Cognitive Mediation of Discourse Processing in Later Life

Médiation intellectuelle du traitement du discours vers la fin de la vie

Sheree T. Kwong See, PhD
Department of Psychology,
McMaster University, Hamilton, Ontario

Ellen Bouchard Ryan, PhD
Department of Psychiatry and Office of Gerontological Studies,
McMaster University, Hamilton, Ontario

Key words: aging, cognition, language, information processing

Abstract

In this article we examine the cognitive processing basis of age differences in discourse comprehension and memory. A framework is presented which outlines the cognitive components involved in discourse processing. A review of the literature with respect to developmental differences in each of the components implicated age differences in working memory capacity, inhibitory efficiency, and processing speed as mediators of age differences in language performance. Of these three, age differences in speed of processing and inhibition may be the fundamental mediating factors.

Abrégé

Dans cet article, nous examinons les processus intellectuels à la base des fluctuations observées au niveau de la compréhension et de la rétention du discours chez les personnes âgées. Les auteurs proposent un cadre mettant en relief les éléments intellectuels du traitement de la conversation. Suit un examen de la documentation sur les différences de développement associées aux variations dues à l'âge des composantes de la mémoire fonctionnelle, de l'efficacité des inhibitions et de la vitesse de traitement en tant que médiateurs des fluctuations des aptitudes linguistiques attribuables au vieillissement. Des trois composantes, la rapidité du traitement et les inhibitions pourraient constituer des facteurs de médiation fondamentaux sur le plan des différences liées à l'âge.

The comprehension and production of language are fundamental to the independent functioning of both young and old people. In the last two decades, examining how aging might affect these important cognitive skills has been an important research endeavour. A wide range of age differences in language performance has been found (Kemper, 1992; Ska & Joanette, this issue). For example, relative to their younger counterparts, older adults have more difficulty comprehending grammatically complex sentences and tend not to recall as much after reading or listening to texts (Kemper, 1992; Verhaeghen, Marcoen, & Goossens, 1993).

Generally, it is not believed that aging is associated with decline in the acquired competency with which language-relevant knowledge and processing skills are brought to bear (Light, 1988). Rather, the age differences in language performance noted above appear to reflect age-related differences in fundamental cognitive components involved in discourse processing. The purpose of this review is to identify and discuss the cognitive processing basis of language performance differences in later life. We confine our discussion to the mediation of comprehension and memory for written and spoken discourse because receptive language performance has been extensively researched.

The article consists of four parts. In the first part, a framework outlining the cognitive operations involved in discourse processing is presented. Following this description of the necessary cognitive components, the literature with respect to age differences in these components is reviewed in part two. In this way the age-compromised cognitive operations mediating age differences in language performance are implicated. This review will show that age differences in working memory capacity, inhibitory efficiency, and processing speed are mediators of age variance in language performance. In part three the results of a study which examined these mediators in the same experiment are summarized. Results of that study revealed that language performance differences are fundamentally mediated by speed and inhibition differences. The article concludes in part four by reintroducing the framework and pointing out its usefulness as an organizer around which the effects on cognition of age-associated clinical conditions can be compared to the effects of normal aging.

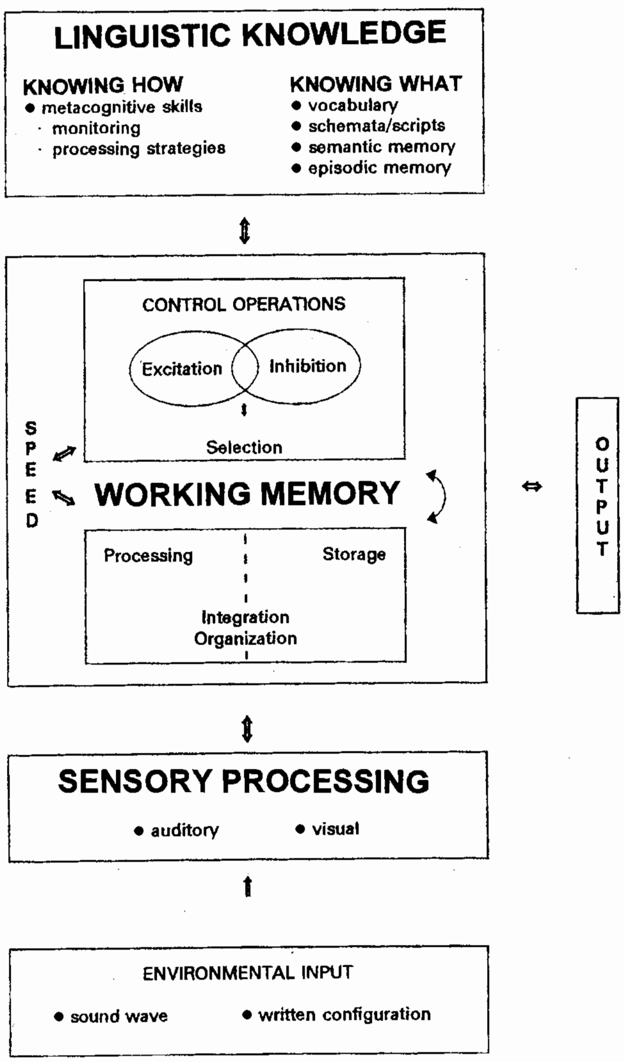
A Framework for Discourse Processing

Since the late 1970s there have been a number of proposals for how discourse becomes mentally represented (e.g., Kintsch & van Dijk, 1978; Meyer, 1975; van Dijk &

Kintsch, 1983). Though differing in the specifics of the operations involved, there is general agreement as to the necessary components of a discourse processing system. Figure 1 depicts the hypothesized important component systems.

The framework shown in Figure 1 is not meant to represent any particular discourse model but rather extracts ideas common to many conceptualizations. It is influenced most heavily by the processing model of Kintsch and van Dijk (1978; van Dijk & Kintsch, 1983) and by a synthesized model outlined by Stine (1990). The box format and linear presentation resemble information processing models and are meant to reflect that discourse models emerged out of an information processing tradition (e.g., Atkinson & Shiffrin, 1968). Bidirectional arrows within the framework imply interactive feedback loops. The vertical arrangement in conjunction with bidirectional arrows signifies that operations flow bottom-up and top-down. Bottom-up processing refers to the notion that to some extent discourse begins as a meaningless stimulus that needs to be organized and given meaning by a discourse processor. Top-down processing refers to the role played by accumulated knowledge in aiding the construction of meaning. In reality the relative contributions of the various components are unknown. The depicted sizes of the boxes are therefore arbitrary.

Figure 1. Framework outlining the cognitive operations involved in discourse processing (adapted from Kwong See, 1994).



The framework has three main components: a *sensory processing* component, a *working memory system* and a *linguistic knowledge base.* Sensory processing is the junction between the external environment and higher-order cognitive operations. At this initial stage the linguistic message is processed by sense organs in a form directly afforded by the stimulus.

There are a number of conceptualizations of the working memory system (e.g., Baddeley, 1986; Daneman & Carpenter, 1980). Although there are differences in the way that theorists model and test the working memory construct, for our purposes we highlight the features of a working memory system which are important for discourse processing. In Figure 1, the working memory system is depicted as comprising three main elements. First, *control operations* are responsible for the excitation of relevant knowledge (van Dijk & Kintsch, 1983) and also the inhibition of irrelevant information (Kintsch, 1988). Emphasis on the active inhibition of irrelevant information has only recently been considered as an important control operation (Gernsbacher, 1990). The control operator can be conceptualized as a selective attention mechanism which serves to filter incoming information and to dampen the activation of information within working memory which becomes "no-longer-relevant" (Hasher & Zacks, 1988). The second element is a limited capacity representational system with capabilities for the temporary *storage and processing* of information. Since the division of these capabilities is contentious, the two are separated in Figure 1 by a dashed line. The third element is *processing speed.* Speed is considered an important processing component since in all models it is assumed that processing operations need to take place quickly. The speed factor also appears to be all-encompassing in that quickness needs to be optimal in all phases of processing. The definition of optimal is admittedly vague. Moreover, the bidirectional arrows associated with speed indicate that the directional influence of speed remains unclear. For example, slower operating speed may lessen capacity for information storage and processing or, conversely, a reduction in capacity may lead to slower speed.

There are many ways of categorizing the types of information presumably stored within the linguistic knowledge base. For the present purposes a broad distinction is made between "knowing how" and "knowing what". *Knowing how* refers to metacognitive skills which are involved, for example, when one decides that one has "missed something" and needs to read again or ask for repetition (i.e., comprehension monitoring). The term *processing strategies* refers to the knowledge that different study or remembering techniques are likely to have different memorial consequences and that one method may be more appropriate than another for a given discourse situation. *Knowing what* encompasses word knowledge (vocabulary), situation knowledge (schemata or scripts), general accumulated world knowledge (semantic memory), and also memory for personal events not generally known (episodic memory). Such knowledge would be necessary in comprehending discourse related to one's family, for example.

In general, the system is said to operate such that incoming linguistic information is processed in segments sequentially in time, and the meaning of discourse is constructed within the limited capacity of working memory. It is presumed that working memory operations intimately interact with stored knowledge.

Aside from this general synopsis, models diverge in specifying the manner in which the discourse representation becomes constructed, especially with respect to constructing the meaning of discourse in working memory. To expand further on how information might move through a system as depicted in Figure 1, reference is made to the model of Kintsch and van Dijk (1978) as their work has been the most influential.

Within their discourse processing model the fundamental segments comprising discourse are called propositions. A proposition is a symbolic representation that expresses a relationship between concepts. For example, the proposition *throw (boy, ball)* represents the meaning of the sentence *The boy threw the ball* and includes the concepts *throw*, *boy* and *ball*. According to Kintsch and van Dijk, discourse processing involves the extraction of propositions, the establishment of the relationships among them, and the mental construction of a propositional hierarchy which represents the discourse meaning. The term hierarchy refers to an assembly of main ideas and subordinate details. Development of the propositional hierarchy involves working memory processing and storage operations. The limited capacity associated with processing and storage requires that the propositions be processed cyclically. That is, as successively more discourse is encountered, some old propositions are carried over from the previous cycle while new propositions are extracted and added to the old. Decisions about which propositions are further processed are based on the principles of recency, with newly encountered segments more likely to be held over, and relevance (i.e., is the idea likely to be needed to maintain coherence with incoming segments?).

In more recent writings, van Dijk and Kintsch (1983) place greater emphasis on the strategic goal-directed nature of discourse processing. Less emphasis is thus placed on the end of the processing cycle as the point at which coherence between ideas is established. Linking happens continuously as new information is encountered. Importantly, because processors are continually creating hypotheses as to discourse meaning, there is a need for a control system which continually activates stored knowledge and supervises the complicated activities occurring in working memory. Because control operations augment the building process with information from the knowledge base, information within the processing cycles need not only be gleaned from concepts read or heard. Therefore, the ideas carried over can be extracted from the stimulus (discourse) itself but also can be self-generated.

Age Differences in Discourse Processing Components

Sensory Processing

Within the discourse processing framework outlined above, age differences in any of the three components will contribute to age differences in language performance. It is well established that aging is associated with changes in sensory processing such as hearing and vision (Fozard, 1990; Schneider, in press). Age-related deterioration in sense organs translates into a less intense and less clear linguistic signal being passed upward for higher-order processing. With respect to speech perception, Pichora-Fuller, Schneider, and Daneman (1995) have argued that the allocation of cognitive resources to the recovery of a poorer signal detracts from the resources needed to process the acoustic signal upstream. That is, there is an interactive effect between sensory processing and the working memory component described in the framework. A similar argument has been made for the importance of age-related sensory differences in mediating age differences in intelligence test performance (Lindenberger & Baltes, 1994).

There is no denying that sensory differences mediate a portion of age variance in language performance. Sensory factors in the comprehension of spoken language, especially with respect to hearing loss, are addressed in detail by Pichora-Fuller (in press). Because the focus of this paper is to identify the impact of cognitive differences occurring upstream, however, we will not focus extensively on the effects of sensory differences. Nonetheless, it is important to acknowledge that there is a complex interaction between working memory operations and sensory processing. The nature of this interaction is not yet fully understood and is in need of further research.

Activation and Representation of Linguistic Knowledge

As seen in Figure 1, age differences in the linguistic knowledge base can also be a source of an older adult's less efficient discourse processing. With respect to the relationship between metacognitive skills and discourse processing, the research has been limited. Using on-line procedures, Zabrucky, Moore, and Schultz (1987) found that young and older adults did not differ in the monitoring of written prose comprehension. Using a questionnaire technique, Zelinski, Gilewski, and Thompson (1980) found a relationship between reports of everyday memory and laboratory performance (including recall of read texts) for older adults but not for young adults. They suggest that older adults may be more accurate in evaluating their memory (i.e., metamemory skills). Finally, Dixon and Hultsch (1983), also using the questionnaire approach but with an instrument measuring several domains of metamemory, found that measures of knowledge about general memory processes, knowledge about changes in one's memory, and sense of control over memory were predictive of memory for read texts. In terms of age differences, measures tapping knowledge about memory (e.g., knowledge of recall strategies) were the best predictors for young adults. For older individuals, memory performance was related more to affective dimensions of metamemory (e.g., levels of anxiety associated with various memory demands).

The results of these studies do not provide a clear picture of the role of metacognitive skills in mediating age differences in language performance. The Zabrucky et al. (1987) and Zelinski et al. (1980) studies suggest that older adults are as aware of their memory states during discourse processing as are young adults. The results of the Dixon and Hultsch (1983) study, however, suggest that older adults may differ in the extent of knowledge about strategies or in the use of these strategies during discourse processing.

With respect to the latter, differences in "knowing how" to process discourse have been explored under the general heading of production deficiency studies (Cohen, 1988). A strong version of this explanation postulates that, due to cohort differences related to schooling or experience, older adults do not spontaneously adopt optimal discourse processing strategies (Meyer, Young & Bartlett, 1989). Cohen (1988) also outlines a "weak" version of the production deficiency explanation. This weak version states that older adults may use less efficient encoding or retrieval strategies because of age-related reductions in processing resources. The relevant processing resource may be working memory capacity, attention, or processing speed. Because the weak version is theoretically indistinguishable from processing resource explanations addressed below, only the strong version of the production deficiency account will be discussed.

The prediction made by the strong version of the production deficiency explanation is that age differences in discourse processing should be qualitative rather than quantitative. A review of the literature suggests that this is not the case. Language performance differences are generally characterized quantitatively (i.e., less rather than different) (Cohen, 1988; Light, 1991). In all, there appears to be little clear evidence to implicate age differences in metacognitive and procedural skills as underlying language performance differences (see Light, 1991 for a review of the metamemory literature).

Investigation of the organization of the linguistic knowledge base has provided considerable evidence for age invariance (Light, 1992), and perhaps even an age-associated growth, if vocabulary is taken as an index (Bayles & Kaszniak, 1987). Researchers investigating the linguistic knowledge base are concerned with whether there are age differences in representation at the level of individual word meanings and higher knowledge structures such as scripts and schemata (Light, 1992).

In investigating possible age differences in organization at the level of word concepts, researchers have made the primary assumption that linguistic knowledge is represented in a nodal network (Collins & Loftus, 1975). In a nodal network, long-term memory is comprised of concepts (e.g., dog) tied together with linking associations which differ in associative strength. For instance, the concepts *dog* and *cat* might be closely linked but the concepts *dog* and *turkey* less closely linked. The research strategy thus has been to employ paradigms such as semantic priming in lexical decision (deciding if word strings are real words as quickly as possible) and word association tasks.

In a semantic priming procedure, lexical decisions typically follow a prime word or sentence which can be semantically related (e.g., decide if *nurse* is a word when preceded by *doctor*) or unrelated (e.g., decide if *nurse* is a word when preceded by *butter*). Semantic priming is defined by faster responding when primed with a related versus unrelated word or sentence. The facilitative effect presumably reflects the fast spread of activation between spatially close concepts. Using this procedure there appears to be age equivalence in the extent and breadth of activation (Balota & Duchek, 1992; Light, 1992). Moreover, young and old adults show equivalent facilitation when primed by words and sentences (Burke & Harrold, 1988; Light, 1992). Consequently, semantic associations between concepts are apparently the same across age groups. Findings from word association experiments concur. When young and old adults are asked to free associate to triads of words (e.g., carrot, lettuce, squash) exemplary of various categories (e.g., vegetables), the pattern of responses are generally similar between age groups. This suggests that the relative strengths of different types of associations do not vary across age (Lovelace & Cooley, 1982).

With respect to the organization of higher knowledge structures, young and old appear to be similar in their representation or utilization of stored knowledge contained in scripts. For example, Light and Anderson (1983, Experiment 1) had young and old adults generate scripts for daily activities such as going to the doctor. There was no indication from responses that the groups differed in the way that these events were mentally represented. Further, Experiment 2 determined that there was no difference in ability to draw inferences from stored knowledge.

In sum, the evidence suggests that it is unlikely that age differences in language performance are due to either inequalities in knowing how to process discourse or in having the knowledge structures in place to do so. Differences in the linguistic knowledge base are not likely to mediate a large proportion of the age variance in language performance.

Working Memory Operations

Much research has been aimed at demonstrating age differences in the intricate activities associated with the working memory system. The research has been focused on isolating differences in the storage and processing operations of working memory, differences in control operations, and the impact of age differences on the speed with which operations are executed. The processing and storage elements are discussed first, as this area has stimulated the most research.

Considerable evidence, gleaned from a number of different methods and procedures, has shown that aging is associated with differences in working memory storage and/or processing (Salthouse, 1990). It is debated as to whether the differences are confined to the storage aspects (e.g., Spilich, 1983) or processing aspects (e.g., Gick, Craik & Morris, 1988). Broadly defined, the processing and storage aspects of working memory are referred to as *capacity.*

There are many metaphors for the capacity notion but perhaps the most strongly implied has been a space metaphor (Salthouse, 1990). Adopting this metaphor, age-related declines in working memory "space" have clear implications for comprehension and memory for discourse. With reference to the framework of discourse processing presented earlier, additional limitations imposed on working memory can be expected to affect the comprehension of and memory for discourse by interfering with integrative processes. The assumption is that older adults' more limited working memory capacity increases the likelihood that recently processed propositions will be forgotten and, hence, fail to be incorporated into a text representation.

The results of several studies are in agreement with this prediction. For example, Spilich (1983) asked young and older adults to read and remember texts. Overall the older adults recalled fewer details than did the younger adults. Moreover, applying a parameter-estimation procedure to the ideas that were remembered, Spilich found that the older adults held fewer propositions in working memory from cycle to cycle. Converging evidence for the working memory capacity explanation was found by Light and Capps (1986), who used a different paradigm. In their experiment, young and old participants listened to sentences of the following type:

> Henry spoke at a meeting while John drove to the beach.
> *He* brought along a surfboard.

The task was to identify the referent for the pronoun "he". To increase working memory load they interspersed zero, one, or two unbiasing sentences before the final sentence containing the pronoun. As would be predicted if aging is associated with decline in working memory capacity, the older adults were differentially less consistent in identifying antecedents as more extraneous material intervened.

Another research strategy has been to index working memory capacity outside of discourse processing, for example by backward span, and then to relate this external measure of capacity to a measure of language performance. Studies using out-of-context assessments of working memory capacity have found older adults have smaller estimates of capacity, and these measures correlate with language performance when discourse is read (e.g., Kwong

See & Ryan, 1995) and heard (e.g., Norman, Kemper, Kynette, Cheung, & Anagnopoulos, 1991; Tun, Wingfield, & Stine, 1991). The evidence suggests, therefore, that age differences in working memory capacity likely mediate a reasonable portion of the age variance in language performance.

A further line of investigation has focused on differences in the control operations of working memory. Control over excitatory mechanisms has not been seen as a potential mediator of poorer language performance. Semantic priming studies discussed above suggest no age difference in the activation of the knowledge base (Balota & Duchek, 1992; Light, 1992). Moreover, the finding of age invariance in using context to disambiguate the meaning of words which can have multiple interpretations (e.g., organ) (Balota & Duchek, 1991) and in drawing appropriate inferences (Hamm & Hasher, 1992) suggests no differences in the selection and application of relevant activated knowledge. The focus, rather, has turned to potential age differences in inhibition (Hasher & Zacks, 1988).

Several studies have provided evidence that aging is characterized by inhibitory compromise. For example, compared to younger adults, older adults are distracted to a greater extent by irrelevant stimuli while performing tasks such as searching for targets in visual arrays (Plude & Doussard-Roosevelt, 1989). With respect to audition, older adults are poorer at attending to a message in one ear when a distracting message is presented to the opposite ear (Wickens, Braune, & Stokes, 1987).

Conceptualized with respect to the framework outlined in Figure 1, inhibition serves to dampen the activation of concepts in working memory that become no longer relevant when processing goals change (Gernsbacher, 1989). The consequence of older adults' less efficient inhibition, therefore, is that working memory is more likely to be cluttered with off-goal path information. The presence of extraneous information can be expected to create competitive noise during the development of a representation of discourse. Ensuing comprehension and retrieval would be handicapped (Gerard, Zacks, Hasher, & Radvansky, 1991). To test the inhibition hypothesis, Hamm and Hasher (1992) had young and older adults read prose passages and probed the kinds of inferences the readers held in mind at different points in the passages. Some passages were deliberately written to be ambiguous and to elicit an inference midway through the text which would be proved wrong by the end of the passage. That is, the context of the passage made it clear by the end that the initial interpretation was not appropriate. When probed midway, both young and older adults were sensitive to the manipulation and appeared to be holding the garden-path inference in mind. Interestingly, by the end of the passage the younger adults appeared to be thinking only of the appropriate inference while the older adults still appeared to have both the appropriate and untenable inference activated. This suggests that older adults are less efficient at inhibiting no-longer-relevant information during discourse processing.

In another study (Connelly, Hasher, & Zacks, 1991), young and older adults were required to read texts, some of which had distracting text (identified by being written in a different font) interspersed. Moreover, the irrelevant text varied in meaningfulness and relatedness to the to-be-read text. Comparison of reading time revealed that the older adults were hindered to a greater extent by the presence of the interspersed text. In addition, older adults were more likely to semantically encode the irrelevant information. Together these findings suggest that age differences in inhibitory efficiency likely contribute to age differences in language performance.

Finally, a third line of investigation has focused on the speed with which working memory operations are executed. In the framework presented in Figure 1, processing operations involved in the development of a discourse representation are hypothesized to take place quickly in time. The slowing of cognitive operations is perhaps the most robust finding in cognitive aging (Salthouse, 1985). Importantly, age-related speed differences have been found on tasks, such as word reading, which are relevant to discourse processing (Myerson, Ferraro, Hale, & Lima, 1992). For these reasons, postulating that age-related slowing accounts for age differences in language performance has strong appeal. The results of several discourse processing studies support this hypothesis. For example, the recall of older adults tends to be differentially impaired by speeded presentation of speech (Stine & Wingfield, 1987; Tun, Wingfield, Stine, & Mecsas, 1992). Inference generation is also impaired by fast speech (Cohen, 1979). Analysis of reading times indicates that older adults need more time than do young adults to organize ideas contained in propositionally dense sentences (Stine & Hindman, 1994). In listening situations, which particularly tax processing speed because greater time cannot be self-controlled, the qualitative recall of older adults is differentially impaired by increased propositional density (Stine & Wingfield, 1988). Therefore, age differences in processing speed also likely mediate age variance in language performance.

Cognitive Mediation of Age Differences in Discourse Processing

In the preceding sections a framework outlining the components involved in discourse processing was presented. Research into age differences in each of the components was then reviewed. From this review it is clear that the search for the processing basis of age differences in language performance can be profitably focused on the processing differences associated with the working memory system. The strategy of focusing on each processing component presented in the framework is not meant to deny that there may be cumulative or interactive effects between several components. These effects were acknowledged with respect to the potential carry-over effects of degraded acoustic signals influencing higher-order processing (Pichora-Fuller et al., 1995). The framework was intended to summarize the existing literature and to implicate cognitive factors likely to mediate the greatest amount of age variance in language performance. To this end, three hypotheses can be identified.

First, the "working memory (capacity)-discourse hypothesis" (Stine, 1990) postulates that age differences in the processing and/or storage aspects of working memory lead to language performance differences. Second, an "inhibitory efficiency-discourse hypothesis" (Hasher & Zacks, 1988) suggests that age differences in the ability to inhibit irrelevant information from gaining entrance to working memory is the basis of age differences in language performance. Finally, a "cognitive slowing-discourse hypothesis" (see Cohen, 1988) proposes that age differences in the speed with which operations associated with working memory are executed mediate age differences in language performance.

Although discussed as separate, the three hypotheses are in fact interrelated. The age variance in language performance accounted for by one is to some degree shared by the others. This is represented in the framework by the bidirectional arrows (see Figure 1) between working memory and processing speed. Kwong See and Ryan (1995) examined the extent to which age differences in working memory capacity, inhibition, and processing speed mediate age differences in language performance and importantly, the extent to which the age-related variance predicted by each hypothesis is unique or shared.

In their study, 82 young adults (M = 20 years) and 92 older adults (M = 68 years) completed a number of reading comprehension and memory tasks and were administered measures of working memory capacity, inhibitory efficiency, and processing speed. As expected, older adults (a) comprehended and remembered connected discourse less well than young adults; (b) were at a disadvantage on the working memory tasks; (c) were less efficient at inhibiting irrelevant information; and (d) were slower in the speed task.

The cognitive mediation of language performance differences by age differences in the component operations was addressed using hierarchical regression. The logic of the statistical procedure was this: if age differences in a component mechanism mediate the relationship between older age and poorer language performance, then statistically partialling the influence of age differences in the component mechanism should attenuate the variance in language performance that is associated with age. A series of regression analyses revealed that age differences in each of the component measures significantly predicted language performance. Thus there was a correlation between each component operation and discourse processing, confirming that working memory capacity, inhibition, and speed are language relevant mechanisms. Critically, entering variance associated with each measure before entering the age variable attenuated variance in language performance that would otherwise be attributed to age. Varying the entry order of the measures in the same equation revealed that after speed variance was partialled, the mediating influence of the inhibition and working memory measures remained significant. Controlling for speed and inhibition differences, the working memory measures could not reliably predict language performance and thus did not significantly attenuate age-associated variance in language performance. The inhibition measure, however, remained a significant predictor when entered after the speed measure and both working memory measures. These results suggest that language performance differences may be fundamentally mediated by age differences in processing speed and inhibitory efficiency. Of the three hypotheses the working memory capacity explanation has been most widely endorsed in the past. However, these results indicate a shift in research focus is in order. To understand the processing basis of age differences in language performance, a focus on age-related inhibition and speed of processing impairments might be more informative and provide more explanatory power than the concept of a generalized working memory capacity.

A Useful Framework: Summary and Conclusions

In this paper we presented a framework which outlined the operations involved in discourse processing. This framework was used to discuss the impact of age differences in component cognitive processes as mediators of age differences in language performance. It was concluded that while age-related differences in sensory processing and linguistic knowledge may mediate a proportion of the age variance in discourse processing, differences in language performance are largely attributable to age differences associated with working memory operations, particularly speed and inhibitory efficiency.

It should be noted that this conclusion refers to the "normal aging" information processing system. In this regard the framework presented should serve as a useful organizer around which the processing impact of various age-associated clinical conditions addressed in this issue can be compared to normal aging. For instance, in the case of clinically significant hearing loss, the impact of sensory processing will be more influential (see Pichora-Fuller, in press). In contrast to normal aging, a key feature of dementia of the Alzheimer type is disruption in the organization of and/or access to linguistic knowledge (Bayles & Kaszniak, 1987; Kemper & Lyons, 1994; Nebes, 1992). The more severe communication problems of the Alzheimer patient in part reflect this difference.

Differential diagnosis, as well as efforts directed at rehabilitation and management of age-associated communication impairment (see Orange & Purves, this issue) will need to consider which and how component mechanisms are compromised in normal aging and various age-associated pathologies. Only then can clinicians hope to attain realistic goals for communication enhancement.

Author Note

Preparation of this article was supported in part by a Norcen Energy/Superior Propane-CAG Post-doctoral fellowship and by a grant from the Social Sciences and Humanities Research Council of Canada.

Please address all correspondence to: Sheree T. Kwong See, Department of Psychology, P220 Biological Sciences Building, University of Alberta, Edmonton, Alberta T6G 2E9. E-mail: kwongsee@psych.ualberta.ca

References

Atkinson, R. C., & Shiffrin, R. M. (1968). Human memory: A proposed system and its control processes. In K. W. Spence & J. T. Spence (Eds.), *The psychology of learning and motivation* (Vol. 2, pp. 89-195). New York: Academic.

Baddeley, A. (1986). *Working memory*. New York: Oxford University Press.

Balota, D. A., & Duchek, J. M. (1991). Semantic priming effects, lexical repetition effects, and contextual disambiguation effects in healthy aged individuals and individuals with senile dementia of the Alzheimer type. *Brain and Language*, *40*, 181-201.

Balota, D. A., & Duchek, J. (1992). Age-related changes and spreading activation: Implications for connectionist models of cognitive aging. In J. E. Morley, R. M. Coe, R. Strong, & G. T. Grossberg (Eds.), *Memory functions in aging and age-related disorders* (pp. 75-94). New York: Springer.

Bayles, K. A., & Kaszniak, A. W. (1987). *Communication and cognition in normal aging and dementia*. Boston: Little, Brown.

Burke, D. M., & Harrold, R. M. (1988). Automatic and effortful semantic processes in old age: Experimental and naturalistic approaches. In L. L. Light & D. M. Burke (Eds.), *Language, memory, and aging* (pp. 100-116). New York: Cambridge University Press.

Cohen, G. (1979). Language comprehension in old age. *Cognitive Psychology*, *11*, 412-429.

Cohen, G. (1988). Age differences in memory for texts: Production deficiency or processing limitations? In L. L. Light & D. M. Burke (Eds.), *Language, memory, and aging* (pp. 171-190). New York: Cambridge University Press.

Collins, A. M., & Loftus, E. F. (1975). A spreading-activation theory of semantic processing. *Psychological Review*, *82*, 407-428.

Connelly, S. L., Hasher, L., & Zacks, R. T. (1991). Age and reading: The impact of distraction. *Psychology and Aging*, *6*, 533-541.

Daneman, M., & Carpenter, P. A. (1980). Individual differences in working memory and reading. *Journal of Verbal Learning and Verbal Behavior*, *19*, 450-466.

Dixon, R. A., & Hultsch, D. F. (1983). Metamemory and memory for text relationships in adulthood: A cross-validation study. *Journal of Gerontology*, *38*, 689-694.

Fozard, J. L. (1990). Vision and hearing in aging. In J. E. Birren & K. W. Schaie (Eds.), *Handbook of the psychology of aging* (3rd ed., pp. 150-170). New York: Academic Press.

Gerard, L., Zacks, R. T., Hasher, L., & Radvansky, G. A. (1991). Age deficits in retrieval: The fan effect. *Journal of Gerontology: Psychological Sciences*, *46*, 131-136.

Gernsbacher, M. A. (1989). Mechanisms that improve referential access. *Cognition*, *32*, 99-156.

Gernsbacher, M. A. (1990). *Language comprehension as structure building*. Hillsdale, NJ: Erlbaum.

Gick, M. L., Craik, F. I. M., & Morris, R. G. (1988). Task complexity and age differences in working memory. *Memory and Cognition*, *16*, 353-361.

Hamm, V. P., & Hasher, L. (1992). Age and the availability of inferences. *Psychology & Aging*, *7*, 56-64.

Hartley, A. A. (1992). Attention. In F. I. M. Craik & T. A. Salthouse (Eds.), *The handbook of aging and cognition* (pp. 3-49). Hillsdale, NJ: Erlbaum.

Hasher, L., & Zacks, R. T. (1988). Working memory, comprehension, and aging: A review and a new view. In G. H. Bower (Ed.), *The psychology of learning and motivation* (Vol. 22, pp. 193-225). New York: Academic Press.

Kemper, S. (1992). Language and aging. In F. I. M. Craik & T. Salthouse (Eds.), *Handbook of aging and cognition* (pp. 213-270). Hillsdale, NJ: Erlbaum.

Kemper, S., & Lyons, K. (1994). The effects of Alzheimer's dementia on language and communication. In M. L. Hummert, J. M. Wiemann, & J. F. Nussbaum (Eds.), *Interpersonal communication in older adulthood* (pp. 58-82). Thousand Oaks, CA: Sage.

Kintsch, W. (1988). The role of knowledge in discourse comprehension: A construction-integration model. *Psychological Review*, *95*, 163-182.

Kintsch, W., & van Dijk, T. A. (1978). Towards a model of text comprehension and production. *Psychological Review*, *85*, 363-394.

Kwong See, S. T. (1994). *Age differences in inhibition: Implications for discourse processing in later life*. Unpublished doctoral dissertation, McMaster University, Hamilton, Ontario.

Kwong See, S. T., & Ryan, E. B. (1995). Cognitive mediation of adult age differences in language performance. *Psychology and Aging, 10*, 458-468.

Light, L. L. (1988). Language and aging: Competence versus performance. In J. E. Birren & V. L. Bengtson (Eds.), *Emergent theories of aging* (pp. 177-213). New York: Springer.

Light, L. L. (1991). Memory and aging: Four hypotheses in search of data. *Annual Review of Psychology, 42*, 333-376.

Light, L. L. (1992). The organization of memory in old age. In F. I. M. Craik & T. Salthouse (Eds.), *Handbook of aging and cognition* (pp. 111-165). Hillsdale, NJ: Erlbaum.

Light, L. L., & Anderson, P. A. (1983). Memory for scripts in young and older adults. *Memory & Cognition, 11*, 435-444.

Light, L. L., & Capps, J. L. (1986). Comprehension of pronouns in young and older adults. *Developmental Psychology, 22*, 580-585.

Lindenberger, U., & Baltes, P. B. (1994). Sensory functioning and intelligence in old age: A strong connection. *Psychology and Aging, 9*, 339-355.

Lovelace, E. A. , & Cooley, S. (1982). Free associations of older adults to single words and conceptually related word triads. *Journal of Gerontology, 37*, 432-437.

Meyer, B. J. F. (1975). *The organization of prose and its effects on memory*. Amsterdam: North Holland.

Meyer, B. J. F., Young, C. J., & Bartlett, B. J. (1989). *Memory improved: Reading and memory enhancement across the life span through strategic text structures*. Hillsdale, NJ: Erlbaum.

Myerson, J., Ferraro, F. R., Hale, S., & Lima, S. D. (1992). General slowing in semantic priming and word recognition. *Psychology and Aging, 7*, 257-270.

Nebes, R. D. (1992). Cognitive dysfunction in Alzheimer's disease. In F. I. M. Craik & T. A. Salthouse (Eds.), *The handbook of aging and cognition* (pp. 373- 446). Hillsdale, NJ: Erlbaum.

Norman, S., Kemper, S., Kynette, D., Cheung, H., & Anagnopoulos, C. (1991). Syntactic complexity and adults' running memory span. *Journal of Gerontology: Psychological Sciences, 46*, 346-351.

Orange, J. B., & Purves, B. (1996). Conversational Discourse and Cognitive Impairment: Implications for Alzheimer's Disease. *Journal of Speech-Language Pathology and Audiology, 20*, 139-150

Pichora-Fuller, M. K. (in press). Language comprehension in older adults. *Journal of Speech-Language Pathology and Audiology*.

Pichora-Fuller, M. K., Schneider, B. A., & Daneman, M. (1995). How young and old adults listen to and remember speech in noise. *Journal of the Acoustical Society of America, 97*, 593-608.

Plude, D. J., & Doussard-Roosevelt, J. A. (1989). Aging, selective attention, and feature integration. *Psychology and Aging, 4*, 98-105.

Salthouse, T. A. (1985). Speed of behavior and its implications for cognition. In J. E. Birren & K. W. Schaie (Eds.), *Handbook of the psychology of aging* (2nd ed., pp. 400-426). New York: Van Nostrand Reinhold.

Salthouse, T. A. (1990). Working memory as a processing resource in cognitive aging. *Developmental Review, 10*, 101-124.

Schneider, B. A. (in press). Psycho-acoustics and aging: Implications for everyday listening. *Journal of Speech-Language Pathology and Audiology*.

Ska, B., & Joanette, Y. (1996). Discourse in older adults: Influence of text, task, and participant characteristics. *Journal of Speech-Language Pathology and Audiology, 20*, 101-108

Spilich, G. (1983). Life-span components of text processing: Structural and procedural differences. *Journal of Verbal Learning and Verbal Behavior, 22*, 231-244.

Stine, E. L. (1990). The way reading and listening work: A tutorial review of discourse processing and aging. In E. A. Lovelace (Ed.), *Aging and cognition: Mental processes, self awareness and interventions* (pp. 301-327). North Holland: Elsevier Science Publishers.

Stine, E. L., & Hindman, J. (1994). Age differences in reading time allocation for propositionally dense sentences. *Aging and Cognition, 1*, 2-16.

Stine, E. L., & Wingfield, A. (1987). Process and strategy in memory for speech among younger and older adults. *Psychology and Aging, 2*, 272-279.

Stine, E. A. L., & Wingfield, A. (1988). Memorability functions as an indicator of qualitative age differences in text recall. *Psychology and Aging, 3*, 179-183.

Tun, P. A., Wingfield, A., & Stine, E. A. L. (1991). Speech-processing capacity in young and older adults: A dual-task study. *Psychology and Aging, 6*, 3-9.

Tun, P. A., Wingfield, A., Stine, E. A. L., & Mecsas, C. (1992). Rapid speech processing and divided attention: Processing rate versus processing resources as an explanation of age effects. *Psychology and Aging, 7*, 546-550.

van Dijk, T. A., & Kintsch, W. (1983). *Strategies of discourse comprehension*. New York: Academic Press.

Verhaeghen, P., Marcoen, A., & Goossens, L. (1993). Facts and fiction about memory aging: A quantitative integration of research findings. *Journal of Gerontology: Psychological Sciences, 48*, 157-171.

Wickens, C. D., Braune, R., & Stokes, A. (1987). Age differences in the speed and capacity of information processing: I. A dual task approach. *Psychology and Aging, 2*, 70-78.

Zabrucky, K., Moore, D., Schultz, N. R., Jr. (1987). Evaluation of comprehension in young and old adults. *Developmental Psychology, 23*, 39-43.

Zelinski, E. M., Gilewski, M. J., & Thompson, L. W. (1980). Do laboratory tests relate to self-assessment of memory ability in the young and old? In L. W. Poon, J. L. Fozard, L. S. Cermak, D. Arenberg, & L. W. Thompson (Eds.), *New directions in memory and aging* (pp. 519-544). Hillsdale, NJ: Erlbaum.