

## Aging, Memory, and Comprehension

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### Abstract

There are changes in the ability to comprehend and remember information with aging. In general, older adults perform more poorly than younger adults at tasks that require knowledge of the information that was actually encountered. However, they can perform as well as or better than younger adults at tasks involving more global levels of understanding, such as in the use of information in a situation model. This increased emphasis on situation models may serve to compensate for deficits at lower levels of processing and may be achieved through more focused selection of situation-defining information, increased dependence on schemas, and a broader generation and use of inferences.

### Keywords

aging; memory; comprehension; situation models

As people age, various changes occur in cognition. The focus in this article is on changes in the ability to comprehend and remember information. This is a research tradition whose modern manifestation began with work by Cohen (1979). The goal of comprehension is to derive an understanding of described states of affairs. This understanding then needs to be stored in memory so that it can be used later. Researchers often assess the success of comprehension by the degree to which a person can successfully retrieve and use that information in the future. However, it is not always the case that an initial impression of comprehension leads to later memory retrieval. How many students have been dismayed to discover that although they experienced understanding when they read their textbook, they are unable to retrieve and use this information during the exam?

The path to successful comprehension is by no means simple. Comprehension involves many layers of processing and representation. It is generally agreed that

memory representations can be roughly divided up into three levels: the surface form, a propositional abstraction (textbase), and a situation model. The most rudimentary level of representation is the *surface form*. This corresponds to the actual words and syntactic form of the information. Older adults have some difficulty with processing at this rudimentary level (e.g., Kemper, 1987). However, although processing ability at this level is critical, this information often becomes unavailable to memory within a few minutes after it has been encountered. This rapid forgetting occurs for both younger and older adults. I therefore concentrate on more lasting representations.

At a more intermediate level is the *propositional abstraction*. This is a representation of the presented idea units that is more removed from the surface form. For example, active and passive versions of a sentence could be stored by the same propositional representation. Most people would agree that "The woman delivered the package" and "The package was delivered by the woman" mean basically the same thing. Although the information in this abstraction is readily available for a longer time than the surface form, it also has a relatively short

shelf life. After a day or so, under normal circumstances, much of this information is not readily available.

At the highest level is the *situation model*. The surface form and propositional abstraction reflect more what the information was, whereas the situation model captures what the information was about. The situation model serves as a mental simulation of the described events that incorporates information from (a) the surface form, (b) the abstraction, and (c) additional inferences made based on prior knowledge. Often construction of a situation model is guided by the goal of understanding why various events occurred. Successful comprehension can be thought of as the ability to create and maintain a coherent and reasonably accurate situation model. Situation models are readily available in memory for long periods of time.

### PROPOSITIONAL ABSTRACTION

One of the established means of measuring comprehension and memory is to assess the degree to which retrieved information contains the propositions presented earlier. This method requires that a discourse (often a text) is coded for its propositional content, that is, the simple idea units that are present. Sometimes a single sentence captures a single proposition, such as "The Browns won." Other times, a sentence may contain several propositions. For example, "The underdog Browns won the game in overtime" contains three propositions: (a) *the Browns were underdogs*, (b) *the Browns won the game*, and (c) *the game went into overtime*.

A ubiquitous finding in the literature on cognitive aging is that older adults' memory for propositions is consistently and markedly

poorer than that of younger adults. Analyses of propositional content have found deficits for older adults on two counts. First, older adults often remember fewer specific propositions. Second, older adults may be less efficient at organizing their mental representation of the propositions. Specifically, they often show poorer memory for important text items compared with younger adults (e.g., Stine & Wingfield, 1988). Different propositions do not all have the same importance for structuring the information. Some propositions, such as detail information, are relatively low in importance, whereas other propositions are more central. Because these more important propositions are more central to organizing the information, they should be remembered better than low-importance propositions. The fact that older adults appear to be less sensitive to informational importance, especially for propositionally dense texts, has been interpreted as indicating that older adults have difficulty organizing propositions, and so, have a greater difficulty remembering them.

### SITUATION MODELS

As stated earlier, a situation model refers to the described situation, rather than the information itself (see Zwaan & Radvansky, 1998, for a review). The model contains information that was presented, as well as likely inferences about the situation. Because situations in the world are complex, model construction is aimed at reflecting this complexity, although the models themselves are often incomplete. In general, they are often focused on capturing the primary functional relations that define the situation.

There has been relatively little work on situation-model use and

aging. However, the work that has been done has shown that the basic construction and use of these representations is unaffected by changes in the natural aging process. In one of the earliest studies of this type (Radvansky, Gerard, Zacks, & Hasher, 1990), people heard a series of sentences and then took a forced-choice recognition test in which they had to select which of two sentences they had heard earlier. More errors were made if an incorrect distractor sentence referred to the same situation as the original sentence than if it referred to a different situation. For example, people confused the sentences "The hostess bought a mink coat from the furrier" and "The hostess bought a mink coat at the furrier's" more often than they confused "The hostess received a telegram from the furrier" and "The hostess received a telegram at the furrier's," even though the propositional change between the sentences is the same in the two pairs. The reason for this pattern of errors is that the sentences in the first pair are likely to be interpreted as referring to the same situation, but those in the second pair are not. These findings suggest that people make memory decisions using situation models that were formed earlier. Younger and older adults performed similarly on this task, suggesting that they use similar types of situation models.

Another source of evidence that the use of situation models remains stable with aging was reported in a study examining the presence or absence of interference during a recognition test (Radvansky, Zacks, & Hasher, 1996). Pieces of information that are related in some way, such as by having concepts in common, but are stored in separate situation models can interfere with one another during memory retrieval. In contrast, pieces of information that

can be readily interpreted as referring to a common situation can be integrated into a single model. In such cases, there are no competing models, and no interference during retrieval. In this study, both older and younger adults showed evidence of interference when information referred to separate situations. More important for the present concerns, both older and younger adults were able to integrate information into situation models that referred to the same situation, and thereby avoid interference.

There is also evidence that younger and older adults are similarly able to update their models with new information. Curiel and I have demonstrated that younger and older adults update goal information in a similar fashion (Radvansky & Curiel, 1998). Goal information is an important situation-defining dimension. To understand a described situation, people need to update information about the characters' goals (e.g., Jimmy wants a bicycle). Goals that have been completed (Jimmy's mother buys him a bike) do not need to be maintained at a high level of availability in memory. In contrast, goals that are uncompleted (Jimmy's mother refuses to buy him a bike) are kept more available, to help explain why a character is engaging in various actions or feeling various emotions. We monitored the availability of goal information with a probe identification task in which people indicated whether information was true or not based on what had occurred earlier in the passage (e.g., Did Jimmy want a bicycle?). Curiel and I found that the differential availability of these two classes of goals did not change as a function of aging. This finding, along with studies of processing of other types of information (e.g., Morrow, Stine-Morrow, Leirer, Andrassy, & Kahn, 1997), suggests that there is little to

no age difference in the ability to update situation models.

As should be clear, there are several sources of evidence that older adults are less efficient than younger adults at remembering information when they are assessed for specific information that was presented earlier. However, older adults appear to retain the ability to represent the described situation. Thus, older adults may have difficulty remembering what a text was, but do remember what a text was about, provided that they can derive this information initially. However, this conclusion is based on studies that looked at either the retention of propositions or the use of situation models. These studies suggest that older adults place a greater emphasis on situation models than on propositions, but direct support for this idea would require observing a decline in use of propositional information and preserved use of situation models in the context of the same study.

There have been some recent efforts along these lines. A study by Stine-Morrow, Loveless, and Soederberg (1996) looked at reading times for clauses in short texts and how they were affected by text characteristics at word, propositional, and discourse levels. Age differences in reading patterns were observed at lower levels, but not for the situation model. Also, in an ongoing study, Jackie Curiel, David Copeland, Rolf Zwaan, and I are looking at memory performance at the surface-form, propositional, and situation-model levels concurrently. People first read a series of texts (reading times are also collected) and then take a recognition test. The items on this recognition test are varied to assess the influence of information at the surface-form, propositional, and situation-model levels (after Schmalhofer & Glavanov, 1986). Our primary finding is that

younger adults show better memory for information at the surface-form and propositional levels than older adults. In contrast, older adults have better memory for the situation-model level than younger adults. Although these age differences require further verification, it is clear that older adults placed a greater emphasis on situation models. Thus, older adults appear to have preserved abilities that help them gain an understanding of what is being referred to by the presented information. In some sense, this emphasis on higher level processing can be viewed as compensating for deficiencies at lower levels of processing. The issue that now needs to be addressed is what underlies this preserved ability.

#### CURRENT DIRECTIONS

There are three possibilities to be explored concerning older adults' abilities to create and use situation models, despite their deficiencies at lower levels of processing. The first is that older adults may be more selective than younger adults in the information they select for more extensive processing during comprehension. From this perspective, comprehension can be viewed as a skill. For skilled performance, experts are better able than novices to select those aspects of a situation that are important for more complete understanding. Older adults, being more practiced, and thus likely to be more expert, may be able to identify those portions of the information that are pertinent to model construction. Although this idea needs further investigation, there is some evidence consistent with it. In the study by Curiel, Copeland, Zwaan, and myself, described in the preceding section, there has been a trend for the reading times

of older adults to be more sensitive than the reading times of younger adults to information identified as being relevant to model construction (e.g., the introduction of new people).

The second possibility is that older adults' memory and comprehension performance reflects a greater reliance on knowledge already stored in memory, such as schemas (collections of knowledge about commonly encountered aspects of the world). The research on older adults' use of schemas is mixed. Although it is clear that younger and older adults have schemas with similar content and structure, it is unclear to what extent older adults place an emphasis on this information in cognitive processing. Some researchers have suggested that they do not differ from younger adults, whereas others have suggested that older adults may place a greater emphasis on schema-based knowledge over situation-specific knowledge. There is some evidence that older adults may be more dependent on schematic knowledge during comprehension than younger adults (Soederberg Miller & Stine-Morrow, 1998).

The third possibility is that during comprehension, older adults may generate, or at least maintain, a wider range of inferences (e.g., Hamm & Hasher, 1992) based on the information that they were able to successfully encode and process. Creating a situation model is essentially an inference-making process in which the available information and general world knowledge are used to construct an understanding of the described situation. This hypothesis also needs some further investigation, but there is some evidence that is consistent with it. For example, studies of storytelling by older and younger adults have found that older adults are generally more verbose than are younger adults.

Moreover, this increased speech is more likely to be off-topic. However, even though this additional information is nominally off-topic, the stories of older adults are also rated as more informative, more interesting, and of a higher quality (James, Burke, Austin, & Hulme, 1998). Thus, older adults are bringing more information to their understanding of an event (increased inferences), which is consistent with the idea that they are placing a greater emphasis on situation models.

Also consistent with this idea that older adults are creating more inferences and incorporating them into their understanding is work by von Hippel, Silver, and Lynch (in press). In this study, after the researchers measured subjects' prejudice, impression management (being concerned with how others view oneself), and inhibition, the subjects read a narrative describing a student. There were two versions of the story that were equal except that one suggested the student was Caucasian and the other suggested he was African American. People were explicitly told to form an impression of this student and to not allow social-category information to influence their responses. The results showed that older adults were more prejudiced against the African-American student than were the younger adults. That is, compared with younger adults, they inferred and used more information based on the student's assumed racial background, despite the fact that the older adults scored higher on impression management than the younger adults. Performance was related to inhibitory ability, not to measures of impression management or prejudice. Put simply, the older adults were generating more inferences than the younger adults to help them understand the described situation.

## CONCLUSIONS

In sum, older adults show signs of having difficulty remembering information they encountered earlier when the performance measure taps into lower levels of processing, such as the level of propositional abstraction. However, when comprehension and memory are assessed at the higher level of the situation model, older adults appear to do as well as younger adults. Several potentially complementary possibilities may account for this age invariance. There is much progress to be made in this area, with much to be gained. It is still unclear to what extent these higher level abilities are preserved, and what it is about aging and cognition that leads to preserved performance on tasks that rely on this sort of processing.

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## Note

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