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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.

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