INTRODUCTION

As we age, we have more difficulty remembering specific information from what we have read (Johnson, 2003), particularly when reading material is unfamiliar (Hartley, 1993) or densely laden with ideas (Stine & Wingfield, 1990). Age-related declines in cognitive ability may affect the way we understand and process text (Stine-Morrow, Shake, Miles, & Noh, 2006). One theory proposes that reductions in processing resources lead older adults to encode information less efficiently when reading (Nessler, Johnson, Bersick, & Friedman, 2006). According to Craik and Lockhart (1972), deep and elaborate encoding emphasizing highly-integrated semantic associations results in better long-term memory of information. Studies have demonstrated that older adults engaging depth of encoding have improved recall for single words (Froger, Taconnat, Landre, Beigneux, & Isingrini, 2008) and text (McDaniel, Ryan, & Cunningham, 1989).

One way of encoding deeply is by practicing information retrieval by immediate testing; this "testing effect" (Roediger III & Karpicke, 2006) is a robust finding in younger adults where recalling information after studying improves long-term retention. To our knowledge, the effect of retrieval after study (testing effect) or during study has not been examined in older adults. While certain memory training techniques use recall or summary as part of their protocols (e.g., Meyer & Poon, 2001; Schmidt, Berg, & Deelman, 2000), these studies have not evaluated the isolated outcomes of retrieval on information retention. The current study examined the effect of depth and elaboration of encoding on text retention in older adults by comparing two different studying techniques: "Read Attentively, Summarize, Review" (RASR) and "Read And Reread Attentively" (RARA).

RASR is a studying technique modified from "Attentive Reading and Constrained Summarization" (Rogalski & Edmonds, 2008) and Read-Recite-Review (McDaniel, Howard, & Einstein, 2009) that emphasizes summarization and review of single paragraphs, enabling more specific information encoding while reducing the resource demands of whole passage summarization. RASR encourages deeper encoding compared with RARA, a shallower method which requires repeated readings of single paragraphs. We predicted that older adults using the RASR technique would recall more information after a delay than those using RARA. Additionally, since the presence of an immediate test after study results in better delayed retention of information (the "testing effect"), we predicted that both groups would benefit from an immediate post-study test, but the RASR group would experience greater benefit than the RARA group.

METHODS

Participants. Thirty-nine adults (16 males) between 60-75 years old were randomized into either the RASR or the RARA group. All participants reported no history of a reading disorder or neurological illness, nor were they taking medications for memory. Groups did not differ significantly by age (range: 60-74 years), education (range: 16-22 years), vocabulary, or Montreal Cognitive Assessment scores. This study was funded by the University of Florida College of Public Health and Health Professions graduate student grant.

Stimuli. The first author constructed three expository reading passages about unusual animals: Raccoon Dog, Pistol Shrimp, and Velvet Worm. Passages were matched on 13 variables including length (256-258 words), propositions (idea units) (105), paragraphs (3), and grade level (6. 4-6. 8). In a separate study, passages were rated similarly in terms of level of interest, familiarity, clarity, coherence, and ease of understanding.

Studying Techniques. Both groups were initially asked to read the entire 3-paragraph passage aloud once. Specific directions for the RASR group were: 1) read the first paragraph aloud attentively, 2) summarize the information aloud from memory in any order using your own words as much as possible, 3) reread the paragraph aloud to confirm what you remembered and to check what you missed. Directions for the RARA group were: "Read the first paragraph aloud three times while paying attention to the details. Read it as though you will be asked to recall it. " Both groups were instructed to study the remaining two paragraphs of the passage using the particular technique they had learned.

Procedure. All participants individually completed two 1-hour sessions, one day apart. During the first session, participants were presented with three different passages. They read aloud the first passage once and were tested orally on immediate recall. This served as the control "single reading" condition. They then studied the other two passages using their assigned study technique. Immediate oral recall was tested for one of these passages (the "study" condition) but not for the other (the "study-no-immediate-test" condition). On the second day, participants were asked for their delayed recall of all three passages. Passage order (dog, worm, or shrimp) and passage chosen for immediate testing were pseudo-randomized across participants. Responses were digitally recorded.

Scoring. All responses were transcribed verbatim. The first author, blinded to group, coded each of the participants' five transcripts (2 immediate and 3 delayed) for number of correct propositions (idea units).

RESULTS

To examine the effect of studying technique on retention of propositions across time, we used a 2 group (RASR or RARA) by 2 condition (single reading or study) by 2 retention interval (immediate or delayed) repeated measures ANOVA. We found an interaction between condition and group [$F(1, 37) = 6.85$, $p = .01$, $\eta^2 = .04$]; groups did not differ in recall of non-studied passages, but the RASR group recalled more propositions from studied passages than the RARA group. Retention interval and study condition also interacted, [$F(1, 37) = 7.06$, $p = .01$, $\eta^2 = .16$]: participants had better immediate retention than delayed retention for studied passages compared with unstudied passages. Interactions between retention interval and group and between retention interval, study condition, and group were not significant. See Figure 1.

To examine the effect of immediate testing (the testing effect) on propositions recalled after a delay, a 2 group (RASR, RARA) by 2 testing condition (study-plus-immediate-test or study-no-immediate-test) repeated measures ANOVA was performed. We found a significant main effect of testing condition [$F(1, 37) = 5.96$, $p = .02$, $\eta^2 = .14$]; regardless of study method, participants remembered more propositions if they were tested previously on their recall than if they were not. We found no interaction between testing condition and group [$F(1, 37) = .38$, $p = .54$, $\eta^2 = .01$]. See Figure 2.

DISCUSSION

Consistent with our predictions, participants using RASR, a technique involving deep, elaborative semantic encoding, had better delayed recall of text information than those using RARA, a shallower encoding technique emphasizing massed reading. Though both groups recalled more information after studying than after one reading, the RASR group retained more information for studied passages than the RARA group. Similarly, immediate testing after study promoted better delayed recall of information (Roediger III & Karpicke, 2006); however, the RASR group did not receive any additional advantage over the RARA group.

According to Brown and Craik (2000), retrieving information from memory recruits deep semantic processing that acts as a "second encoding." Our results demonstrate that explicit instruction in using a deep encoding technique incorporating summarization and review can help older adults overcome age-related deficits in memory for unfamiliar, idea-rich texts. Furthermore, testing their recall after studying promotes additional retention. Based on these findings and those of a previous study (Rogalski and Edmonds, 2006), we suggest that explicit instruction in deep encoding techniques may benefit other populations with reduced processing resources, such as those with traumatic brain injury, mild cognitive impairment or early dementia.

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Figure 1. Number of propositions recalled by group (RASR, RARA) on immediate and delayed testing as a function of condition (Single Reading, Study).

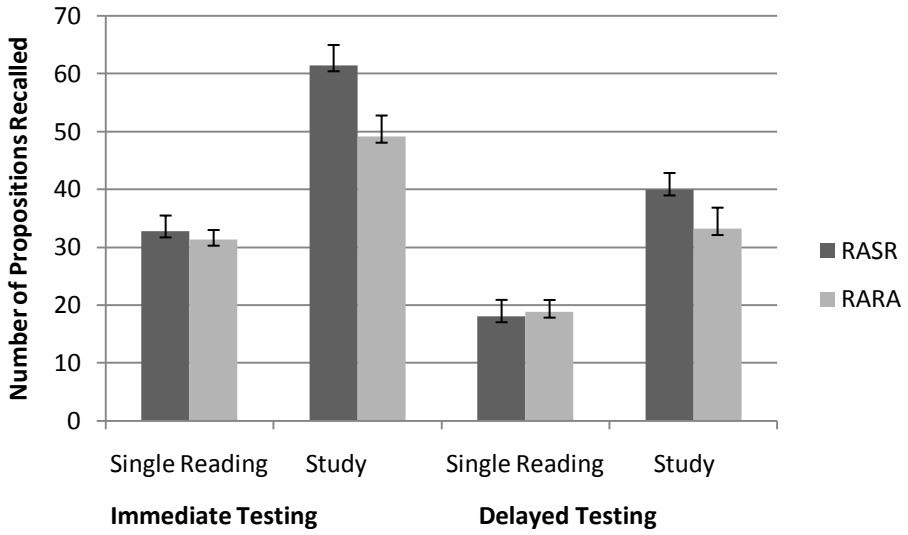

Figure 2. Delayed recall of propositions by group (RASR, RARA) as a function of test condition