Language in Adulthood

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It is tempting to postulate that language development across the lifespan is U-shaped such that language "regression" mirrors language acquisition (Jackson, 1958; Jakobson, 1941/1968). Typically, this regression hypothesis is put forth to account for aphasic disorders (Grodzinsky, 1990); it has also been applied to language loss with regard to the discontinued use of a first language (Hyltenstam & Obler, 1989) and the decline of language in dementia (Emery, 1985, 1986). Both strong and weak forms of the regression hypothesis have been proposed: The strong form holds that language regression is the mirror image of language acquisition at all levels of analysis; the weak form suggests parallels while acknowledging different mechanisms or principles. There is little empirical support for the strong hypothesis (see Kemper, 1992a, for a discussion). This chapter and the corresponding chapter on acquisition (Golinkoff & Hirsh-Pasek, Chapter 14, this volume) explore the weak hypothesis.

Within the cognitive-aging framework, there has been an emphasis on four contrasting accounts of age-related changes to language: cognitive slowing, inhibitory deficits, the effects of working-memory limitations, and language-specific effects on word retrieval. This chapter considers each account with regard to a salient phenomenon: older adults' use of a simplified speech register resulting from an age-related decline in the syntactic complexity of oral and written language.

Older adults appear to use to simplified speech register (Benjamin, 1988; Cooper, 1990; Davis, 1984; Kemper, Kynette, Rash, Sprott, & O'Brien, 1989; Kynette & Kemper, 1986; Shewan & Henderson, 1988), and this simplification appears to be progressive with age. Kemper, Thompson, and Marquis (2001) have traced this age-related simplification of language by tracking two aspects of the linguistic structure of spontaneous speech: developmental level (D-level) and propositional density (P-density).

D-level is computed by assigning points to sentences based on their complexity and order of emergence in children's language. D-level is sensitive to

the amount of embedding and the type of embedding used to create complex sentences. Simple, one-clause sentences earn zero points. Sentences containing infinitives, gerunds, relative clauses, and other forms of embedding earn 1 to 6 points. Sentences with multiple forms of embedding and subordination earn 7 points. The second measure, propositional density (P-density), assesses how much information is packed into a sentence relative to the number of words. Each utterance is decomposed into its constituent propositions, which represent propositional elements and relations between them. The P-density for each speaker is defined as the average number of propositions per 100 words.

The oral language samples were elicited from a panel of older adults, and mixed modeling was used to examine longitudinal change in D-level and P-density (see Figures 15.1 and 15.2). The fixed effects describe two aspects of the linguistic measures: the initial level (or intercept) and the pattern of change with age

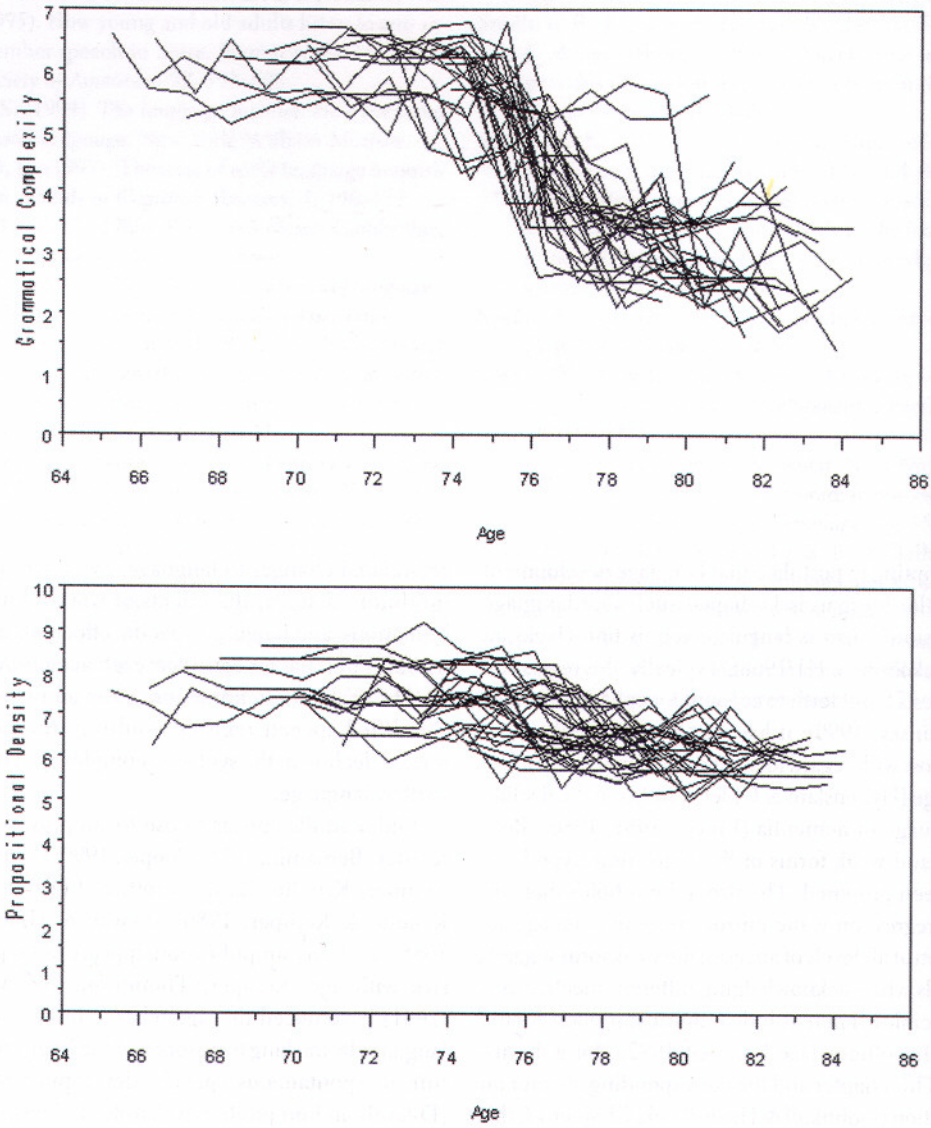

FIGURE 15–1. Longitudinal change in grammatical complexity (D-level) (top panel) and in propositional content (P-density) (bottom panel) for healthy older adults. (From Kemper, Thompson, & Marquis, 2001. Reprinted with permission of the American Psychological Association.)

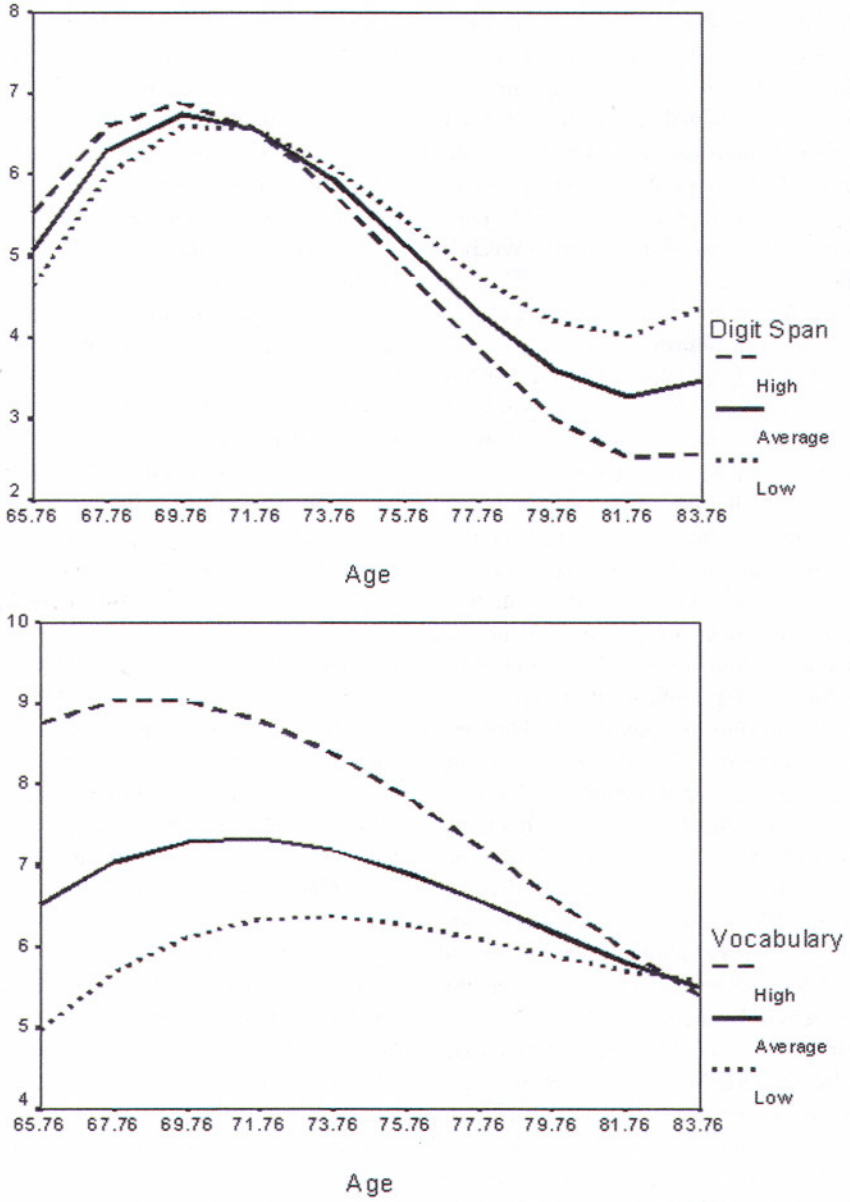

FIGURE 15–2. Illustration of digit span as a covariate in the age by grammatical complexity model for the healthy older adults (top panel) and vocabulary as a covariate in the age by propositional content model for the healthy older adults (bottom panel). (From Kemper, Thompson, & Marquis, 2001. Reprinted with the permission of the American Psychological Association)

(coefficient for the linear slope for age, and, potentially, coefficients for higher order age terms—e.g., age^2 and age^3). Random effects indicate that there is individual variation in the intercepts or pattern of change. This analysis indicated that the syntactic complexity of healthy adults' speech declines in late adulthood. Both the grammatical complexity and the propositional content of older adults' spontaneous speech decline between ages 74 and 78. In both cases, the pattern of decline was a cubic function of age, such that a period of relative stability was followed by a period of accelerated decline and by a third period of

more gradual decline. The mixed modeling also indicated that there was considerable individual variation in older adults' initial level of grammatical complexity and propositional content, as well as individual variation in their rate of decline. The initial level of grammatical complexity was predicted in part by the participant's composite score on the Digits Forward and Digits Backwards test from the Wechsler Adult Intelligence Scales–Revised (WAIS) (Wechsler, 1958); further, the grammatical complexity of those with higher initial scores also declined somewhat more rapidly with advancing age. In contrast, the initial level of propositional content was predicted in part by the participant's score on the Vocabulary test from the WAIS, and those with higher initial scores declined somewhat more rapidly with advancing age.

The age-related decline in grammatical complexity and propositional content may have its onset in young adulthood. Snowdon et al. (1996) analyzed language samples from a group of nuns, members of the School Sisters of Notre Dame. The nuns produced autobiographical writing samples at the time they took their final religious vows, between 18 and 32 years of age. When the nuns were 75 to 93 years of age, they were given a battery of tests of cognition and memory designed to assess probable Alzheimer's dementia. Low linguistic ability in young adulthood, indicated by low D-level (termed *grammatical complexity* by Snowdon et al., 1996) and/or low P-density (or *idea density*) in these language samples, was associated with increased risk for poor performance on the cognitive and memory tests in late adulthood. Low P-density in young adulthood was also associated with increased neuropathology characteristic of Alzheimer's disease for a small number of nuns who had died. In a follow-up study, Snowdon, Greiner, Kemper, Nanayakkara, and Mortimer (1999) linked low linguistic ability, measured by P-density in young adulthood, to increased all-cause mortality among the nuns.

Kemper, Greiner, Marquis, Prenovost, and Mitzner (2001) have traced these measures of linguistic ability over the lifespan, comparing the initial samples collected from the nuns to those elicited when they were in their 40s, 70s, and 80s. Further, they investigated how education and adult experiences affected initial linguistic ability and its decline. P-density appears to be a general measure of cognitive and neurological development that is not related to grades in high school English or mathematics nor is it affected by adult experiences including obtained advanced educational degrees. Low P-density in young adulthood may reflect poor neurocognitive development, which in turn may increase susceptibility to age-related decline due to Alzheimer's or other diseases.

The simplified speech register used by older adults differs from three other simplified speech registers (restricted codes, pidgin languages, and elderspeak). Bernstein (1968) characterized the speech of individuals from lower socioeconomic levels as involving "short, grammatically simple, often unfinished, sentences with a poor syntactical construction; simple and repetitive use of conjunctions . . . thus modifications, qualifications, and logical stress tend to be indicated by non-verbal means; frequent use of short commands and questions; rigid and limited use of adjectives and adverbs; infrequent use of the impersonal pronoun (it, one) as subject of a conditional sentence; statements formulated as questions. . . . a statement of fact is often used as both a reason and a conclusion . . . traditional phrases . . . symbolism of a low order of generality . . . implicit meaning" (1968, p. 228). While the speech of older adults and young adults under dual-task conditions shares many of these properties, it differs from this "restricted" register in a number of ways, most significantly in terms of its varied vocabulary and expressive content, as reflected in the P-density measure. Sentence length exceeds that reported by Bernstein and a wide range of grammatical constructions are used, although complex forms with relative clauses, embedded infinitives, that-clauses, and so on are infrequent.

This simplified speech register of older adults also differs from another form of simplified speech, pidgin language. Pidgins are simplified languages formed when speakers of two or more languages come in contact in trade or maritime situations. Pidgins are typically lacking many features, including "consistent marking of tense, aspect, and modality; relative clauses; movement rules; embedded complements, in particular infinitival constructions; articles, especially indefinite" (Bickerton, 1981). Older adults' speech resembles pidgin language only that complex, embedded constructions are rarely produced, reflecting the demands placed on working memory by these constructions.

Another form of simplified speech is elderspeak. Elderspeak is a special speech register directed to older adults; it is evoked by negative stereotypes of older adults but it is also used somewhat indiscriminately (Caporael, 1981; Caporael & Culbertson, 1986; Kemper, 1994; Ryan, Giles, Bartolucci, & Henwood, 1986). Many of the characteristics of elderspeak, such

as its slow rate, exaggerated prosody, and simplified syntax and vocabulary, resemble the characteristics of other speech registers such as those directed at young children, foreigners, and household pets (see Golinkoff & Hirsh-Pasek, Chapter 14, this volume).

Kemper and her collaborators (Kemper, Vandeputte, Rice, Cheung, & Gubarchuk, 1995; Kemper, Othick, Warren, Gubarchuk, & Gerhing, 1996) have examined this claim experimentally. They have shown that young adults spontaneously adopt a simplified speech register when addressing older listeners during a referential communication task. Young adults provide more information in terms of words, utterances, instructions, and location checks on the listener's progress and they also "package" this information differently. The young adults pause more often, use shorter sentences, use few complex syntactic constructions, and reduce the informational content of individual utterances by lowering the propositional density. These speech adjustments appeared to benefit the older listeners, who were able to reproduce the maps more accurately than when they were paired with older speakers.

The use of elderspeak in these studies did enhance the performance of the older adults, but the older adults reported experiencing more expressive and receptive communication problems when they were paired with young partners who used elderspeak. The use of elderspeak appeared to trigger older adults' perceptions of themselves as communicatively impaired and led to increased self-report of expressive and receptive problems. Harwood, Giles, and Ryan (1995) argue that the use of elderspeak, as well as other age-based behavioral modifications, contributes to development of an "old" identity, reinforcing negative stereotypes of older adults and lowering older adults' self-esteem.

Kemper and Harden (1999) tried to disentangle those parameters of elderspeak that actually benefit older adults' performance from those that trigger older adults' negative self-assessments. They concluded, after a series of experimental studies evaluating different variants of elderspeak, that semantic elaborations and syntactic simplifications improve the performance of young and older adults, whereas reducing sentence length and using exaggerated prosody have no effect on performance. They also found that older adults experience more negative self-assessments when their partners address them in modified "babytalk"—with high pitch, exaggerated prosody, slow speaking rate, and short sentences.

Older adults do not appear to adopt different speech registers for different partners (Kemper et al., 1995, 1996). In these studies, the older adults used a consistent speech register for young versus older partners. They may do so for a variety of reasons: they may not be sensitive to the same situational or interpersonal cues that elicit code-switching by young adults, or they may be unwilling to adopt a form of babytalk when addressing peers because they are sensitive to its negative connotations. Older adults may use elderspeak with other older adults whom they perceive to be cognitive impaired, but will not use elderspeak with healthy, active older adults in order to avoid giving offense or being patronizing.

FOUR ACCOUNTS OF AGE-RELATED CHANGES TO LANGUAGE

Effects of Cognitive Slowing

General slowing has been implicated in a variety of models of the effects of aging on cognition (Salthouse, 1992), including language and text processing. Wingfield and his colleagues have investigated how cognitive slowing may constrain older adults' language processing using a variety of auditory listening paradigms. Stine, Wingfield, and Poon (1986), for example, tested whether increased propositional density of text and increased presentation rates disrupt older adults' recall of auditorily presented text. Stine and colleagues found that older adults were not differentially affected by propositionally dense text, though their recall performance was differentially poorer for speeded text presentation. In a related study, Wingfield, Tun, and Rosen (1995) examined younger and older adults' recall of speech segments that varied in terms of rate of presentation, length, and syntactic well-formedness (i.e., whether or not the segment started or concluded at a syntactic boundary). Older adults' recall, like that of young adults,' was best at normal rates of speech and for segments that occurred at syntactic boundaries. These findings suggest that older adults encounter a processing bottleneck in parsing rapidly presented speech, particularly when its segmentation is random. Recall was poorest for segments presented at fast rates and that occurred at random intervals. Cognitive slowing has also been implicated in a series of studies using a self-paced listening procedure in which participants are able to

control the auditory presentation of texts segment by segment. Older adults tend to select slower speech rates and smaller segments (Wingfield & Ducharme, 1999; Wingfield, Lahar, & Stine, 1989).

Cognitive slowing may also affect how young and older adults allocate processing time during reading. Studies by Stine-Morrow and her colleagues (Stine, 1990; Stine, Cheung, & Henderson, 1995; Stine-Morrow & Hindman, 1994; Stine-Morrow, Milinder, Pullara, & Herman, 2001) examined word-by-word reading times, regressing young and older adults' reading times on a variety of word-level, sentence-level, and text-level features. In general, young and older adults have been found to allocate time very similarly; however, age differences in reading-time allocation have been reported for specific aspects of syntactic and semantic processing. For example, Stine (1990) found that both young and older adults allocate reading time to word-level and constituent-level processing. However, they found qualitative differences in how time was allocated at clause and sentence boundaries. Young adults spent extra time reading words that occurred at sentence boundaries, minor clause boundaries, and major clause boundaries. While older adults also allocated extra time to major and minor clause boundaries, they did not spend extra time at sentence boundaries.

Stine-Morrow, Ryan, and Leonard (2000) confirmed this finding in a study of sentence processing, comparing subject-relative ("The noise that terrified the baby was very loud") and object-relative ("The noise that the man made was very loud") clause constructions. They found that young adults allocated additional processing time to the object-relative constructions whereas older adults did not. As a result, young adults had good comprehension of these constructions whereas older adults often interpreted these constructions incorrectly.

Stine-Morrow, Loveless, and Soderberg (1996) let young and older adults read syntactically coherent text at their own pace. Both young and older adults who achieved good recall allocated extra reading time to syntactically complex sentences. However, some age differences were found with regard to other time-allocation strategies used to achieve good recall. For young adults, good recall was related to the allocation of additional reading time to infrequent words and to new concepts first mentioned in the text. However, for older adults, good recall was related to allocation of additional reading time as they progressed serially through the text. These findings indicate that older adults use a different strategy than do young adults to achieve good recall. Whereas young adults rely on recalling key words and concepts, older adults may rely on recalling a global text structure that is built up serially.

If so, context may be particularly beneficial to older adults, as it is for children. Soederberg Miller and Stine-Morrow (1998) explored the effects of background knowledge on reading strategies. In one condition, a passage title established a meaningful context. The titles did facilitate conceptual integration at sentence boundaries, particularly for older adults. When no titles were provided, the readers spent more time accessing low-frequency words and read more slowly as the text progressed serially, suggesting that they were spending additional time building up a context in which to interpret individual words and sentences. The latter effect was exacerbated for older readers, again suggesting that older readers rely on a global or situational model in order to interpret what they read. Successful older readers may be those who are best able to differentially allocate reading time and other cognitive resources (see also Morrow, Stine-Morrow, Leirer, Andrassy, & Kahn, 1997).

Critique

It is plausible that an overall decline in processing speed might account for older adults' use of a simplified speech register. Two assumptions are necessary: (1) Speech production is constrained by implicit or explicit time pressures in many tasks and situations; and (2) older adults' slower rate of speaking reflects general slowing of all component linguistic processes. Hence, older adults may adopt a simplified speech register in order to maintain acceptable speech-production rates by avoiding costly production rate increases associated with complex constructions. However, this account would also imply that older adults' complexity should vary with their speech rate and perception of time pressures; this does not appear to be the case. Kemper et al. (1995, 1996) examined older adults' speech rates with different partners and found that speech rates with young partners were equivalent to those with older partners who might be expected to be more tolerant of slow production rates.

Effects of Inhibitory Deficits

A different account of older adults' language has been put forth by Hasher and Zacks (1988). They proposed that inhibitory mechanisms weaken with age and permit the intrusion of irrelevant thoughts, personal preoccupations, and idiosyncratic associations during text encoding and retrieval. These irrelevant thoughts compete for processing resources and impair older adults' comprehension and recall. Hence, older adults' comprehension may be affected by distractions or intrusive thoughts. For example, when a text contains distracting words printed in a different typeface, young adults are able to ignore the distracting material, even when it is related to the text, whereas older adults are not able to ignore the distracting material, which slows their reading, impairs their comprehension, and renders them subject to memory distortions (Connelly, Hasher, & Zacks, 1991; Zacks & Hasher, 1997).

Hasher, Zacks, and May (1999) postulate three functions of inhibition: preventing irrelevant information from entering working memory, deleting irrelevant information from working memory, and restraining probable responses until their appropriateness can be assessed. They argue that older adults suffer from a variety of processing impairments that can be attributed to decreased inhibitory mechanisms. Hence, older adults' language processing may mirror that of young adults whenever the task requires the active application of processing strategies, since excitatory mechanisms are spared, whereas older adults' language processing may be impaired relative to young adults' whenever inhibitory mechanisms are required to block out distractions, clear away irrelevancies, or switch between activities. Individuals with poor inhibitory mechanisms may not only be more susceptible to distraction but also be less able to switch rapidly from one task to another and rely on well-learned "stereotypes, heuristics, and schemas" (Yoon, May, & Hasher, 1998, p. 123).

This hypothesis received support in a study by Kwong See and Ryan (1996). Kwong See and Ryan examined individual differences in text processing attributable to working-memory capacity, processing speed, and efficiency of inhibitory processes, estimated by backward digit span, color naming speed, and Stroop interference, respectively. Their analysis suggested that older adults' text-processing difficulties can be attributed to slower processing and less efficient inhibition, rather than to working-memory limitations

Two studies by Connelly et al. (1991) compared young and older adults' reading to provide key support for inhibitory deficit theory. In the first study, the investigators compared passage reading times and answers to probe-comprehension questions for young and older adults for texts that did or did not have distracting material interspersed amid target texts. In the distracting version, irrelevant words and phrases were inserted every three to four words. The distractors were presented in a different typeface. The distractors consisted of words or phrases conceptually related to the content of the target text (in experiment 1) and recurred repeatedly throughout the target text. Connelly et al. reported that young adults not only read the texts containing the distracting material more rapidly than older adults but also showed greater comprehension of the target material. This simple finding has provided the clearest support for inhibitory-deficit theory. Older adults are more distractible than young adults because they are less able to suppress or inhibit reading-task-irrelevant words and phrases.

In their second experiment Connelly et al. (1991) compared three types of distractors: words related in meaning to the passage, words unrelated in meaning, and meaningless strings of Xs. They found that related distractors slowed older adults' reading times more than unrelated ones and that the Xs slowed older adults' reading times relative to a baseline condition. They also found that young adults' reading times were slowed by the Xs as well as by distractor words, but that related versus unrelated distractors did not differentially affect the young adults. They suggested that the related distractor words "produce what might be a greater breadth of spontaneous activation" (p. 539) for older adults who may also expend "greater effort to understand" (p. 539) the related distractors and text passage. Despite their efforts to understand the text, older adults are ultimately less successful than young adults in terms of performance on the comprehension probes.

Connelly et al.'s (1991) conclusion has been challenged by Dywan and Murphy (1996), who modified the procedure to include a surprise word-recognition test for the interposed material. They found that the young adults had superior recognition memory for the distractor words, a result that is difficult to explain if the young adults are assumed to have been successful at inhibiting processing of the distractors. Burke (1997) also argues that research on semantic priming, the activation of word meanings, and the detection of

ambiguity provides "no support" for claims that "older adults are deficient in suppressing contextually irrelevant meaning or that they activate more irrelevant semantic information than young adults or that they retrieve more high frequency, dominant, or typical information than young adults" (p. P257).

However, inhibitory deficits may contribute to a variety of difficulties reported for older adults in dual- and multi-tasking situations. For example, Stine, Wingfield, and Myers (1990) examined younger and older adults' recall of information from a television newscast that was presented in auditory format, auditory supplemented with a written transcript, or the original auditory and visual recording. Although the written transcript and visual presentation aided younger adults' recall of the information, older adults did not benefit from a written transcript.

Tun, O'Kane, & Wingfield (2002) asked young and older adults to listen to lists of words while ignoring competing speech. They varied whether the competing speech was meaningful (read in English) or meaningless (read in Dutch by the same speaker). Whereas young adults were capable of ignoring the competing speech, the older adults' recall of the target words was severely impaired by the competing speech. This competing speech effect was greater for older adults when the competing speech was in English than when it was in Dutch (a language that closely resembles English phonology and prosody), suggesting that the effect is due to attentional factors (see also Tun & Wingfield, 1999). Indeed, controlling for hearing acuity did not eliminate this effect. They concluded that young adults are able to filter out competing speech whereas older adults are less able to do so.

Critique

Is inhibitory deficit theory a good candidate for explaining the simplified speech of older adults? Inhibitory deficit theory predicts that older adults should be more distracted as they speak; thus, older adults' speech should resemble that of young adults' under divided attention conditions. There does not appear to be a significant research literature on the effects of distraction on speech, apart from a few studies of the effects of distraction on speech organization and fluency. These studies suggest that hesitations, false starts, filled and unfilled pauses, and vague, disorganized "scattered" speech result (Hassol, Margaret, & Cameron, 1952; Jou & Harris, 1992; Southwood & Dagenais, 2001).

Some support for inhibitory deficit theory comes from a recent study by Kemper, Herman, and Lian (2003) that suggests that the speech of young adults is sensitive to dual-task demands and can shift to a speech register resembling that of older adults under demanding conditions. Hence, speech production may compete for critical processing resources with other tasks, affecting grammatical complexity at the cost of maintaining secondary task performance.

Hasher and Zacks (1988; Zacks & Hasher, 1997) have suggested that off-target verbosity (Arbuckle & Gold, 1993) is a characteristic of older adults resulting from the breakdown of inhibitions, but this claim is highly controversial. Even if off-target verbosity is proved to be an age-related phenomenon, it is inconsistent with the observed simplification of older adults' speech. While off-target speech does tend to have reduced propositional density, as it is often vague, redundant, and repetitious, it can be syntactically complex as well as rapid and fluent. Hence, inhibitory deficit theory does not seem to provide a viable account of older adults' use of a simplified speech register.

Effects of Working Memory

Working-memory limitations do appear to affect older adults' language. Most of the support for this hypothesis is correlational. For example, Kemper et al. (1989) reported that the mean number of clauses per utterance, a general measure of the complexity of adults' language, is positively correlated with the adults' backward digit span using the WAIS subtest (Wechsler, 1958). Further, Kemper and Rash (1988) calculated Yngve depth (Yngve, 1960), a measure of the working memory demands of sentence production, and found that it was positively correlated with WAIS digit span as well as with mean clauses per utterance.

The working-memory explanation for age-related changes to language is supported by findings from a few studies of sentence comprehension. For example, Zurif, Swinney, Prather, Wingfield, and Brownell (1995) examined younger and older adults' online processing of object- and subject-relative sentences using a cross-modal priming task. In object-relative sentences, the object "moves" from the object position of the subordinate clause and leaves a "gap"or trace (e.g., "The tailor hemmed the cloak$_i$ that the

actor from the studio needed (t_i) for the performance"). In subject–relative sentences, the gap is indexed by the object of the matrix clause (e.g., "The gymnast loved the professor$_i$ from the Northwestern city who (t_i) complained about the bad coffee"). The focus of their analysis was to determine whether reactivation of the antecedent occurs at the gap during sentence processing. Zurif et al. (1995) found that older adults evidenced priming for the subject- but not object-relative sentences (experiment 1). In a second experiment, Zurif et al. (1995) reduced the distance between gap and antecedent in object-relative sentences from seven or eight intervening words to five and found a significant priming effect at the gap position. The authors conclude that older adults reactivate the antecedent when the distance between antecedent and gap is short. Zurif et al. do not report a direct comparison of young and old, but interpret their results as showing that older adults' immediate syntactic analysis of a sentence is affected by working-memory limitations.

This study and other studies attempting to link sentence-processing problems to working-memory limitations have been severely criticized on a number of methodological and procedural grounds (see Caplan & Waters, 1999, and subsequent responses). Caplan and Waters (1999, 2002) have argued that syntactic parsing and other interpretive processes—including lexical access, assignment of thematic roles, and the determination of topic, focus, and coreference—rely on a specialized processing system with a separate sentence-interpretation resource unrelated to traditional span measures of working memory. The Caplan and Waters's theory (1999) predicts similar patterns of online processing for all readers since interpretive processes are buffered from working-memory limitations. All readers should show increased processing delays at points of maximal syntactic complexity.

Caplan and Waters (1999) point to a study by Kemtes and Kemper (1997) as support for their theory. Kemtes and Kemper examined the relationship between younger and older adults' working memory and online syntactic processing. They used a word-by-word reading paradigm to assess younger and older adults' online comprehension of temporarily ambiguous sentences (e.g., "Several angry workers warned about low wages . . .") that were resolved with either a main verb *interpretation* ("Several angry workers warned about low wages during the holiday season"), or a reduced relative clause interpretation ("Several angry workers warned about low wages decided to file complaints"). Kemtes and Kemper also assessed adults' off-line comprehension of the sentences by presenting a comprehension question immediately after each sentence had been read. The primary finding was that while older adults' online reading times were slower than those of younger adults, the syntactic complexity did not differentially impair older adults' online comprehension of the sentences. In contrast, older adults' off-line question comprehension was influenced by the syntactic ambiguity manipulation in that question comprehension was reliably poorer, relative to young, for the syntactically ambiguous sentences.

Waters and Caplan (1996a, 1996b, 2001), in a series of studies, have directly examined the hypothesis that working-memory limitations affect older adults' ability to process complex sentences. These studies have used the auditory moving windows paradigm. This technique allows the listener to start and stop the presentation of sentence and permits the analysis of phrase-by-phrase listening times, analogous to visual moving windows paradigms that permit the analysis of word-by-word or phrase-by-phrase reading times. The studies by Caplan and Waters typically examine the processing of subject- and object-relative clause constructions, such as those below:

Subject Relative Clause: The cabin$_{i,j}$ that (t_i) *warmed* the scout (t_j) contained the firewood.

Object Relative Clause: The cabin$_{i,j}$ that the scout warmed (t_i) (t_j) contained the firewood.

The subject-relative clause construction imposes few processing demands on the reader or the listener: In the relative-clause construction, the subject of the main clause, (t_j), is also the subject of the embedded relative clause, (t_i). The object-relative clause construction challenges the reader or listener to assign the correct syntactic relations. In the relative clause construction, the subject of the main clause,(t_j), must also be interpreted as the object of the embedded clause, (t_i).

Waters and Caplan (2001) compared how young and older readers allocate listening time to critical phrases of relative clause sentences. Despite differences in working memory, listening times were distributed similarly by young and older listeners. All paused longer when they heard the embedded verb in the complex relative-clause sentences than when

they heard the corresponding verb in the simple version; this additional time is attributable to the extra processing required to recover its direct object. They found no evidence that differences in age or working memory led to different processing strategies, supporting their theory.

Critique

Although few of the studies reviewed by Caplan and Waters hold up under their scrutiny, their own experiments are not without flaw. The central issue is their choice of the auditory moving window paradigm over other, more widely accepted techniques such as word-by-word reading paradigms or eye-tracking paradigms. They defend the auditory moving window paradigm as "not obviously less natural" (Waters & Caplan, 2001) than other techniques. However, it may clash with the findings of Wingfield and his colleagues (discussed above) who compared young and older adults' segmentation strategies, preferred presentation times, and allocation of processing time during listening and reading tasks. Wingfield et al. (1989, 1999) showed that older adults prefer slower speech rates but also smaller segments than young adults. Stine et al. (1995) showed that older adults ignore clause, phrase, and sentence boundaries. Waters and Caplan segment the sentences so that they can compare listening times for words or phrases used in different constructions. Some segments are single words, some noun phrases, some a complementizer plus a noun phrase. Hence, participants do not control the length of segments or the location of segment boundaries, only the interval between the presentation of one segment and the next. It may be that this imposed segmentation conflicts with older adults' natural segmentation strategies, obscuring any differences in the remaining processing parameter—time—owing to age or working memory. A task that permits participants to control both segmentation and presentation may be more sensitive to individual differences in syntactic processing than the auditory moving window paradigm.

A recent study by Kemper, Crow, and Kemtes (2004) using eye-tracking methodology re-examined these issues. Eye-tracking is a more naturalistic task that imposes few restrictions on readers; they are free to skip words or phrases, read ahead and glance backwards, and reread entire segments. Using this technology, Kemper and colleagues examined three aspects of reading: first fixations to key phrases, regressions to earlier phrases, and the total time key phrases were fixated. They examined reduced relative clause sentences such as those below:

> Reduced Relative Clause Sentence: Several angry workers warned about the low wages decided to file complaints.
>
> Main Clause Sentence: Several angry workers warned about the low wages during the holiday season.
>
> Focused Reduced Relative Clause Sentence: Only angry workers warned about the low wages decided to file complaints.

Kemper and colleagues (2004) found partial support for Waters and Caplan's theory: young and older adults' first pass fixations were alike and both groups showed a clear "garden path" effect: a peak in fixation time at the second verb in reduced relative-clause sentences but not main-clause sentences. This garden path effect suggests that all readers initially interpret the first verb as the main verb and must reanalyze it when they encounter the second verb in the reduced relative-clause sentence. However, Kemper and colleagues also observed an increase in regressions and in total fixation times for older readers for the reduced relative-clause sentences, suggesting that older adults were unable to correctly process these sentences. Further, low-span readers, identified by their scores on a battery of working-memory tests, also produced more regressions and an increase in total fixation times for reduced relative-clause sentences, suggesting that they were unable to correctly parse the sentences. The results from the eye-tracking analysis of the focused reduced relative-clause sentences also posed problems for Caplan and Waters' theory: high-span readers initially allocated additional processing time to the first noun phrase and then were able to avoid the "garden path" because the focus operator "only" led them to correctly interpret the first verb phrase as a reduced relative clause.

Thus, this eye-tracking study poses some challenges to Waters and Caplan's theory by revealing age-group and span-group differences in reading. Eye-tracking may be more sensitive to individual differences in language processing that the auditory moving window paradigm and may reveal subtle differences in processing strategies that other techniques miss. Caplan and

Waters may be able to accommodate these findings by carefully specifying the range of interpretative versus post-interpretative processes.

Language-Specific Deficits

Word-finding problems are among the most frequent complaints of older adults. Pauses, circumlocutions, "empty speech" such as pronouns lacking clear referents, and substitution errors during spontaneous speech may all reflect age-related impairments in accessing and retrieving lexical information (Cohen, 1979; Obler, 1980). It appears that older adults have difficulty accessing lexical information, especially the phonological form of words (Burke, MacKay, Worthley, & Wade, 1991). Consequently, tip-of-the-tongue experiences, in which familiar words are temporarily irretrievable, are more common for older adults than for young adults and less often resolved by retrieval of the intended word.

Burke and her colleagues (Burke & Laver, 1990; Burke et al., 1991) have offered an explanation of word retrieval failures: the transmission deficit hypothesis. This theory holds that aging affects the strength of mental connections linking an idea to the pronunciation of a specific word—or in more formal terms, a network linking conceptual representations to phonological specifications. If one or more links between the idea and pronunciation is broken, a speaker will be able to retrieve the idea but be unable to translate that idea into an actual spoken word. The transmission deficit hypothesis pinpoints the locus of the broken connection as the link between the idea and the pronunciation of the word because speakers will often have partial phonological information about the target word as well as detailed information about the target idea. Older adults are more vulnerable to word retrieval failures because all network connections weaken with age; words are more vulnerable than ideas because words must be precisely articulated from a unique sequence of phonological features (pronouncing "cat" partially correctly might get you a "hat" instead), whereas ideas are redundantly specified by many converging associations and linkages (instead of thinking of a "cat" you might think of a "lion" or a "tiger" or Garfield).

In a clever experiment, James and Burke (2000) asked young and older adults general-knowledge questions designed to promote word retrieval failures. The questions were embedded in a list of words. Sometimes, these words shared phonological features with the target, sometimes they were unrelated to the target word. James and Burke reported that fewer retrieval failures occurred when the target was preceded by phonologically related words than when it wasn't. For example, participants were more likely to correctly answer the question "What word means to formally renounce a throne?" [*abdicate*] when they had just read "abstract" than when they had read "reread." White and Abrams (2002) report that words sharing the first syllable with the target—for example, *abacus, abrogate,* are most effective at reducing word retrieval failures, whereas words sharing other phonologically features with the target, such as *indigent, handicap, educate,* and *duplicate* are ineffective.

Critique

The transmission deficit hypothesis implies that older adults' speech should become increasingly fragmented as a result of increasing common word-finding problems. When word retrieval fails, sentence production should be disrupted. However, older adults' speech does not appear to become fragmented but simplified, and when fragments do occur, they seem to reflect syntactic planning problems rather than word finding problems (Kemper, 1992b). It may be that older adults who are prone to word-finding problems have developed skilled metalinguistic strategies to cover up or compensate for these disruptions.

CONCLUSION

Many aspects of the language of older adults are unafflect by cognitive slowing, processing limitations, inhibitory deficits, or word-retrieval problems. Basic verbal abilities, as measured by vocabulary tests, have been traditionally studied by testing older adults' abilities to produce definitions (Wechsler, 1958), select synonyms (Shipley, 1940), pronounce phonologically irregular words (Grober & Sliwinski, 1991), or name pictures or drawings (Dunn & Dunn, 1997). Across a wide range of tests both longitudinally and cross-sectionally, vocabulary has been shown to increase throughout the middle adult years but to decline in late adulthood (Albert, Heller, & Milberg, 1988; Botwinick & Siegler, 1980; Eisdorfer & Wilkie, 1973; Hultsch,

Hertzog, Dixon, & Small, 1998; Schaie, 1996). Basic syntactic and morphological processes appear unaffected by aging: on metalinguistic judgment tasks, older adults typically do well except when challenged by complex constructions imposing temporary processing demands on working memory (Kemper, 1997; Pye, Cheung, & Kemper, 1992); older adults are no more prone than young adults to produce agreement errors ("he *run* fast"), case errors ("*me* got it"), overgeneralizations ("he *sitted* down on chair"), or other types of morphological errors such as those characteristic of children with language impairments. Healthy older adults do not regress to fragmented or formulaic speech, two- and three-word utterances, or vague empty non sequiturs, even when dual-task demands are high (Kemper, Herman, & Nartowitz, 2003); rather, they slow down both their actions and their words, and may use fillers, such as "you know" and "well" to segment their speech into smaller production units.

Although allocation of attention seems to be relevant for language development in children (see Golinkoff & Hirsh-Pasek, Chapter 14, this volume), few aspects of the language development of children have been linked to developmental changes in the speed of processing, reductions in processing limitations, gains in inhibition, or improvements in lexical access. There are some exceptions:

1. Speed of processing, particularly of rapid auditory information, has been implicated in delays and disorders of language development (Benasich & Leevers, 2003; Benasich & Tallal, 2002; Tallal, 2003).
2. Working memory limitations have been implicated in a variety of syntactic processing problems associated with intermediate stages of language development (Adams & Willis, 2001; Crain & Shankweiler, 1988, 1990) and may characterize poor readers (Daneman & Blennerhassett, 1984; Engel, Carullo, & Collins, 1991; Shankweiler & Smith, 1984). Working memory limitations have also been implicated in developmental language disorders (Conti-Ramsden & Botting, 2001; Dollaghan & Campbell, 1998; Gathercole & Baddeley, 1990a, 1990b; Montgomery, 1995).
3. Inhibitory deficits have been linked to a variety of developmental disorders including dyslexia (Chiappe, Hasher & Siegal, 2000; Chiappe, Siegal, & Hasher, 2002; Gernsbacher & Robertson, 1995; Gioia, Isquith, Kenworthy, & Barton, 2002; McNamara & McDaniel, 2004).
4. Word-finding deficits have been associated with dyslexia as well as other language-disorders (Faust, Dimtrovsky, & Davidi, 1997; Faust, Dimtrovsky, & Shacht, 2003; Wiig & Becker-Caplan, 1984).

It is important to know that these linkages are intended to explain significant delays and disorders of language development, rather than normal variation in the rate of acquisition or pattern in the acquisition of specific forms.

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