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Do Negative Views of Aging Influence Memory and Auditory Performance Through Self-Perceived Abilities?

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Memory and hearing are critical domains that interact during older adults' daily communication and social encounters. To develop a more comprehensive picture of how aging influences performance in these domains, the roles of social variables such as views of aging and self-perceived abilities need greater examination. The present study investigates the linkages between views of aging, self-perceived abilities, and performance within and across the domains of memory and hearing, connections that have never been examined together within the same sample of older adults. For both domains, 301 older adults completed measures of their views of aging, their self-perceived abilities and behavioral tests. Using structural equation modeling, we tested a hypothesized model in which older adults' negative views of aging predicted their performance in the domains of memory and hearing through negatively affecting their self-perceived abilities in those domains. Although this model achieved adequate fit, an alternative model in which hearing performance predicted self-perceived hearing also was supported. Both models indicate that hearing influences memory with respect to both behavioral and self-perception measures and that negative views of aging influence self-perceptions in both domains. These results highlight the importance of views of aging and self-perceptions of abilities within and across these domains.

Keywords: views of aging, self-perceptions, memory, hearing

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> People assume that just because you don't stand as straight as a sapling, you're deaf. Or that your mind is like pumpkin mush.
>
> —*The Book of Negroes*

The focus of Lawrence Hill's (2007) *The Book of Negroes* is on racism and slavery, but age-based stigma also is acknowledged on the very first page, when the main character, Amanita Diallo, reflects on her life now that she is an older woman. She notes that others assume she is hard of hearing and cognitively impaired due to her age. Her reflections are not surprising given that memory and hearing are two domains in which older people are often negatively stereotyped (Chasteen, Schwarz, & Park, 2002; Cuddy, Norton, & Fiske, 2005; Goffman, 1963; Hummert, Garstka, Shaner, & Strahm, 1994; Levy, 2009; Levy, Slade, & Gill, 2006; Wallhagen, 2010) and that declines in these two domains are known to be strongly associated (e.g., Albers et al., 2015; Baltes & Lindenberger, 1997; Lindenberger & Baltes, 1994; Lin, Yaffe et al., 2013; for a review see Schneider, Pichora-Fuller, & Daneman, 2010). Although age-related declines in memory and hearing are common, they may be exacerbated when older adults fall prey to negative stereotypes of aging. As well, these negative views of aging may be one reason why older people's self-perceptions of ability do not always accurately reflect their actual function (Hertzog & Dunlosky, 2011; Hertzog & Hultsch, 2000). In particular, negative age stereotypes, as well as negative self-perceptions, may affect how well older adults function in everyday activities, such as communication and social interaction, which depend on both hearing and memory (Ryan, Giles, Bartolucci, & Henwood, 1986). A better understanding of how negative views of aging affect these

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two functionally interrelated domains could guide efforts to improve the quality of life of older adults. Indeed, it is surprising, especially given the effects of these two domains on older adults' quality of life, that there has been no research investigating the pattern of relationships among older adults' negative views of aging, their self-perceptions, and their memory and hearing performance. Thus, the purpose of the present study was twofold: a) to examine how older adults' negative views of aging influence their self-perceptions and performance on both memory and hearing tests, and b) to further our understanding of the cross-domain relationships between memory and hearing.

Memory Performance and Hearing Performance

Memory and hearing are both domains in which the biological influences of aging are well known (e.g., Salthouse, 2010; Schneider & Pichora-Fuller, 2000). In addition, an important connection between sensory and cognitive aging has been established in experimental and population studies (e.g., Albers et al., 2015; Baltes & Lindenberger, 1997; Gates et al., 2010; Lindenberger & Baltes, 1994; Tun, McCoy, & Wingfield, 2009; for a review see Schneider et al., 2010). Furthermore, recent epidemiologic and population-based studies have provided provocative evidence that hearing loss is predictive of cognitive decline and incident dementia (Gates, Anderson, McCurry, Feeney, & Larson, 2011; Gates, Beiser, Rees, D'Agostino, & Wolf, 2002; Gurgel et al., 2014; Lin, 2011; Lin, Ferrucci et al., 2011; Lin, Metter et al., 2011; Lin, Yaffe et al., 2013). Despite the growing evidence that auditory declines are linked to and precede cognitive declines, the mechanisms underpinning these age-related cross-domain connections remain unknown. Notably, the relevance of the connection between cognitive and auditory aging to older adults is suggested by recent qualitative research showing that half of the older adults who were interviewed were aware of these connections and that their perceptions of these connections influenced their expectations, self-image and ways of coping; in particular, they considered auditory-cognitive connections when setting priorities for communication and social interaction and when making decisions about seeking help from health professionals (Preminger & Laplante-Lévesque, 2014). Thus, social psychological factors may influence the connections between hearing and cognitive health in older adults. It is possible that older adults' negative views of aging may be a common variable that leads to lower self-perceptions of hearing and memory abilities and, in turn, to parallel declines in function in both domains. Another possibility is that lower-level age-related declines in hearing could exacerbate higher-level declines in self-perceptions and memory performance.

Self-Perceptions of Memory Ability and Hearing Ability

Age-related declines in hearing performance and memory performance may be modulated by variables such as older adults' self-perceptions in the corresponding domain (Hertzog & Dunlosky, 2011; Lachman, 2006; Payne et al., 2012) and/or their views of aging (Levy & Leifheit-Limson, 2009; Levy et al., 2006; Plaks & Chasteen, 2013). Although there is solid evidence of age-related declines in memory and hearing based on both behavioral tests and subjective self-report measures, the agreement between behavioral and self-report measures varies with age and other demographic factors. For example, behavioral tests and self-report measures of hearing are moderately correlated with each other; however, discrepancies between these measures vary with age, as well as with cognitive, affective and personality factors (Gatehouse, 1990, 1991; Kempen et al., 1996; Kiely, Gopinath, Mitchell, Browning, & Anstey, 2012) and also the degree of hearing loss (Banh, Singh, & Pichora-Fuller, 2012). In a recent study, data from 3,557 participants over the age of 50 years was examined to determine the relations between behavioral and subjective measures of hearing using percent correct classification and misclassification bias (Kamil, Genther, & Lin, 2015). Overall, the percentage of participants whose self-reports underestimated the degree of hearing loss based on behavioral testing increased with age from 20% for those 50–59 years old, to 37% for those 60–69 years old, to 70% for those 70–79 years old, and to 93% for those over 80 years old. The age-related increase in underestimation of hearing loss may reflect older adults' views that hearing loss is "normal" as people age, especially if they become less aware of problems because their social and physical environments have become less demanding (Holland & Rabbitt, 1992). Similarly, associations between memory performance and memory self-perceptions have been found, but the magnitude of the relation also can vary (Hertzog & Dunlosky, 2011; Lachman, 2006; Hertzog & Hultsch, 2000).

Importantly, although sensory and cognitive declines can interact when people perform activities in everyday life (Heyl & Wahl, 2012; Jang, Haley, Mortimer, & Small, 2003; Marsiske, Klumb, & Baltes, 1997) and qualitative research has shown that people are aware of these interactions (Preminger & Laplante-Lévesque, 2014), virtually no quantitative research has examined the strength of the relations between older adults' self-perceptions and objective performance on behavioral tests across domains within a single sample or investigated if their perceptions are the same or different depending on domain. A comparison across domains may provide a better understanding of how performance in later life may be influenced by self-perceptions within and across these domains.

Negative Views of Aging

In addition to associations between self-perceptions and performance, older adults' views of aging also have been shown to influence their performance in a variety of domains. Some research suggests that older people who hold negative views of aging tend to have lower memory performance (Levy & Langer, 1994; but see Yoon, Hasher, Feinberg, Rahhal, & Winocur, 2000). In terms of hearing, another study also showed that hearing thresholds declined less in older adults who held more positive views of aging compared to those who held more negative views (Levy et al., 2006). Older adults' views of aging also have been shown to predict functional health over time (Levy, Slade, & Kasl, 2002) and survival (Levy, Slade, Kunkel, & Kasl, 2002). Importantly, these studies also showed that the longitudinal influences of views of aging were partially mediated by self-perception variables like perceived control (Levy, Slade, & Kasl, 2002) and will to live (Levy, Slade, Kunkel et al., 2002). Such results provide support for the idea that older adults' views of aging might influence their performance in other domains, such as memory and hearing,

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through other self-related variables such as self-perceived ability in each domain.

It should be noted that older adults' function also has been shown to be directly influenced by negative age stereotypes. For example, when older adults were implicitly primed with negative age stereotypes, they experienced a number of negative outcomes, including poorer memory performance (Hess, Hinson, & Statham, 2004; Levy, 1996; but see Stein, Blanchard-Fields, & Hertzog, 2002), elevated stress responses (Levy, Hausdorff, Hencke, & Wei, 2000), and impaired physical balance (Levy & Leifheit-Limson, 2009). As well, situations that activate older adults' negative views of aging (i.e., age stereotypes) have been shown to worsen their memory function, such as when older people are affected by stereotype threat (Chasteen, Bhattacharyya, Horhota, Tam, & Hasher, 2005; Hess, Auman, Colcombe, & Rahhal, 2003; for reviews see Barber & Mather, 2014; Chasteen, Kang, & Remedios, 2011; Lamont, Swift, & Abrams, 2015). As illustrated by this extensive body of work, older adults' memory performance can be worsened due to negative views of aging and aging stereotypes, with more limited evidence showing a similar effect on their hearing.

Study Overview and Proposed Model

The present study focuses on older adults' negative views of aging and examines the linkages among older adults' negative views, their self-perceptions, and their function for the domains of hearing and memory. Unlike past research, we propose a model that considers the relationships among these variables across the two domains. To our knowledge, no prior studies have examined these linkages within and across these two domains in a single sample of older adults. Below we outline the predicted relationships within our model.

Our model incorporates the relations between older adults' negative views of aging, their self-perceived abilities and their performance on behavioral tests within each of the two domains, as well as the relations between the two domains (see Figure 1). We began with the prediction that negative views of aging influence memory and hearing performance through the corresponding domain-specific self-perceived abilities. Specifically, we expected a negative relation between negative views of aging and self-perceptions, such that more negative views of aging would be associated with less positive self-perceptions of ability in both domains. We also expected that positive self-perceptions would be positively related to performance in both domains, such that more positive self-views would be associated with better performance.

In addition, we hypothesized that there would be specific relations between the two domains, such that hearing performance would predict memory performance, with a comparable relation between self-perceived hearing ability and self-perceived memory ability. Specifically, we expected there would be a positive relation between older adults' hearing and memory performance, such that better hearing would be associated with better recall performance. Given that predicted relation, we also expected that older adults' self-perceptions of hearing ability would be positively related to their self-perceived memory ability, such that feeling better about one's hearing would be associated with feeling better about one's memory.

As for age, we expected the age of the participants to be negatively associated with a) self-perceived abilities for both hearing (Gatehouse, 1990, 1991) and memory (Johansson, Allen-Burge, & Zarit, 1997; McDonald-Miszczak, Hertzog, & Hultsch, 1995) and b) performance on behavioral tests of memory (Salthouse, 2010) and hearing (Cruickshanks, Zhan, & Zhong, 2010; Morrell, Gordon-Salant, Pearson, Brant, & Fozard, 1996). In contrast, consistent with our earlier findings regarding age stigma (Kang & Chasteen, 2009), we did not expect older adults' age to be related to their negative views of aging because older adults have had exposure to negative aging stereotypes throughout their

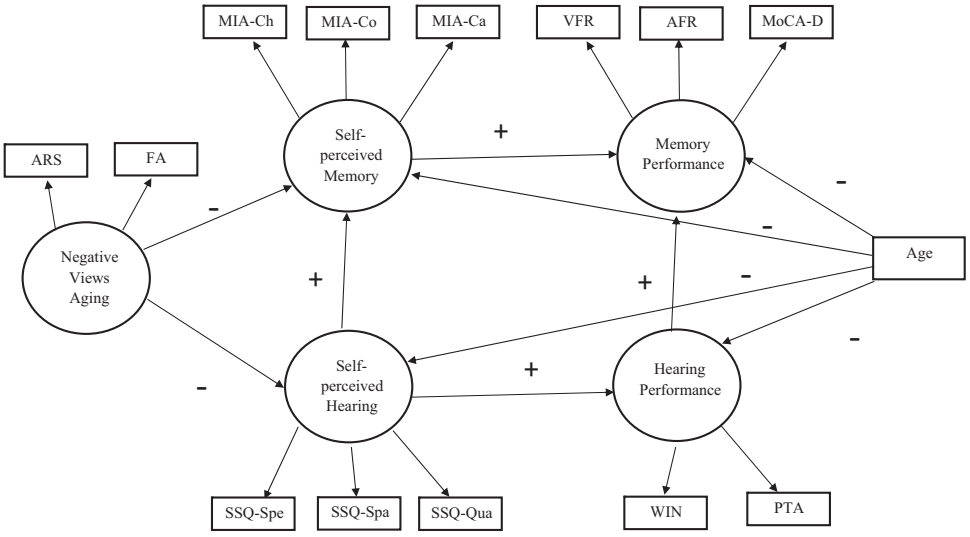

Figure 1. Hypothesized model. MIA = Metamemory in Adulthood; VFR = visual free recall; AFR = auditory free recall; MoCA-D = Montreal Cognitive Assessment; ARS = Age-Based Rejection Sensitivity Questionnaire; FA = fear of aging; SSQ = Speech, Spatial, and Qualities of Hearing Questionnaire; PTA = pure tone auditory; WIN = Words-in-Noise test.

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lives and in later life those stereotypes become self-relevant as they receive societal cues that they are older (Levy, 2009).

Method

Participants

A total sample of 301 older adults (192 women, 109 men) participated. All participants were community-dwelling volunteers who responded to advertisements in the newspaper about participating in studies on aging. They ranged in age from 56 to 96 years old (M = 71.13, SD = 7.40), were well-educated (M = 15.67 years of education, SD = 3.48) and healthy as indicated on a self-report scale ranging from 1 (*poor*) to 4 (*excellent*) (M = 3.10, SD = 0.74).

Given the mean age of our sample and the well-known age-related increases in the prevalence of sensory and cognitive impairments in the population, it would be expected that about 15% of the participants would have impairments of moderate or greater hearing loss (Davis, Smith, Ferguson, Stephens, & Gianopoulos, 2007), low vision (Swenor, Ramulu, Willis, Friedman, & Lin, 2013), and/or clinically significant mild cognitive impairment or dementia (Yesavage et al., 2002). To characterize these sensory and cognitive impairments in our sample, we administered screening tests for hearing, vision, and cognition. The results of the screening tests confirmed that these impairments occurred at rates similar to or less than would be expected in the general population of older people.

Pure-tone thresholds were obtained for each ear at octave frequencies from 250 to 8,000 Hz and at interoctave frequencies of 3,000 and 6,000 Hz (ANSI, 2004). Hearing thresholds were measured using standard audiometric procedures; participants were tested in a sound-attenuating booth and pure tones were presented using a clinical audiometer (Grason-Stadler, Model 61) with headphones (Telephonics TDH-50P). See group audiometric thresholds in Figure 2. Note that thresholds less than or equal to 25 dB HL are considered to be clinically normal (Clark, 1981) and the average thresholds for the sample at each frequency are consistent with the median values given the age of the participants (ISO, 2000). In keeping with common clinical practice, the pure-tone average in the better ear (PTA) for 500, 1,000, and 2,000 Hz was used as a summary measure of audiometric pure-tone hearing sensitivity (e.g., Smith, Bennett, & Wilson, 2008). Consistent with population estimates, 13% of the participants had a PTA of 40 dB HL or more in the better ear, indicating a moderate or worse hearing loss; however, all but two of those with this degree of hearing impairment used a hearing aid. (Descriptive statistics for PTA are provided in Table 1).

Participants' binocular far visual acuity was assessed using a Snellen E chart. Participants were asked to wear their glasses or contact lenses during testing. The Snellen scores were converted to LogMAR units for the purposes of statistical analyses (Holladay, 1997). A Snellen score of 20/50 (equivalent to LogMAR 0.4) or worse indicates low vision (Smith et al., 2008; Swenor et al., 2013; Haegerstrom-Portnoy, Schneck, & Brabyn, 1999). The mean vision far acuity (LogMAR) of our sample was 0.11 (SD = 0.19; range −0.20–0.70). Consistent with population estimates, 13% had results suggesting low vision; however, the percentage with low vision may be overestimated because the glasses or lenses used by participants may not have been the best correction and almost a third of those in this category did not use any correction during testing.

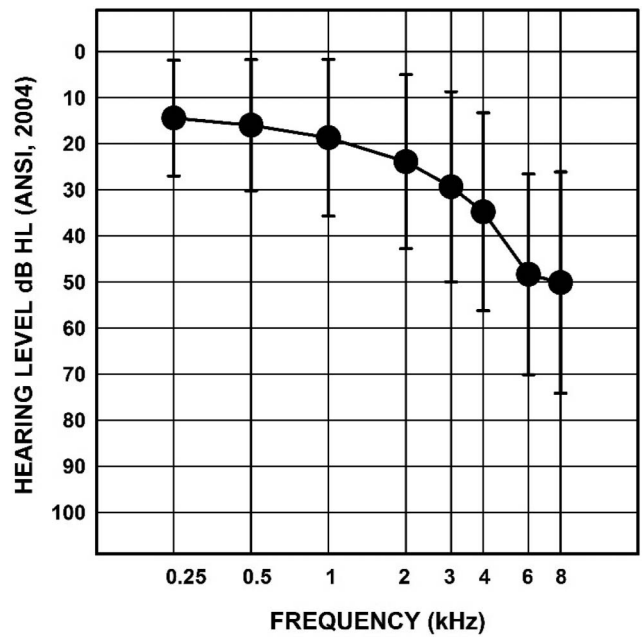

Figure 2. Mean audiometric pure-tone air-conduction thresholds in the better ear (+/− SD).

The Montreal Cognitive Assessment (MoCA; Nasreddine et al., 2005) was administered to screen for cognitive loss. The MoCA has 13 items designed to measure cognitive abilities including attention, memory, language, and visuospatial functions. It is scored out of 30, with education-adjusted scores of 26/30 or higher considered to be within the normal range, scores of 25 or below indicating the possibility of mild cognitive impairment, and scores of 21 or below indicating the possibility of a more severe impairment (Nasreddine et al., 2005). The average MoCA score for our sample was 25.3 (SD = 2.89; range 15–30). Consistent with population estimates, 10% obtained scores indicative of more severe cognitive impairment.

Measures Used in the Model

Participants completed several tasks and questionnaires in order to assess their negative views of aging, self-perceptions of hearing and memory ability, and their hearing and memory performance. Descriptive statistics and scale reliabilities are provided in Table 1. Correlations among the measures are shown in Table 2.

Hearing performance. Two measures of auditory function, pure-tone audiometry (PTA described above) and the Words-In-Noise test (WIN; Wilson, Abrams, & Pillion, 2003; Wilson & Burks, 2005), were used as indices of participants' hearing performance.

For the WIN test, participants had to repeat 35 words presented at seven different signal-to-noise ratios (SNRs; 24- to 0-dB SNR in 4-dB decrements) that become increasingly difficult. Following the standard procedure for administering the test, to achieve the SNRs, the level of the noise was fixed at 80 dB SPL or 90 dB SPL

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Table 1
Descriptive Statistics for All Measures

Measure	*M*	*SD*	Obtained range	Possible range
Age (years)	71.13	7.40	56–96	55+
Negative view of aging				
Fear of aging	4.69	1.35	1.58–8.28	1–9
Rejection sensitivity–Age	11.37	7.00	1–33.07	1–36
Overall memory performance				
MoCA delayed recall	2.89	1.55	0–5	0–5
Visual free recall	5.26	2.05	0–12	0–15
Auditory free recall	5.79	2.08	0–12	0–15
Memory self-perceptions				
MIA capacity	.24	.64	−1.71–1.76	−2–2
MIA control	.55	.64	−1.22–2.00	−2–2
MIA change	−.19	.70	−1.82–1.59	−2–2
Overall hearing performance				
WIN threshold (dB SNR)	10.41	4.65	−1.20–26	−2–26
PTA better ear (dB HL)	20.30	15.57	−3.33–76.67	−10–105
Hearing self-perceptions				
SSQ spatial	7.03	1.87	.35–10.00	0–10
SSQ speech	6.37	2.03	1.14–9.93	0–10
SSQ sound quality	7.84	1.46	.75–10.00	0–10

Note. MIA = Metamemory in Adulthood; MoCA-D = Montreal Cognitive Assessment; SSQ = Speech, Spatial, and Qualities of Hearing Questionnaire; PTA = pure tone auditory; WIN = Words-in-Noise test; SNR = signal-to-noise ratio; HL = hearing level.

(re: PTA <40 dB HL or 41–60 dB HL, respectively) and the level of the target words varied to create the SNRs. The WIN test was reproduced on compact disk (Sony CE375), routed through the clinical audiometer, and presented under headphones in the better ear (as determined by comparing PTAs between the two ears). In cases when PTAs were identical across the two ears, the test was presented to the right ear. The WIN threshold was determined as the dB SNR at which the participant could correctly repeat 50% of the words. Higher WIN thresholds indicate more difficulty understanding words in noise (i.e., poorer performance).

In audiology, lower scores on these measures (e.g., pure-tones and WIN thresholds) indicate better performance; however, in order to increase the clarity of the associations with hearing ability in the model, we transformed the scores on the hearing performance measures by multiplying them by −1 so that higher scores indicate better performance. By doing so, we were able to have similar predictions about the nature of the associations between self-perceptions of ability and performance for both hearing and memory.

Memory performance. Participants completed three recall tasks. Two of the recall tasks measured free recall for lists of 15 words, one for visual and the other for auditory stimuli. For the visual free recall (VFR) test, the list of words was presented on a 17-inch computer screen in size 72 black Calibri font on a white background using Powerpoint. For the auditory free recall (AFR) test, an audio-recording of a different word list than that used for the VFR test was presented binaurally over headphones at the same level as the target words of the WIN test were presented for

Table 2
Intercorrelations Among the Measured Variables

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Age	—													
2. WIN threshold (Reversed)	−.37**	—												
3. PTA better ear (Reversed)	−.33**	.68**	—											
4. Auditory free recall	−.38**	.48**	.39**	—										
5. Visual free recall	−.26**	.18**	.21**	.50**	—									
6. MoCA delayed recall	−.20**	.20**	.24**	.34**	.40**	—								
7. MIA capacity	−.15*	.11	.16**	.20**	.17**	.15**	—							
8. MIA control	−.15**	.13*	.21**	.16**	.11	.09	.44**	—						
9. MIA change	−.18**	.09	.16**	.22**	.14*	.17**	.68**	.48**	—					
10. SSQ speech	−.24**	.44**	.57**	.37**	.21**	.22**	.31**	.19**	.31**	—				
11. SSQ spatial	−.15*	.27**	.43**	.21**	.06	.05	.24**	.18**	.26**	.66**	—			
12. SSQ quality	−.18**	.38**	.53**	.32**	.17**	.16**	.31**	.26**	.30**	.72**	.71**	—		
13. Rejection sensitivity–Age	.14*	−.05	−.09	−.02	−.09	−.07	−.09	−.15*	−.23**	−.14*	−.13*	−.19**	—	
14. Fear of aging	−.03	.12*	0	0	0	.05	−.31**	−.44**	−.42**	−.07	−.14*	−.18**	.30**	—

Note. WIN = Words-in-Noise test; PTA = pure tone auditory; MoCA = Montreal Cognitive Assessment; MIA = Metamemory in Adulthood; SSQ = Speech, Spatial, and Qualities of Hearing Questionnaire.
* $p < .05$. ** $p < .01$.

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the participant (i.e., at either 80 or 90 dB SPL depending on their PTA). For each task, participants were then given 3 min to write down as many words as they could recall. The third recall task was the delayed recall item from the MoCA (MoCA-D; Nasreddine et al., 2005). Participants heard and repeated a list of five words twice during the learning phase and were then asked to recall them after a delay of about 5 min with intervening test items. On all three recall tasks, higher scores indicated better memory performance.

Self-perceptions of memory ability. Three subscales (change, control, capacity) of the Metamemory in Adulthood questionnaire (Dixon, Hultsch, & Hertzog, 1988) were used to assess participants' views of their memory. Using a response scale ranging from (−2) strongly disagree to (+2) strongly agree, participants indicated their level of agreement with each statement. Sample items from the subscales include "My memory will get better as I get older" (change; MIA-Ch), "If I were to work on my memory I could improve it" (control; MIA-Co), and "I am good at remembering names" (capacity; MIA-Ca). Negatively worded items were reverse-coded so that higher scores on each subscale indicated a more positive self-perception of memory ability. The subscales had acceptable to good internal consistency, Cronbach's alpha = .89 (MIA-Ch), .79 (MIA-Co), and .86 (MIA-Ca).

Self-perceptions of hearing ability. The Speech, Spatial, and Qualities of Hearing Questionnaire (SSQ; Gatehouse & Noble, 2004) was used to assess participants' perceptions of their hearing ability. The 47-item version of the SSQ that was used excludes questions concerning listening experiences with hearing aids (Singh & Pichora-Fuller, 2010) and consists of three main subscales, including 14 items related to hearing speech (SSQ-Spe; e.g., "Can you easily have a conversation on the telephone?"), 17 items related to spatial hearing (SSQ-Spa; e.g., "Can you tell how far away a bus or a truck is, from the sound?"), and 16 items related to sound qualities (SSQ-Qua; e.g., "When you listen to music, does it sound clear and natural?"). For each item, respondents rate their ability to hear on a 0 to 10 scale, with larger values always indicating greater ability. There also is a "not-applicable" option for each item. In the current study, the total scale score on each subscale was used to represent participants' views of their hearing, such that higher scores indicated more positive self-perceptions of hearing ability. All three measures had excellent internal consistency, Cronbach's alpha = .96 (speech; SSQ-Spe), .96 (spatial; SSQ-Spa), and .92 (qualities; SSQ-Qua).

Negative views of aging. Two measures were used to assess participants' negative views of aging. One measure was the Age-based Rejection Sensitivity Questionnaire (ARS; Kang & Chasteen, 2009), which assesses feelings of age-based stigma by having respondents read about and imagine 15 different scenarios and then rate their concerns about and expectations of rejection based on age for each scenario. A sample scenario is "Imagine that you are involved in a minor accident while driving. It is unclear who is at fault." For this sample scenario, participants rate their concerns and expectations about their age playing a role in the scenario using the following two statements and scales, "How concerned/anxious would you be that the blame for the accident might be placed on you because of your age" (1) *very unconcerned* to (6) *very concerned*, and "I would expect that that the blame for the accident might be placed on me because of my age" (1) *very unlikely* to (6) *very likely*. Product scores are then computed by multiplying the concern/anxiety and expectation scores in order to represent the cognitive and affective components of stigma concerns. The mean score is obtained by taking the mean of the product scores for each item, with higher scores indicating greater age-based rejection sensitivity. The measure had excellent internal consistency, Cronbach's alpha = .95.

The other measure used to assess negative views of aging was a 25-item Fear of Aging (FA) Scale that included items from the Expectations Regarding Aging (ERS) scale (Sarkisian, Steers, Hays, & Mangione, 2005) and the Anxiety about Aging Scale (Lasher & Faulkender, 1993). The measure consists of six subscales: fear of dependence (e.g., "I fear that as I get older I will be unable to do everything I want to"), fear of cognitive decline (e.g., "I expect that as I grow older I will become more forgetful"), fear of physical decline (e.g., "I am nervous about the physical slowness that accompanies old age"), fear of loneliness (e.g., "I expect that as I get older I will spend more time alone"), fear of depression (e.g., "I fear it will be very hard for me to find contentment in old age"), and fear of losing attractiveness (e.g., "I expect that as I get older I will become less attractive"). Participants responded to these items on a scale ranging from 1 (*strongly disagree*) to 9 (*strongly agree*). The composite fear of aging measure was highly reliable. Higher numbers on each of the measures (stigma, fear of aging) indicated a more negative view of aging. The measure had excellent internal consistency (Cronbach's alpha = .92).

Procedure

Upon arrival in the laboratory, participants completed a consent form. They then completed the behavioral tasks to assess hearing, vision, and cognitive performance, including clinical screening measures, as well as other behavioral measures of memory and hearing performance that were used in modeling. Participants also completed a set of questionnaires that assessed their views of aging and their self-perceived memory and auditory abilities. The questionnaires were administered via computer using MediaLab version 2008 (Empirisoft, New York, NY). The entire session took approximately 2 hr on average, with breaks offered throughout. At the end of the session, participants were debriefed and were given a small honorarium. All procedures used for this study were approved by the university ethics board.

Results

Preliminary Analyses

Means, standard deviations, and ranges (obtained and possible) for all of the study variables are displayed in Table 1; note that the obtained range of scores on most of the measures was similar to the possible range. Correlations among the measures are presented in Table 2. Note that the correlations with age are consistent with previous findings in these domains. Specifically, age was negatively correlated with participants' self-perceptions of memory and of hearing ability and also with their memory and hearing performance, suggesting that increasing age was associated with worsened self-perceptions and memory and hearing performance. Age was uncorrelated with participants' fears of aging, but was positively correlated with their sensitivity to age stigma, such that with increasing age participants had greater age-based stigma sensitivity.

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Analytic Approach

We conducted structural equation modeling using AMOS version 22.0 (IBM SPSS, 2013) to test our hypothesized model as well as two alternative models. We examined five indices of fit: the chi-square goodness-of-fit index, the relative chi-square, the Comparative Fit Index (CFI), the Normative Fit Index (NFI), and the Root Mean Square Error of Approximation (RMSEA). The chi-square goodness-of-fit index tests whether the difference between the estimated and observed models is significantly different from zero. For the chi-square, a value of zero is considered to be the optimal fit, whereas higher values indicate increasingly poorer fit. However, the chi-square is sensitive to sample size, such that large samples can produce significant chi-square values (Byrne, 2010). The relative or normed chi-square is considered to be less sensitive to sample size and equals the chi-square value divided by the degrees of freedom. Schumacker and Lomax (2004) propose that a relative chi-square less than 5 indicates acceptable fit. The CFI indicates the degree to which the hypothesized model fits the data better than a null model that specifies no associations among the variables. The index can range from 0 to 1, with higher values indicating better fit. A value of at least .93 has been proposed as indicating acceptable fit (Byrne, 1994), whereas others have advised using a cut-off value closer to .95 (Hu & Bentler, 1995). The NFI is similar to the CFI and provides another comparison of the hypothesized model to a null model. The NFI also ranges from 0 to 1, where 1 is optimal fit. Values ranging from .90 (Byrne, 1994) to .95 (Schumacker & Lomax, 2004) have been proposed as indicating acceptable fit. The RMSEA assesses the error of approximation in the population, or the degree to which the hypothesized model would fit the population if those data were available. Values less than .08 are considered to indicate acceptable model fit (Browne & Cudeck, 1993), whereas values less than .05 are thought to indicate good fit (Steiger, 2000).

Measurement model. Before testing our hypothesized structural model, we first determined the best-fitting measurement model. In line with our hypothesized structural model (see Figure 1), we tested a measurement model in which there was one observed variable (participant age) and five latent constructs (negative views of aging, self-perceived memory ability, self-perceived hearing ability, memory performance, hearing performance). In the confirmatory factor analysis, we allowed all of the variables to covary with one another, resulting in a model with adequate fit: $\chi^2(63) = 145.84$, $p < .001$; relative $\chi^2 = 2.32$; CFI = .94, NFI = .91; RMSEA = .07, 90% CI [.05, .08]. We found that alternative measurement models that included second-order latent constructs such as a general self-perceptions construct or a general performance construct had poorer fit than our measurement model (e.g., relative $\chi^2 > 2.44$, CFIs $\leq .94$), suggesting that the measurement model with the one observed and five latent constructs was the best way to conceptualize the variables. We note also that, as predicted, age and negative views of aging were unrelated, $\beta = -0.01$, $Z = -0.19$, $p = .85$. Age and negative views of aging were also unrelated when we included that path in the structural models described below, βs $= -0.01$, Zs ≤ -0.21, ps $\geq .83$. We therefore dropped the covariance path between these two variables when testing the structural models.

Hypothesized model. As shown in Figure 1, our hypothesized model depicted relationships among the variables such that older adults' negative views of aging indirectly predict their memory performance and hearing performance through their self-perceived abilities in the corresponding domains. Based on prior literature, we also expected that older adults' hearing performance would be predictive of their memory performance. Likewise, we expected that their self-perceptions of hearing ability would be predictive of their self-perceptions of memory ability. Moreover, we expected participants' age to be associated with their self-perceptions and performance in each domain.

This model had acceptable fit, $\chi^2(68) = 157.51$, $p < .001$, relative $\chi^2 = 2.32$, CFI = .94, NFI = .90, RMSEA = .07, 90% CI [.05, .08]. As shown in Figure 3, as expected, we found support for the predicted associations among the variables. Older adults' negative views of aging were negatively associated with their self-perceptions of their memory, $\beta = -0.52$, $Z = -4.53$, $p < .001$, which in turn were positively associated with their memory performance, $\beta = 0.16$, $Z = 2.25$, $p < .05$. A similar pattern occurred for hearing, such that older adults' negative views of aging were negatively associated with their self-perceptions of their hearing, $\beta = -0.19$, $Z = -2.46$, $p = .01$, which in turn were positively associated with their hearing performance, $\beta = 0.60$, $Z = 9.92$, $p < .001$. These results suggest that older adults' negative views of aging affect their memory performance and hearing performance by influencing their self-perceived ability in the corresponding domains.

In terms of associations across domains, as expected, there was a positive association between self-perceptions of hearing and of memory ability, $\beta = 0.28$, $Z = 4.16$, $p < .001$, as well as between hearing and memory performance, $\beta = 0.43$, $Z = 5.00$, $p < .001$. Removing the paths between these two domains resulted in worse model fit, $\chi^2(70) = 200.17$, $p < .001$, relative $\chi^2 = 2.86$, CFI = .91, NFI = .88, RMSEA = .08, 90% CI [.07, .09]. As well, changing the direction of the associations between these variables, so that self-perceptions of memory predict self-perceptions of hearing, and memory performance predicts hearing performance, also resulted in worse model fit, $\chi^2(68) = 175.70$, $p < .001$, relative $\chi^2 = 2.58$, CFI = .93, NFI = .89, RMSEA = .07, 90% CI [.06, .09]. Together, these findings suggest it is important to include the linkages between hearing and memory performance and between hearing and memory self-perceptions when considering the factors that influence older adults' function in these two domains.

The associations for age were in the expected direction, with participant age being negatively associated with the self-perception and performance variables in each domain. Specifically, greater age was associated with worse self-perceived memory ability, $\beta = -0.15$, $Z = -2.76$, $p < .01$, worse self-perceived hearing ability, $\beta = -0.23$, $Z = -3.89$, $p < .001$, worse memory performance, $\beta = -0.24$, $Z = -3.44$, $p < .001$, and worse hearing performance, $\beta = -0.27$, $Z = -5.09$, $p < .001$.

Hearing-as-predictor model. Converging evidence suggests that hearing loss influences memory performance. For example, there is epidemiological evidence that age-related auditory decline can predict incident cognitive decline (e.g., Lin, Yaffe et al., 2013) and neuroscience evidence that lower-level peripheral hearing loss can affect higher-level cognitive-linguistic processing in the brain (e.g., Peelle, Troiani, Grossman, & Wingfield, 2011; Wingfield & Peelle, 2012). As described earlier, hearing performance is moderately correlated with self-perceived hearing ability. Other research suggests that self-perceptions of memory also may be negatively affected by hearing loss in older adults (e.g., Bazargan & Barbre, 1994). Recent

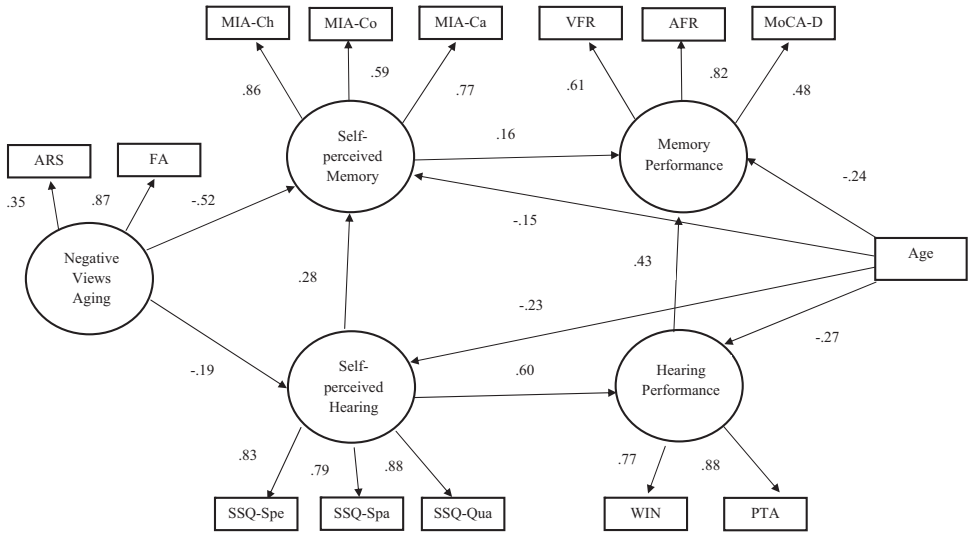

Figure 3. SEM for hypothesized model. Path coefficients are standardized regression weights. All structural path coefficients are significant at $p < .05$. MIA = Metamemory in Adulthood; VFR = visual free recall; AFR = auditory free recall; MoCA-D = Montreal Cognitive Assessment; ARS = Age-Based Rejection Sensitivity Questionnaire; FA = fear of aging; SSQ = Speech, Spatial, and Qualities of Hearing Questionnaire; PTA = pure tone auditory; WIN = Words-in-Noise test.

experiments in younger adults even showed that memory self-perceptions, but not memory performance, were reduced by distorting speech to slow auditory perceptual fluency (e.g., Besken & Mulligan, 2014). In light of this evidence, we tested an alternative hearing-as-predictor model. In this alternative model, all of the paths were the same as in the hypothesized model (see Figure 4), except that older adults' hearing performance now predicted self-perceptions of hearing ability and self-perceptions of memory ability, in addition to predicting their memory performance.[1] It may be the case that the relation between older adults' self-perceptions of memory ability and their memory performance could be accounted for by their hearing performance, which we were able to test in this alternative model. Indeed, this model had slightly better fit than the hypothesized model, $\chi^2(67) = 148.63$, $p < .001$; relative $\chi^2 = 2.22$; CFI = .95; NFI = .91; RMSEA = 0.06, 90% CI [0.05, 0.08].

All of the paths in the alternative hearing-as-predictor model that were the same as in the hypothesized model retained similar associations (see Figure 4). Importantly, older adults' self-perceptions of memory ability were still positively associated with their memory performance, $\beta = 0.17$, $Z = 2.44$, $p < .05$. In terms of the paths that differed from the hypothesized model, age was no longer associated with self-perceived hearing ability, $\beta = 0.05$, $Z = 0.84$, $p = .40$, likely due to the strong positive association between hearing performance and older adults' self-perceptions of hearing ability, $\beta = 0.68$, $Z = 9.45$, $p < .001$. Hearing performance, however, was not associated with older adults' self-perceptions of memory ability, $\beta = -0.02$, $Z = -0.16$, $p = .87$. Thus, in this alternative model where hearing performance was allowed to play a stronger role, it predicted older adults' self-perceptions of hearing ability, but did not directly predict their self-perceptions of memory ability. Importantly, the relation between older adults' self-perceptions of memory ability and their memory performance remained when accounting for the variance explained by hearing performance.

We also note that, in this alternative model, older adults' negative views of aging again influenced their memory performance through their self-perceived memory abilities (see Figure 4). Given our exploration of alternative accounts of the relations among the variables, we also took this opportunity to test whether older adults' negative views of aging might directly influence their memory and hearing performance, or whether the relations between negative views of aging and performance in the two domains operate only indirectly through the corresponding self-perceptions. When we added direct paths from negative views of aging to memory performance ($\beta = 0.14$, $Z = 1.40$, $p = .16$) and to hearing performance ($\beta = 0.04$, $Z = 0.59$, $p = .56$) in this alternative model, we found nonsignificant paths, suggesting that older adults' negative views of aging are most strongly associated with their self-perceptions of abilities in the two domains.

Reverse model. Although both the hypothesized model and the alternative hearing-as-predictor model provide support for the notion that older adults' negative views of aging predict their self-perceptions of memory and hearing, it is conceivable that older people's negative views of aging are instead influenced by their memory and hearing performance through the associated self-perceptions. Of course, only a longitudinal study could truly provide the evidence needed to determine if negative views of aging accelerate declines in performance or if declines in performance result in views of aging becoming more negative. Nevertheless, we attempted to address the possibility of a reversal by creating an alternative model in which participants' age predicted their memory and hearing performance, which then predicted their associated self-perceptions, which then predicted their negative views of aging. In essence, this model served as a reverse of the hypothesized model, whereby the direction of the paths between negative views of aging, self-perceptions, and performance were

[1] We thank an anonymous reviewer for this suggestion.

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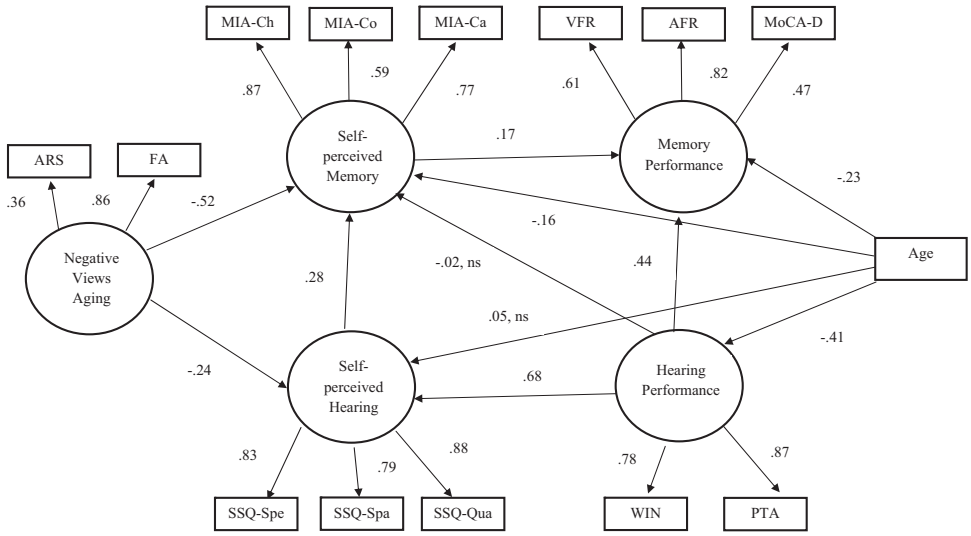

Figure 4. SEM for hearing-as-predictor model. Path coefficients are standardized regression weights. All structural path coefficients are significant at $p < .05$, unless otherwise indicated. MIA = Metamemory in Adulthood; VFR = visual free recall; AFR = auditory free recall; MoCA-D = Montreal Cognitive Assessment; ARS = Age-Based Rejection Sensitivity Questionnaire; FA = fear of aging; SSQ = Speech, Spatial, and Qualities of Hearing Questionnaire; PTA = pure tone auditory; WIN = Words-in-Noise test.

reversed. This reverse model had relatively worse fit than both the hypothesized and the hearing-as-predictor models, $\chi^2(68) = 165.84$, $p < .001$, relative $\chi^2 = 2.44$, CFI = .93, NFI = .90, RMSEA = 0.07, 90% CI [0.06, 0.08], suggesting that having older adults' negative views of aging predicted by their hearing and memory performance via their self-perceptions does not provide a better picture of the relations among these variables than when negative views of aging serves as a predictor of those self-perceptions. Although these analyses cannot rule out the possibility that older adults' negative views of aging are influenced by their memory and hearing performance, they suggest that it is reasonable to believe that older people's negative views of aging play a role in their self-perceptions of hearing and memory and thus indirectly in their memory and hearing performance. In reality, rather than a unidirectional causal relationship, it is more likely that there is a feedback loop in which progressive declines are fueled by the interconnections.

Discussion

We had two objectives for the present study. The first was to examine how older adults' negative views of aging influence their self-perceptions and performance for both memory and hearing. For both domains, more negative views of aging were associated with less positive self-perceptions of memory and hearing ability. Moreover, these self-perceptions of ability predicted performance in both domains, as shown in our hypothesized model. Our second objective was to further our understanding of the cross-domain relations between memory and hearing. Consistent with past research (e.g., Lin, Yaffe et al., 2013), we found that hearing predicts memory performance. A novel finding that emerged from this study is that there was also a relationship between self-perceptions of hearing and of memory, such that hearing self-perceptions predicted memory self-perceptions. An alternative model that we tested provides further evidence for the influence of hearing on self-perceptions and memory performance (see below). Our examination of these variables using modeling demonstrated that similar processes are common to hearing and memory performance, but that hearing influences memory performance. Taken together, these findings emphasize the need for examining older adults' cognition within the context of both sensory and social factors.

Negative Views of Aging

In both the hypothesized and alternative hearing-as-predictor models, we found significant associations between older adults' negative views of aging and their self-perceptions of memory and hearing ability. In the hypothesized model, these self-perceptions were associated with performance in the corresponding domain, suggesting that negative views of aging may influence memory and hearing performance through self-perceptions of ability in those two domains. These findings are consistent with prior work showing that the longitudinal effects of older adults' views of aging on their functional health and on their survival were partially mediated by self-perception variables (Levy, Slade, & Kasl, 2002; Levy, Slade, Kunkel et al., 2002). As well, our finding showing an indirect influence of negative views of aging on function, particularly memory performance, is consistent with some research on the effects of age-based stereotype threat on older adults' memory performance whereby older adults' reduced cognitive performance under threat was mediated by their lowered performance expectations (Desrichard & Köpetz, 2005; Hess, Hinson, & Hodges, 2009). Taken together, the literature suggests that self-perceptions of ability play a critical part in the effects of negative views of aging on older people's function.

Other research has shown that negative age stereotypes can directly affect older adults' cognitive performance (e.g., Hess et al., 2004; Levy, 1996; but see Stein et al., 2002). However, these direct effects on cognitive function have been found mostly using implicit primes,

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rather than explicit measures of older adults' views of aging. As well, it remains unknown whether such priming effects would occur for hearing performance. Given the association between hearing and memory performance we found in the present study, it would be interesting to see whether implicitly priming older adults with negative age stereotypes would not only affect hearing performance measured immediately after exposure to the primes, but might affect their memory performance measured much later in an experimental session. Although the time course of the effects of implicit age stereotypes is still relatively unknown, it might be the case that the priming effects would persist through immediately affecting performance in one domain (e.g., hearing) that then influences later performance in a related domain (e.g., memory).

Despite the fact that our older adults' negative views of aging consistently predicted their self-perceptions of memory ability and their self-perceptions of hearing ability in two models, it also is plausible that those negative views may be influenced by those self-perceptions based on performance in those domains. Although the reverse model we tested did not support the idea that considering negative views of aging as an outcome provides a better account of the relations among the variables, the correlational nature of the present study cannot rule out this possibility. Indeed, a longitudinal design would be needed in order to truly understand how performance and self-perceptions affect older adults' negative views of aging, as well as how those views might then influence future performance and self-perceptions of memory and hearing. Intervention studies also could be used to determine if the relations between negative views and performance could be altered by either improving performance and/or reducing negative views of aging.

Although we found no relation between older adults' negative views of aging and age in the present study, it would be worthwhile in future work to determine when negative views of aging vary by age. Kang and Chasteen (2009) found age differences in age-based rejection sensitivity between young and older adults. It may be the case that similar differences would occur between middle-aged and older adults. Moreover, it would be beneficial to pinpoint when negative views of aging influence self-perceptions in adults, and midlife seems a likely turning point at which such influences might emerge.

Interrelations of Memory and Hearing

Our second goal in the present study was to better understand the cross-domain relations between hearing and memory. Whereas prior work typically has focused on a single domain, some research has identified links between sensory and cognitive abilities and older adults' everyday functioning (e.g., Heyl, & Wahl, 2012; Marsiske et al., 1997). To learn more about how social psychological factors are involved in the relations between these two domains, we investigated the influence of older adults' negative views of aging on both domains within the same sample. We selected the domains of memory and hearing because there are negative aging stereotypes about each domain (Cuddy et al., 2005; Gagné, Southall, & Jennings, 2009; Hétu, 1996; Hummert et al., 1994), and because there is increasing interest in the relations between age-related declines in these two domains. Clinicians and older adults alike are aware that hearing and cognitive health are interrelated (Preminger & Laplante- Lévesque, 2014). Compelling evidence that hearing loss is associated with cognitive decline and that hearing loss can predict incident dementia has been found in repeated epidemiological studies of aging (Gates et al., 2011, 2002; Lin, 2011; Lin, Ferrucci et al., 2011; Lin, Metter et al., 2011; Lin, Yaffe et al., 2013). While the mechanisms are not yet determined, one possible explanation for the connection between hearing and cognitive decline is that people who become hard-of-hearing may cope by withdrawing from social interaction, thereby diminishing opportunities for mental and physical activity that would be conducive to healthy cognitive aging (e.g., Lin, Yaffe et al., 2013). Our model explores how negative views of aging may play a role in this potential cascade of effects from one domain to the other. Consistent with past research, we found that older adults' hearing performance predicted their memory performance in all of the structural models that we tested. Specifically, better hearing performance was associated with better memory performance. We found a parallel relation for self-perceptions, whereby hearing self-perceptions predicted memory self-perceptions in all three models. These findings indicate that not only do lower-level processes such as sensory function predict performance in higher-level processes such as memory, but that self-perceptions of ability in a lower-level domain (i.e., hearing) similarly influence self-perceptions of ability in a higher-level domain (i.e., memory). Thus, future research on higher-level processes such as memory would benefit not only from considering how sensory function influences memory performance, but also how self-perceptions of sensory ability and of memory ability predict memory performance. The present data suggest that considering these other factors, above and beyond the influence of chronological age, may provide a deeper understanding of the everyday cognitive functioning of older adults.

Although the results within the domains were similar insofar as there were significant associations between self-perceptions and performance for both hearing and memory, there also were noteworthy differences. Specifically, there were stronger associations between age and hearing performance than between age and memory performance, and there also were stronger associations between hearing self-perceptions and hearing performance than between memory self-perceptions and memory performance. In contrast, older adults' negative views of aging were more strongly associated with self-perceptions of memory than with hearing self-perceptions, in both the hypothesized and hearing-as-predictor models. Taken together, these patterns of associations suggest that older adults' hearing, and in turn their self-perceptions of hearing, may be influenced more by age (i.e., biological changes in sensory mechanisms), whereas memory and self-perceptions of memory ability may be influenced more by social factors such as negative views of aging, as well as by hearing.

In addition, we found compelling evidence that hearing performance can influence self-perceptions of hearing, as shown in both the hearing-as-predictor and reverse models. Notably, hearing performance did not directly influence older adults' self-perceptions of memory ability when we tested that path in the hearing-as-predictor model. Instead, hearing performance seems to operate indirectly in predicting self-perceptions of memory ability, through self-perceived hearing ability. When we compared the hearing-as-predictor and measurement models we found that the hearing-as-predictor model fit the data as well as our measurement model in which all paths among the latent variables and observed variable were estimated, $\chi^2(4) = 2.77$, $p = ns$. In contrast, the hypothesized model was significantly different from the measurement model, $\chi^2(5) = 11.07$, $p < .05$. Taken together, these comparisons suggest that the hearing-as-predictor model provides a more parsimonious account of the relations among the variables.

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Limitations and Future Directions

Although we found parallel within-domain associations between negative views of aging, self-perceptions, and performance, as well as between-domain associations for self-perceptions and performance, the strength of those associations varied. It could be that the variability in the strength of associations is due, in part, to differences in the measures of self-perceived hearing ability and self-perceived memory ability. Future work would benefit from using self-perception measures of memory and hearing that are more similar, in order to allow for a more comparable comparison.

As noted earlier, the analyses reported in this paper are correlational, and as a result causality cannot be determined. It is possible that a reverse process occurs by which older adults' performance predicts their self-perceived abilities, in turn influencing negative views of aging. Nevertheless, the findings from all three structural models support the idea of considering negative views of aging as a predictor. Future longitudinal or intervention research would be able to determine the possible feedback cycle that may occur over time, which would have potential clinical implications. One approach would be to develop interventions with the aim of breaking the deleterious cycle of effects by promoting more positive views or reducing negative views to slow down the rate of decline, facilitate help-seeking and increase benefit from rehabilitation for hearing and/or memory impairments. Alternatively, if negative views of aging arise from declining performance, then developing interventions to improve hearing performance and/or memory performance also should improve self-perceptions of ability, and, ultimately, counteract negative views of aging. Future interventions might be even more effective if clinicians combined techniques to improve performance with strategies for counteracting negative views of aging.

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