategic control of false memory by Watson et al., we expected that those with greater working memory capacity would better maintain these task instructions and minimize susceptibility to automatic associations. Consequently, in Experiment 2, individuals high in working memory capacity should be better able to exert control over the negative stereotype of age and driving, thereby lowering their $D$ scores on our IAT measure to appear more positive with respect to their attitude on aging and driver safety.

## EXPERIMENT 2

### Method

#### *Participants*

Two-hundred and twenty-six young adults (age range 18–30 years, $M = 21.60$ years) from the University of Utah participated in exchange for course credit. Data from 10 participants were not retained for analysis because of Operation Span (OSPAN) math accuracy of below 80%.

*Materials and procedures*

The materials and procedures were identical to those of Experiment 1 with two notable exceptions. Prior to the IAT tests, participants took an OSPAN test of working memory capacity. The automated OSPAN task (Unsworth, Heitz, Schrock, & Engle, 2005) was administered to multiple participants at a time. In this task, participants solved math equations (e.g., $(8/4)+3=?$), indicating if the solution provided (e.g., 3) was correct or incorrect by selecting 'True' or 'False' on their computer screen. Each equation and solution was followed by a to-be-remembered letter. After each set of equation–solution–letter triads, participants were prompted to recall all of the letters of each set in serial order. Set sizes ranged from 3 to 7 equation–solution–letter triads, where the order of set sizes was randomized. An absolute span scoring system gave participants points equal to the set size when all of the letters of the set were recalled in the correct serial order, summing points across all recall periods with a maximum possible score of 75. Throughout the OSPAN task, math performance was recorded and accuracy feedback was provided in order to keep math accuracy high and to encourage participants to comply with the dual-task math/memory instructions.

As an additional difference from Experiment 1, after completing the OSPAN and the first IAT, 107 participants were given instructions, modeled after Cvencek and colleagues (Cvencek et al., 2010), to adopt the goal of changing their IAT scores. These participants were told to take a second IAT test while responding as though they were hypothetical older adults by (i) going slowly for the condition in which the *young-safe* and *old-dangerous* category pairings shared a response key, and (ii) going quickly for the condition in which *young-dangerous* and *old-safe* shared a response key. To provide a comparison group that controlled for potential practice effects on the IAT, an additional 109 participants were given instructions to simply take the test again.

**Results and discussion**

Means and standard deviations for implicit and working memory capacity measures are displayed in Table 1. For each participant, two IAT $D$ scores, one for each time participants took the test, were calculated using the algorithm of Experiment 1. One participant's data were removed from the control condition because more than 10% of trials had latencies less than 300 milliseconds, but this participant had already been tagged for exclusion because of low math performance on the OSPAN. On the first IAT, mean $D$ scores of both groups were consistent in magnitude and direction with the young adults in Experiment 1 (i.e., $D \approx 0.43$). One samples $t$-tests determined that both means significantly differed from zero [goal-oriented $t(106)=18.74$, $p<.001$, $d=1.80$; control $t(108)=15.93$, $p<.001$, $d=1.67$], replicating the findings of Experiment 1. Like in Experiment 1, we again calculated a feeling thermometer difference score by subtracting each participant's rating on item 1 (older adults' driving) from their rating on item 2 (others' driving). Both groups reported greater feelings of warmth toward others' driving than older adults' driving (goal-oriented = 2.40; control = 2.17) with both mean differences significantly differing from zero [goal-oriented $t(106)=10.30$, $p<.001$, $d=1.0$; control $t(108)=9.32$, $p<.001$, $d=0.90$].

Table 1. Experiment 2: means (and standard deviations) of implicit scores (IAT1 $D$ and IAT2 $D$) and working memory capacity (OSPAN)

| | IAT1 $D$ | IAT2 $D$ | OSPAN |
|---|---|---|---|
| Condition | | | |
| Control | 0.40 (0.26) | 0.39 (0.24) | 42.00 (18.32) |
| Goal-oriented | 0.45 (0.25) | −0.18 (0.62) | 43.48 (18.15) |

Bivariate correlations between IAT $D$s and OSPAN were examined for both the control and goal-oriented groups on the first and second IATs. On the first IAT, the correlation between IAT $D$ and OSPAN did not reach significance for either group [practice group $r(107)=-.13$, $p=.191$, goal-oriented group $r(105)=.02$, $p=.836$]. On the second IAT, the correlation between IAT $D$ and OSPAN was only significant for the goal-oriented group $r(105)=-.20$, $p=.037$ [practice group $r(107)=.011$, $p=.910$]. Next, hierarchical multiple linear regression was used to test for main effects and interactions on the dependent measure $D$. The categorical variables of warning condition (control vs. goal-oriented) and test (one vs. two) and the continuous variable of working memory capacity were entered simultaneously in the first step of the regression. Three 2-way interaction terms were also created, one for each two-way product combination (i.e., warning condition × test, warning condition × working memory capacity, and working memory capacity × test), and one 3-way interaction term was created as the product of all three independent variables. The two-way interaction terms were entered simultaneously in the second step of the regression. Finally, the three-way interaction term was entered in the third step. The first [$R^2=.21$, $F(3{,}428)=38.11$, $MSe=0.17$, $p<.001$], second [$R^2=.33$, $F(6{,}425)=35.26$, $MSe=0.14$, $p<.001$], and third [$R^2=.34$, $F(7{,}424)=31.26$, $MSe=0.14$, $p<.001$] steps all resulted in significant models. In the first step, there were main effects of warning condition ($\beta=-2.58$, $p<.001$) and test ($\beta=-3.19$, $p$ .001), but not working memory capacity ($\beta=-.002$, $p=.06$). In the second step, the two-way interaction between warning condition and test was significant ($\beta=-.620$, $p<.001$); however, neither of the other two-way interactions was significant [warning condition × working memory capacity ($\beta=-.002$, $p=.21$); test × working memory capacity ($\beta=-.003$, $p=.20$)]. Most importantly, in the third step, the three-way interaction of working memory capacity, warning condition, and test on $D$ scores was significant ($\beta=-.009$, $p=.05$).

To better understand the nature of this three-way interaction, extreme groups were created by dividing participants into quartiles on the basis of their absolute OSPAN scores. Participants in the highest (high-span) and lowest (low-span) quartiles were retained for further analysis of IAT $D$ scores. OSPAN scores ranged from 0 to 29 (low-spans) and 55 to 75 (high-spans). These IAT data were submitted to a 2 (working memory capacity: low-span vs. high-span) by 2 (warning condition: control vs. goal-oriented) by 2 (test: one vs. two) ANOVA. In this ANOVA, test was manipulated within-subjects, whereas working memory capacity and warning condition were between-subjects variables. There were main effects of test, $F(1,104) = 52.74$, $p < .001$, $\eta_p^2 = 0.34$, and warning condition, $F(1,104) = 24.07$, $p < .001$, $\eta_p^2 = 0.19$. However, the main effect of working memory capacity was not significant, $F(1,104) = 0.96$, $p = .33$, $\eta_p^2 = 0.19$. There was also a two-way interaction between test and warning condition, $F(1,104) = 38.04$, $p < .001$, $\eta_p^2 = 0.27$. IAT *D* scores only differed from test 1 to test 2 in the goal-oriented condition. Most importantly, there was a three-way interaction among warning condition, test, and working memory capacity, $F(1,104) = 4.84$, $p < .05$, $\eta_p^2 = 0.04$, such that in the goal-oriented condition, high-spans produced more IAT change from test 1 to test 2 than low-spans. As predicted, as shown in the bottom panel of Figure 2, high-spans lowered their *D* scores on our IAT measure to appear more positive with respect to their attitude on aging and driver safety. High-spans most likely utilized their greater working memory capacity to maintain task goals and, hence, were better able to control implicit stereotype expression. In contrast, as shown in the top panel of Figure 2, the IAT *D* scores were virtually equivalent across the two span groups and tests in the control condition where no warning about the stereotype was given.

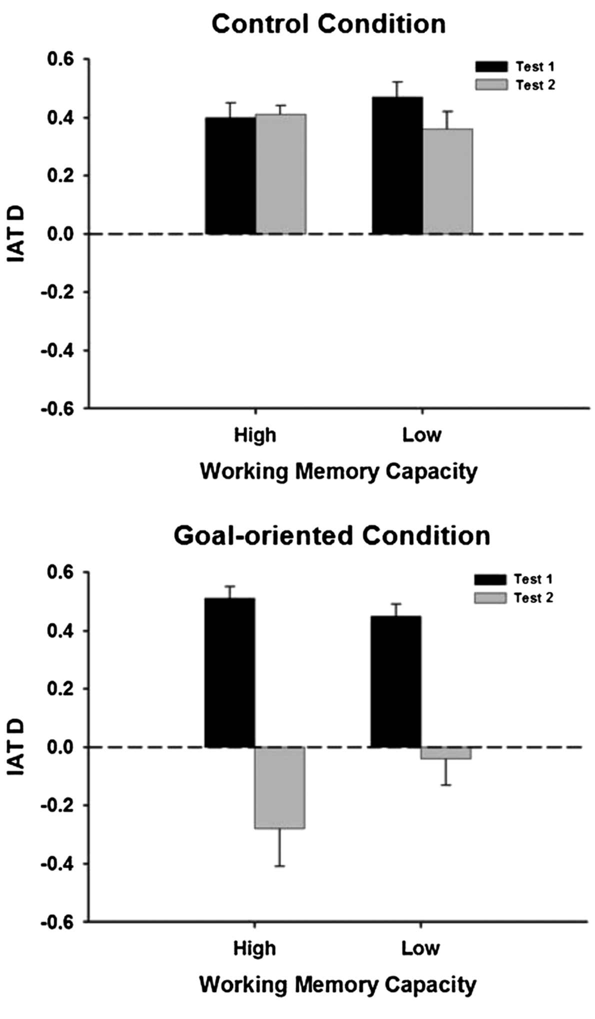


Figure 2. Mean IAT *D*s by condition [control (top panel) vs. goal-oriented (bottom panel)] and working memory capacity quartile (high = top 25%, low = bottom 25%). Error bars correspond to the standard error of the mean. IAT *D*s only differ in the goal-oriented condition where participants higher in working memory capacity show more change from test 1 to test 2, suggesting greater control of the negative stereotype of age and driving

## GENERAL DISCUSSION

The present study makes two important contributions. First, it empirically documents implicit and explicit stereotypes of older adult drivers. Second, it identifies working memory capacity as a moderator of the successful implementation of faking instructions to change one's IAT score. These patterns suggest that working memory capacity plays a critical role in controlling implicit associations, which may, in turn, have implications for suppressing stereotypic associations outside the laboratory. It is noteworthy that the role of working memory capacity demonstrated here is consistent with the broader literatures on social stereotypes and individual differences in cognition. For example, Schmader and Johns (2003) showed that bringing negative stereotypes about one's group to his or her attention can affect performance by depleting working memory capacity. Furthermore, using a weapon identification task, Payne (2005) found that performance on a working-memory-related anti-saccade task moderated the relationship between automatic stereotype activation and the behavioral expression of race bias. The results of the present study build on this prior work, providing theoretical leverage on who is most capable of regulating susceptibility to stereotype activation. More specifically, increased working memory capacity may confer individuals with a greater ability to control the expression of negative stereotypes, particularly when increased capacity is coupled with an explicit task goal to alter or fake outcomes in a manner that contradicts automatically activated attitudes about stereotyped groups.

The results of the present study also have important, applied implications. There is a long-established relationship between negative stereotypes, prejudice, and discrimination (Fiske, 1998; Krueger, 1996). Hence, the identification of a negative stereotype of older drivers informs our understanding of the breadth and complexity of ageism in our society. It also suggests that older adults may be at risk of experiencing the negative effects of ageism in an under-recognized domain: driving. Over a decade of research in social psychology has demonstrated that stereotypes of stigmatized groups can impact behavior on stereotype-relevant domains through a phenomenon called stereotype threat (Steele & Aronson, 1995; Smith, 2004). If this domain is driving, safety may be jeopardized. Consistent with this argument, stereotype threat has been shown to affect driving performance. Specifically, Yueng and von Hippel (2008) found that women were 50% more likely to hit jay-walking pedestrians in a driving simulator when negative stereotypes about female drivers were activated. Our lab's recent research extended this finding to include older adults (Lambert et al., under review). Using a high-fidelity driving simulator, we found that, under stereotype threat, older adults low in working memory capacity exhibited slower brake reaction times and longer following distances compared with an older adult control group and that, regardless of working memory capacity, older adults under stereotype threat were over six times more likely to experience a collision. Moreover, Steele and Aronson (1995) showed that stereotype threat need not be explicitly manipulated to impact behavior. When African-American participants were asked to simply indicate their race on a demographic questionnaire, they underperformed on a subsequent intelligence test. Thus, simply making one's group salient can activate negative stereotypes and elicit stereotype threat. For our purposes, even the mere mention of imposing driving restrictions on senior citizens could impact driving performance.

The primary purposes of the present research were to (i) implicitly and explicitly document an older adult driving stereotype and (ii) demonstrate the moderating role of working memory capacity in controlling the behavioral expression of that stereotype's activation. These two goals were accomplished across two experiments. In Experiment 1, we included both in-group (older adults) and out-group (young adults) samples because we felt the inclusion of both samples to be important for thorough stereotype documentation. However, in Experiment 2, we only tested younger adults because we felt this to be the logical first step by which to test our research question regarding the controllability of implicit associations given goal-specific instructions. In this respect, our work is consistent with the attentional control literature linking working memory capacity with applied performance outcomes, which has traditionally looked first to young adult samples (see Engle, 2002 for an overview). Further, the immediate inclusion of older adults in the Experiment 2 IAT paradigm could entail an important theoretical complication. Older adults would be asked to control a self-stereotype and, as such, may be especially motivated to utilize the goal-oriented instructions to change the direction of their IAT scores. In fact, there is evidence of this possibility given the implicit/explicit dissociation observed in Experiment 1 where older adults did not show an explicit negative self-stereotype of their driving performance. Thus, in the present context, older adults may be motivated to override a self-stereotype, and this could potentially wash out any moderating effect of working memory capacity such that older adults higher in working memory capacity may optimally reverse the direction of the implicit associations regardless of the instruction manipulation (goal-oriented vs. practice). In other words, older adults could be considered to be chronically under a goal-oriented condition because the stereotype directly relates to them, thereby making the goal-oriented and practice conditions functionally equivalent. In this situation, working memory capacity would moderate the degree to which older adults in both groups (goal-oriented and practice) could alter their IAT scores. Nonetheless, the implicit/explicit dissociation should be interpreted with caution, however, given that it consisted of only a few self-report items.

Still, one might wonder if the same pattern of moderation would emerge for older adults, had they been included in Experiment 2. Again harkening to the DRM memory illusion literature, McCabe and Smith (2002) and Watson, McDermott, and Balota (2004) have demonstrated that, like young adults, older adult are able to use warning instructions to avoid false memories. Thus, it seems logical that older adults should also be able to implement faking instructions to augment their IAT scores given sufficient working memory capacity. Further, such moderation would be consistent with our recent findings using the stereotype threat paradigm (Lambert et al., under review). Although replication of Experiment 2 with older adults comprises an interesting and logical next step, the results of the two experiments in the present paper make important contributions. To our knowledge, the present study is the first to scientifically document negative implicit stereotypes of older adults' driving ability despite the wide circulation of anecdotal examples in the media and positive stereotypes of older adult drivers exemplified in the scientific literature. It produced clear evidence that young and older adults possess negative implicit stereotypes of dangerous older adult driving and that young adults explicitly endorse this attitude. Further, working memory capacity predicted young adults' ability to change their IAT scores. Those higher in working memory capacity showed greater change in their implicit expression of the aging stereotype of driving when instructed explicitly to do so, a finding that entails important implications for stereotype control in the real world.

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## APPENDIX A

### IAT stimuli corresponding to the categories of safe and dangerous driving

*Safe*: ability, awake, aware, capable, control, focused, observant, skilled

*Dangerous*: overwhelmed, crash, hazardous, drowsy, fearful, impaired, inattentive, risky