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Narrative Comprehension and Aging: The Fate of Completed Goal Information

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Previous research has shown that older adults are able to use situation models in a manner similar to younger adults. However, other areas of cognition have shown that older adults are less able to remove irrelevant information from the current stream of processing. Accordingly, the authors tested whether older and younger adults would differ in reducing the availability of information about a completed goal in a situation model during narrative comprehension. In 2 experiments, memory probes tested for the availability of protagonist goal information during reading when it was either failed goal, completed goal, or neutral information. The results for both age groups showed that goal information was most available in the failed goal condition, less available in the completed goal condition, and least available in the neutral condition. No reliable differences between younger and older adults in the pattern of response times were observed. Reading time data were also examined to explore the possibility that older adults engage in a longer wrap-up period after a goal is completed, but no such difference was found.

Language comprehension proceeds at many different levels. Most researchers have distinguished among at least three: (a) the surface level, which is composed of the actual words and syntax used, (b) the propositional level, which captures the meaning of an utterance in an abstract form, and (c) the situation model, which captures the gist of the situation described by an utterance (e.g., Johnson-Laird, 1983, 1989; Kintsch, 1988; Schmalhofer & Glavanov, 1986; van Dijk & Kintsch, 1983). Successful language comprehension requires establishing representations at all these levels, as well as constantly monitoring and updating them as new information is acquired. Although the effects of aging on language processing at each of these levels is of interest (Stine, Soederberg, & Morrow, 1996; Stine-Morrow, Loveless, & Soederberg, 1996), this article is concerned with the effects of aging on cognitive processing at the level of the situation model. The particular focus is on the ability to separate relevant and irrelevant information when updating a situation model (see Graesser, Singer, & Trabasso, 1994, for a review of updating processing involving situation models during narrative comprehension).

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Situation Models

Situation models represent the gist of a described situation. For example, when people try to identify previously heard sentences, they have difficulty when there are distractors that describe the same situations as the original sentences (e.g., Bransford, Barclay, & Franks, 1972; Garnham, 1981). Garnham found that when people heard a sentence such as "The hostess bought the mink coat from the furrier," they were likely to mistakenly identify that they heard "The hostess bought the mink coat at the furrier's." This is because these two sentences potentially describe the same situation. However, when people heard "The hostess received a telegram from the furrier," they were less likely to mistakenly say that they heard "The hostess received a telegram at the furrier's." even though the difference between these two sentences is propositionally identical to the difference between the first two. The sentences about the telegram are less confusable because they are likely to be interpreted as describing different situations, and thus would be represented by different situation models.

In a study modeled after Garnham's (1981), Radvansky, Gerard, Zacks, and Hasher (1990) found that younger and older adults produced a similar pattern of such confusion errors on a recognition test. Although the older adults made more errors overall, they were like the younger adults in that they made more errors when the distractor sentence described a similar situation as the original sentence than if it described a different situation. The similarity in the retrieval patterns suggests that the older adults created and used situation models in a manner similar to younger adults.

In an investigation of the ability to update a situation model, Morrow, Leirer, Altieri, and Fitzsimmons (1994) found that younger and older adults were similar in their use of situation models during narrative comprehension when that updating involves a shift of attention across a previously memorized spatial layout. This study was modeled after a series of experiments by

Morrow, Bower, and their colleagues (e.g., Morrow, Bower, & Greenspan, 1989; Morrow, Greenspan, & Bower, 1987). In these studies people memorized a map of a building, such as a research center, which included a number of rooms as well as the names and locations of objects in the rooms. After memorizing the map, people read a series of narratives about a character who moved from room to room. At different points during reading, people were interrupted with memory probes consisting of the names of two objects in the building. The task was to indicate whether the probe objects were both in the same room. The primary result was that response times to positive probes increased as a function of increased distance between the location of the objects and the story protagonist's current position. In Morrow et al.'s (1994) study, they found that although older adults were slower and more error prone overall, the two age groups responded in a similar fashion.

However, Morrow et al.'s (1994) study focused on only one type of updating, namely a shift in attention from one spatial region to another. Situation models are complex representations that vary along a variety of dimensions (Zwaan, Langston, & Graesser, 1995; Zwaan, Magliano, & Graesser, 1995). Updating can occur in any of these dimensions and in a variety of ways. In the Morrow et al. research, in which no age differences in the pattern of responding was observed, the updating was a shift in focus. Age differences may be found with other types of updating, such as when updating involves decreasing the relevance of information in a situation model. This would be consistent with other research showing age differences in other types of mental updating where previously relevant information becomes irrelevant (e.g., Hamm & Hasher, 1992; Zacks, Radvansky, & Hasher, 1996). Also, the Morrow et al. study focused on spatial dimension as the described shifts were from one room to the next. This study examines situation model updating that involves the removal of irrelevant information, rather than a shift in focus, in the context of processing character goal information during narrative comprehension.

Processing Character Goal Information

After a goal of a story protagonist has been introduced, readers keep that part of the situation model more available in memory so that it can be used to make inferences to help them interpret the subsequent actions of the story protagonist (e.g., Suh & Trabasso, 1993). A reader normally tries to relate current information to the most recently mentioned unfulfilled goal. This explanation-based account has been supported by detailed analyses of verbal protocols looking at both the types of inferences made during comprehension as well as the source of information from which the inference is drawn (Suh & Trabasso, 1993; Trabasso & Magliano, 1996; Trabasso & Suh, 1993). The maintenance of goal-related information only occurs until the character's goal has been satisfied. When a goal has been completed, that part of the situation model is no longer kept in a state of heightened availability.

This idea has been tested by having people read stories and then giving them memory probes later in the story to assess the availability of goal-related information (Lutz & Radvansky, 1997; Suh & Trabasso, 1993; Trabasso & Suh, 1993). In these experiments, there are two critical story versions. In the *failed goal* story versions, the story characters have goals they want to achieve. However, when they first try to achieve those goals, they are blocked, and so they must try to find some other way to complete the goals. An example of a failed goal story is provided in Table 1A.

In this story, in the third sentence the reader is told that Roy has the goal of wanting to buy his boss a retirement gift. This is the goal information that is probed for later in the passage. Because this is the primary goal of the character in the story, it

Table 1
Different Versions for a Sample Story

Story version		
A. Failed goal	B. Completed goal	C. Neutral
Once there was a bank teller named Roy.	Once there was a bank teller named Roy.	Once there was a bank teller named Roy.
Roy realized his boss was retiring in 4 days.	Roy realized his boss was retiring in 4 days.	Roy realized his boss was retiring in 4 days.
He wanted to give her a retirement gift.	He wanted to give her a retirement gift.	He bought her a big-screen TV for a retirement gift as he wanted.
Roy went to the department store.	Roy went to the department store.	Roy then went to the department store.
He couldn't find anything nice enough.	He bought a nice big-screen TV for his boss.	He bought himself a new set of pans.
He felt discouraged.	He felt pretty good.	He felt pretty good.
A couple of days later, Roy saw an ad for a Caribbean cruise.	A couple of days later, Roy saw an ad for a Caribbean cruise.	A couple of days later, Roy saw an ad for a Caribbean cruise.
(Experiment 1 Critical Probe)	*(Experiment 1 Critical Probe)*	*(Experiment 1 Critical Probe)*
Roy wanted to get some tickets.	Roy wanted to get some tickets.	Roy wanted to get some tickets.
He went to a travel agent.	He went to a travel agent.	He went to a travel agent.
He looked over several brochures.	He looked over several brochures.	He looked over several brochures.
Roy picked out the best deal.	Roy picked out the best deal.	Roy picked out the best deal.
He purchased the tickets.	He purchased the tickets.	He purchased the tickets.
(Experiment 2 Critical Probe)	*(Experiment 2 Critical Probe)*	*(Experiment 2 Critical Probe)*
He gave them to his boss.	He gave them to his wife.	He gave them to his wife.
His boss was excited when she got the present.	His wife was excited when she got the present.	His wife was excited when she got the present.

is referred to here as Goal 1 information. After the goal is established, Roy tries to achieve it by going to the department store. However, his efforts are thwarted because he cannot find anything. This failure to satisfy Goal 1 places this story version in the failed goal condition. After the initial failure to satisfy Goal 1, Roy sees an advertisement for a cruise that sets up a second goal (called Goal 2) of wanting to get cruise tickets that serve as a subgoal to help Roy achieve Goal 1. After he gets the tickets, he presents them to his boss as a retirement gift.

In the *completed goal* story versions, the story characters have goals that are soon achieved without any initial failures. After the goal has been achieved, this information does not remain in a heightened state of availability. Because the character's goal has been achieved, there is little reason to think that subsequent actions are related towards achieving that goal. An example of a completed goal story version is provided in Table 1B.

In this story version, after introducing Roy's goal of wanting to get his boss a gift in the third sentence, in the fifth sentence he completes his goal by buying his boss a big-screen TV. The rest of the story is as similar to the failed goal version as possible, taking into account that Goal 1 has been successfully achieved early on. For example, rather than describing Roy as discouraged in the sixth sentence, he is described as feeling pretty good. Because Goal 1 has been completed, when Goal 2 is introduced, Roy's desire to get some cruise tickets should not be interpreted as a subgoal of his wanting to get his boss a gift. Instead, the Goal 2 information should be treated as a subsequent, but unrelated, goal. When Roy completes Goal 2 by purchasing the tickets, this should not lead the reader to try to make connections back to Goal 1.

Using probes at the same locations in the failed and completed goal story versions, Suh and Trabasso (1993) have shown that completed goal information is less available than failed goal information. This suggests that information pertaining to character goals in a situation model is updated as the status of those goals changes over the course of the narrative. However, on the basis of this work, it is unclear whether this difference was due to a decrease in the availability of the completed goal information, an increase in the availability of the failed goal information, or both. Lutz and Radvansky (1997) compared the availability of completed goal information against a neutral condition. These *neutral* story versions contained the same information that was probed for in the failed and completed story versions and was presented at the same location in the different stories. The term *neutral* is used here to reflect the idea that this information is unlikely to be considered to be part of the goal path of the story. Responses in the neutral story conditions could be directly compared with the failed and completed conditions because the same memory probes were used in all three cases. However, in the neutral story versions, this information was presented as "dead-end" information, which is information not likely to be used to draw causal inferences. An example of a neutral story version is provided in Table 1C.

In the neutral story version, the reader is told in the third sentence that Roy had already accomplished the goal of getting his boss a retirement gift. Thus, there is no reason to relate any information in the subsequent story sentences to the Goal 1 information or to even place this information prominently within the goal path of the story.

Lutz and Radvansky (1997) found that completed goal information was more available than neutral information. Thus, people responded faster to probes in failed goal story versions, slower in completed goal story versions, and slowest in neutral story versions (failed < completed < neutral). It should be noted that although there is a difference in the distance between the last time the probed-for information was mentioned in the neutral and completed story versions, Lutz and Radvansky (Experiment 2) found that this distance difference had no influence on the pattern of data. This pattern of availability is consistent with the idea that any information that is integrated into the causal chain of events is better remembered than other types of information (Black & Bower, 1980; Fletcher & Bloom, 1988; Myers & Duffy, 1990; Myers, Shinjo, & Duffy, 1987; Trabasso, Secco, & van den Broek, 1984; Trabasso & van den Broek, 1985) and is rated as being more important (Trabasso & Sperry, 1985; Trabasso & van den Broek, 1985; van den Broek, 1988). As such, failed and completed goal information have privileged status in the causal structure of the situation model. Completed goal information is reduced in availability relative to failed goal information, but not to the level of neutral information, which is not highly integrated in the causal structure.

Aging and the Ability to Update Goal Information

The issue addressed here is whether older adults show a similar pattern of goal information availability as part of updating their situation models. It has been suggested that older adults may be less efficient in drawing causal connections among text elements during reading (Hess, 1995). As such, older adults may be generally less efficient in processing goal-related information during reading. More to the point, there has also been research suggesting that older adults, relative to younger adults, may persist in keeping irrelevant information available during language comprehension after that information is no longer relevant (Hamm & Hasher, 1992). Such results are best interpreted from the perspective of Hasher and Zacks' (1988; Zacks & Hasher, 1994) suppression hypothesis. This is an attention-based view that assumes that older adults have greater difficulty removing irrelevant information from the current stream of processing. Specifically, older adults are thought to have difficulty suppressing inappropriate information, even after more appropriate information has been made available. This decreased ability of older adults to suppress irrelevant information has been found in a number of settings, including long-term memory fact retrieval (Gerard, Zacks, Hasher, & Radvansky, 1991; Radvansky, Zacks, & Hasher, 1996), negative priming paradigms (Hasher, Stoltzfus, Zacks, & Rypma, 1991; Tipper, 1991; but see Kieley & Hartley, 1997; Sullivan & Faust, 1993), directed forgetting (Zacks et al., 1996), and narrative comprehension (Hamm & Hasher, 1992).

The current experiments addressed this issue in the context of the availability of completed goal information. In some sense, the difference between responses in failed and completed goal conditions reflects a reduction of the availability of the Goal 1 information in the current stream of processing. Specifically, when a story protagonist completes a goal, the availability of

that goal information in the situation model should be reduced. If older adults have difficulty doing this, then the availability of completed goal information should be similar to the availability of failed goal information. However, if older adults are able to update their situation model as effectively as younger adults, then this difference should not be observed.

Experiment 1

In Experiment 1, people were probed for the goal information soon after the goal had either been successfully completed or an unsuccessful attempt had been made at achieving the goal. Previous research (Suh & Trabasso, 1993) has found that the differential availability of completed and failed goal information can be detected two or three sentences after the presentation of the outcome of the first attempt to achieve the goal, just before the introduction of the second goal in these narratives. In the example story, people would have been probed just before the sentence "Roy wanted to get some tickets."

If the older adults maintain goal information longer than the younger adults, then a smaller difference in the availability of failed and completed goal information would be expected for the older adults. In contrast, if the older adults are as effective as the younger adults in processing goal-related information, then the difference between the failed and completed goal conditions should not differ with age. The neutral condition was included to provide a better estimate of the relative state of the activation of information in the failed and completed goal conditions if the difference between these two conditions changes for the older adults. Specifically, if data from the failed and completed goal conditions are similar, then the neutral condition allows for an assessment of whether the completed goal information has not been reduced in availability and has remained at the heightened state of availability with the failed goal information or whether the failed goal information has not been effectively maintained and has decreased to the level of availability of the completed goal information.

Method

Readers. Thirty-six people were tested in each of the two age groups. The younger adults ranged in age from 17 to 22 (M = 19.1) years. These people had 12–15 (M = 12.9) years of education and scored from 22 to 38 (M = 31.1) on the Shipley-Institute of Living Scale for Measuring Intellectual Impairment (Shipley) Vocabulary Test. They were recruited from the University of Notre Dame community and were given partial class credit. The older adults ranged in age from 58 to 88 (M = 73.4) years. These people had 8–18 (M = 12.8) years of education and scored from 25.5 to 40 (M = 33.2) on the Shipley Vocabulary Test. The older adults were recruited through a local senior citizen community center. These people were tested at the center and were paid for their participation. The older and younger adults did not differ in the number of years of education, $t < 1$. However, the older adults did have higher scores on the Shipley Vocabulary Test, $t(70)$ = 2.49. Finally, the data from 9 additional people were replaced: 5 younger and 2 older adults for making more than 3 errors (greater than 50%) in either a failed goal, completed goal, or neutral condition; and 2 older adults for not finishing the study because of a need to meet other appointments.

Materials. The stories used in this experiment were drawn from Lutz and Radvansky (1997). There were 18 experimental, 5 practice, and 30 filler stories. The experimental narratives ranged from 13 to 17 sentences in length (M = 14.3, SD = 1.1). The practice narratives ranged from 13 to 15 sentences in length (M = 13.8, SD = 0.8). The filler narratives ranged from 11 to 15 sentences in length (M = 13.4, SD = 1.0). The practice and filler narratives had a similar structure as the experimental narratives. This was done so that people could not anticipate which narratives were the experimental narratives.

All narratives had two memory probes. These probes took the form of a question (e.g., "Had Roy wanted to buy his boss a gift?"). For the experimental narratives, the same probes were used for all three versions. Furthermore, in the experimental narratives, there were two types of probes. The first was the critical probe that asked about Goal 1 information. The critical probe always occurred just prior to the introduction of Goal 2. At this point the initial goal would have been identified as completed in the completed goal versions. This critical probe served as a measure of the availability of Goal 1 information. The correct answer to the experimental probes was always "yes." The second probe of the experimental narratives was always a filler and asked about some portion of the story that was unrelated to the Goal 1 information. Filler probes could be either true or false.

For the filler and practice stories, both probes were fillers and occurred at various locations of the story. The locations of the filler probes were selected so that readers could not anticipate where in the narrative the first probe would occur. Across all narrative types, the first probe (either critical or filler) was located approximately one third of the time in the first third of the narrative, one third of the time in the middle third of the narrative, and one third of the time in the last third of the narrative. Furthermore, across all narratives there were an equal number of true and false probes.

Procedure. Participants were first given the Shipley vocabulary test as an assessment of general verbal ability. Following this, they were presented with the experimental task.

Narratives were presented, one sentence at a time, on an IBM-compatible 486 computer. Each sentence appeared in white half-way down a black screen, in 40-column mode. Readers were told to try to comprehend each sentence as it appeared. Presentation was self-paced. Readers pressed the space bar with their left hand to advance to the next sentence. Readers were told that they would be interrupted with probe questions during the course of reading and that they should answer each probe as quickly and as accurately as possible. Responses were made by pressing one of two buttons on a computer mouse with the right hand. The left button was marked with a *Y* for "Yes, this is true," and the right button was marked with an *N* for "No, this is false." Readers were instructed to always keep their right hand on the mouse. The probes were presented in red to distinguish them from the rest of the story.

Readers were given five practice narratives to familiarize them with the procedure, but were not told that these narratives were practice. The experimental and filler narratives were given in an order that was randomized for each reader, with the constraint that each person received all 18 experimental narratives, 6 of each version.

After each story, people were given feedback on the accuracy of their responses. They were then given a distractor task of mentally adding two 3-digit numbers together (e.g., 364 + 727 = ?). Addition problems were presented until at least 10 s had elapsed from the time the first problem was presented to the time the last solution was given. No record of the time spent on this task was kept. Following the 10-s deadline, the word *STORY* appeared on the screen, signaling the next story. The time spent on the distractor task served to decrease a person's memory of the previous story, thus reducing the chance of that information interfering with the next story. Each experimental session lasted approximately 1 hr.

Results

The results of Experiment 1 were that older adults, although generally slower overall, appeared to process the goal informa-

tion in a similar fashion as the younger adults. Specifically, both older and younger adults responded more slowly to probes for the completed goal versions than for the failed goal versions. This suggests that completed goal information was less available than failed goal information in both age groups, and to a similar degree. Furthermore, both older and younger adults responded more slowly to probes for the neutral versions than for the completed goal versions. This suggests that the completed goal information was more available than the neutral information in both age groups, again to a similar degree. These data indicate that older adults are as efficient as younger adults at removing goal information from the current stream of processing after story characters have completed their goals.

Response times. The response time data for Experiment 1 are presented in Table 2. These data are based on the mean response times. Additional analyses were done in both experiments using median response times. With the one exception noted below in Experiment 1, the pattern of significant and nonsignificant effects were the same, therefore only the analyses of the means are reported. As a reminder, the correct response to the experimental probes was always "yes." Response times to the target questions were submitted to a pair of 2 (age) × 3 (condition) analyses of variance (ANOVAs). The first treated readers as a random variable (subscript 1) and the second treated stories as a random variable (subscript 2). Age was a between-subjects factor in the readers analysis, but a within-stories factor in the stories analysis. Unless otherwise mentioned, a rejection level of $p < .05$ is assumed. As can be seen in Table 2, there was a significant main effect of Condition, $F_1(2, 140) = 30.27$, $MSE = 243{,}013$, $F_2(2, 34) = 28.01$, $MSE = 157{,}380$, with readers responding fastest in the failed goal condition, slower in the completed goal condition, and slowest in the neutral condition. Separate analyses demonstrated that probes were responded to faster in the failed goal condition than the completed goal condition, $F_1(1, 70) = 8.25$, $MSE = 155{,}903$, $F_2(1, 17) = 4.83$, $MSE = 112{,}293$—this difference was only marginally significant in the median analysis, $F(1, 71) = 2.50$, $MSE = 173{,}377$, $p = .12$—and faster in the completed goal condition than the neutral condition, $F_1(1, 70) = 24.91$, $MSE = 272{,}624$, $F_2(1, 17) = 23.27$, $MSE = 193{,}675$.

Table 2
Response Time (RT) Results (in Milliseconds) for Experiments 1 and 2

	Condition						
	Failed goal		Completed goal		Neutral		
Participants	RT	*SD*	RT	*SD*	RT	*SD*	*M*
Experiment 1							
Younger	1,920	470	2,144	629	2,522	795	2,195
Older	3,692	972	3,847	1,055	4,337	1,214	3,959
M	2,806		2,996		3,430		
Experiment 2							
Younger	1,994	512	2,136	549	2,387	614	2,172
Older	3,385	850	3,685	1,152	4,044	1,252	3,705
M	2,690		2,911		3,216		

Although there was a significant main effect of age, $F_1(1, 70) = 88.20$, $MSE = 1{,}903{,}562$, $F_2(1, 17) = 462.34$, $MSE = 174{,}989$, with the older adults responding slower than the younger adults, the Age × Condition interaction was not significant, both Fs < 1. This suggests that older and younger adults were equally able to process the goal-related information.

To test whether there may be an effect of age, but only for the oldest adults, a measure of the effect size was calculated. This was the average of the differences between the completed and failed goal conditions and between the neutral and completed goal conditions. Considering the data from the older adults only, this difference score was found to be positively correlated with age, $r = .43$, $p = .009$. Thus, the difference between the conditions increased with age in contrast with what would be expected if inhibition were operating and if inhibition were compromised with age. Slower responding with increased age would account for this pattern.

Error rates. The error rate data for Experiment 1 were submitted to ANOVAs similar to the response time data. There was a significant main effect of condition, $F_1(2, 140) = 19.34$, $MSE = 101$, $F_2(2, 34) = 4.75$, $MSE = 206$, with people making fewer errors in the failed and completed goal conditions (both 4%) and more errors being made in the neutral condition (13%). Both the failed and completed goal conditions were less than the neutral condition, $F_1(1, 70) = 21.51$, $MSE = 136$, $F_2(1, 17) = 5.31$, $MSE = 276$, and $F_1(1, 70) = 25.41$, $MSE = 115$, $F_2(1, 17) = 4.81$, $MSE = 305$, respectively. Also, the main effect of age was significant, $F_1(1, 70) = 18.02$, $MSE = 98$, $F_2(1, 17) = 19.31$, $MSE = 46$, with the older adults making more errors (10%) than the younger adults (4%), but the Age × Condition interaction was not significant, $F_1(2, 140) = 1.31$, $MSE = 101$, $p > .20$, $F_2(2, 34) = 1.17$, $MSE = 57$, $p > .30$.

Discussion

The results of this study are consistent with previous research by Lutz and Radvansky (1997) in showing that failed goal information is more available than completed goal information and that completed goal information is more available than neutral information. This experiment also extends that research by showing that this pattern of results is also observed when people are probed for the goal information early on in the passage, just before the introduction of the second goal of the story, as well as late in the story, as was done by Lutz and Radvansky.

There were no differences observed in the pattern of response times and error rates for the younger and older adults. When a character successfully completed a goal, readers in both age groups no longer kept this information as highly available as when this same goal had yet to be completed (failed goal). Furthermore, this completed goal information was kept more available than neutral information in both age groups, again suggesting that both age groups are equally effective at handling this type of information during narrative comprehension. This is in contrast to the results such as those reported by Hamm and Hasher (1992), where it was found that older adults were less able to disregard inappropriate inferences. An explanation of this difference is delayed until after the presentation of Experiment 2 when a broader set of data can be considered.

Experiment 2

Experiment 1 established that there was no difference between younger and older adults in the ability to update a situation model by reducing the availability of a completed goal. However, it may be that a difference between younger and older adults could be observed later in the passages. Research by Suh and Trabasso (1993) has shown that in the failed goal story versions, soon after the subgoal is introduced, the availability of the Goal 1 information decreases somewhat until that subgoal is successfully completed. After that, the failed goal information becomes highly available again (Suh & Trabasso, 1993). This is because the successful completion of the subgoal opens the door for successful completion of the original goal. In Experiment 2 we consider the possibility that a difference between older and younger adults may be observed at this later point during story processing.

There are two possibilities considered here, either of which would be consistent with a reduced ability of older adults to regulate the contents of processing. The first centers on the refocusing of processing on the Goal 1 information in the failed goal story versions. Older readers could have difficulty reactivating this information when it is needed because of competing sources of information, namely the other (sub) goals in the story. Such a finding would be consistent with other research that has shown that older adults experience more interference when there are competing memory traces (Cohen, 1990; Gerard et al., 1991; Radvansky et al., 1996). As such, in the current paradigm, for older adults, the difference between the failed and completed goal conditions may be attenuated or eliminated, whereas the difference between the completed and neutral conditions would remain.

The other possibility centers on access to the Goal 1 information in the completed goal versions. It may be that later in the story, when a character performs actions that can be interpreted as involving Goal 1, in the completed goal versions the older adults may be less able to keep this Goal 1 information from being inappropriately reactivated. Such a finding would be consistent with other research that has shown that older adults experience more difficulty in keeping irrelevant information from becoming highly active (e.g., Connelly, Hasher & Zacks, 1991; Dywan & Murphy, 1996; Hasher et al., 1991). If this were the case, then, for older adults, it would be expected that the difference between the failed and completed goal conditions would be attenuated or eliminated, whereas the difference between the failed goal and neutral conditions would remain.

Experiment 2 was conducted to assess whether either of these possibilities is true. People read the same stories as in Experiment 1. However, rather than probing for Goal 1 information early in the story, the critical probes were presented late in the story, just prior to the resolution of the Goal 1 information in the failed goal story versions. In the example stories presented in Tables 1–3, the probe would be located between the sentences "He purchased the tickets." and "He gave them to his wife–boss." Previous studies (Lutz & Radvansky, 1997; Suh & Trabasso, 1993) have shown that a clear difference between the failed and completed goal versions is observed at this point for younger adults. As such, it should enable an evaluation of the two hypotheses laid out above.

Method

Readers. Thirty-six people were tested in each of the two age groups. The younger adults ranged in age from 18 to 27 (M = 19.7) years. These people had 12–18 (M = 13.3) years of education and scored from 24 to 37 (M = 32.0) on the Shipley vocabulary test. The younger adults were recruited from the University of Notre Dame community and were either paid for their participation or were given partial class credit. The data for the younger adults were reported in Experiment 1 by Lutz and Radvansky (1997). The older adults ranged in age from 60 to 84 (M = 70.4) years. These people had 10–20 (M = 13.1) years of education and scored from 23 to 38 (M = 32.5) on the Shipley vocabulary test. The older adults were recruited through a South Bend, Indiana, senior citizen center. These people provided their own transportation to the university and were paid for their participation. The older and younger adults did not differ in either the number of years of education or their vocabulary scores, all $ts < 1$. The data from 7 additional people were replaced: 2 younger and 3 older adults for making more than three errors in either the failed goal, completed goal, or neutral condition (greater than 50%), 1 younger adult for failing to follow instructions, and 1 older adult for not finishing the study.

Materials and procedure. The same stories and probes were used as in Experiment 1. The major difference was in the location of the probes. Specifically, the critical probes were located just prior to the completion of the Goal 1 information in the failed goal versions. Also, a different distractor task was used between each of the stories. Readers were given a three-digit number (e.g., 654), and were asked to count backwards by 3s (e.g., 654, 651, 648, . . .). After 10 s, the word *STORY* appeared on the screen. This also served as a signal to the readers to stop counting and to write the last number that they counted to on a response sheet.

Results

The results of Experiment 2 were that older adults, although generally slower than younger adults, processed the narratives in a similar fashion. Like Experiment 1, both older and younger adults responded to probes for the completed goal versions more slowly than for the failed goal versions. This suggests that completed goal information was less available than failed goal information in both age groups and to a similar degree. Also, both older and younger adults responded to probes for the neutral versions more slowly than for the completed goal versions. Thus, the completed goal information was more available than the neutral information in both age groups, and to a similar degree.

Response times. The response time data for Experiment 2 are presented in Table 2. Response times to the target questions were submitted to a pair of 2 (age) × 3 (condition) ANOVAs as in Experiment 1. There was a significant main effect of condition, $F_1(2, 140) = 19.74$, $MSE = 238{,}904$, $F_2(2, 34) = 15.34$, $MSE = 144{,}017$. Separate analyses showed that probes in the failed goal condition were responded to faster than in the completed goal condition, $F_1(1, 70) = 8.67$, $MSE = 171{,}886$, $F_2(1, 17) = 8.74$, $MSE = 130{,}912$, and faster in the completed goal condition than in the neutral condition, $F_1(1, 70) = 13.93$, $MSE = 240{,}574$, $F_2(1, 17) = 6.06$, $MSE = 175{,}852$. There was also a significant main effect of age, $F_1(1, 70) = 69.80$, $MSE = 1{,}843{,}537$, $F_2(1, 17) = 314.18$, $MSE = 217{,}008$, with the older adults responding slower than the younger adults. However, the critical Age × Condition interaction was not significant, $F_1 = 1.01$, $F_2(2, 34) = 1.26$, $MSE = 63{,}006$, $p > .20$. Like Experiment 1, for the older adults, to see if there was an influence of

age that might only be observed for the oldest adults, age was correlated with the average size of the difference between the three conditions. However, this correlation was not significant, $r = -.14$, $p = .41$.

Error rates. The error rate data were submitted to an ANOVA similar to that used with the response time data. There was a significant main effect of condition, $F_1(2, 140) = 26.18$, $MSE = 81$, $F_2(2, 34) = 6.12$, $MSE = 150$, with people making the fewest errors in the failed goal condition (3%), followed by the completed goal condition (4%), with the greatest number of errors being made in the neutral condition (13%). Separate analyses showed that the first two were not different from one another, both Fs < 1, but that both of these were less than the neutral condition, $F_1(1, 70) = 33.79$, $MSE = 106$, $F_2(1, 17) = 5.83$, $MSE = 265$, and $F_1(1, 70) = 34.20$, $MSE = 81$, $F_2(1, 17) = 7.87$, $MSE = 150$, respectively. The main effect of age was not significant, $F_1 < 1$, $F_2(1, 17) = 1.10$, $MSE = 29$, $p > .30$, with older adults making a similar number of errors (7%) as the younger adults (6%). The Age × Condition interaction was also not significant, $F_1(2, 140) = 1.53$, $MSE = 81$, $p > .20$, $F_2(2, 34) = 1.20$, $MSE = 55$, $p > .30$.

Discussion

The results of Experiment 2 parallel those of Experiment 1. Goal information was more available in the failed goal condition than the completed goal condition, and information was more available in the completed goal condition than the neutral condition. Although the older adults were slower overall, there was no difference in the pattern of availability. As such, these data indicate that under these conditions, older adults are as efficient as younger adults at making goal information available again after a subgoal has been successfully completed. Furthermore, there is no evidence that completed goal information is inappropriately activated under circumstances that would have activated that same information had the goal not been completed.

Before accepting the conclusion that there are no age differences in the processing of goal information as suggested by the probe data, we consider an alternative explanation. It may be that no differences were observed in these two experiments because any difficulty in processing that may have been encountered was resolved earlier in the passage, before the probes were presented. As such, by the time readers reached the probe location, there was no longer any effect to observe. Such an explanation would be consistent with research showing that older readers may not generate causal connections immediately as younger adults do (e.g., Hess, 1995). Instead, the older adults may spend more time reading sentences where causal, goal-related connections need to be made.

One way to test this possibility is to look at the reading times for the story sentences as a function of the role they played in helping the reader to interpret the causal structure of the story. Because reading times were collected in both of these experiments, we could perform this analysis. According to this wrap-up hypothesis, there should be an increase in processing time either at the location where the goal was completed, or soon after. This would indicate wrap-up processing of the sort that is seen at clause and sentence boundaries (e.g., Aaronson & Scarborough, 1976; Just & Carpenter, 1980). There is evidence that under some circumstances older and younger adults may differ in how much time they spend processing information at different wrap-up points in a text (e.g., Haberlandt & Graesser, 1989; Stine, 1990). Although the wrap-up processing considered here differs from that in other studies, in that the focus is on a more global level story unit than on a syntactic level unit, the basic idea is similar. If older adults have more difficulty removing completed goal information from a high state of availability, then they may show a substantially greater slowdown at, or soon after, the sentence in which a goal was completed.

The reading time analysis was based on reading time per syllable. The results are summarized in Figure 1. In the figure, G stands for a goal sentence, O stands for an outcome sentence, P stands for preliminary sentences, I stands for the intervening sentences between the goal and outcome sentences, and B stands for the sentences between the Outcome 1 and Goal 2 sentences. The values at the P, I, and B positions represent averages across all sentences falling into those categories. This was done because the stories differed in the number of sentences in each of these categories.

For the reading time analysis of Experiments 1 and 2, the critical locations are Outcome 1, the sentence that distinguishes completed and failed goal story versions, and the sentences that immediately follow Outcome 1. According to a wrap-up hypothesis, readers should take more time to read these sentences in the completed than the failed goal story versions. Furthermore, if older adults have more difficulty wrapping up a completed goal than the younger adults, then it would be expected that they would show a greater slowdown.

As predicted, readers did take longer to read the Outcome 1 sentences in the completed goal story versions than in the failed goal versions. However, there was no indication that this reading time difference was any greater for the older adults. If anything, it was smaller. A 2 (age) × 2 (condition) mixed ANOVA on the reading time data for the Outcome 1 sentence showed main effects of age, $F(1, 142) = 93.07$, $MSE = 6095$, and condition, $F(1, 142) = 10.12$, $MSE = 2178$, but the interaction was not significant, $F < 1$. Thus, there does not appear to be any evidence to support the idea that older adults spent a greater amount of time and effort to reduce the availability of goal information soon after it had been completed.

General Discussion

The experiments reported here tested whether older adults would differ from younger adults in their ability to update a situation model when that updating involved character goal information. In particular, we looked at the availability of goal information after the goal had been successfully completed. Research in narrative comprehension with younger adults (Lutz & Radvansky, 1997; Suh & Trabasso, 1993) has shown that goal information is less available when the story character has successfully completed that goal than when it has not been completed. As such, there is an updating of the situation model in which the goal information goes from a state of high availability to a state of lessened availability.

The availability of goal information in neutral, completed, goal, and failed goal conditions was tested using memory probes at two locations within the experimental stories. In addition,

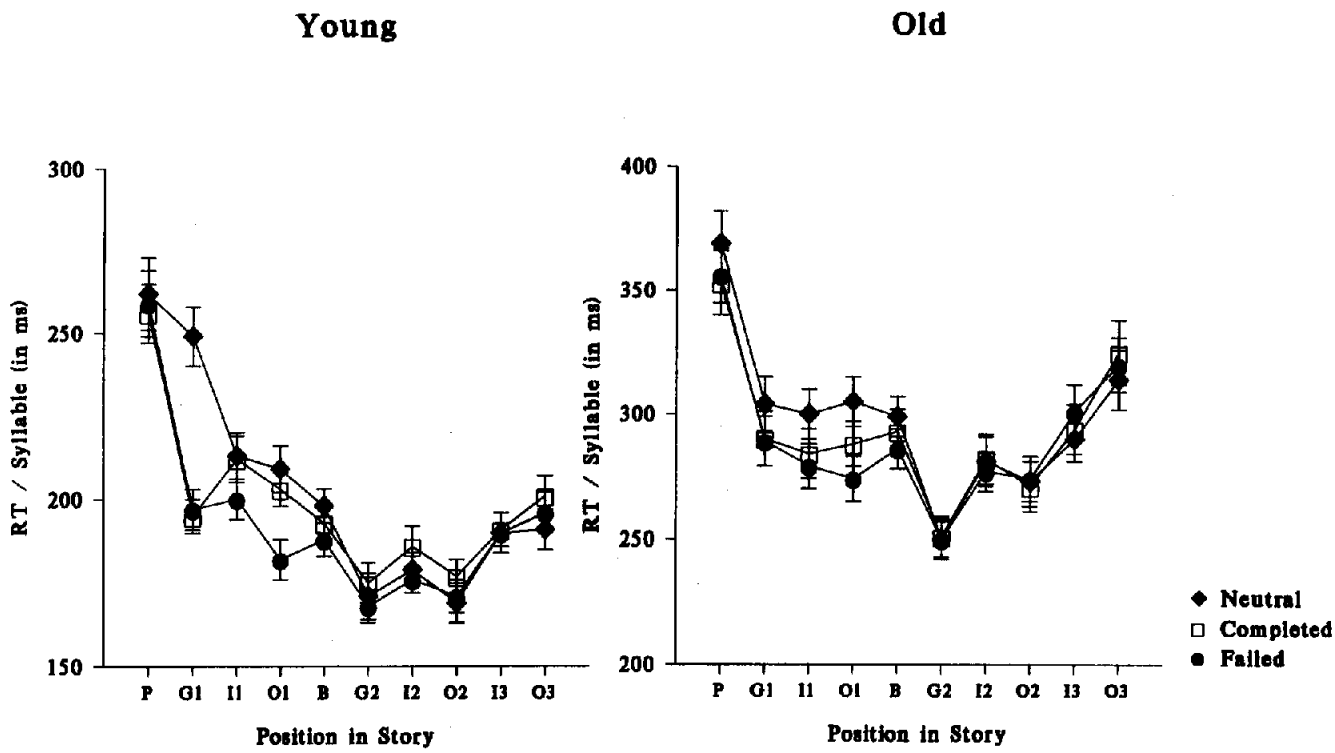

Figure 1. Reading time (RT) data for Experiments 1 and 2. The values at positions P, I, and B represent averages across all sentences falling into those categories because the stories differed in the number of sentences in each of these categories. G = goal sentence; O = outcome sentence; P = preliminary sentences; I = intervening sentences between the goal and outcome sentences; B = sentences between the Outcome 1 and Goal 2 sentences.

reading times were analyzed to assess whether age differences would be observed using an on-line measure. Although performance on the probe response time and reading time measures varied with respect to condition, we did not observe any influence of age on the processing of completed goal information. This absence of a difference between the younger and older adults is consistent with previous research on situation models that has shown that younger and older adults are similar in the way they create situation models (Radvansky et al., 1990; Radvansky et al., 1996) and in their ability to update those situation models (Morrow et al., 1994). Furthermore, these results parallel those of Morrow et al. (1994) in that, during reading, when a shift from one location to another was made, older adults were effective in reducing the availability of information in the previous location, much like the older adults in these experiments were able to reduce the availability of completed goal information.

The results of the current experiments should be considered in light of another study that clearly illustrates a decreased ability of older adults to suppress irrelevant information at the level of the situation model. This is a study of narrative comprehension by Hamm and Hasher (1992). In this study people read a series of narratives in which the appropriateness of generated inferences was manipulated. In half of the passages, an inference was encouraged early on in the passage that subsequently turned out to be incorrect. At some later point, the reader was provided with disambiguating information that forced them to drop the original inference and adopt a new and more appropriate one. For example, in a story about a woman named Carol, a reader was told that she was feeling ill, had asked a nurse friend for some advice, and had entered a large building. At this point in the story, readers are likely to infer that Carol is in a hospital. However, they are soon provided with information that she is looking for some books and then checks some out at a desk, making it clear that she is in a library, although this still needs to be inferred from the text. As such, a reader needs to correct the inappropriate inference that Carol is in a hospital to an inference that she is in a library. This requires an updating of the situation model in that the reader must reinterpret the situation being described by the text. The situation model is updated by removing the incorrect information. To assess the availability of the different types of inferences (e.g., hospital or library), readers were given memory probes at two points: halfway through the story, before the disambiguating information, and at the end of the story.

The results of this study show that younger and older adults were equally able to generate the appropriate inference by the end of the story. The critical finding is that the original, inappropriate inference was maintained in a more active state by the older adults than by the younger adults. This suggests that one of the problems older adults may have during cognitive processing is that they keep too much irrelevant information active.

At first glance, the results of the current experiments appear at odds with the results of the study by Hamm and Hasher (1992). Specifically, although they observed that older adults continued to keep inappropriate information (inferences) active, the inappropriate information in our experiments (completed goal information) was not kept more active by the older adults than the younger adults. More generally, these results also seem inconsistent with the Hasher and Zacks (1988) model of aging, which suggests that older adults are less effective at removing irrelevant information from the current stream of processing.

In a very broad sense, this conclusion is true. However, this broad characterization misses important aspects of the cognitive processes and experimental task that enable older adults to perform like younger adults. One way of characterizing the circumstances under which age differences are more likely to be observed (that is implicit in Hasher and Zacks' writings) is that the irrelevant information should be "strong and wrong."[1] By strong we mean that the information is present at or near the focus of attention in the environment or is strongly implied by the information that is present. As such, this information would have the potential for a potent influence on the information involved in the current stream of processing. By wrong we mean that the information is inappropriate, contradictory, or both to the current processing goals. Information that is strong and wrong places a larger demand on inhibitory processes and thus makes it more likely that an age difference would be observed.

In those cases where inhibitory deficits in older adults are observed, inappropriate competitors of some type interfere with the processing of the appropriate information. For example, in negative priming studies (e.g., Hasher et al., 1991; Tipper, 1991) the physical presence of a (wrong) distractor that is associated with an incorrect response, against which people need to select the correct item, results in interference. This attests to the strength of those items. In directed forgetting research (Zacks et al., 1996), a to-be-forgotten item is presented in a study list, thereby establishing a reasonably strong memory trace. Later, this information is inappropriate (wrong) for later memory retrieval because it is supposed to be forgotten. Finally, in fact-retrieval situations, a greater fan effect is observed in older adults than younger adults (Cohen, 1990; Gerard et al., 1991; Radvansky et al., 1996). The occurrence of the fan effect indicates that there are memory traces that are strong enough to interfere with the retrieval of the appropriate trace. The fact that these memory traces are not the ones needed to verify a memory probe is what makes them wrong.

The Hamm and Hasher (1992) study clearly falls into the strong and wrong category. The initial inference that their readers generated while reading the story can be clearly identified as strong because it is made by 70–80% of the readers in both age groups prior to those portions of the texts that suggest an alternative inference. The information was wrong because a more appropriate inference becomes plausible later on during the story and these two inferences are mutually incompatible. For example, it is impossible for a person to be in both a library and a hospital at one time (unless for some odd reason one is contained within the other).

In our experiments, the completed goal information would not be classified as strong and wrong. Although the completed goal information was initially strong because it is explicitly presented in the text, after the protagonist's goal was satisfied, that information is not really needed to draw causal inferences later on in the story and thus does not continue to receive activating strength from the rest of the text. This is evidenced by verbal protocol data from Suh and Trabasso's (1993) and Lutz and Radvansky's (1997) studies. In these studies, readers were asked to verbalize their understanding of the story after reading each sentence. For completed goal versions, the Goal 1 information was mentioned initially between 80% to 95% of the time. However, soon after the goal was completed (by the introduction of the second goal), the goal information is only mentioned between 1% to 40% of the time. Thus, the protagonist's goal moved from being strong to weak, or at least from being strong to not as strong.

When a goal is completed, the information is wrong in the sense that it is not likely to be needed to draw further causal inferences to motivate a character's actions, but it is right in the sense that it is still needed to understand the story as a whole, as well as to answer the probe questions. Thus, our experiments are similar to the Morrow et al. (1994) study in the sense that an understanding of all of the information presented in the text is needed in order to comprehend the whole story.

Moreover, although the information was moved from a heightened state of availability to a less heightened state of availability, this information is still available. This can be seen from the fact that goal information is more available in the completed goal condition than in the neutral condition, even for the younger adults. Within the context of the task, the information is appropriate but not immediately needed. It could be that this information remains somewhat available because it may be needed at some point later in processing. There is no evidence that the completed goal information is being actively suppressed. Instead, this information is no longer being actively supported to such a high degree. In this light, these results are not contradictory to Hamm and Hasher's (1992) data and to the Hasher and Zacks' (1988) theory.

In summary, our experiments showed that older and younger adults do not differ in their ability to update the goal information of a situation model during the reading of a passage when that updating involves the reduction in availability of goal information after a story character has completed that goal. As such, these data provide further support for the idea that although older adults may be compromised in language processing at other levels, the processing of information at the level of the situation model is better preserved (e.g., Adams, 1991; Stine-Morrow et al., 1996). Difficulties in processing at this level experienced by older adults are a result of the text "garden pathing" or somehow misleading the reader (Hamm & Hasher, 1992; Zacks, Hasher, Doren, Hamm, & Attig, 1987) or of failure to explicitly provide information needed to establish causal connections (Hess, 1995). As such, once an older adult is able to establish a situation model, if there are no misleading portions

[1] The idea that age differences in inhibitory processing may be most prominent when information is both "strong and wrong" emerged through conversations with researchers at the Michigan State University Cognitive Aging Lab, including Rose Zacks, Karin Butler, Doug Davidson, and Carrick Williams.

in the text, comprehension should proceed much like that for younger adults.

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Call for Nominations

The Publications and Communications Board has opened nominations for the editorships of **Experimental and Clinical Psychopharmacology, Journal of Experimental Psychology: Human Perception and Performance (JEP:HPP), Journal of Counseling Psychology,** and **Clinician's Research Digest** for the years 2000–2005. Charles R. Schuster, PhD, Thomas H. Carr, PhD, Clara E. Hill, PhD, and Douglas K. Snyder, PhD, respectively, are the incumbent editors.

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