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Locus of Control and the Age Difference in Free Recall From Episodic Memory

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Locus of Control and the Age Difference in Free Recall From Episodic Memory

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ABSTRACT. The authors investigated the relation of locus of control (LOC) to age differences in free-recall memory performance. Older and younger participants completed P. C. Duttweiler's (1984) Internal Control Index (ICI) and subsequently performed free-recall memory tasks. Compared with the younger participants, the older participants exhibited poorer recall with more intrusions and uncorrected repetition errors as well as reduced categorical clustering. For the older participants with less internal LOC, recall proportion and item-pair associative recall clustering were lower than for the older participants with more internal LOC. By contrast, the younger participants did not exhibit any LOC effects in their recall performance. The results suggest that a differential memory organization deficit may underlie the age differences in free recall among individuals varying in LOC when they are performing an intentional learning task. This deficit is discussed in terms of a reduced-inhibition account of cognitive aging.

ONE VARIABLE OFTEN ASSOCIATED with aging and personality is a change in perceptions of locus of control (LOC; Lachman, 1986; Molinari & Neiderehe, 1984; Nehrke, Hulicka, & Morganti, 1980; Shewchuk, Foelker, & Niederehe, 1990; Siegler & Gatz, 1985). As characterized recently by Riggs, Lachman, and Wingfield (1997), people with a more internal LOC tend to believe that individual ability, effort, and self-reliance are the determinants of task outcomes. In contrast, those with a less internal, or external, LOC tend to attribute task outcomes to forces outside their control.[1]

[1]The scale used in the present study—Duttweiler's (1984) Internal Control Index—is ostensibly a measure of internal control. Arguments have been made (Riggs et al., 1997) that internality and externality do not lie on the same unidimensional continuum of LOC. Nonetheless, other internality scales (e.g., the Internal subscale of Lachman et al., 1982, from their PIC battery) exhibit a statistically significant negative correlation with external-

There is a pervasive perception that LOC is generally more externally oriented among older adults as a group than among younger adults (Cornelius & Caspi, 1986; Lachman, 1991). This view may stem from the perception of older persons' greater reliance on others, or it may simply reflect a self-fulfilling stereotype that older people are "helpless" as well as "old." Not surprisingly, the sense of loss of an internal LOC has been associated with impaired physical and mental health, decreased personal and social well-being, and increased rates of mortality in older persons (Adamson & Shamale, 1965; Kahana & Col, 1969; Lieberman & Tobin, 1983; Schulz, 1976). Further, Mancini (1980) reported that among older public-housing residents, high levels of life satisfaction were correlated with an internal LOC. Also, positive correlations between good coping skills, low defensiveness, and internal LOC have been reported by Kuypers (1971).

Differences in recall and memory organization have been found between younger persons with internal LOC and those with external LOC (e.g., Brooks & McKelvie, 1986; Wolk & DuCette, 1974), particularly when stimuli were processed under noisy conditions (Ellis & Franklin, 1983; Starnes & Loeb, 1993). For example, Ellis and Franklin found that intentional free recall was greater for individuals with internal LOC than for those with external LOC when common nouns were encoded in a distracting context (varied background color across the word list); however, no difference was found between those groups when items were encoded in a neutral context (constant background color across the word list). Moreover, in the distracting context, the persons with external LOC were much less likely than those with internal LOC to use semantic category, but more likely to use background color, as an organizational strategy. In the neutral context, however, the two groups did not differ in their organizational strategy. Starnes and Loeb found that in an intentional, free-recall task involving concurrent auditory noise, individuals with external, but not internal, LOC decreased their use of a semantic strategy (item category similarity) and increased their use of a perceptual strategy (item rhyme similarity) in organizing items for later recall. In those two studies, younger persons with external LOC had difficulty inhibiting distracting information; that difficulty resulted in the

ity scales (e.g., the Chance subscale of Lachman et al., 1982, from the PIC battery). Moreover, by her own description, Duttweiler's items are worded *internally* or *externally*. Accordingly, in this article, we used interchangeably the terms *more internal* and *internal* as well as *less internal* and *external* to facilitate comparisons with results from earlier studies using unidimensional LOC scales (often Rotter's, 1966, Internality-Externality scale).

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greater use of surface-level and reduced use of semantic-level information in their memory organization of the items to be recalled. When such distracting information was not present, however, LOC had no effect on intentional free recall in younger persons.

Because older adults tend to have a less internal LOC (Riggs et al., 1997) and reliably exhibit poorer cognitive and memory performance than younger adults do (e.g., Craik & McDowd, 1987; see Kausler, 1994, for a review), researchers have investigated the potential link between the two observations (Grover & Hertzog, 1991; Lachman, Baltes, Nesselroade, & Willis, 1982; Riggs et al., 1997; Welch & West, 1995). For example, Riggs et al. (1995) had older people with internal LOC and older people with external LOC monitor a spoken prose passage or a random word list and choose segments they believed they could recall correctly. For the prose passages, the participants with external LOC chose larger segments but recalled fewer of the words of their selected segments than did those with internal LOC. For the random word lists, the two groups did not differ in their chosen segment lengths, but the participants with external LOC tended to recall fewer words per chosen segment than did those with internal LOC. Lachman, Baltes, Nesselroade, and Willis (1982) used three scales (Internal, Chance, and Powerful Others) to assess the relation between LOC and a range of cognitive tasks, including a number of memory measures (e.g., digit span), among older individuals. Of particular relevance to the present study, memory performance was positively correlated with greater internality and negatively correlated with greater externality of LOC. This relation was found also in a later study by Grover and Hertzog (1991).

In a study similar to that conducted by Ellis and Franklin (1983), Singer (1982) investigated the role of LOC in free recall among a group of older participants. Specifically, his focus was the effect of individual differences in LOC on the likelihood and extent of spontaneous categorical clustering in the recall of categorically related words. Singer predicted that older persons with greater external LOC would exhibit less spontaneous clustering than would their counterparts with internal LOC, a situation that should lead to poorer recall performance for the former group. His results, assessed by a causal model, supported his basic clustering–recall assumption and, moreover, revealed that for participants with at least a high school education, LOC did, indeed, predict the extent of spontaneous categorical clustering and its ultimate effect on recall frequency.

Despite the informativeness of the studies just described, a direct comparison of older and younger adults with regard to LOC differences in free recall is difficult to find in the literature. How might these differences influence memory recall for older and younger individuals? Because older participants, in general, are more susceptible than their younger counterparts to distracting and irrelevant stimuli (Kausler & Kleim, 1978; Rabbitt, 1980), one would expect not only that older persons would have poorer recall than younger persons but also that older persons would be more sensitive than younger ones to differences in LOC. In light

of the findings of Ellis and Franklin (1983) and Starnes and Loeb (1993) concerning the interactive effects of noise and LOC on free recall in younger persons, one would expect (a) that even in the absence of externally presented noise, older persons with less internal LOC would exhibit poorer recall and recall organization than older persons with more internal LOC but (b) that younger persons would exhibit no such differences in recall related to LOC.

This prediction is consistent with an extended version of the *neural noise* hypothesis that has pervaded the literature on cognitive aging for some time (e.g., Birren, 1965; Cremer & Zeef, 1987; Salthouse & Lichty, 1985; Welford, 1958; see also Kausler, 1994, for a review). That hypothesis posits that greater random neuronal activity in older persons leads to decrements in cognitive performance. A related and more recent general resource account is the *inhibition model* (Hasher & Zacks, 1988; Hartman & Hasher, 1991), which posits that older people experience breakdowns in the inhibitory processes that maintain the integrity of episodically learned material (item-specific and item-relational information) by prohibiting intrusive internal thoughts and external stimuli from interfering with the information needed for accurate task performance. According to the inhibition model in the present context, older persons should exhibit not only poorer recall and recall organization than their younger counterparts but also more recall errors (i.e., intrusions and uncorrected repetitions).

Of relevance here is a recent study by Greenhut-Wertz and Manning (1995), in which older and younger participants read, either silently or aloud, visually presented lists of seven-letter sequences. Letter sequences were subsequently recalled by voice or by writing in strict serial order. Overall, the older participants recalled fewer correct sequences under all the presentation and recall conditions; interestingly, they also produced more extralist intrusion errors. In direct relation to the inhibition model, the researchers concluded that older persons may experience *internally generated noise*—realized as additional items entering the set of correct responses—that they have difficulty inhibiting at time of recall. Assuming that older persons with less internal LOC are even less successful than their counterparts with more internal LOC in inhibiting such noise at time of recall, we correspondingly expected a greater rate of recall error commission for the former than for the latter—or at least a greater disruption in recall organization because of their poorer inhibition of noise.

In the current study, we assessed the relationship between LOC and age with regard to level, accuracy, and organization of free recall from episodic memory. We presented older and younger participants with a study list of 48 words organized into 24 item pairs. The 48 words consisted of 2 exemplars for each of 24 conceptual categories. We randomly assigned words to the items pairs in such a manner that category members never appeared together. In this way, two types of recall organization could be assessed in a balanced manner: item-pair associative clustering (*seriation*; see Hultsch, 1974) and categorical

clustering. Item-pair associative clustering—contiguous recall of the item pairs—represents use of the surface structure (or *primary organization*) of the study list as a means of encoding and retrieving the items to be remembered; categorical clustering—contiguous recall of words denoting objects from the same category—represents the use of conceptual structure of the items to be recalled and entails a reorganization (or *secondary organization*) of the items following their encoding, to be used at their retrieval. Evidence for age-related differences in the mixing of modes has been noted within a single study–test trial, even when the modes function as competing recall strategies (Witte, Freund, & Brown-Whistler, 1993). Specifically, Witte et al. (1993) found that upon first learning a list of items, younger persons exhibited recall clustering favoring the associations among contiguous study-list items over the categorical similarity of those items; however, older persons exhibited a balance in their use of these forms of clustering (although overall, the older persons clustered less than the younger persons).

Thus, to the extent that clustering, in general, predicts free recall (see Kausler, 1994), we expected to find less clustering overall among the older than among the younger participants. Given the findings of Witte et al. (1993), we expected this difference to be attributable primarily to less item-pair associative clustering among the older participants. As for LOC, we expected less clustering for the older participants with less internal LOC than for the older participants with more internal LOC. Specifically, there is evidence that younger persons optimize recall by initially organizing a study list for item order (Mandler & Dean, 1969; Pellegrino & Battig, 1974), whereas older persons apparently do not do so to the same degree (Witte et al., 1993). We, therefore, expected that item-pair associative clustering would further distinguish the older participants with less internal LOC from the older participants with more internal LOC, given the inference that under functionally noisy conditions (in this case, age based and internally generated), less internal individuals do not use efficient clustering strategies (Ellis & Franklin, 1983).

Method

Participants

Our sample consisted of 18 older participants (9 men and 9 women) and 18 younger participants (9 men and 9 women). The age range for the older participants was 66–84 years ($M = 73.94$, $SD = 5.35$); for the younger participants, the age range was 18–28 years ($M = 20.39$, $SD = 2.52$). The older participants were healthy people recruited from the Albuquerque community, where they lived independently. All the older participants had at least 12 years of education, and many of them had attended college. We screened them for health problems, in particular, for neurological disorders (e.g., stroke and Alzheimer's disease). The

younger participants were healthy undergraduates enrolled in introductory psychology courses at the University of New Mexico.[2]

Design and Materials

This study had a 2 × 2 factorial design with age group (older or younger) and LOC group (less internal or more internal) as between-subjects variables; written recall of the study list was the primary dependent measure.

All participants were administered the Internal Control Index (ICI; Duttweiler, 1984), a measure of internal LOC focusing on aspects of personal choice, autonomy, resistance to attempts to influence, delay of gratification, and self-confidence. We chose it from the several available unidimensional (e.g., Rotter, 1966) and multidimensional (Lachman et al., 1982; Levenson, 1974) scales because it offered an efficient and sensitive measure of variables associated with optimal, autonomous, cognitive functioning (see Duttweiler, 1984). The ICI consists of 28 items with response alternatives falling along a Likert-type scale ranging from 1 (*rarely*) to 5 (*usually*). Thus, the maximum attainable composite score is 140, indicating a decidedly *more internal* response pattern. The minimal attainable composite score is 28, indicating a decidedly *less internal* response pattern.

Overall, the older participants had lower ICI scores ($M = 98.06$, $SD = 12.48$) than did the younger participants ($M = 102.5$, $SD = 11.77$); however, this difference was nonsignificant, $F(1, 32) = 1.21$, $p > .27$, $MSE = 147.22$. To provide a standard means to assess the separate and conjoint effects of aging and LOC, we assigned the participants' recall data and errors to either a less internal or a more internal LOC group on the basis of a median (101) of those participants' ICI scores collapsed over age group. As a result, we assigned 11 older and 7 younger participants to the less internal group and 7 older and 11 younger participants to the more internal group. Mean ICI scores for the two LOC groups were 90.39 ($SD = 6.12$) and 110.17 ($SD = 7.77$), respectively; $F(1, 34) = 71.99$, $p < .0001$, $MSE = 48.91$.[3]

Within each group, the average ages of the corresponding less internal and more internal group members did not differ significantly. The average ages for the older participants in the less internal and more internal groups, respectively, were 74.55 ($SD = 4.68$) and 73.00 ($SD = 6.56$) years, $F(1, 16) = .34$, $p > .56$, $MSE = 29.80$; the average ages for the younger participants in the less internal and more

[2]Because of time constraints, we did not take specific measures of verbal ability; however, the experimenters' verbal interaction with the older participants indicated that consistent with the prevalent finding in the verbal memory and aging literature (e.g., Kitzan, Ferraro, Petros, & Ludorf, 1999), these participants most likely had verbal abilities (e.g., vocabulary knowledge) that exceeded those of the younger participants.

[3]This assignment is not significantly different from one in which there are four groups, each with $n = 9$; $\chi^2(1) = 1.78$, $p > .05$.

internal groups, respectively, were 21.00 (SD = 3.46) and 20.55 (SD = 2.54) years, $F(1, 16) = .10$, $p > .75$, $MSE = 8.55$.

For the memory recall task, all participants read a list of 24 word pairs (see Appendix). From the Category Norms from Battig and Montague (1969), we selected the two most frequently generated words for each of 24 categories. We excluded words from color categories, words with three or more syllables, and proper nouns. Pair items were randomly sampled and ordered for each participant, with the constraint that the two words from a common category never be paired.

Procedure

We tested the older and younger participants individually; each sat at a table across from the experimenter in a quiet room. Upon giving their informed consent, participants were instructed to complete the ICI and study the 24 word-pair list for later recall. We presented word pairs from the study list at 2-s intervals and used a cover sheet to mask the other words of the list. The participants read aloud each word pair during each interval. They read the list three times in succession and then recalled as many words as possible, regardless of pair membership or list order. The participants were given 10 min to recall the words. Afterward, the participants were debriefed and dismissed. The experimental session lasted approximately 30 min.

Results

For each participant, recall data consisted of the total number of items correctly recalled, collapsed over serial position. Correspondingly, for each participant, error data consisted of the total number of words either incorrectly recalled (intrusions) or words repeatedly recalled without corrections (repetitions). We analyzed these data to determine proportion of correct recall, recall error rate, and recall clustering indices by using analyses of variance (ANOVAs) with age group (older or younger) and LOC group (less internal or more internal) as fixed variables; the participants within these groups were the random variable. The data were arcsine transformed in these analyses to stabilize within-group variance (see Myers, 1971). For purposes of interpretability, the untransformed condition means are presented in the text, and untransformed condition means and standard errors are given in Figures 1 and 2.

Correct Recall

Overall, the older participants recalled, on average, a significantly lower proportion (.229) of words than did the younger participants (.490), $F(1, 32) = 34.35$, $p < .0001$, $MSE = 0.084$. Moreover, a lower proportion of words was recalled by the less internal group (.339) than by the more internal group (.380), though this

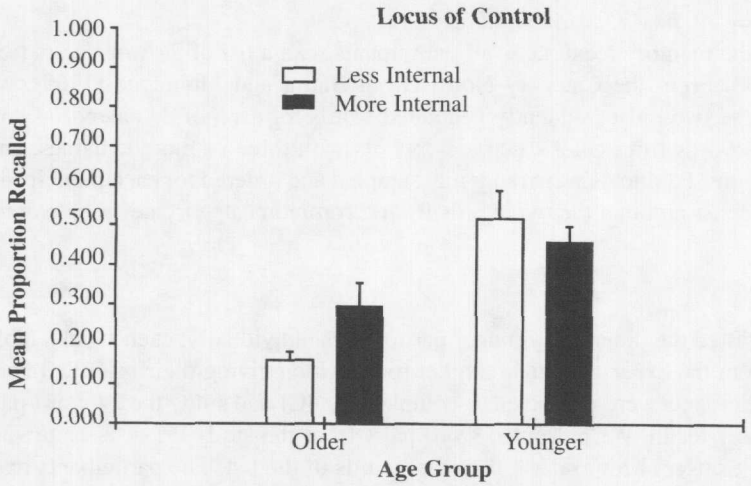

FIGURE 1. Mean proportions and standard errors of words correctly recalled plotted as a function of age group (older or younger), and locus of control group (less internal or more internal).

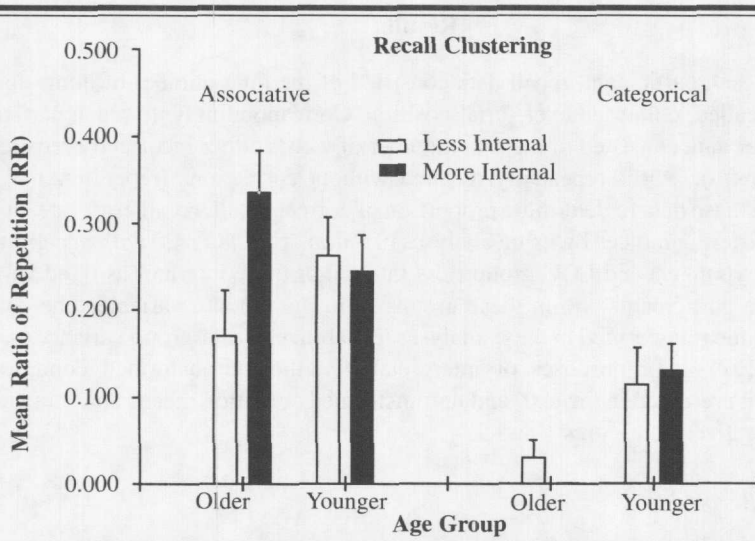

FIGURE 2. Mean ratio of repetition (RR) values and standard errors plotted as a function of recall organization (associative or categorical), age group (older or younger), and locus of control group (less internal or more internal).

difference was not significant, $F(1, 32) = 1.10$, $p > .30$, $MSE = 0.084$. Age group and LOC group, however, interacted significantly, $F(1, 32) = 5.21$, $p < .03$, $MSE = 0.084$. That interaction was such that for older participants, the less internal group recalled a lower proportion of words (.161) than did the more internal group (.298), $F(1, 16) = 7.10$, $p < .02$, $MSE = 0.065$ (see Figure 1). For younger participants, however, the less internal group recalled a slightly higher proportion of words (.518) than did the more internal group (.462), a difference that was nonsignificant, $F(1, 16) = .62$, $p > .44$, $MSE = 0.102$.

Intrusion and Repetition Errors

Intrusions and repetition errors were standardized according to the total number of words produced in the recall protocol (correct and incorrect) for each participant. The older participants produced a higher rate of errors (.087) in their recall protocols than did the younger participants (.019), $F(1, 32) = 4.26$, $p < .05$, $MSE = 0.150$. Slightly more intrusion and repetition errors were produced by the less internal group (.059) than by the more internal group (.048); however, this difference was nonsignificant, $F(1, 32) = .11$, $p > .74$, $MSE = 0.150$. Moreover, age group and LOC group did not significantly interact, $F(1, 32) = .16$, $p > .69$, $MSE = 0.150$.

Recall Organization

We computed two measures of recall organization on the recall protocols: ratio of repetition (RR; Murphy & Puff, 1982) and adjusted ratio of clustering (ARC; Roenker, Thompson, & Brown, 1971). We selected those measures because they provide an assessment of recall clustering independent of recall level (Murphy, 1979; Murphy & Puff). We computed RR and ARC for two kinds of recall organization: (a) item-pair associative recall, in which the words presented within the item pairs (e.g., "table–dog" and "cat–chair") were recalled in immediate succession, regardless of specific intrapair word order (e.g., "table–dog" and "chair–cat"), and (b) categorical recall, in which the words presented in the item pairs (e.g., "table–dog" and "cat–chair") had been reorganized in recall such that words denoting same-category objects were ordered in immediate succession (e.g., "table–chair" and "dog–cat"). We found a nearly identical pattern of results for the RR and ARC measures; for sake of brevity, we describe only RR here.

RR values averaged over participants are plotted in Figure 2 according to age group, LOC group, and type of recall organization (associative or categorical). For item-pair associative recall, there was a significant RR difference neither between the older (.253) and the younger (.254) participants, $F(1, 32) = .22$, $p > .64$, $MSE = 0.194$, nor between the less internal (.216) and more internal (.290) participants, $F(1, 32) = 2.38$, $p > .13$, $MSE = 0.194$. Age group and LOC group,

however, interacted significantly, $F(1, 32) = 4.37$, $p < .05$, $MSE = 0.194$. This interaction was such that for the older group, RR for the less internal participants (.170) was substantially less than for the more internal participants (.336), $F(1, 16) = 5.06$, $p < .04$, $MSE = 0.253$; however, for the younger participants, there was no significant RR difference between the less internal (.263) and the more internal (.245) participants, $F(1, 16) = .22$, $p > .64$, $MSE = 0.135$. Moreover, RR for the more internal older (.336) and younger (.245) participants did not significantly differ, $F(1, 16) = 1.85$, $p > .19$, $MSE = 0.139$.

In contrast, for categorical recall, there was a significant difference between the age groups: RR was substantially less for the older (.016) than for the younger (.123) participants, $F(1, 32) = 22.11$, $p < .0001$, $MSE = 0.108$. There was, however, neither a significant RR difference between the less internal (.072) and the more internal (.066) participants, $F(1, 32) = .04$, $p > .83$, $MSE = 0.108$, nor a significant interaction between age group and LOC group, $F(1, 32) = 1.84$, $p > .18$, $MSE = 0.108$.

Because RR for item-pair associative recall and RR for categorical recall were negatively correlated, $r(34) = -.375$, $p < .05$, we computed partial correlations to determine independently the relationship of each RR clustering measure with recall performance across the participants of both age groups. These correlations were significant and positive both for item-pair associative clustering, $r(33) = .573$, $p < .05$, and for categorical clustering, $r(33) = .669$, $p < .05$.[4] Finally, underscoring the results of the ANOVAs, RR was significantly and positively correlated with LOC for item-pair associative clustering for older participants, $r(16) = .490$, $p < .05$, but not for younger participants, $r(16) = -.068$, $p > .05$. In addition, RR for categorical clustering was not significantly correlated with LOC for older participants, $r(16) = -.238$, $p > .05$, or for younger participants, $r(16) = .203$, $p > .05$.

Discussion

The purpose of our research was to explore the relation between age and LOC and the role of that relation in the pervasive reduction in free recall observed for older persons relative to younger persons (Kausler, 1994). Specifically, because older persons appear to function under conditions of greater internally generated "noise" (e.g., Greenhut-Wertz & Manning, 1995), we predicted that they would demonstrate a pattern of LOC effects in their free recall similar to the pattern reported for younger persons processing stimuli under conditions of externally present-

[4]The negative correlation between the two types of clustering measures reflects the fact they are competing modes of recall organization, given our study-list configuration. Moreover, this correlation was less than the product of the correlations between each clustering measure and recall proportion indicating a situation of *suppression* (Cohen & Cohen, 1983) and necessitating the separate determination of the contribution of each clustering measure in accounting for recall performance.

ed noise. In contrast, without explicitly presented noise, younger participants were not expected to exhibit any LOC effects (Ellis & Franklin, 1983). Indeed, we found that, overall, the older participants exhibited more recall errors in the form of intrusions and uncorrected repetitions. Moreover, the older participants with less internal LOC recalled a smaller proportion of the study list than did their more internal counterparts, whereas the younger participants exhibited no LOC effects.

Relatedly, we expected a pattern of recall organization among the age and LOC groups likewise analogous to the results reported for younger participants by Ellis and Franklin (1983)—notably, less categorical clustering for the less internal than for the more internal older participants but no LOC differences for younger participants. Although it is true that (a) recall organization, across clustering measures, was less for the less internal older participants than for the more internal older participants and (b) no LOC differences in recall organization were observed in the younger participants, there was a clear dissociation between the two clustering measures with regard to age group and LOC group. For example, item-pair associative clustering distinguished the less internal and more internal older participants but not the corresponding LOC groups of younger participants. Categorical clustering, however, distinguished the two age groups—the older participants, compared with the younger participants, exhibited negligible categorical clustering—but did not distinguish the LOC groups. This pattern of clustering results suggests that the LOC effects in the recall data stemmed from the reduced spontaneous use of item-pair associative clustering by the less internal older participants; indeed, this clustering is statistically equivalent between the more internal older participants and younger participants. Accordingly, the reduced spontaneous use of categorical clustering by the older participants, in general, accounts for at least a portion of the remaining difference in recall between the two age groups. Given that the clustering modes significantly accounted for unique variance among the participants in their proportion of correct recall, these clustering results suggest a testable two-factor model of age and LOC differences in free recall from episodic memory.

We should note that aspects of this recall pattern are not consistent with the seriation and categorical clustering findings of Witte et al. (1993). For example, we would have expected the older participants to exhibit less item-pair associative clustering than their younger counterparts. Overall, however, we found no difference between our two age groups. Interestingly, that prediction is supported when we consider only our less internal older participants, an observation that suggests the possibility that the older participants of Witte et al. were sufficiently less internal in LOC than their younger participants to produce their seriation results.

Moreover, whereas Witte et al. (1993) reported more categorical clustering among their older than among their younger participants (on their comparable first list study–test trial), we found quite the opposite. Specifically, as a group, our older participants exhibited negligible categorical clustering that was substantially less than the categorical clustering in our younger participants. Our

results are consistent with those in a number of studies indicating that without explicit instructions, older persons are less likely to process stimuli for their semantic attributes (especially concerning relational elaboration; see Kausler, 1994). We attribute the discrepancy between our results and those of Witte et al. to the greater categorical diagnosticity of their study list relative to ours: Whereas their list consisted of 8 categories of 10 exemplars each, our list consisted of 24 categories of 2 exemplars each. Because we were expressly interested in a balanced assessment of the contiguous recall of pairs of words, either as those presented in the item pairs or reorganized as category members, we opted for this list configuration.

We should also comment about the greater item-pair associative clustering relative to the categorical clustering observed for both groups in our study. We intended the presentation of explicit item pairs in the study list as a means to assess a directly available, structural aspect of list organization that the participants could use to facilitate recall. This mode of item presentation, however, provided information that influenced both item-word encoding and retrieval. On the other hand, the category exemplars (two per category) influenced only item-word retrieval (and then only if the item pairs were reorganized after encoding; see Neath, 1998). It is not surprising, then, that item-pair associative clustering was the predominant means of recall organization for both age and LOC groups.

The finding of no difference in recall between the internal and external younger participants when external noise was not explicitly presented is consistent with the finding of Ellis and Franklin (1983). In studies using more complex verbal materials such as sentences from thematic paragraphs, however, external younger participants have exhibited poorer recall performance than their internal counterparts (Brooks & McKelvie, 1986; Wolk & DuCette, 1974). In any case, complexity of materials, per se, did not appear to be an issue in our study because the younger participants recalled, on average, only about 50% of the items presented in the stimulus list, allaying any concerns about possible ceiling effects for this age group.

In sum, our results reveal both inter- and intra-age group differences in performance on a free-recall memory task. Moreover, our results suggest that the effect of LOC on free recall for the less internal older participants is not attributable simply to less clustering per se but, rather, to less clustering pertaining to the structure (i.e., item order) in the study list—precisely more of which was seen in the better recall protocols of the more internal older participants and the younger participants (Mandler & Dean, 1969; Pellegrino & Battig, 1974).

We take our results concerning the relation among age, LOC, and recall performance as collaborative support for the inhibition model (Hartman & Hasher, 1991; Hasher & Zacks, 1988) as an explanation for at least some of the profound and ubiquitous recall deficits seen in older people. Specifically, the reduction in older persons' ability to filter out irrelevant thoughts and environmental stimulation (McDowd & Filion, 1992) leads to greater internally generated "noise"

caused by a corruption of episodic memory traces for list items. If one assumes a limit on cognitive resources available for successful performance of the recall task (Ellis & Franklin, 1983), this corruption leads to both a loss of traces for items that were presented in the word list as well as the addition of traces for intruding items that were not presented in that word list. Moreover, this corruption also leads to repeated recall of items, apparently by the additional loss of episodic traces pertaining to items that have already been recalled. Last, this same corruption can limit the usefulness of organizational attributes (both structural and conceptual) of a study list and, thus, limit the extent of clustering that leads to a better level of recall.

An explanation of why less internal older persons exhibit even poorer recall than do their more internal counterparts is suggested by the reduction in item-pair associative clustering arising from the impact of age-related internal noise: Less internal older persons are even less likely than their more internal counterparts to use the immediately available structure present in the study list. Therefore, it may be that less internal older persons lack the ability to inhibit intruding thoughts and environmental stimulation to such an extent that facilitating recall mechanisms are particularly impaired. Although the less internal participants had a greater error rate (.0949) than did the more internal participants (.0795), the finding that there was no significant difference in recall errors among the older LOC groups suggests that what less internal older persons do (or fail to do) with this general age-related increase in distractibility reduces their item-pair associative clustering. This is exemplified by an anecdotal statement made by one of our less internal older participants. When commenting on his inability to recall additional words during the recall period, he remarked, "There are so many words which may or may not have been in the list . . . I just don't want to make a mistake."

There have been several theoretical accounts proposed for the substantial drop in recall from episodic memory among older persons relative to younger persons, including accounts appealing to less spontaneous memory organization, slower speed of processing (Salthouse, 1988), and poorer inhibition of internally generated noise (see Kausler, 1991, for a review). As our current results indicate, however, the role of individual personality variables needs to be incorporated into any memory theory for it to be viable as an account of such age differences in memory performance. As many studies have indicated, there are profound decrements in cognitive functioning that can be generalized across older persons, but contrary to the comments of some researchers (e.g., Kausler, 1994), the interaction between those decrements and individual personality variables such as LOC should not be discounted.

Can the LOC effects on older persons' memory performance observed in our study be reversed by direct interventions to increase motivation for thinking and remembering? Older people are possibly unwitting victims of negative labeling and stereotypes with an overemphasis on their physical decline. As Rodin (1980) reported, when given increased responsibility in making decisions, older persons

reduced their own negative self-labeling, became more involved and active, and reported feeling happier. To the extent that such changes would produce a shift toward a more internal LOC, we would expect improved memory performance as well. Relatedly, Lachman (1991) reported studies in which ratings of self-efficacy among older participants concerning their memory abilities and their actual memory performance were enhanced by jointly training the participants on a useful memorial strategy (method of loci) and giving them persuasive information that memory loss is neither inevitable nor irreversible in old age. If that is so, then independently manipulating LOC in an older sample of participants would allow a comprehensive test of the contribution of LOC to the nature of free recall for this age group, particularly in terms of the differences in recall organization observed here.

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APPENDIX

Sample Organization of Word List

UNCLE–MOUNTAIN	MINUTE–DOOR	WINDOW–COPPER
BUS–BEER	PEPPER–SPOON	ROBIN–CHAIR
VALLEY–FOOTBALL	INCH–WHISKEY	WOOL–NICKELS
BOOTS–ORANGE	APPLE–LAWYER	BASEBALL–CAR
IRON–MILE	SAW–SALT	SPARROW–DOLL
GAS–LEGS	CAT–KNIFE	ARMS–BALL
COTTON–DOLLARS	TABLE–OIL	
DOG–HOUR	SHOE–PEA	
CARROT–AUNT		
DOCTOR–HAMMER		

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