Age Differences in Encoding Specificity

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Abstract:
In two experiments (one under full attention, the other under divided attention), old and young adults were presented with a cued recall task in an encoding specificity paradigm. Targets and associated cues were either pictures or matched words, and there was either a strong or weak semantic relationship between targets and cues. Additionally, cues presented at recall were either the same as or different from those presented at encoding, resulting in four encoding cue—retrieval cue combinations: (a) strong encoding cue and (same) strong retrieval cue; (b) weak encoding cue and (same) weak retrieval cue; (c) weak encoding cue and (different) strong retrieval cue; (d) strong encoding cue and (different) weak retrieval cue. For the most part, the results revealed strong encoding specificity effects for both age groups, as both old and young participants recalled more when the same cues were presented at encoding and retrieval than when different cues were presented. However, when elderly participants received verbal cues under divided attention conditions, evidence for general encoding rather than encoding specificity occurred. Results are discussed in terms of both the encoding specificity principle as well as a more process-oriented interpretation.

Article:
The encoding specificity principle of memory (Tulving & Thomson, 1973) states that memory is best when information available at encoding is also available at retrieval. In other words, cues that are present at encoding are the maximally effective ones for facilitating retrieval. This principle is important because it provides a general theoretical framework for understanding how context variables influence memory. According to the encoding specificity principle, how information can be retrieved depends upon how it is stored, and how it is stored depends upon how it was encoded (Tulving, 1979). To the extent that contextual information accompanying to-be-remembered items is encoded with those items, the contextual information should provide effective retrieval cues for accessing the to-be-remembered information.

It has been suggested, however, that the encoding specificity principle may not adequately describe the memory processes of older adults. Craik and Simon (1980) have argued that older adults "encode events in a less context-specific" (p. 106), more general fashion than do younger adults. If Craik and Simon are correct, older people would be unlikely to encode specific information about either targets or accompanying context. Because specific contextual information is not encoded, it cannot function as an effective retrieval cue for the to-be-remembered information, even if it is present at the time of retrieval. Consequently, Craik and Simon argue that although context-specific cues maximize retrieval for young adults, older adults' retrieval is maximized by general cues which automatically activate semantic• information and may provide access to the to-be-remembered information.

Rabinowitz, Craik, and Ackerman (1982) investigated this argument by designing an encoding specificity experiment in which old and young adults studied cue-target word pairs at encoding and were required to recall the target words when presented with cues at retrieval. As in Tulving and Thomson (1973), cues presented at retrieval were either the same as or different from cues that had been presented with targets at encoding. In addition, cues and their targets also shared either a strong or a weak semantic relationship, resulting in four encoding-retrieval cue combinations: (a) strongly related encoding cue and (same) strongly related retrieval cue; (b) weakly related encoding cue and (same) weakly related retrieval cue; (c) weakly related encoding cue and (different) strongly related retrieval cue; (d) strongly related encoding cue and (different) weakly related retrieval cue.

Consistent with the encoding specificity principle, young adults performed better when the same cues were presented at encoding and retrieval (strong-strong and weak-weak conditions). However, older adults displayed an encoding specificity effect only with strongly associated targets and cues (strong-strong condition), whereas their performance in the weak-weak condition was no better than in the weak-strong condition. Rabinowitz et al. (1982) hypothesized that this was because of elderly subjects' limited processing resources, resulting in difficulty in integrating weakly related cues to target information, so that retrieval was no more effective in the (same) weak-weak condition than it was in the (different) weak-strong condition. Encoding specificity effects occurred in elderly persons for the strong-strong condition relative to the weak-strong condition because strong cues activated general semantic features that required little effort to encode and were thus useful to both old and young.

In contrast to these findings, Park, Puglisi and Sovacool (1984) reported a large encoding specificity effect for both old and young adults with a different paradigm involving a picture recognition task. This experiment involved complex line drawings in which the presence or absence of contextual background was varied factorially at encoding and retrieval. Both old and young persons performed better in conditions where contextual cues were the same at encoding and retrieval (background present-present and absent-absent), so that unlike Rabinowitz et al., no age × encoding specificity interaction was observed.

In a later study, Park, Puglisi, Smith, and Dudley (1987) investigated whether the lack of evidence for an age × encoding specificity interaction in the 1984 study was due to the highly integrated perceptual relationship between the background detail and the target pictures in Park et al. (1984). They presented old and young adults with simple line drawings as targets and varied the presence or absence of unrelated line drawings as cues at encoding and retrieval. They again found encoding specificity effects of equal magnitude for young and old, an effect replicated even under conditions of divided attention.

Despite these data, which suggest that there are limiting conditions that apply to the general encoding hypothesis, the notion that older adults encode only at a general level is becoming well-entrenched in the gerontological literature. Thus, the present experiments were designed to investigate further the parameters of the effect reported by Rabinowitz et al. (1982). In both Park et al. studies (1984, 1987), line drawings were used as stimuli in a recognition paradigm where encoding/retrieval cues were either present or absent. In contrast, Rabinowitz et al. utilized words in a cued recall paradigm where cues varied in strength rather than in terms of presence or absence. We hypothesized that the findings of general encoding in older adults might be limited to the verbal mode, to recall paradigms, or to situations where the target-cue relationships varied in strength (weak/strong) rather than in whether the cue was absent or present. In the present experiments, the procedures used by Rabinowitz for words were mimicked to compare directly encoding specificity effects for matched pictures and words in old and young adults in a recall paradigm. Thus, the present studies were designed to determine the boundary conditions for the effects observed by Rabinowitz et al. and further our understanding of conditions under which older adults do or do not provide evidence for general encoding of both target and contextual information. Because the present experiment was designed to compare memory for pictures and words, we could not use the same verbal stimuli as in the Rabinowitz experiments. It was not possible to create pictures matched to the word stimuli used by Rabinowitz et al. because many of these words were not concrete nouns. In addition, when adapting the Tulving and Thomson procedure, Rabinowitz and colleagues did not determine whether the strength of associations for strong and weak cues differed for old and young. Thus, it was necessary to develop an entirely new set of matched and normed word/picture stimuli for use in the present investigation (Puglisi, Park, & Smith, 1987) to ensure that the strength of the cue/target relationship was equated between the two age groups.

Finally, Rabinowitz et al. reported that when young adults were tested in the verbal memory task under conditions of divided attention, their performance mirrored that of the old adults, providing evidence for general encoding in young adults under these conditions. Park, Puglisi, and Smith (1986) and Park et al. (1987) compared the performance of old to young when both performed the same divided attention task in a picture recognition study and found little evidence that the encoding specificity effect was compromised by age as a function of divided attention. If, in fact, older adults have limited processing resources relative to young adults, as Rabinowitz et al. hypothesize, further limiting of the older adult's capacity through a divided attention task should exacerbate differences, particularly if no age-related differences arc observed in control conditions initially. To investigate fully the role of limited processing resources in encoding specificity effects, we measured the performance of old and young persons under divided attention conditions, utilizing word and picture stimuli.

Experiment

METHOD

Participants. — Twenty-four active older persons (16 women, 8 men; M age = 71.4 years, SD = 6.0; M education = 12.4 years; SD = 2.96) who were community-dwelling and involved in a Senior Center recreation program participated in the study. There were also 24 college student participants (6 women, 18 men; M age = 19.2 years; SD = 1.4;M education = 13.5 years, SD = 1.02) in Experiment 1. Scores of the two groups on the Gardner and Monge (1977) Word Familiarity Survey, a measure of verbal intelligence, did not differ significantly, $t(46) = 2.13$, $p > .05$, old M = 15.5, young M = 12.4. Thirty-three percent of older participants considered their health excellent, 42% considered it good, and 25% considered it fair (no one reported poor health). Among younger participants, 42% considered their health excellent and 58% considered it good.

Stimuli. — Target stimuli were 48 Snodgrass and Vanderwart (1980) line drawings (picture condition) and their matched verbal labels (word condition). Age-specific associations and their associative strengths were available for these pictures (Puglisi et al., 1987), and were based on a production procedure similar to that developed by Noble (1953) for words. Associative strength in this case refers to the frequency of verbal associations generated under a continued association format wherein respondents were instructed to generate as many words as they could in response to each stimulus picture within a fixed time limit. Cues were chosen from these associations based upon high/low associative strength and picturability. Examples of targets followed by high and low associates, respectively, are ashtray-cigarette/ fire; hammer-nails/drill; pencil-eraser/phone. Twenty-four items and their strong/weak cues were chosen for use as actual test stimuli, and the remaining 24 items and their cues were used in a practice phase of the experiment. The 24 test items were chosen based on high agreement between old and young norm groups as to verbal labels (M per item agreement, old = 98.7%, range = 91%-100%; young = 99.5%, range = 92%-100%), associative strength of strong cues (M per item generating cue, old = 64.3%, range = 50%-91%; young = 64.7%, range = 32%-96%), and associative strength of weak cues (M per item generating cue, old = 5.3%, range = 4%–l0%; young = 5.3%, range = 4%–12%). Thus, an item was selected as a test stimulus only if old and young norm groups showed agreement on the item's name, on both a strong cue and a weak cue, and only if there was a high degree of agreement within each age group as to name and cue strength. Because the cues were subject-generated to the Snodgrass and Vanderwart pictures, they were not available as part of the Snodgrass and Vanderwart stimulus set. Consequently, an artist was employed to draw pictures of the cues that were similar in size, style, and complexity to the Snodgrass and Vanderwart stimuli for use with the pictorial targets.

Half the targets were paired with strong cues and half with weak cues at encoding. At recall, half were cued with the same cues that participants studied at encoding (strong-strong and weak-weak conditions) and half with different cues (weak-strong and strong-weak conditions). New recall cues had not previously been presented with any of the targets at encoding. Thus, each participant was presented with six items in each of four encoding-retrieval cue conditions: (a) strong encoding cue and (same) strong retrieval cue (e.g., for target of ashtray, cigarette would be cue' at encoding and retrieval; (b) weak encoding cue and (same) weak retrieval cue (e.g., for ashtray, fire at both encoding and retrieval; (c) weak encoding cue and (different) strong retrieval cue (e.g., for ashtray, fire at encoding and cigarette at retrieval; (d) strong encoding cue and (different) weak retrieval cue (e.g., for ashtray, cigarette at encoding and fire at retrieval). Picture targets were always accompanied by pictorial cues, whereas word targets were always paired with word cues. Across participants, each target was paired with its strong and weak cues an equal number of times at both encoding and retrieval. Presentation order was determined randomly.

Design and procedure. — The experiment involved a mixed design in which age (young vs old) and stimulus format (pictures vs words) were between-groups variables and encoding cue (strong or weak) was factorially crossed with retrieval cue (strong or weak). Participants were told that they were to study slides containing paired items, one on the left side (cue) and one on the right side (target, underlined) of each slide, so that they would later be able to recall the targets when presented with the cues. As in the Tulving and Thomson (1973) and Rabinowitz et al. (1982) studies, participants first studied and recalled a practice list of 24 item pairs for which targets were always cued at recall with the same cue presented at encoding. After filling out a demographic questionnaire, participants were presented with the 24 pairs of test items. As in Tulving and Thomson and Rabinowitz et al., participants were not informed at the time of encoding that half the targets would later be cued with different (new) cues. At recall, however, participants were told that they would sometimes be presented with new cues which were related to the targets they had studied, so that these new cues would sometimes remind them of target items. If so, they were told to write down the target item. If not, they were encouraged to guess. Item pairs were presented at a 7-s encoding rate. (Rabinowitz tested two groups of older persons, one at a 5-s rate, the other at a 10-s rate.) Recall immediately followed acquisition, with recall cues presented at a 15-s rate. Participants then completed the Gardner and Monge Word Survey (1977).

RESULTS

Data for probability of cued recall were subjected to a mixed ANOVA with age (young vs old) and stimulus format (pictures vs words) as between groups variables and encoding cue (strong or weak) and retrieval cue (strong or weak) as within-subject variables. Results revealed significant main effects of age, $F(1,44) = 17.91$, $p < .01$, eta = .027; format $F(1,44) = 32.84$, $p < .01$, eta = .050; encoding cue $F(1,44) = 11.56$, $p < .01$, eta = .014; and retrieval cue $F(1,44) = 29.38$, $p < .01$, eta = .029. As Table 1 indicates, young adults recalled more than old adults, and more pictures were recalled than words. The main effects of encoding cue and retrieval cue were qualified by a significant Encoding Cue × Retrieval Cue interaction, $F(1,44) = 369.24$, eta = .627, $p < .01$, which occurred because of substantial encoding specificity effects. Subjects performed best in the strong-strong and weak-weak conditions, and performance was substantially worse with the weak-strong and strong-weak condition. Table 1 confirms that this effect held for both age groups under both stimulus format conditions, and the interactions which would have suggested a different effect for older persons did not reach significance: Age × Encoding × Retrieval, $F < 1$, and Age × Format × Encoding x Retrieval, $F < 1$.

Finally, there was a significant Format x Retrieval interaction, $F(1,44) = 8.15$, $p < .01$, eta = .010. Multiple comparison tests using Tukey's procedure indicated this interaction occurred because the presence of a strong cue at retrieval was more facilitative for pictures compared to words. The means for the picture-weak retrieval cue and strong retrieval cue conditions were .53 and .72, respectively, whereas for words, the means were .43 and .49 in the weak and strong retrieval cue conditions respectively. (Since the strong/weak norms used in this experiment were standardized from pictorial stimuli, it is hypothesized that the interaction was significant because the cuing effects were more substantial when presented in the pictorial modality compared to the verbal. Since the interaction was not compromised by an age effect, it does not cloud interpretations of effects involving age.)

Table 1. Probability of Recall for Pictures and Matched Words (Experiment 1)

	Words			Pictures			Combined		
Cue	Young	Old	*M*	Young	Old	*M*	Young	Old	*M*
Strong-Strong	.78 (.13)[a]	.71 (.24)	.75	1.0 (0)	.92 (.11)	.96	.89	.81	.85
Weak-Weak	.85 (.13)	.71 (.25)	.78	.97 (.07)	.72 (.33)	.85	.91	.72	.81
Weak-Strong	.26 (.24)	.21 (.16)	.24	.53 (.29)	.43 (.28)	.48	.40	.32	.36
Strong-Weak	.15 (.15)	.01 (.05)	.08	.28 (.22)	.14 (.14)	.21	.22	.08	.15
M	.51	.41	.46	.70	.55	.63	.61	.48	

[a]Standard deviations are presented in parentheses.

Experiment 2

Craik and Simon (1980) argued that the basis for general encoding was limited processing resources in the elderly. Perhaps we failed to observe the age interaction they would predict because processing resources were adequate for the Experiment 1 task. By introducing a divided attention task, one should leave less remaining capacity for the elderly compared to the young to use for the memory task. If general encoding is caused by limited processing resources, the age interaction should emerge.

METHOD

Experiment 2 was a replication of Experiment 1 under conditions of divided rather than full attention. All stimuli and procedures were identical to those employed in the first experiment except that participants performed a digit monitoring task during the encoding phase of the second experiment. As in the Rabinowitz et al. (1982) study, participants listened to digit pairs presented on a tape recorder at a 3-s rate. Their task was to write down any pairs made up of two odd numbers while at the same time studying acquisition items to recall later. Digit pairs were generated using a random number table. Approximately 25% of these pairs were odd-odd, 25% were even-even, 25% were odd-even, and 25% were even-odd. Participants were 24 older persons (18 women, 6 men, M age = 68.5 years, SD = 5.4; M education = 13.0 years, SD = 1.91) drawn from the senior recreation center, and 24 college students (9 women, 15 men, M age = 19.7 years, SD = 2.8;M education = 13.6 years; SD = 1.06). Older persons (M = 16.6) in this sample obtained higher scores than younger persons (M = 11.9) on the Gardner and Monge Word Survey (1977), $t(46) = 3.41$, $p < .01$. Twenty-nine percent of older participants considered their health excellent, 67% considered it good, and 4% considered it fair compared to 58%, 33%, and 8% respectively among younger participants.

RESULTS

As in Experiment I , data for probability of cued recall were subjected to a mixed ANOVA with age and stimulus format as between groups variables and encoding and retrieval cue as within subject variables. Results revealed significant main effects of age, $F(1,44) = 12.71$, $p < .001$, eta = .040, and format, $F(1,44) = 16.86$, $p < .001$, eta = .053. As Table 2 indicates, young adults recalled more than old adults, and more pictures were recalled than words. The main effect of retrieval cue was also significant, $F(1,44) = 70.30$, $p < .001$, eta = .053, due to the more facilitative effect of strong compared to weak cues at retrieval (M = .52 and .36 respectively). In addition, there were three significant interactions. First, encoding cue and retrieval cue interacted, $F(1,44) = 253.33$, $p < .001$, and accounted for a substantial amount of variance, eta = .464. The interaction occurred because the two conditions where encoding and retrieval cues were the same (strong-strong and weak-weak) resulted in much better recall than when the cues differed. As Table 2 indicates, the means for strong-strong and weak-weak were .73 and .62, whereas recall in the weak-strong and strong-weak conditions was .31 and .10 respectively. There was also a significant Age × Encoding × Retrieval interaction, $F(1,44) = 10.57$,$p < .003$, eta = .02, with these means also displayed in Table 2. Multiple comparison tests using Tukev's procedure indicated that the old recalled significantly fewer items than the young in the strong-strong ($M_{old} = .62$, $M_{young} = .83$) and weak-weak ($M_{old} = .48$ and $M_{young} = .75$) conditions, but there were no age differences for the weak-strong or strong-weak conditions. As a result, the encoding specificity effect observed for younger adults was substantially larger than that observed for older adults in this experiment. This finding suggests that specific information associated with target and context was less efficiently encoded by older adults under the divided attention conditions in Experiment 2. As a result, specific cues were less effective for them at retrieval. Since the Age × Encoding × Retrieval × Format interaction did not even approach significance ($F < 1.0$), the interaction suggests that these relationships were the same for pictures and words. However, an examination of the means in Table 2 for word recall only reveals a pattern of findings virtually identical to that reported by Rabinowitz et al., namely that young adults recall more words in the weak-weak compared to the weak-strong conditions (.65 vs .33), but performance does not differ between these two conditions for the elderly (Ms of .29 and .24). Because of the importance of this comparison, the word data were analyzed separately from the picture data, confirming that there was a significant Age × Encoding × Retrieval interaction, $F(1,22) = 6.94$, $p < .01$, just as Rabinowitz et al. found. These findings suggest that the addition of the divided attention task to the procedure resulted in elderly adults finding the weak cues difficult to use effectively for words but not pictures.

Table 2. Probability of Recall for Pictures and Matched Words Under Divided Attention (Experiment 2)

Cue	Words			Pictures			Combined		
	Young	Old	M	Young	Old	M	Young	Old	M
Strong-Strong	.72 (.21)[a]	.46 (.29)	.59	.93 (.09)	.79 (.23)	.86	.83	.62	.73
Weak-Weak	.65 (.22)	.29 (.24)	.47	.85 (.19)	.67 (.21)	.76	.75	.48	.62
Weak-Strong	.33 (.21)	.24 (.28)	.22	.33 (.16)	.32 (.21)	.33	.33	.28	.31
Strong-Weak	.10 (.13)	.07 (.11)	.08	.13 (.18)	.11 (.21)	.12	.11	.09	.10
M	.45	.26	.36	.56	.47	.52	.51	.37	

[a]Standard deviations are presented in parentheses.

The final significant interaction was Format × Encoding × Retrieval $F(1,44) = 15.47$, $p < .001$, eta = .030. Multiple comparisons using Tukey's procedure indicated that the interaction occurred because recall was substantially better for pictures compared to words in the strong-strong and weak-weak conditions, whereas picture recall did not differ from word recall in the weak-strong and strong-weak conditions. (As discussed in Experiment 1, we hypothesize that this effect occurred because the strong-weak norms were standardized on pictures rather than words.) An analysis of covariance (ANCOVA) with Gardner and Monge verbal ability scores as the covariate suggested that variable did not compromise the pattern of performance, as no changes occurred in which effects were or were not significant compared to the original analysis.

An additional ANOVA was conducted on the proportion of digit pairs correctly intensified on the secondary task. There were no significant main effects or interactions and performance was high ($M_{\text{young-pictures}} = .96$, $M_{\text{young-words}} = .94$, $M_{\text{old-pictures}} = .91$, $M_{\text{old-words}} = .99$). Thus, the interpretation of the data is not compromised by differences in performance among groups on the digit-monitoring task.

DISCUSSION

The major results of these experiments can be summarized as follows. First, strong encoding specificity effects were observed for both young and old adults in this experiment, indicating that the general encoding hypothesis does not universally characterize the memory processes of older adults. Under full and divided attention for pictures, and under full attention for words, both young and old participants recalled more when the same cues were presented at encoding and retrieval than when different cues were presented, regardless of whether the cues were strong or weak. Second, there was evidence for general encoding in older adults only with word stimuli under conditions of divided attention. Finally, no evidence for general encoding emerged for either age group with picture stimuli.

The finding that older adults only demonstrated general encoding effects with word stimuli under divided attention conditions illustrates the limited generality of the hypothesis that the encoding specificity principle interacts with age. A review of the literature to date suggests that there is little evidence in support of this hypothesis for pictures under either full or divided attention, as demonstrated by the present pattern of findings as well as findings reported by Park et al. (1984; 1987). Furthermore, there is no evidence that encoding specificity effects are compromised with elderly persons when the task involves recognition rather than recall (Park et al., 1984; 1987). However, Experiment 2 in this study and the results of other studies (Craik & Simon, 1980; Rabinowitz et al., 1982) suggest that the general encoding effects are sometimes observed in the elderly in verbal recall paradigms.

One question of interest with respect to the verbal domain (word stimuli) is why older participants in Experiment I evidenced specific rather than general encoding when Rabinowitz et al. reported the opposite result. The most obvious hypothesis (which is consistent with the finding of general encoding for older adults under divided attention in Experiment 2) is that general encoding effects only emerge when a task is very difficult or processing resources arc severely limited. This hypothesis would suggest that the task in Experiment 1 was easier than the Rabinowitz et al. task. However, an examination of recall probabilities in this experiment compared with those of Rabinowitz et al. fails to confirm this prediction. An alternate hypothesis is that general encoding effects may vary depending on stimulus characteristics such as abstractness, imageability, etc. All of the word stimuli used in the present experiments had to be concrete nouns in order to be matched with the picture stimuli, but Rabinowitz et al. used many stimulus words which were not concrete. Perhaps the items used in the present experiment were more sensitive to the encoding and retrieval support provided by cues due to underlying dual codes at the verbal and visual level (Paivio, 1971), resulting in more access to items. Experiments that manipulate task difficulty and stimulus characteristics that affect representation are needed to determine the precise conditions under which general versus specific encoding reliably occurs.

Another finding of major interest was the difference in general encoding for pictures compared to words. Overall, recall for pictures was higher in both experiments, and no evidence was found for general encoding, even under divided attention conditions. This may have occurred because pictures are processed in a qualitatively different fashion from words or simply because the picture recall task was less demanding. The reliable finding that memory for real-world pictures does not show an age-related decline (Park et al., 1984; 1986; 1987) is suggestive of qualitative differences in pictorial vs verbal memory in the elderly. At the same time, it may be that general encoding effects would emerge if subjects were presented with a different and/or more demanding secondary task, which leaves less capacity available to devote to pictures. Perhaps the present (verbal) digit monitoring task, produced less interference for the picture recall task than for the word recall task, so that more capacity remained available for picture recall than for word recall as demonstrated by Atwood (1971) and Brooks (1968) with selective interference paradigms. It is also possible that capacity is a multiple, rather than a unitary, phenomenon, so that the digit monitoring task simply did not tap the same "capacity" as the picture recall task, resulting in less interference (Salthouse, 1982).

Finally, although encoding specificity is often described as superior performance in conditions where information available at encoding is also available at retrieval, it may be useful to conceptualize the present findings, as well as those of Rabinowitz et al., in terms of processes rather than conditions. A process-oriented analysis provides three important insights for interpreting these findings: (a) Retrieval cues that are identical to encoding cues can provide direct (paired associate) access to targets, resulting in efficient recall. If direct access is not achieved, successful recall can be accomplished by generating associates to retrieval cues and then recognizing associates which match targets. (b) Retrieval cues that are different from encoding cues cannot provide direct access to targets, so recall must depend on the success of the generate/recognize process. (c) Successful recall under the generate/recognize process should be a function of the strength of the semantic relationship between retrieval cues and targets, because targets that are strong associates of retrieval cues are more likely to be generated than targets that are weak associates.

This process-oriented analysis suggests that recall probabilities should be (a) very high when strong encoding cues are combined with the same strong retrieval cues, (b) very low when strong encoding cues are combined with different weak retrieval cues, and (c) intermediate when weak encoding cues are combined either with the same weak retrieval cues or with different, but strong, retrieval cues. This is exactly the pattern of findings reported both in the present studies and by Rabinowitz et al. Moreover, the actual levels of recall in weak-weak and weak-strong conditions would depend upon the absolute strength or weakness of the semantic relationship between retrieval cues and targets. Variations in the absolute strength of "strong" cues would affect recall probabilities in the weak-strong condition while variations in the weakness of "weak" cues would affect recall probabilities in the weak-weak condition, so that these probabilities might converge (as in Rabinowitz et al.) or diverge (as in the present experiments).

In summary, these experiments demonstrate clearly that the encoding specificity principle does describe the memory processes of older adults in a variety of situations. These experiments and others in the literature suggest that there are limiting conditions regarding evidence for general encoding in the elderly and for age interactions involving the encoding specificity principle. General encoding effects have not been demonstrated to date with picture or recognition paradigms, and have been found to be unreliable with word recall paradigms. The present study does not point to a specific underlying mechanism but points toward capacity limitations, selective interference, or task difficulty as potentially controlling the general encoding effect when it occurs. As the evidence to support any of these mechanisms was equivocal, further systematic investigation appears warranted. Rather than characterizing the processing Of old and young adults as qualitatively different (i.e., general vs specific), it may be that both our findings and those of Rabinowitz et al. are the result of similar processes which are simply less efficient in older people.

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