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Language Processing in Normal Aging

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### Abstract

Language is arguably the most important component of our cognitive and social identity. It allows for the expression of vital information and enables social interaction. Some have argued that the reliance on language as a means for promoting social networks becomes even more crucial as we age. As a result of growing interest in the communicative abilities of older adults, research into the underlying causes of age-related changes in language has blossomed in recent decades. Although older adults experience declines in some aspects of language, especially the production of language and word retrieval, they remain effective communicators well into late adulthood. This chapter begins with a brief discussion of the theoretical explanations that have been proposed to explain older adults' language abilities. We then review empirical research on age-related changes in language comprehension and production and the relevance of these changes to conversational interactions. The chapter concludes with a discussion on directions for future research with a focus on improving the functioning of and communication with older adults.

## Language Processing in Normal Aging

Older adults' ability to perceive, comprehend, and produce language has been an area of interest to researchers in recent years. One of the core questions under study has been whether aging affects the processing of language universally or only in specific ways. In general, an asymmetric pattern emerges, where older adults experience greater difficulties when producing language compared to comprehending it (e.g., Burke, MacKay, & James, 2000). In particular, word-retrieval problems are some of the most noticeable and frustrating language difficulties reported by older adults (e.g., Lovelace & Twohig, 1990). Although these difficulties are much less significant than the profound language impairments found in clinical disorders such as aphasia, they nonetheless have important consequences for older adults' ability to communicate. For example, difficulty retrieving someone's name during a conversation can result in negative perceptions of older adults' competence, both from the listener and the speaker (e.g., Cohen, 1994; Hummert, Garstka, Ryan, & Bonnesen, 2004; Kemper & Lacaal, 2004; Ryan, See, Meneer, & Trovato, 1994). This negative perception of aging is misleading, as there are positive aspects of aging, such as consistent increases in vocabulary that occur across the lifespan (e.g., Verhaeghen, 2003).

The purpose of the present chapter is to review the literature on language processing in healthy older adults, with a particular focus on the cognitive processes underlying language and the circumstances that lead to impairments in older adults' language comprehension and production. This chapter begins with a brief review of theories of cognitive aging, as they relate specifically to language processing. The remainder of the chapter discusses research-based findings regarding language processing in old age, covering comprehension and production of both oral and written language as well as language use in conversational settings. We conclude

with some discussion about our own directions for future research and suggestions for enhancing the ability to communicate with older adults.

### **Theories of Cognitive Aging**

Salthouse (1988) suggested that there was a paucity of theories of cognitive aging in comparison to the number of empirical findings at that time. In the two subsequent decades, a number of theoretical explanations have been proposed to explain age-related changes in language processing. Generally, these theories can apply to other aspects of cognition besides language, but for the purposes of this chapter, we have highlighted their relevance to language processing specifically. Brief descriptions of each theory and some corresponding empirical evidence are given below.

#### *Working Memory*

Working memory is a limited-capacity memory system that temporarily holds and manipulates information as we perform cognitive tasks (e.g., Baddeley, 1986). Some theorists suggest that older adults suffer overall decreases in working memory capacity, i.e., the amount of information that can be held (e.g., Craik, 1983; Salthouse, 1991). An alternative viewpoint is that aging is accompanied by changes in processing efficiency in working memory, not necessarily capacity (e.g., MacDonald & Christiansen, 2002). In this view, older adults have less efficient processing, such as slower spreading of activation throughout the networks of the language system, which in turn constrains the amount of information that they are able to process concurrently. Regardless of the cause of working memory deficits in old age, older adults do have greater difficulty with language tasks that are dependent on working memory, such as the production and comprehension of complex grammar or semantically difficult content (e.g., Kemper, 1987; Kemper, 1992; Kemper & Kemtes, 1999; Kemper & Sumner, 2001; Kemper,

Thompson, & Marquis, 2001; Obler, Fein, Nicholas, & Albert, 1991; Zurif, Swinney, Prather, Wingfield, and Brownell, 1995). For example, Kemper and Sumner (2001) reported that several measures of grammatical complexity were positively correlated with traditional working memory span measures, including reading span and digit span.

### *Inhibition Deficits*

Another explanation for age-related changes in language processing comes from inhibition deficit theory (e.g., Hasher, Lustig, & Zacks, 2007; Hasher & Zacks, 1988). In this theory, aging weakens inhibitory processes, which are responsible for regulating the information that enters and leaves working memory. The main consequence of older adults' inefficient inhibitory processes is that irrelevant information gains entry into working memory, is not deleted, and thus creates interference. Inhibition deficits have been used to explain various impairments in older adults' perception and comprehension of language, such as older adults having greater difficulty understanding speech when background speech or noise is present (e.g., Pichora-Fuller, Schneider & Daneman, 1995; Tun, O'Kane & Wingfield, 2002) or when there is competition from similar-sounding words (e.g., Sommers, 1996; Sommers & Danielson, 1999). Older adults also have greater difficulty ignoring visually-distracting information during reading (e.g., Connelly, Hasher, & Zacks, 1991; Li, Hasher, Jonas, May, & Rahhal, 1998). Difficulties with inhibition have also been used to explain some age-related deficits in language production, such as older adults producing more speech that is off-topic (e.g., Arbuckle, Nohara-LeClair, & Pushkar, 2000; Gold, Andres, Arbuckle, & Schwartzman, 1988).

### *General Slowing*

Theories of general slowing propose that age-related deficits in language processing are due to slowing of component processes (e.g., Birren, 1965; Cerella, 1985; Myerson, Hale,

Wagstaff, Poon, & Smith, 1990; Salthouse, 2000). Specifically, the speed at which older adults execute cognitive operations, i.e., processing speed, may be too slow to accomplish a task in a given amount of time (e.g., Salthouse, 1996). Age-related declines in processing speed have been used to explain older adults' deficits in time-limited tasks, such as comprehension of speeded speech (e.g., Wingfield, 1996; Wingfield, Poon, Lombardi, & Lowe, 1985). Processing speed deficits have also been used to explain some of older adults' difficulties with sentence comprehension, such as a reduction in the use of contextual information to help resolve ambiguity (e.g., Dagerman, MacDonald, & Harm, 2006). Although general slowing theories have been applied to some language tasks, they generally are used to explain older adults' performance on a much broader range of cognitive tasks (e.g., Salthouse, 1985).

#### *Transmission Deficit Hypothesis*

The Transmission Deficit Hypothesis offers the most specific mechanism to explain the asymmetric effect of aging on language processing, where certain aspects of language processing, namely semantic representations and retrieval, are actually well-preserved into late adulthood, relative to phonological and orthographic representations (e.g., Burke et al., 2000). In this framework, linguistic information is stored as nodes in a vastly interconnected network separated into multiple systems, including a semantic system for word meanings, a phonological system for sounds, and an orthographic system for spellings (MacKay, 1987; MacKay & Abrams, 1998). As people age, the strength of connections between these nodes becomes gradually degraded throughout the entire network (Burke & MacKay, 1997; MacKay & Abrams, 1996; MacKay & Burke, 1990), which influences the speed and amount of activation that is transmitted between nodes. The architecture of the network leaves the phonological and orthographic systems particularly vulnerable to age-related transmission deficits because it relies

on single connections between the semantic representation of a word's meaning and the word's phonological/orthographic form. Evidence in support of the Transmission Deficit Hypothesis comes from an age-associated increase in tip-of-the-tongue (TOT) experiences, a temporary inability to produce a word despite knowing its meaning (e.g., Burke, MacKay, Worthley, & Wade, 1991; White & Abrams, 2002), more frequent slips of the tongue (e.g., MacKay & James, 2004), and increased spelling errors (e.g., Abrams & Stanley, 2004; MacKay & Abrams, 1998; Margolin & Abrams, 2007).

### **Language Comprehension**

Current theories of cognitive aging need to account for the observation that while some language functions are maintained or even improved throughout most of late adulthood, other capacities are significantly corrupted by the cognitive aging process. This age-linked asymmetry in linguistic abilities is classically demonstrated by the comparison of input- to output-side language processes (Burke et al., 2000; James & MacKay, 2007). We focus first on input processes, which refer to the perception of speech sounds and letters and comprehension at the word, sentence, and discourse level. Aging appears to have a less deleterious effect on input-side processes, although some deficits do emerge.

#### *Sensory/Perceptual vs. Cognitive Deficits*

A common cause of deficits in older adults' comprehension of language is sensory and perceptual deficits. With respect to vision, older adults experience declines in visual acuity, retinal blurring (e.g., Artal, Ferro, Miranda, & Navarro, 1993), a reduction in the accuracy of voluntary saccadic eye movements (e.g., Scialfa, Hamaluk, Pratt, & Skaloud, 1999), and reduced light transmitted to the retina (e.g., Scialfa, 2002). These changes in vision have consequences for visual language processing, such as a reduction in the speed and accuracy of recognizing

words and reading text (e.g., Akutsu, Legge, Ross, & Schuebel, 1991; Scialfa, 2002; Steenbekkers, 1998). Similar sensory and perceptual declines occur in the auditory system, where aging is frequently accompanied by presbycusis, or pure-tone hearing loss characterized by the loss of higher frequencies (e.g., Cheesman, 1997; CHABA, 1988; Frisina & Frisina, 1996; Willott, 1991). These age-related auditory changes can lead to poorer identification of individual sounds and words, even in ideal listening situations (e.g., Humes, 1996).

However, when younger and older adults are equated on hearing ability, age differences sometimes still emerge, suggesting that cognitive deficits may also contribute to age-related impairments in spoken language processing (e.g., CHABA, 1988; Frisina & Frisina, 1997; Schneider & Pichora-Fuller, 2000; Wingfield & Tun, 2001). Specifically, reductions in processing resources described earlier, such as working memory capacity, processing speed, or inhibitory control, have been proposed to explain age differences in spoken language processing (see Sommers, 2008, for a review). Support for this view comes from studies showing that increasing or decreasing the cognitive demands on speech perception and comprehension determines the degree of impairment that older adults experience. For example, older adults show exacerbated declines under listening conditions that increase the amount of resources required for successful perception and comprehension, such as background noise (e.g., Frisina & Frisina, 1997; Pichora-Fuller et al., 1995; Tun, 1998; Tun & Wingfield, 1999), accelerated speaking rates (e.g., Gordon-Salant & Fitzgibbons, 1999; Stine, Wingfield, & Poon, 1986; Wingfield, Peelle, & Grossman, 2003), multiple people talking at once relative to a single talker (e.g., Sommers, 1997; Sommers & Danielson, 1999; Tun & Wingfield, 1999), or unfamiliar talkers (e.g., Yonan & Sommers, 2000). Conversely, circumstances that reduce the cognitive demands of spoken language processing facilitate older adults' performance, often more so than

younger adults. For example, older adults' speech perception is improved by presenting words in highly predictive or semantic contexts (e.g., Frisina & Frisina, 1997; Pichora-Fuller et al., 1995; Sommers & Danielson, 1999; Wingfield, Aberdeen, & Stine, 1991; Yonan & Sommers, 2000), when speaking rates are slower (e.g., Wingfield & Ducharme, 1999; Wingfield, Tun, Koh, & Rosen, 1999), or when prosodic and syntactic information is provided (e.g., MacKay & Miller, 1996; Wingfield, Lindfield, & Goodglass, 2000).

### *Word-Level Comprehension*

Despite the additive effects of hearing loss and cognitive declines, the majority of healthy older adults maintain an ability to successfully communicate in a variety of settings (e.g., Wingfield & Grossman, 2006). One explanation is that older adults may be able to make use of environmental and contextual cues as a compensatory strategy to offset their sensory, perceptual, and cognitive changes (e.g., Craik, 1986; Humphrey & Kramer, 1999; Sommers, 2008).

Alternatively, older adults may be able to employ effective top-down strategies that make use of preserved semantic knowledge, which appears to resist the age-related degradation observed in other domains of cognition (e.g., Burke et al, 2000; Burke & Shafto, 2008; Thornton & Light, 2006; Kemper, 1992). Because input-type lexical processes rely on the ability to link current linguistic information onto existing semantic knowledge, many aspects of language comprehension remain markedly intact among older adults, at least at the single-word level (e.g., Burke & MacKay, 1997; Thornton & Light, 2006).

Semantic priming studies, which examine how word meanings are processed and organized in the semantic network, have demonstrated that older adults experience the benefit of semantic priming at least to the same degree as younger adults (e.g. Balota, Watson, Duchek, & Ferraro, 1999; Burke, White, & Diaz, 1987; Faust, Balota, & Multhaup, 2004; Howard,

McAndrews, & Lasaga, 1981; Lazzara, Yonelinas, & Ober, 2002; Tree & Hirsh, 2003; White & Abrams, 2004). Individuals are faster to identify a target word, e.g. DOCTOR, when it is preceded by a semantically-related prime, e.g. NURSE, compared to an unrelated word, e.g. TABLE, and the degree of facilitation from the semantic prime is comparable for younger and older adults (see Laver & Burke, 1993 for a meta-analysis). Similarly, both age-groups benefit equivalently from exposure to contextually-related sentences prior to single-word comprehension tasks (e.g., Burke & Yee, 1984; Stine & Wingfield, 1994). Furthermore, older adults are equally if not more accurate in making decisions about the lexical status of linguistic stimuli, such as decisions about whether visually presented items are actual words or not (e.g., James & MacKay, 2007).

In sum, although age-related sensory declines restrict the speed with which older adults are able to comprehend lexical items, there seems to be little or no change in their ability to process and organize the meanings of words. The findings that older adults perform consistently well on these comprehension tasks are likely the product of a superior vocabulary and a dense semantic network, which continues to grow throughout most of adulthood.

#### *Sentence and Discourse Comprehension*

The picture is somewhat more complex when considering older adults' comprehension at the sentence and discourse level. Unlike the observed pattern in word-level comprehension, older adults do show impairment in comprehension and retention of sentences and longer texts (e.g., Johnson, 2003; Kemper & Sumner, 2001; see also reviews by Burke & Shafto, 2008; Kemper, 2006; Thornton & Light, 2006; Wingfield & Stine-Morrow, 2000). Age differences in comprehension have largely been attributed to declines in component cognitive processes like working memory (e.g., De Beni, Borella, & Carretti, 2007; Margolin & Abrams, in press; Stine-

Morrow, Soederberg Miller, Gagne, & Hertzog, 2008). Sentence and discourse comprehension requires processing current linguistic input and integrating it with previously read material in order to create a cohesive representation of the text. As a result, older adults are more vulnerable to syntactically complex or ambiguous sentences (e.g., Kemper, Crow, & Kemtes, 2004; Kemtes & Kemper, 1997; Zurif et al., 1995) and prefer segmenting text into smaller chunks in order to offset the demands on working memory (e.g., Wingfield et al., 1999). However, difficulties with processing negation during sentence comprehension do not seem to increase with age (Margolin & Abrams, in press).

Most comprehension measures used in research rely on readers' memory for the text; as a result, older adults' impairments in comprehension may more accurately reflect age-related declines in episodic memory (e.g., Burke & Shafto, 2008) and not a decline in reading ability. Furthermore, older adults may be able use their superior vocabulary and semantic knowledge to counteract processing deficits during the comprehension of discourse. A reader's *situation model* refers to his/her global representation of the text. It is created and constantly updated while reading to include information about the shifts in time and space, character and theme development, as well as to incorporate the textual information with pre-existing knowledge structures (e.g., van Dijk & Kintsch, 1983; Zwaan, Magliano, & Graesser, 1995; Zwaan & Radvansky, 1998). Situation models differ from *surface level* and *textbase* representations, which are data-driven and exist independent of the reader's knowledge (e.g., Stine-Morrow et al., 2008). Surface-level representations consist of the individual meaning of words and the syntactic structure of sentences. At the next level, the textbase captures the semantic meaning explicitly provided in the text and links multiple concepts. Older adults demonstrate an intact ability to construct mental representations of discourse and update situation models as necessary during

reading (e.g., Morrow, Stine-Morrow, Leirer, Andrassy, & Kahn, J., 1997; Radvansky, Copeland, & Zwaan, 2003; Radvansky, Zwaan, Curiel, & Copeland, 2001), despite impaired memory and comprehension for surface and textbase information.

Older adults may actually depend more on self-constructed situation models during reading because they are able to utilize existing knowledge when forming representations. As a result, older adults may not remember specific details (likely to be asked on typical comprehension measures) but will have preserved understanding of the global meaning or gist of the text. For example, older adults' memory for situation model information was superior to younger adults for passages about history (e.g., Radvansky et al., 2001) as well as narratives (e.g., Radvansky et al., 2003). Recently, Stine-Morrow et al. (2008) compared the reading abilities and strategies of younger and older readers using individual sentences, scientific expository texts, and narratives. Resource allocation was measured as a function of the amount of time readers spent on text features thought to reflect surface-level, textbase-level, and discourse-level processing. Collapsed across genre type, they found that compared to younger adults, older adults allocated more resources to surface-level processes (increased reading times for low-frequency and multi-syllabic words) and textbase processes (increased time spent on the introduction of new concepts) when reading individual sentences. However, these differences were diminished by contextual facilitation, as age differences disappeared for narrative texts and were less pronounced for the expository texts. Stine-Morrow et al. proposed that older adults may compensate for obvious processing deficits, such as declines in working memory capacity, by relying on superior knowledge-based processing and preserved contextual understanding, as well as by allocating additional resources as needed.

### **Spoken Language Production**

In contrast to the input side, the output side of language requires the activation and retrieval of phonological information (for spoken language production) and orthographic information (for written language production). Comparisons of input- and output-side processes demonstrate significantly greater age-related deficits on production tasks, relative to comprehension tasks (e.g., Burke et al., 2000; James & MacKay, 2007; MacKay & Abrams, 1998). Tasks of production typically involve lexical retrieval, in spoken or written form.

#### *Tip-of-the-Tongue States*

On some occasions, word production fails and results in a tip-of-the-tongue (TOT) state, a temporary and often frustrating inability to retrieve a known word (e.g., Brown & McNeill, 1966). TOT states increase with aging, both in the laboratory and in everyday life (e.g., Abrams, 2008; Burke, Locantore, Austin, & Chae, 2004; Brown & Nix, 1996; Burke et al., 1991; Cross & Burke, 2004; Evrard, 2002; Gollan & Brown, 2006; Heine, Ober, & Shenaut, 1999; Maylor, 1990), despite older adults having larger vocabularies (e.g., Verhaeghen, 2003). TOT states are thought to reflect selection of the appropriate word whose phonological encoding failed. The inability to retrieve phonology (and result in a TOT) increases with age, presumably because aging reduces transmission of excitation to phonological representations (MacKay & Burke, 1990), a difficulty that seems to derive from atrophy in the left insula (Shafto, Burke, Stamatakis, Tam, & Tyler, 2007). Consistent with this explanation, compared to younger adults, older adults can retrieve less phonological information about the TOT word, such as number of syllables or first and last letters (e.g., Burke et al., 1991; Brown & Nix, 1996; Heine et al., 1999; James & Burke, 2000), and they are less likely to have an alternate word during a TOT state, an incorrect word that involuntarily comes to mind and often overlaps phonologically with the TOT word (e.g., Burke et al., 1991; Heine et al., 1999; White & Abrams, 2002). TOT states are more likely

to occur for low- than high-frequency words (e.g., Vitevitch & Sommers, 2003), and proper names have the greatest susceptibility to TOT states, especially in old age (e.g., Burke et al., 1991; Evrard, 2002; James, 2006; Rastle & Burke, 1996).

Research has shown that activation of phonological representations thought to cause TOT states can be achieved by prior production of words that share phonology with the TOT word (e.g., James & Burke, 2000; see Abrams, Trunk, & Margolin, 2007, for a review). For example, James and Burke (2000) showed that after pronouncing a list of words that included *abstract*, *indigent*, *truncate*, *tradition*, and *locate*, people were less likely to have a TOT for *abdicate*. Pronouncing phonologically-related words during a TOT can also help to resolve the TOT, i.e., retrieve the intended word (e.g., Abrams & Rodriguez, 2005; Abrams, Trunk, & Merrill, 2007; Heine et al., 1999; James & Burke, 2000; Meyer & Bock, 1992), and the initial syllable is the key to TOT resolution in both age groups (Abrams, White, & Eitel, 2003; White & Abrams, 2002). There are some age-related changes in the ability to resolve TOT states following phonologically-related words, but the deficits are specific to older adults in their late 70s and 80s. Adults in their 60s and early 70s show an increase in resolving their TOT states following phonologically-related words to the same degree as younger adults (e.g., Heine et al., 1999; James & Burke, 2000; White & Abrams, 2002), whereas adults in their late 70s and 80s have significantly less or no TOT resolution following phonologically-related words (e.g., Heine et al., 1999; White & Abrams, 2002).

Recent research has documented instances where phonologically-related words do not facilitate TOT resolution. Abrams and Rodriguez (2005) discovered that phonologically-related words only help to resolve TOT states when these words are from a different part of speech as the TOT word. For example, when in a TOT state for the noun *bandanna*, reading *banish* (a

verb) helped to resolve the TOT state, but reading *banjo* (a noun) did not. Abrams et al. (2007b) found that adults aged 61–73 showed a similar pattern, while adults aged 75–89 not only did not benefit from reading *banish*, but their retrieval of *bandanna* was worse after reading *banjo* compared with an unrelated word. These findings suggest that similar-sounding words in the same grammatical class as the TOT word may compete with the TOT word for production and that these potential alternative words become more competitive for retrieval as we age.

### *Picture Naming*

The suggestion that older adults have an increased difficulty in activating the connections between words and their phonology is also supported by research on picture naming. Studies requiring older adults to produce the names of visually-presented pictures have shown older adults name objects less accurately and more slowly than younger adults (e.g., Feyereisen, 1997). However, age deficits in picture naming are not always found in individual studies (e.g., Goulet, Ska, & Kahn, 1994). One possible explanation is that older adults' larger vocabularies give them greater familiarity with the rarer picture names than younger adults, which then masks the age-linked decline in picture naming that would have appeared if both age groups were equally familiar with the words (e.g., Schmitter-Edgecombe et al., 2000). Furthermore, similar to research on TOT states, there are differences within the older adult group, namely that many of the age differences in picture naming are found only when older adults reach their seventies (e.g., Barresi, Nicholas, Connor, Obler, & Albert, 2000; Connor, Spiro, Obler, & Albert, 2004; MacKay, Connor, Albert, & Obler, 2002; Morrison et al., 2003; Nicholas, Obler, Albert, & Goodglass, 1985).

Another use of picture naming studies has been to measure the influence of distractors, but there are virtually no studies with older adults. The only published study of which we are

aware is Taylor and Burke (2002), who examined picture-word interference effects in younger and older adults as a function of auditory semantic and phonological distractors presented either before or after the picture appeared. Relative to unrelated distractors, interference (slower latencies) emerged when semantic distractors preceded the pictures, and older adults showed greater interference than younger adults. In contrast, facilitation (faster latencies) occurred when phonologically-related distractors were presented after the picture, and this facilitation was equivalent for both age groups. These findings are consistent with the idea that older adults have a more elaborate semantic network, which results in greater priming to related concepts and subsequently more interference. Conversely, the lack of an age difference in degree of phonological facilitation suggests that presentation of phonologically-related words strengthens the transmission of excitation to all connected words and that this "priming" process remains stable with age, a claim supported by research in other production tasks (e.g., James & Burke, 2000; White & Abrams, 2004).

### *Speech Errors*

Compared to TOT states and picture naming, there is considerably less research on aging and speech errors. Speech errors provide us with an understanding about how language production is planned and how this planning can sometimes go awry and lead to errors in articulation. The patterns of speech errors that emerge have given researchers insight into the mechanisms that underlie speech production more generally. Two classes of errors that have been studied in aging include slips-of-the-tongue and dysfluencies. A slip-of-the-tongue occurs when a speaker rearranges one or more sounds across words to be produced, such as e.g., *darn bore* instead of *barn door*, or swaps entire words, e.g., *I'm writing a mother to my letter* instead of *I'm writing a letter to my mother*. Similar to other forms of speech production, a word's

frequency appears to influence the likelihood of a speech error. Compared to high-frequency words, low-frequency words appear more often in natural speech error corpora (e.g., Stemberger & MacWhinney, 1986) and result in more sound misorderings in experiments that induce speech errors (e.g., Dell, 1990).

The majority of research on speech errors initially emerged via observational methods, which examined the distribution of linguistic features in large samples of spontaneous speech (e.g., Fromkin, 1971; Garrett, 1975). Since speech errors occurred relatively infrequently in spontaneous speech, experimental methods of error elicitation were developed to create processing circumstances that lead to making speech errors. MacKay and James (2004) used the transform technique with younger and older adults, where they were asked to change /p/ to /b/, or /b/ to /p/, whenever there was a /p/ or /b/ in a visually presented word. Age differences in speech errors in their responses occurred for some error types but not others. For example, older adults were more likely than younger adults to make an omission error (e.g., *pans* misproduced as *pan*), whereas younger adults were more likely than older adults to make a nonsequential substitution error (e.g., *pug* misproduced as *puck*). This selective increase in certain types of speech errors with age conflicts with the findings of Vousden and Maylor (2006), who used the repetition of tongue twisters (e.g., *a bucket of blue bug's blood*) to induce speech errors in younger and older adults. They found no age-related increase in the number of errors, as younger and older adults had equivalent error rates, but they pointed out some methodological issues, such as older adults' inability to produce speech at the desired rate when the rate was relatively fast.

Another type of speech error is dysfluencies, which represent interruptions in otherwise fluent speech. Dysfluencies can be nonlexical (e.g., *uh*, *um*) or lexical (e.g., *you know*) and include pauses, stutters, word repetitions, and errors in stress and intonation. Older adults

produce more dysfluencies than younger adults (see Mortensen et al., 2006, for a review), especially during difficult tasks and during tasks that place few constraints on the content of the utterance, such as picture description tasks (e.g., Cooper, 1990; Heller & Dobbs, 1993; Kemper, Rash, Kynette, & Norman, 1990; Le Dorze & Bédard, 1998; Schmitter-Edgecombe et al., 2000), sentence production tasks (e.g., Altmann, 2004; Kemper, Herman, & Lian, 2003), and conversational interactions (e.g., Bortfeld, Leon, Bloom, Schober, & Brennan, 2001). These age-related increases in dysfluencies are thought to result from older adults having more word retrieval problems (e.g., Bortfeld et al., 2001), as dysfluencies could serve the purpose of giving them more time to locate the intended word.

### **Written Language Production**

Compared to speech, there is considerably less research on older adults' ability to produce language in written form. The main area of research has focused on older adults' orthographic production, i.e., spelling. Subjectively, older adults often report that they notice a decrease in their ability to spell (e.g., MacKay & Abrams, 1998; Margolin & Abrams, 2007), and this intuition has been supported empirically. Stuart-Hamilton and Rabbitt (1997) found that adults in their 70s produced written correct spellings less often than adults in their 60s, who were less accurate than adults in their 50s. MacKay and Abrams (1998) found that older adults (aged 60 and above) were more likely to produce misspellings when spelling auditorily-presented words than college students. Furthermore, the oldest half of the older adult group (aged 73-88) made certain types of errors more often than the other adults, such as misspelling the "c" in *calendar* as "k", despite "c" being the more common spelling for that sound. Interestingly, these age-related declines in spelling occur even when older adults are able to accurately perceive that a word was correctly spelled (e.g., Abrams & Stanley, 2004; MacKay, Abrams, & Pedroza, 1999). Using

visually-presented words shown very briefly, these studies showed that older adults were as accurate as younger adults in detecting whether or not a word was correctly spelled, but made more errors in producing the spellings that they just saw. These findings are consistent with an age-linked asymmetry between input-side and output-side language processes mentioned earlier, where deficits in production are consistently larger than those in comprehension, and extend this asymmetry to the perception and retrieval of orthographic information.

While these results suggest a universal decline in spelling with increasing age, Margolin and Abrams (2007) showed that age-related declines in spelling only occurred for poor spellers. Older adults who were poor spellers were less accurate in recognizing and producing correct spelling than younger adults who were poor spellers. In contrast, no age differences occurred for good spellers. These results indicate that aging alone is not detrimental to the processes underlying recognition or production of spelling but instead compounds existing problems caused by poor spelling. In any case, access to orthographic representations seems to weaken with age, similar to phonological representations, consistent with the idea that lower-level language representations are particularly susceptible to aging (e.g., MacKay & Abrams, 1998; MacKay et al., 1999).

Spelling rare words in isolation or under time pressure is a relatively limited context to explore older adults' written production. Recently, White and her colleagues (White, Abrams, & Protasi, 2008; White, Abrams, Zoller, & Gibson, 2008) have developed an innovative method to study whether older adults are susceptible to written errors for more commonly-used words embedded in context, specifically homophones presented in sentences. Homophones are words that are pronounced identically but have different spellings and meanings, e.g., *beech* and *beach*. In these studies, sentences are presented auditorily for people to write down, and homophone

spelling errors occur when the contextually appropriate word, e.g., *beech*, is instead replaced with its homophone, e.g., “The lawyer was most proud of the *beach* tree in his garden.” Unlike traditional spelling errors, older adults produced fewer homophone errors than younger adults (White et al., 2008a). White et al. also explored the influence of a homophone's spelling probability, which is defined as the frequency with which a particular spelling is used for a given sound. For example, the spelling *ail* is a high-probability spelling because it is a more common spelling for those sounds than is *ale*. Although both younger and older adults made more errors on homophones with a low-probability spelling relative to those with a high-probability spelling, this increase in errors due to spelling probability was *greater* for younger adults than older adults.

These findings are consistent with Cortese, Balota, Sergent-Marshall, and Buckner (2003), who found that when spelling spoken homophones in isolation (so that either spelling is correct), older adults relied more on a homophone's meaning, producing the spelling corresponding to the most commonly-used meaning even when the spelling was low probability. In contrast, younger adults relied more on spelling probability, producing the high-probability spelling even when it corresponded to a less frequently-used meaning. These findings suggest a shift from reliance on orthography to semantics with normal aging. One explanation for this shift is that older adults might shift to a reliance on semantics as a way to compensate for deficits in lower-level language representations, such as phonology and orthography (MacKay & Burke, 1990).

### **Language in Conversation**

The magnitude of age differences in language processing seems to depend on a number of factors, such as the type of experimental task, type of linguistic material, or even the

individual goals of the speaker (e.g., Wingfield & Stine-Morrow, 2000). Given this variability, it is important to consider the degree to which empirical evidence translates into the *practical* language abilities of older adults. How do these selective changes in language processing influence the everyday interactions of older adults? Likewise, how do perceptions about the aging process affect the quality of communication? Language samples procured in the laboratory are useful for modeling the changing architecture of language abilities throughout the lifespan. However, it is important to keep in mind the social and pragmatic function that language plays in the real world; it enables and enriches social interactions and allows for the communication of crucial information about health, finances, and family.

### *Storytelling*

Older adults' difficulties with speech production, such as word-finding problems during TOT states, might lead to the assumption that older adults are less engaging in conversation and poorer communicators. However, research on older adults' competence at socially-driven communication has suggested the opposite. Results from storytelling and collaborative communication studies have shown that older adults have a heightened understanding of the interpersonal dynamics of communication (e.g., Gould, Kurzman, & Dixon, 1994; Kemper et al., 1990; Mergler, Faust, & Goldstein, 1985). Overall, older adults are rated as better storytellers than younger adults, a preference that is not limited to their own cohort (James, Burke, Austin, & Hulme, 1998; Kemper, Kynette, Rash, O'Brien, & Sprott, 1989; Kemper et al., 1990; see also Wingfield & Stine-Morrow, 2000, for a review). Younger adult listeners preferred stories read by older adults compared to younger adult readers (e.g., Mergler et al., 1985), and listeners from a variety of ages rated personal narratives told by older adults as more interesting and enjoyable than those told by younger and middle-aged adults (e.g., Pratt & Robins, 1991). Some have

argued that older adults' superior storytelling is due to structural choices made by older adults, like using more complex narrative structures (e.g., Kemper et al., 1990) or using an exciting climactic build-up that is resolved at the end (e.g., Pratt & Robins, 1991). On the other hand, older adults' stories could be preferred because of their reduced speech rate, more appealing prosody, or their ability to focus the story directly at their listener (e.g., Wingfield & Stine-Morrow, 2000).

### *Off-Topic Speech*

Off-topic speech (OTS), or off-topic verbosity, has been defined as speech that may start out on-topic, but quickly becomes prolonged, unconstrained, and irrelevant to the present topic at hand (e.g., Arbuckle & Pushkar Gold, 1993; Gold et al., 1988). Some researchers have suggested that older adults are more verbose in autobiographical contexts such as life-history interviews, in non-autobiographical contexts such as referential communication tasks, and in the ability to tell stories based on pictures (e.g., Arbuckle & Gold, 1993; Arbuckle et al., 2000; Glosser & Deser, 1992; Juncos-Rabadan, 1996). However, other research has failed to demonstrate a uniform, age-linked increase in OTS (e.g., Gould & Dixon, 1993; Heller & Dobbs, 1993; James, Burke, Austin, & Hulme, 1998; Trunk & Abrams, 2008), possibly because of the heterogeneous measures used to assess OTS, some of which involve more subjective assessments than others. For example, many studies that observed an age-related increase in OTS focused on individual words as either on- or off-topic, which may overestimate OTS by not accounting for the entire context in which words are used.

One explanation for extraneous wordiness in old age has been linked to a processing deficit in inhibiting irrelevant material (e.g., Arbuckle & Pushkar Gold, 1993; Pushkar Gold & Arbuckle, 1995), but more recent claims suggest that this impairment only applies to a minority

of older adults (e.g., Arbuckle et al., 2000; Pushkar, Basevitz, Arbuckle, Nohara-LeClair, Lapidus, & Peled, 2000). Another explanation is that given that older adults have typically had more experience with telling stories throughout their life (e.g., Boden & Bielby, 1983; Kemper, 1992), they may simply possess different goals for communicating, some of which encourage elaborative speech, particularly in autobiographical situations (e.g., James et al., 1998). Recently, Trunk and Abrams (2008) quantified younger and older adults' communicative goals and showed that age-related changes in OTS emerged only when *younger* adults changed their goals, i.e., selecting goals designed to produce more succinct stories for certain types of topics. In contrast, older adults consistently reported the same communicative goals for various topics, possibly because these goals lead them to consistently produce higher-quality stories as discussed above (e.g., James et al., 1998; Pratt & Robins, 1991).

### *Elderspeak*

Communication can be influenced by the style that people use when speaking with older adults. In particular, there is a type of speech style called "elderspeak" that represents a specific set of accommodations used to address older adults, often when difficulties in communication are expected (e.g., Hummert et al., 2004; Kemper, 2006; Kemper & Harden, 1999; Ryan, Giles, Bartlucci, & Henwood, 1986). These accommodations are intended to simplify speech for older adults by using shorter and less syntactically complex sentences, speaking more slowly, repeating and paraphrasing, altering pitch and intonation for emphasis, and using terms of endearment such as "honey". Research has addressed whether elderspeak is helpful or harmful to older adults (e.g., Kemper & Harden, 1999). Some studies have shown that some aspects of elderspeak increase older adults' comprehension, specifically repetitions and elaborations as well as less syntactically complex sentences (which minimize the demands on working memory).

Other aspects of elderspeak, such as slower speech rates and exaggerated intonation, actually impair comprehension. In addition to comprehension, elderspeak has a significant influence on older adults' self-perceptions. Older adults generally perceive elderspeak as condescending, although it can also be associated with positive feelings, such as affection (e.g., Ryan et al., 1986). If older adults feel like they are being patronized, they are more likely to question their language competence (e.g., Kemper & Harden, 1999), which in turn can lead to negative social consequences, such as withdrawing from social interaction.

### *Cognitive Demands and Communicative Strategies*

Age differences in communication styles may also reflect pragmatic choices made by older adults during speech production. One measure thought to reflect these pragmatic choices is the syntactic complexity of spoken and written language, measured by counts of different types of embedded clauses and of clauses per utterance. Research has shown that when responding to questions (e.g., Kemper & Sumner, 2001), describing pictures (e.g., Mackenzie, 2000), or writing in diaries or essays (e.g., Kemper, 1987; Kemper, Greiner, Marquis, Prenovost, & Mitzner, 2001), older adults tend to use sentences with restricted grammatical complexity. Age-associated declines in working memory may leave older adults with insufficient capacity to produce complex syntactic structures. As a result, older adults may unconsciously shift their communicative strategies to reduce the cognitive burden (produce simpler sentences) while simultaneously preserving the integrity of the intended message.

If older adults are choosing to produce simpler sentences as a pragmatic choice, then dual-task situations should be especially likely to reveal age-related declines in grammatical complexity. However, not all studies support this claim (e.g., Kemper et al., 2003; Kemper, Herman, & Nartowicz, 2005). For example, Kemper et al. (2003) examined the fluency,

complexity, and content of spoken language samples of younger and older adults who were simultaneously performing one of three motor activities: walking, simple finger tapping, and complex finger tapping. Younger adults experienced greater dual-task costs than older adults in some areas, evidenced by decreased sentence length, grammatical complexity, and content when doing concurrent tasks. Older adults also exhibited dual-task costs by decreasing their speech rate, but the level of grammatical complexity of their responses was unaffected. This is difficult to interpret because older adults' baseline language (in absence of a concurrent task) was less grammatically complex and content-filled than the younger adults, making further reductions in grammatical complexity more difficult to obtain. More research is needed to better understand the relationship between working memory processes and the complexity of discourse production as well as the interaction between resource limitations and strategy use.

### **Conclusions**

This chapter highlights the complexity of the relationship between aging and language processes. Unlike other cognitive functions, late adulthood is not accompanied by pervasive deterioration of language abilities, but instead results in declines only for specific functions, with spared or even improved abilities in other areas. Despite our growing knowledge about the language processing capabilities of healthy older adults, there are many gaps left to be filled. The focus of our research is to fill some of those gaps, specifically those in our knowledge about aging and language production, a topic which can be methodologically challenging (see, e.g., Vousden & Maylor, 2007). By creating novel methods and measures that are appropriate for multiple age groups, older adults' language abilities can be assessed under conditions where their cognitive, sensory, and perceptual deficits are less critical to performance. For example, our laboratory is currently conducting an experiment using a visual picture-word interference task

with younger adults and two groups of older adults. Given that phonological distractors generally facilitate picture naming, we are investigating whether the picture's word frequency and the distractor's grammatical class are relevant to these findings and how these factors interact with age. Through this work, we aim to better understand why age-related declines in production are more prevalent than those in comprehension, in hopes of refining current theories of cognitive aging, which ultimately will lead to discovering ways to reduce these declines.

A second focus of our research is the differences that are emerging *within* the older adult group, to which future research on aging and language processing needs to be sensitive. The oldest adults seem to exhibit greater declines in various language tasks, such as TOT resolution (e.g., Abrams et al., 2007; Heine et al., 1999; White & Abrams, 2002), spelling production (e.g., MacKay & Abrams, 1998), and even vocabulary (e.g., Lindenberger & Baltes, 1997).

Unfortunately, a large proportion of aging research still reports data from an "older adult group" that spans three or four decades, thereby neglecting the cognitive changes likely to occur throughout those years. Making generalizations about aging without acknowledging that declines may be due to the very oldest members presents an overly pessimistic picture about language processing that may not be representative of the population it intends to represent. More precisely specifying the age at which language declines begin to emerge may also lead to the development of methods for combating impairments as well as a greater understanding of the changes in language that should be viewed as normal.

Finally, it is important to use the findings of research to improve communication with older adults. For example, despite knowledge that some aspects of elderspeak can facilitate communication with older adults, there is no evidence that speakers are accommodating their speech to highlight the beneficial components (e.g., Kemper & Kemtes, 2000). Similarly,

understanding the causes of increased word finding failures in old age (and that they are a normal part of the aging process) may improve the way older adults view themselves in communicative settings and identify better ways for listeners to respond in situations where an older adult speaker is struggling to recover a specific word. Findings of research need to be disseminated to the people who can most benefit from them: Clinicians working with older adults, family members who interact with an aging parent, and most importantly, the older adults themselves.

## References

- Abrams, L. (2008). Tip-of-the-tongue states yield language insights. *American Scientist*, *96*, 234-239.
- Abrams, L., & Rodriguez, E. L. (2005). Syntactic class influences phonological priming of tip-of-the-tongue resolution. *Psychonomic Bulletin and Review*, *12*, 1018-1023.
- Abrams, L., & Stanley, J. H. (2004). The detection and retrieval of spelling in older adults. In S. P. Shohov (Ed.), *Advances in Psychology Research* (Vol. 33, pp. 87-109). Hauppauge, NY: Nova Science Publishers, Inc.
- Abrams, L., Trunk, D. L., & Margolin, S. J. (2007a). Resolving tip-of-the-tongue states in young and older adults: The role of phonology. In L. O. Randal (Ed.), *Aging and the Elderly: Psychology, Sociology, and Health* (pp. 1-41). Hauppauge, NY: Nova Science Publishers, Inc.
- Abrams, L., Trunk, D. L., & Merrill, L. A. (2007b). Why a superman cannot help a tsunami: Activation of grammatical class influences resolution of young and older adults' tip-of-the-tongue states. *Psychology and Aging*, *22*, 835-845.
- Abrams, L., White, K. K., & Eitel, S. L. (2003). Isolating phonological components that increase tip-of-the-tongue resolution. *Memory and Cognition*, *31*, 1153-1162.
- Akutsu, H., Legge, G. E., Ross, J. A., & Schuebel, K. J. (1991). Psychophysics of reading: X. Effects of age-related changes in vision. *Journal of Gerontology: Psychological Sciences*, *46*, P325-P331.
- Altmann, L. J. P. (2004). Constrained sentence production in probable Alzheimer disease. *Applied Psycholinguistics*, *25*, 145-173.

- Arbuckle, T. Y., Nohara-LeClair, M., & Pushkar, D. (2000). Effect of off-target verbosity on communication efficiency in a referential communication task. *Psychology and Aging, 15*, 65–77.
- Arbuckle, T. Y., & Pushkar Gold, D. P. (1993). Aging, inhibition and verbosity. *Journal of Gerontology: Psychological Sciences, 48*, P225–P232.
- Artal, P., Ferro, M., Miranda, I., & Navarro, R. (1993). Effects of aging in retinal image quality. *Journal of the Optical Society of America A, 10*, 1656–1662.
- Baddeley, A. D. (1986). *Working memory*. New York: Oxford University Press.
- Balota, D. A., Watson, J. M., Duchek, J. M., & Ferraro, F. R. (1999). Cross-modal semantic and homograph priming in healthy young, healthy old, and in Alzheimer's disease individuals. *Journal of the International Neuropsychological Society, 5*, 626–640.
- Barresi, B. A., Nicholas, M., Connor, L. T., Obler, L., & Albert, M. L. (2000). Semantic degradation and lexical access in age-related naming failures. *Aging, Neuropsychology, and Cognition, 7*, 169–178.
- Birren, J. E. (1965). Age changes in speed of behavior: Its central nature and physiological correlates. In A. T. Welford & J. E. Birren (Eds.), *Behavior, aging, and the nervous system: Biological determinants of speed of behavior and its changes with age* (pp. 191-216). Springfield, IL: Charles C. Thomas.
- Boden, D., & Bielby, D. (1983). The past as resource: A conversational analysis of elderly talk. *Human Development, 26*, 308-319.
- Bortfeld, H., Leon, S. D., Bloom, J. E., Schober, M. F., & Brennan, S. E. (2001). Disfluency rates in conversation: Effects of age, relationship, topic, role, and gender. *Language and Speech, 44*, 123–147.

- Brown, R., & McNeill, D. (1966). The “tip of the tongue” phenomenon. *Journal of Verbal Learning and Verbal Behavior*, 5, 325–337.
- Brown, A. S., & Nix, L. A. (1996). Age-related changes in the tip-of-the-tongue experience. *American Journal of Psychology*, 109, 79–91.
- Burke, D. M., Locantore, J., Austin, A., & Chae, B. (2004). Cherry pit primes Brad Pitt: Homophone priming effects on young and older adults’ production of proper names. *Psychological Science*, 15, 164–170.
- Burke, D. M., & MacKay, D. G. (1997). Memory, language and ageing. *Philosophical Transactions of the Royal Society: Biological Sciences*, 352, 1845–1856.
- Burke, D. M., MacKay, D. G., & James, L. E. (2000). Theoretical approaches to language and aging. In T. Perfect & E. Maylor (Eds.), *Models of cognitive aging* (pp. 204–237). Oxford: Oxford University Press.
- Burke, D. M., MacKay, D. G., Worthley, J. S., & Wade, E. (1991). On the tip of the tongue: What causes word finding failures in younger and older adults. *Journal of Memory and Language*, 30, 542–579.
- Burke, D. M., & Shafto, M.A. (2008). Language and aging. *The handbook of aging and cognition* (3rd ed., pp. 373-443). New York: Psychology Press.
- Burke, D. M., White, H., & Diaz, D. L. (1987). Semantic priming in young and older adults: Evidence for age constancy in automatic and attentional processes. *Journal of Experimental Psychology: Human Perception and Performance*, 13, 542–579.
- Burke, D. M., & Yee, R L. (1984). Semantic priming during sentence processing by young and older adults. *Developmental Psychology*, 20, 903-910.
- Cerella, J. (1985). Information processing rates in the elderly. *Psychological Bulletin*, 98, 67–83.

- CHABA (Committee on Hearing and Bioacoustics Working Group on Speech Understanding and Aging) (1988). Speech understanding and aging. *Journal of the Acoustical Society of America*, 83, 859-895.
- Cheesman, M. F., (1997). Speech perception by elderly listeners: Basic knowledge and implications for audiology. *Journal of Speech-Language Pathology and Audiology*, 21, 104–110.
- Cohen, G. (1994). Age-related problems in the use of proper names in communication. In M. L. Hummert, J. M. Wiemann, & J. N. Nussbaum (Eds.), *Interpersonal communication in older adulthood* (pp. 40-57). Thousand Oaks, CA: Sage Publications.
- Connelly, S. L., Hasher, L., & Zacks, R. T. (1991). Age and reading: The impact of distraction. *Psychology and Aging*, 6, 533–541.
- Connor, L. T., Spiro, A., Obler, L. K., & Albert, M. L. (2004). Change in object naming ability during adulthood. *Journal of Gerontology: Psychological Sciences*, 59, P203–P209.
- Cooper, P. V. (1990). Discourse production and normal aging: Performance on oral picture description tasks. *Journal of Gerontology: Psychological Sciences*, 45, P210–P214.
- Cortese, M. J., Balota, D. A., Sergent-Marshall, S. D., & Buckner, R. L. (2003). Spelling via semantics and phonology: Exploring the effects of age, Alzheimer's disease and primary semantic impairment. *Neuropsychologia*, 41, 952–967.
- Craik, F. I. M. (1983). On the transfer of information from temporary to permanent memory. *Philosophical Transactions of the Royal Society of London*, B302, 341-359.
- Craik, F. I. M. (1986). A functional account of age differences in memory. In F. Klix & H. Hagendorf (Eds.), *Human memory and cognitive capabilities: Mechanisms and performance* (pp. 409-22). North Holland: Elsevier.

- Cross, E. S., & Burke, D. M. (2004). Do alternative names block young and older adults' retrieval of proper names? *Brain and Language*, *89*, 174–181.
- Dagerman, K. S., MacDonald, M. C., & Harm, M. W. (2006). Aging and the use of context in ambiguity resolution: Complex changes from simple slowing. *Cognitive Science*, *30*, 311–345.
- De Beni, R., Borella, E., & Carretti, B. (2007). Reading comprehension in aging: The role of working memory and metacomprehension. *Aging, Neuropsychology, and Cognition*, *14*, 189-212.
- Dell, G. S. (1990). Effects of frequency and vocabulary type on phonological speech errors. *Language and Cognitive Processes*, *5*, 313-349.
- Evrard, M. (2002). Ageing and lexical access to common and proper names in picture naming. *Brain and Language*, *81*, 174–179.
- Faust, M. E., Balota, D. A., & Multhaup, K. S. (2004). Phonological blocking during picture naming in dementia of the Alzheimer type. *Neuropsychology*, *18*, 526–536.
- Feyereisen, P. (1997). A meta-analytic procedure shows an age-related decline in picture naming: Comments on Goulet, Ska, and Kahn. *Journal of Speech and Hearing Research*, *40*, 1328–1333.
- Frisina, D. R., & Frisina, R. D. (1997) Speech recognition in noise and presbycusis: Relations to possible neural mechanisms. *Hearing Research*, *106*, 95-104
- Fromkin, V. A. (1971). The non-anomalous nature of anomalous utterances. *Language*, *47*, 27–52.
- Garrett, M. F. (1975). The analysis of sentence production. In G. Bower (Ed.). *Psychology of learning and motivation* (Vol. 9, pp. 133-177). New York: Academic Press.

- Glosser, G., & Deser, T. (1992). A comparison of changes in macrolinguistic and microlinguistic aspects of discourse production in normal aging. *Journal of Gerontology: Psychological Sciences, 47*, P266-P272.
- Gold, D., Andres, D., Arbuckle, T., & Schwartzman, A. (1988). Measurement and correlates of verbosity in elderly people. *Journal of Gerontology: Psychological Sciences, 43*, P27–P33.
- Gollan, T. H., & Brown, A. S. (2006) From tip-of-the-tongue (TOT) data to theoretical implications in two steps: When more TOTs means better retrieval. *Journal of Experimental Psychology: General, 135*, 462–483.
- Gordon-Salant, S., & Fitzgibbons, P. (1999). Profile of auditory temporal processing in older listeners. *Journal of Speech, Language, and Hearing Research, 42*, 300–311.
- Gould, O. N., Kurzman, D., & Dixon, R. A. (1994). Communication during prose recall conversations by young and old dyads. *Discourse Processes, 17*, 149-165.
- Gould, O. N., & Dixon, R. A. (1993). How we spent our vacation: Collaborative storytelling by young and old adults. *Psychology and Aging, 8*, 10-17.
- Goulet, P., Ska, B., & Kahn, H. J. (1994). Is there a decline in picture naming with advancing age? *Journal of Speech and Hearing Research, 37*, 629–644.
- Hasher, L., Lustig, C., & Zacks, R. (2007). Inhibitory mechanisms and the control of attention. In A. Conway, C. Jarrold, M. Kane, A. Miyake, & J. Towse (Eds.), *Variation in working memory*. New York: Oxford University Press.
- 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. 2, pp. 193-225). San Diego: Academic Press.

- Heine, M. K., Ober, B. A., & Shenaut, G. K. (1999). Naturally occurring and experimentally induced tip-of-the-tongue experiences in three adult age groups. *Psychology and Aging, 14*, 445–457.
- Heller, R. B., & Dobbs, A. R. (1993). Age differences in word finding in discourse and nondiscourse situations. *Psychology and Aging, 8*, 443-450.
- Howard, D. V., McAndrews, M. P., & Lasaga, M. I. (1981). Semantic priming of lexical decisions in young and old adults. *Journal of Gerontology, 36*, 707–714.
- Humes, L. E. (1996). Speech understanding in the elderly. *Journal of the American Academy of Audiology, 7*, 161–167.
- Hummert, M. L., Garstka, T. A., Ryan, E. B., & Bonnesen, J. L. (2004). The role of age stereotypes in interpersonal communication. In J. F. Nussbaum & J. Coupland (Eds.), *Handbook of communication and aging research* (2nd ed., pp. 91–114). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.
- Humphrey, D. G. & Kramer, A. F. (1999). Age-related differences in perceptual organization and selective attention: Implications for display segmentation and recall performance. *Experimental Aging Research, 25*, 1-26.
- James, L. E. (2006). Specific effects of aging on proper name retrieval: Now you see them, now you don't. *Journal of Gerontology: Psychological Sciences, 61*, P180–P183.
- James, L. E. & Burke, D. M. (2000). Phonological priming effects on word retrieval and tip-of-the-tongue experiences in young and older adults. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 26*, 1378–1391.
- James, L. E., Burke, D. M., Austin, A., & Hulme, E. (1998). Production and perception of “verbosity” in younger and older adults. *Psychology and Aging, 13*, 355–367.

- James, L., & MacKay, D. G. (2007). New age-linked asymmetries: Aging and the processing of familiar versus novel language on the input versus output side. *Psychology and Aging, 22*, 94-103.
- Johnson, R. E. (2003). Aging and the remembering of text. *Developmental Review, 23*, 261–346.
- Juncos-Rabadan, O. (1996). Narrative speech in the elderly: Effects of age and education on telling stories. *International Journal of Behavioral Development, 19*, 669-685.
- Kemper, S. (1987). Life-span changes in syntactic complexity. *Journal of Gerontology, 42*, 323–328.
- Kemper, S. (1992). Language and aging. In F. I. M. Craik & T. A. Salthouse (Eds.), *The handbook of aging and cognition* (pp. 213–270). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.
- Kemper, S. (2006). Language in adulthood. In E. Bialystok & F. I. M. Craik (Eds.) *Lifespan cognition: Mechanisms of change* (pp. 223–238). New York: Oxford University Press.
- Kemper, S., Crow, A., & Kemtes, K. (2004). Eye-fixation patterns of high- and low-span young and older adults: Down the garden path and back again. *Psychology and Aging, 19*, 157–170.
- Kemper, S., Greiner, L. H., Marquis, J. G., Prenovost, K., & Mitzner, T. L. (2001). Language decline across the life span: Findings from the nun study. *Psychology and Aging, 16*, 227–239.
- Kemper, S., & Harden, T. (1999). Experimentally disentangling what's beneficial about elderspeak from what's not. *Psychology and Aging, 14*, 656–670.

- Kemper, S., Herman, R. E., & Nartowicz, J. (2005). Different effects of dual task demands on the speech of young and older adults. *Aging, Neuropsychology, and Cognition, 12*, 340-358.
- Kemper, S., Herman, R., & Lian, C. (2003). Age differences in sentence production. *Journal of Gerontology: Psychological Sciences, 58*, P260–P268.
- Kemper, S., & Kemtes, K. (1999). Limitations on syntactic processing. In S. Kemper & R. Kliegl (Eds.), *Constraints on language: Aging, grammar, and memory* (pp. 79–106). Boston: Kluwer.
- Kemper, S., & Kemtes, K. (2000). Aging and message production and comprehension. In D. C. Park & N. Schwarz (Eds.), *Cognitive aging: A primer*. (pp. 197–213). New York: Psychology Press.
- Kemper, S., Kynette, D., Rash, S., O'Brien, K., & Sprott, R. (1989). Life-span changes to adults' language: Effects of memory and genre. *Applied Psycholinguistics, 10*, 49-66.
- Kemper, S., & Laca, J. C. (2004). Addressing the communication needs of an aging society. In R.W. Pew & S. B. Van Hemel (Eds.), *Technology for adaptive aging* (pp. 129-149). Washington, D.C.: The National Academies Press.
- Kemper, S., Rash, S. R., Kynette, D., & Norman, S. (1990). Telling stories: The structure of adults' narratives. *European Journal of Cognitive Psychology, 2*, 205–228.
- Kemper, S., & Sumner, A. (2001). The structure of verbal abilities in young and older adults. *Psychology and Aging, 16*, 312–322.
- Kemper, S., Thompson, M., & Marquis, J. (2001). Longitudinal change in language production: Effects of aging and dementia on grammatical complexity and propositional content. *Psychology and Aging, 16*, 227–239.

- Kemtes, K. A., & Kemper, S. (1997). Younger and older adults' on-line processing of syntactically ambiguous sentences. *Psychology and Aging, 12*, 362–371.
- Laver, G. D., & Burke, D. M. (1993). Why do semantic priming effects increase in old age? A meta-analysis. *Psychology and Aging, 8*, 34–43.
- Lazzara, M. M., Yonelinas, A. P., & Ober, B. A. (2002). Implicit memory in aging: Normal transfer across semantic decisions and stimulus format. *Aging, Neuropsychology, and Cognition, 9*, 145–156.
- Le Dorze, G., & Bédard, C. (1998). Effects of age and education on the lexico-semantic content of connected speech in adults. *Journal of Communication Disorders, 31*, 53–71.
- Li, K. Z. H., Hasher, L., Jonas, D., May, C. P., & Rahhal, T. A. (1998). Distractibility, circadian arousal, and aging: A boundary condition? *Psychology and Aging, 13*, 574–583.
- Lindenberger, U., & Baltes, P. B. (1997). Intellectual functioning in old and very old age: Cross-sectional results from the Berlin Aging Study. *Psychology and Aging, 12*, 410–432.
- Lovelace, E. A., & Twohig, P. T. (1990). Healthy older adults' perceptions of their memory functioning and use of mnemonics. *Bulletin of the Psychonomic Society, 28*, 115–118.
- MacDonald, M. C., & Christiansen, M. H. (2002). Reassessing working memory: Comment on Just and Carpenter (1992) and Waters and Caplan (1996). *Psychological Review, 109*, 35–54.
- MacKay, D. G. (1987). *The organization of perception and action: A theory for language and other cognitive skills*. New York: Springer-Verlag.
- MacKay, D. G., & Abrams, L. (1996). Language, memory, and aging: Distributed deficits and the structure of new-versus-old connections. In J. E. Birren & K. W. Schaie (Eds.),

- Handbook of the psychology of aging* (4th ed., pp. 251–265). San Diego, CA: Academic Press.
- MacKay, D. G., & Abrams, L. (1998). Age-linked declines in retrieving orthographic knowledge: Empirical, practical, and theoretical implications. *Psychology and Aging, 13*, 647–662.
- MacKay, D. G., Abrams, L., & Pedroza, M. J. (1999). Aging on the input versus output side: Theoretical implications of age-linked asymmetries between detecting versus retrieving orthographic information. *Psychology and Aging, 14*, 3-17.
- MacKay, D. G., & Burke, D. M. (1990). Cognition and aging: New learning and the use of old connections. In T. M. Hess (Ed.), *Aging and cognition: Knowledge organization and utilization* (pp. 213–263). Amsterdam: North Holland.
- MacKay, A. I., Connor, L. T., Albert, M. L., & Obler, L. K. (2002). Noun and verb retrieval in healthy aging. *Journal of the International Neuropsychological Society, 8*, 764–770.
- MacKay, D. G., & James, L. E. (2004). Sequencing, speech production, and selective effects of aging on phonological and morphological speech errors. *Psychology and Aging, 19*, 93–107.
- MacKay, D. G., & Miller, M. D. (1996). Can cognitive aging contribute to fundamental psychological theory? Repetition deafness as a test case. *Aging, Neuropsychology, and Cognition, 3*, 169-186.
- Mackenzie, C. (2000). Adult spoken discourse: The influences of age and education. *International Journal of Language and Communication Disorders, 35*, 269–285.

- Margolin, S. J., & Abrams, L. (2007). Individual differences in young and older adults spelling: Do good spellers age better than poor spellers? *Aging, Neuropsychology, and Cognition*, *14*, 529–544.
- Margolin, S. J., & Abrams, L. (in press). Not may not be too difficult: The effects of negation on older adults' sentence comprehension. *Educational Gerontology*.
- Maylor, E. A. (1990). Recognizing and naming faces: Aging, memory retrieval and the tip of the tongue state. *Journal of Gerontology: Psychological Sciences*, *45*, P215–P225.
- Mergler, N. L., Faust, M., & Goldstein, M. D. (1985). Storytelling as an age-dependent skill: Oral recall of orally presented stories. *International Journal of Aging and Human Development*, *20*, 205-228.
- Meyer, A. S., & Bock, K. (1992). The tip-of-the-tongue phenomenon: Blocking or partial activation. *Memory and Cognition*, *20*, 715-726.
- Morrison, C. M., Hirsh, K. W., & Duggan, G. B. (2003). Age of acquisition, ageing, and verb production: Normative and experimental data. *Quarterly Journal of Experimental Psychology: Human Experimental Psychology*, *56*, 705–730.
- Morrow, D. G., Stine-Morrow, E. A. L., Leirer, V. O., Andrassy, J. M., & Kahn, J. (1997). The role of reader age and focus of attention in creating situation models from narratives. *Journal of Gerontology: Psychological Sciences*, *52*, P73–P80.
- Mortensen, L., Meyer, A. S., & Humphreys, G. W. (2006). Age-related effects on speech production: A review. *Language and Cognitive Processes*, *21*, 238-290.
- Myerson, J., Hale, S., Wagstaff, D., Poon, L. W., & Smith, G. A. (1990). The information-loss model: A mathematical theory of age-related cognitive slowing. *Psychological Review*, *97*, 475–487.

- Nicholas, M., Obler, L. K., Albert, M. L., & Goodglass, H. (1985). Lexical retrieval in healthy aging. *Cortex*, *21*, 595–606.
- Obler, L. K., Fein, D., Nicholas, M., & Albert, M. L. (1991). Auditory comprehension and aging: Decline in syntactic processing. *Applied Psycholinguistics*, *12*, 433-452.
- 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.
- Pratt, M. W., & Robins, S. L. (1991). That's the way it was: Age differences in the structure and quality of adults' narratives. *Discourse Processes*, *14*, 73-85.
- Pushkar, D., Basevitz, P., Arbuckle, T. Y., Nohara-LeClair, M., Lapidus, S., & Peled, M. (2000). Social behavior and off-target verbosity in elderly people. *Psychology and Aging*, *15*, 361–374.
- Pushkar Gold, D. P., & Arbuckle, T. Y. (1995). A longitudinal study of off-target verbosity. *Journal of Gerontology: Psychological Sciences*, *50*, P307–P315.
- Radvansky, G. A., Copeland, D. E., & Zwaan, R. A. (2003). Aging and functional spatial relations in comprehension and memory. *Psychology and Aging*, *18*, 161–165.
- Radvansky, G. A., Zwaan, R. A., Curiel, J. M., & Copeland, D. E. (2001). Situation models and aging. *Psychology and Aging*, *16*, 145–160.
- Rastle, K. G., & Burke, D. M. (1996). Priming the tip of the tongue: Effects of prior processing on word retrieval in young and older adults. *Journal of Memory and Language*, *35*, 586–605.

- Ryan, E. B., Giles, H., Bartlucci, G., & Henwood, K. (1986). Psycholinguistic and social psychological components of communication by and with the elderly. *Language and Communication, 6*, 1–24.
- Ryan, E. B., See, S. K., Meneer, W. B., & Trovato, D. (1994). Age-based perceptions of conversational skills among younger and older adults. In M. L. Hummert, J. M. Wiemann, & J. N. Nussbaum (Eds.), *Interpersonal communication in older adulthood* (pp. 15–39). Thousand Oaks, CA: Sage Publications.
- Salthouse, T. A. (1985). *A theory of cognitive aging*. Amsterdam: North-Holland.
- Salthouse, T. A. (1988). Resource-reduction interpretations of cognitive aging. *Developmental Review, 8*, 238–272.
- Salthouse, T. A. (1991). *Theoretical perspectives on cognitive aging* (pp. 301–349). Hillsdale, NJ: Lawrence Erlbaum.
- Salthouse, T. A. (1996). The processing-speed theory of adult age differences in cognition. *Psychological Review, 103*, 403–428.
- Salthouse, T. A. (2000). Steps towards the explanation of adult age differences in cognition. In T. Perfect & E. Maylor (Eds.), *Models of cognitive aging* (pp. 19–49). Oxford: Oxford University Press.
- Scialfa, C. T. (2002). The role of sensory factors in cognitive aging research. *Canadian Journal of Experimental Psychology, 56*, 153–163.
- Scialfa, C. T., Hamaluk, E., Pratt, J., & Skaloud, P. (1999). Age differences in saccadic averaging. *Psychology and Aging, 14*, 695–699.

- Schneider, B. A., & Pichora-Fuller, M. K. (2000). Implications of perceptual deterioration for cognitive aging research. In F. I. M. Craik & T. A. Salthouse (Eds.), *Handbook of aging and cognition* (pp. 155–220). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.
- Schmitter-Edgecombe, M., Vesneski, M., & Jones, D. (2000). Aging and word finding: A comparison of discourse and nondiscourse tests. *Archives of Clinical Neuropsychology, 15*, 479–493.
- Shafto, M. A., Burke, D. M., Stamatakis, E. A., Tam, P. P., & Tyler, L. K. (2007). On the tip-of-the-tongue: Neural correlates of increased word-finding failures in normal aging. *Journal of Cognitive Neuroscience, 19*, 2060–2070.
- Sommers, M. S. (1996). The structural organization of the mental lexicon and its contribution to age-related declines in spoken-word recognition. *Psychology and Aging, 11*, 333–341.
- Sommers, M. S. (1997). Stimulus variability and spoken word recognition. II: The effects of age and hearing impairment. *Journal of the Acoustical Society of America, 101*, 2278–2288.
- Sommers, M. S., & Danielson, S. M. (1999). Inhibitory processes and spoken word recognition in young and older adults: The interaction of lexical competition and semantic context. *Psychology and Aging, 14*, 458–472.
- Sommers, M. (2008). Age-related changes in spoken word recognition. *The handbook of speech perception* (pp. 469–493). Malden, MA, US: Blackwell Publishing.
- Steenbekkers, L. P. A. (1998). Visual contrast sensitivity. In L. P. A. Steenbekkers & C. E. M. Bejjsterveldt (Eds.), *Design-relevant characteristics of ageing users. Backgrounds and guidelines for product innovation* (pp. 131–136). Delft: Delft University Press.
- Stemberger, J. P., & MacWhinney, B. (1986). Frequency and the lexical storage of regularly inflected forms. *Memory and Cognition, 14*, 17–26.

- Stine, E. A. L., & Wingfield, A. (1994). Older adults can inhibit high-probability competitors in speech recognition. *Aging and Cognition, 1*, 152–157.
- Stine, E. A. L., Wingfield, A., & Poon, L. W. (1986). How much and how fast: Rapid processing of spoken language in later adulthood. *Psychology and Aging, 1*, 303–311.
- Stine-Morrow, E. A. L., Soederberg Miller, L. M., Gagne, D. D., & Hertzog, C. (2008). Self-regulated reading in adulthood. *Psychology and Aging, 23*, 131-153.
- Stuart-Hamilton, I., & Rabbitt, P. (1997). Age-related decline in spelling ability: A link with fluid intelligence? *Educational Gerontology, 23*, 437-441.
- Taylor, J. K., & Burke, D. M. (2002). Asymmetric aging effects on semantic and phonological processes: Naming in the picture-word interference task. *Psychology and Aging, 17*, 662–676.
- Thornton, R., & Light, L. L. (2006). Language comprehension and production in normal aging. In J. E. Birren and K. Warner Schaie (Eds.), *Handbook of the psychology of aging (6th ed., pp. 261–287)*. Burlington, MA: Elsevier.
- Tree, J. J., & Hirsh, K. W. (2003) Sometimes faster, sometimes, slower: Associative and competitor priming in picture naming with young and elderly participants, *Journal of Neurolinguistics, 16*, 489–514.
- Trunk, D. L., & Abrams, L. (2008). *Do younger and older adults' communicative goals influence off-topic speech in autobiographical narratives?* Manuscript submitted for publication.
- Tun, P. A. (1998). Fast noisy speech: Age differences in processing rapid speech with background noise. *Psychology and Aging, 13*, 424–434.

- Tun, P. A., O'Kane, G., & Wingfield, A. (2002). Distraction by competing speech in young and older adult listeners. *Psychology and Aging, 17*, 453–467.
- Tun, P. A., & Wingfield, A. (1999). One voice too many: Adult age differences in language processing with different types of distracting sounds. *Journals of Gerontology: Psychological Sciences, 54*, P317–P327.
- van Dijk, T. A., & Kintsch, W. (1983). *Strategies of discourse comprehension*. New York: Academic Press.
- Verhaeghen, P. (2003). Aging and vocabulary score: A meta-analysis. *Psychology and Aging, 18*, 332–339.
- Vitevitch, M. S., & Sommers, M. S. (2003). The facilitative influence of phonological similarity and neighborhood frequency in speech production in younger and older adults. *Memory and Cognition, 31*, 491–504.
- Vousden, J. I., & Maylor, E. A. (2006). Speech errors across the lifespan. *Language and Cognitive Processes, 21*, 48–77.
- White, K. K., & Abrams, L. (2002). Does priming specific syllables during tip-of-the-tongue states facilitate word retrieval in older adults? *Psychology and Aging, 17*, 226–235.
- White, K. K., & Abrams, L. (2004). Phonologically mediated priming of preexisting and new associations in young and older adults. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 30*, 645–655.
- White, K. K., Abrams, L., & Protasi, M. (2008a). *Contextual and orthographic influences on young and older adults' written homophone substitution errors*. Manuscript in preparation.

- White, K. K., Abrams, L., & Zoller, S. M., & Gibson, S. M. (2008b). Why did I right that? Factors that influence the production of homophone substitution errors. *The Quarterly Journal of Experimental Psychology*, *61*, 977-985.
- Willott, J. F. (1991). *Aging and the auditory system: Anatomy, physiology, and psychophysics*. San Diego: Singular Press.
- Wingfield, A. (1996). Cognitive factors in auditory performance: Context, speed of processing, and constraints of memory. *Journal of the American Academy of Audiology*, *7*, 175–182.
- Wingfield, A., Aberdeen, J. S., & Stine, E. A. (1991). Word onset gating and linguistic context in spoken word recognition by young and elderly adults. *Journal of Gerontology: Psychological Sciences*, *46*, P127-P129.
- Wingfield, A., & Ducharme, J. L. (1999). Effects of age and passage difficulty on listening rate preferences for time-altered speech. *Journal of Gerontology: Psychological Sciences*, *54*, P199–P202.
- Wingfield, A., & Grossman, M. (2006). Language and the aging brain: Patterns of neural compensation revealed by functional brain imaging. *Journal of Neurophysiology*, *96*, 2830-2839.
- Wingfield, A., Lindfield, K. C., & Goodglass, H. (2000). Effects of age and hearing sensitivity on the use of prosodic information in spoken word recognition. *Journal of Speech, Language, and Hearing Research*, *43*, 915–925.
- Wingfield, A., Peelle, J. E., & Grossman, M. (2003). Speech rate and syntactic complexity as multiplicative factors in speech comprehension by young and older adults. *Aging, Neuropsychology, and Cognition*, *10*, 310–322.

- Wingfield, A., Poon, L. W., Lombardi, L., & Lowe, D. (1985). Speed of processing in normal aging: effects of speech rate, linguistic structure, and processing time. *Journal of Gerontology, 40*, 579–585.
- Wingfield, A., & Stine-Morrow, E. A. L. (2000). Language and speech. In F. I. M. Craik & T. A. Salthouse (Eds. ), *The handbook of aging and cognition* (2nd ed., pp. 359–416). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.
- Wingfield, A., & Tun, P. A (2001). Spoken language comprehension in older adults: Interactions between sensory and cognitive change in normal aging. *Seminars in Hearing, 22*, 287-301.
- Wingfield, A., Tun, P. A., Koh, C. K., & Rosen, M. J. (1999). Regaining lost time: Adult aging and the effect of time restoration on recall of time-compressed speech. *Psychology and Aging, 14*, 380-389.
- Yonan, C. A. & Sommers, M. S. (2000). The effects of talker familiarity on spoken word identification in younger and older listeners. *Psychology and Aging, 15*, 88-99.
- Zurif, E., Swinney, D., Prather, P., Wingfield, A., and Brownell, H. (1995). The allocation of memory resources during sentence comprehension: Evidence from the elderly. *Journal of Psycholinguistic Research, 24*, 165-182.
- Zwaan, R., Magliano, J. P., & Graesser, A. C. (1995). Dimensions of situation model construction in narrative comprehension. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 21*, 386-397.
- Zwaan, R. A., & Radvansky, G. A. (1998). Situation models in language comprehension and memory. *Psychological Bulletin, 123*, 162–185.

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