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Aging and Distraction by Irrelevant Speech: Does Emotional Valence Matter?

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Objectives. From prior studies, we know that older adults are rarely more distracted by irrelevant speech than younger adults, which is remarkable in light of the inhibitory deficit view of aging. We tested the hypothesis that older adults are more distracted by emotional irrelevant speech during a visual cognitive task than younger adults.

Methods. Forty-eight younger (mean age = 21.9 years) and 48 older individuals (mean age = 68.1 years) performed a visual counting task while being exposed to irrelevant speech consisting of random numbers intermixed with neutral, positive, or negative words. Performance in these conditions was compared with that in a silence condition.

Results. Irrelevant speech increased counting time and decreased accuracy similarly for younger and older adults. Furthermore, the emotional conditions did not elicit a stronger effect than the neutral condition. Finally, we found implicit memory for irrelevant speech, but its level was independent of emotional valence and age.

Discussion. We conclude that emotional irrelevant speech has no disproportionate impact on cognitive performance in older adults. This can be regarded as a challenge to the inhibitory deficit hypothesis.

Key Words: Distraction—Emotional valence—Inhibition—Irrelevant speech.

A persisting enigma in cognitive aging research is the phenomenon that older adults are not more distracted by irrelevant speech or sounds during a visual cognitive task than younger adults (e.g., Bell & Buchner, 2007; Rouleau & Belleville, 1996; Van Gerven, Meijer, Vermeeren, Vuurman, & Jolles, 2007), whereas a disproportionate level of distraction would be predicted based on the inhibitory deficit hypothesis (Hasher & Zacks, 1988; Lustig, Hasher, & Zacks, 2007). Although most explanations for this discrepancy, such as lack of statistical power (Bell & Buchner), age-related hearing loss (Murphy, McDowd, & Wilcox, 1999), and different levels of interference (Van Gerven et al.), have been ruled out, the possibility that older people are disproportionately distracted by emotional irrelevant speech has not been addressed so far.

In younger adults, negative irrelevant speech has been found to have a stronger impact on serial recall than neutral and positive irrelevant speech (Buchner, Rothermund, Wentura, & Mehl, 2004). There is good reason to believe that older adults are even more distracted by emotional stimuli. For example, in the emotional Stroop task, older adults show more interference from arousal-inducing stimuli than their younger counterparts (Wurm, Labouvie-Vief, Aycock, Rebucal, & Koch, 2004). Furthermore, older adults appear to be equally affected by positively and negatively valenced visual distractors but have better memory for positive distractors, whereas younger adults are more distracted by negative than by positive distractors and also have better memory for negative distractors (Thomas & Hasher, 2006).

The current study investigated whether older adults are differentially distracted by emotional irrelevant speech. For that purpose, we used an adapted version of the irrelevant speech paradigm employed by Van Gerven and colleagues (2007). Younger and older participants engaged in a visual counting task while being exposed to irrelevant background speech consisting of random numbers intermixed with neutral, positive, or negative words. These three background speech conditions were compared with a silence condition. To measure the extent to which irrelevant speech was inadvertently processed, we used an implicit memory test, which was based on the degraded word-identification task of Church and Schacter (1994). Although measurement of implicit memory in the irrelevant speech paradigm is quite rare, we believe that it provides important additional information because it enables us to distinguish the processing of irrelevant speech from its impact on performance, effects that do not necessarily go together.

Based on the literature, we expected a detrimental effect of irrelevant speech on performance in both younger and older adults in all background speech conditions relative to silence. In the older participants, we expected this effect to be relatively strong in both emotional conditions, whereas in the younger participants, we expected this effect to be relatively strong only in the negative condition. Finally, we expected disproportionate implicit memory for positive irrelevant speech in the older participants and for negative irrelevant speech in the younger participants.

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Methods

Participants

Originally, we conducted two consecutive studies with samples of 48 participants each, which we subsequently merged into one study of 96 participants: forty-eight younger (38 women; M_{age} = 21.9 years, SD = 2.0) and 48 older individuals (23 women; M_{age} = 68.1 years, SD = 5.2). Only in the second study, which involved 24 younger (20 women; M_{age} = 22.0 years, SD = 2.1) and 24 older participants (14 women; M_{age} = 70.1 years, SD = 4.0), we decided to administer the implicit memory test. All participants had at least received preuniversity level education. They were native speakers of the Dutch language, were in good health, and had normal or corrected-to-normal vision and hearing abilities. They received €15 for their participation.

Materials

Star Counting Test.—In the Star Counting Test (SCT; after De Jong & Das-Smaal, 1995), a display consisting of nine lines of up to six unevenly spaced asterisks was presented. The task of the participant was to count the asterisks from left to right and from top to bottom, starting from a random number indicated in the upper left corner of the display. The participant had to count alternately forward or backward, which was indicated with plus and minus signs. After arriving at the last asterisk, the counting result had to be compared with a probe number in the lower right corner of the display. Participants pressed a key labeled "yes" if the count equaled the probe and "no" if the count did not equal the probe. SCT performance was measured as counting time (in seconds) and accuracy (proportion of correct responses).

Background speech sources.—Irrelevant speech was presented at a fixed sound level of around 70 dB(A). Seventy-five percent of the irrelevant speech in all three background conditions consisted of random numbers between 1 and 99. The numbers presented during a trial ranged from 10 below the starting count (with a minimum of 1) to 10 above the probe count (with a maximum of 99). In this way, interference of the irrelevant numbers with the counting task was maximized. Twenty-five percent of the speech consisted of neutral, positive, or negative words. These words were randomly drawn from a database assembled by Hermans and De Houwer (1994). The complete version of this database consists of 740 words, which have been rated by a panel of 352 psychology students according to their affective valence on a 7-point scale, ranging from "*very negative*" (1) to "*very positive*" (7). From this database, we selected subsets of 100 most negatively rated words (M_{rating} = 1.72, SD = 0.23), 100 neutrally rated words (M_{rating} = 3.87, SD = 0.21), and 100 most positively rated words (M_{rating} = 6.01, SD = 0.16). The numbers and words were recorded by both a Dutch male and a Dutch female student with a clear and neutral voice.

Implicit memory test.—Implicit memory for irrelevant speech was assessed by asking participants to identify filtered versions of previously presented distractor words as well as filtered versions of words of the same category that were not presented before. This was accomplished by putting all test words (i.e., both "old" and "new" words) through a 1000-Hz low-pass filter, which left only fundamental frequencies and prosodic contour information intact. Of each set of 100 neutral, negative, and positive words, 25 were randomly selected that were not presented as irrelevant speech during the SCT (the other 75 words of each category were used as irrelevant background stimuli in the corresponding condition). The filtered version of these words represented the "new" part of the test. Of the 75 words that had been presented during the SCT, 25 were randomly selected whose filtered versions represented the "old" part of the test. Old and new test words were presented randomly intermixed such that each word was presented once. The participant was instructed to say aloud the words that he or she heard. No reference was made to the earlier presented irrelevant speech. Answers were scored manually.

Procedure

Participants were tested in individual sessions. The SCT started with four practice trials. The experiment proper included 20 SCT trials in each condition. The order of the conditions was counterbalanced within groups according to a 4 × 4 Latin square. Auditory stimuli were presented at an interstimulus interval of 50 ms. One half of the participants heard a female voice pronouncing the numbers and a male voice pronouncing the words. For the other one half of the participants, this was the other way round. Participants completed the implicit memory test immediately after finishing each condition.

Results

Counting time and accuracy data from the SCT were analyzed with 2 (age group) × 4 (condition) repeated measures analyses of variance (ANOVAs). Implicit memory was analyzed with a 2 (age group) × 3 (condition) ANOVA, which excluded the silence condition. Furthermore, all pairwise contrasts were analyzed.

Counting Time

Only counting times pertaining to correct trials were included in the analysis. Mean counting time as a function of condition is depicted in Figure 1. The older participants were around 5 s slower than the younger participants, $F(1, 94) = 16.26$, MSE = 233.45, $p < .001$, $\eta^2 = .15$. The presence of irrelevant speech caused all participants to take significantly longer to count the stars, $F(3, 282) = 5.39$, $MSE = 18.32$,

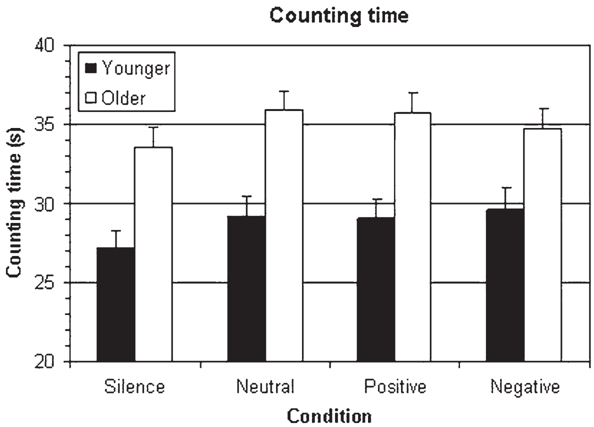

Figure 1. Mean counting time (in seconds) as a function of background condition. Error bars indicate 1 *SEM*.

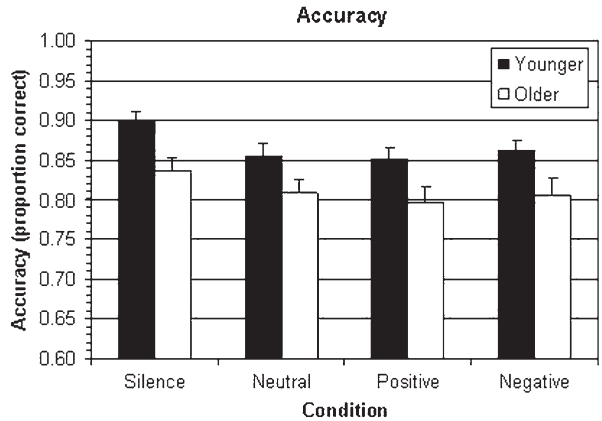

Figure 2. Mean accuracy (proportion correct) as a function of background condition. Error bars indicate 1 *SEM*.

$p = .001$, $\eta^2 = .05$. Contrast analyses show that neither positive nor negative words had a greater impact on counting time than neutral words (all *F*s < 1). Finally, the effect of condition did not interact with age group ($F < 1$).

Accuracy

Mean proportion correct as a function of condition is depicted in Figure 2. Older participants were significantly less accurate than their younger counterparts, $F(1, 94) = 9.12$, $MSE = .003$, $p < .01$, $\eta^2 = .09$. Furthermore, irrelevant speech had a significant detrimental effect on accuracy, $F(3, 282) = 4.93$, $MSE = .007$, $p < .01$, $\eta^2 = .05$. Again, however, this effect did not differ across the different background speech conditions, as was revealed by the contrast analyses (all *F*s < 1). Moreover, the effect of condition did not interact with age group ($F < 1$).

Implicit Memory

The implicit memory results can be found in Table 1. A critical indicator of implicit memory is the difference between old (i.e., presented earlier but ignored) and new (i.e., not presented earlier) words that were correctly identified. Because old words are better recognized than new words, the proportion of correctly identified new words was subtracted from the proportion of correctly identified old words. To exclude any individual or group differences in the ability to identify the filtered words, we analyzed the difference scores after correcting them for the proportion of correctly identified new words, which we regarded as a baseline. We did this by dividing the difference scores by the corresponding baselines (last column of Table 1). Thus, difference scores were expressed as a proportion of baseline performance. The 2 × 3 ANOVA yielded no main effect of age group ($F < 1$), which is logically due to the baseline correction procedure. There was a significant intercept, $F(1, 46) = 10.26$, $MSE = .02$, $p < .01$, $\eta^2 = .18$, suggesting that the difference scores were greater than zero and, thus, confirming that there was implicit memory for irrelevant speech. Finally, there was no main effect of condition nor was there an interaction with age group (both *F*s < 1).

Discussion

We tested the hypothesis that emotional background speech has a stronger detrimental effect on counting performance in older than in younger individuals. Our finding that

Table 1. Implicit Memory for Irrelevant Speech by Age Group and Condition: Mean Proportion (and standard deviations) of Correctly Identified Filtered Words

	Old words		New words		Difference (old−new)		Difference/baseline (difference/new)	
	M	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)
Younger								
Neutral	0.70	(0.15)	0.66	(0.13)	0.04	(0.14)	0.08	(0.23)
Positive	0.80	(0.12)	0.78	(0.10)	0.02	(0.09)	0.03	(0.13)
Negative	0.77	(0.14)	0.72	(0.13)	0.05	(0.15)	0.10	(0.26)
Older								
Neutral	0.62	(0.11)	0.59	(0.14)	0.02	(0.13)	0.08	(0.28)
Positive	0.70	(0.15)	0.68	(0.14)	0.02	(0.15)	0.06	(0.25)
Negative	0.67	(0.13)	0.66	(0.13)	0.02	(0.15)	0.06	(0.26)

there is no disproportionate irrelevant speech effect in older adults is in line with most previous studies (e.g., Bell & Buchner, 2007; Rouleau & Belleville, 1996; Van Gerven et al., 2007; but see Bell, Buchner, & Mund, 2008). However, they are in contrast with earlier results from studies on visual emotional distraction (e.g., Thomas & Hasher, 2006). The absence of age-related effects might be explained by the notion that a biased processing of emotional distraction requires sufficient cognitive resources, which may not be available if older people are engaged in a demanding primary task, such as the SCT (cf. Mather & Knight, 2005). Our implicit memory results furthermore suggest that older adults do not process more of the irrelevant speech than younger adults. This outcome is comparable with results obtained by Murphy and colleagues (1999), who used a different measure of implicit memory for nonemotional irrelevant speech (i.e., reduced auditory threshold for earlier presented stimuli), but did not find any age differences as well. Finally, our implicit memory data show that there is no age-related processing bias toward positive or negative irrelevant speech, which is again in contrast with the results by Thomas and Hasher in the visual domain.

To compare the emotional valence of the stimuli in our study with the emotional valence of the stimuli in the study by Thomas and Hasher (2006), we transformed the average 7-point valence ratings of our stimuli to the 9-point ratings used in their study by applying the following conversion: (7-point rating/7) × 9. This yielded values of 2.21, 4.98, and 7.73 for the negative, neutral, and positive stimuli, respectively, where the values reported by Thomas and Hasher were 2.42, 5.45, and 7.66. This means that, if anything, our manipulation with regard to emotional valence was slightly stronger. Moreover, our emotional stimuli were more balanced in terms of their distance from the neutral stimuli (negative: 2.77 and positive: 2.75) than were the emotional stimuli used by Thomas and Hasher (negative: 3.03 and positive: 2.21).

Since the seminal work by Rouleau and Belleville (1996), a robust pattern of age-independent distraction by irrelevant speech has emerged in the literature, which can be regarded as a challenge to the inhibitory deficit hypothesis. The current study underlines this challenge by showing that irrelevant speech has a similar impact on younger and older adults, regardless of the dependent measure that is taken into account (i.e., primary task performance or implicit memory for distractors). Besides providing converging evidence that older adults are not more distracted by irrelevant speech than younger adults, the current study shows that age-related effects of emotional distraction, which have been repeatedly found in the visual modality, may not exist in the auditory modality.

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References

Bell, R., & Buchner, A. (2007). Equivalent irrelevant-sound effects for old and young adults. *Memory & Cognition*, *35*, 352–364.

Bell, R., Buchner, A., & Mund, I. (2008). Age-related differences in irrelevant-speech effects. *Psychology and Aging*, *23*, 377–391.

Buchner, A., Rothermund, K., Wentura, D., & Mehl, B. (2004). Valence of distractor words increases the effects of irrelevant speech on serial recall. *Memory & Cognition*, *32*, 722–731.

Church, B. A., & Schacter, D. L. (1994). Perceptual specificity of auditory priming: Implicit memory for voice intonation and fundamental frequency. *Journal of Experimental Psychology: Learning Memory, and Cognition*, *20*, 521–533.

De Jong, P. F., & Das-Smaal, E. A. (1995). Attention and intelligence: The validity of the Star Counting Test. *Journal of Educational Psychology*, *87*, 80–92.

Hasher, L., & Zacks, R. T. (1988). Working memory, comprehension, and aging: A review and a new view. In G. H. Bower (Ed.), *The psychology of learning and motivation: Advances in research and theory* (Vol. 22, pp. 193–225). San Diego, CA: Academic Press.

Hermans, D., & De Houwer, J. (1994). Affective and subjective familiarity ratings of 740 Dutch words. *Psychologica Belgica*, *34*, 115–139.

Lustig, C., Hasher, L., & Zacks, R. (2007). Inhibitory deficit theory: Recent developments in a "new view". In C. M. MacLeod & D. S. Gorfein (Eds.), *Inhibition in cognition* (pp. 145–162). Washington, DC: American Psychological Association.

Mather, M., & Knight, M. (2005). Goal-directed memory: The role of cognitive control in older adults' emotional memory. *Psychology and Aging*, *20*, 554–570.

Murphy, D. R., McDowd, J. M., & Wilcox, K. A. (1999). Inhibition and aging: Similarities between younger and older adults as revealed by the processing of unattended auditory information. *Psychology and Aging*, *14*, 44–59.

Rouleau, N., & Belleville, S. (1996). Irrelevant speech effect in aging: An assessment of inhibitory processes in working memory. *Journal of Gerontology: Psychological Sciences*, *51B*, P356–P363.

Thomas, R. C., & Hasher, L. (2006). The influence of emotional valence on age differences in early processing and memory. *Psychology and Aging*, *21*, 821–825.

Van Gerven, P. W. M., Meijer, W. A., Vermeeren, A., Vuurman, E. F., & Jolles, J. (2007). The irrelevant speech effect and the level of interference in aging. *Experimental Aging Research*, *33*, 323–339.

Wurm, L. H., Labouvie-Vief, G., Aycock, J., Rebucal, K. A., & Koch, H. E. (2004). Performance in auditory and visual emotional Stroop tasks: A comparison of older and younger adults. *Psychology and Aging*, *19*, 523–535.