Chapter 8: Aging in bilinguals: Normal and abnormal

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Abstract

In bilinguals, changes in language abilities across the adult lifespan are not necessarily parallel in both languages. Language use in both normal and abnormal aging is not static, and this can affect and interact with language changes due to aging. In normal aging, difficulties with language skills such as lexical retrieval are further confounded in bilinguals by differences in language proficiency and dominance, age of acquisition and language use, as well as the types of assessments and stimuli used to test them. In abnormal aging, such as dementia, Parkinson's disease or stroke, these changes in language use and abilities become highly variable and often more extreme than in normal aging. They need to be carefully considered in clinical assessments and treatment. The advantages of bilingualism in older adults extend well beyond the ability to communicate with more people, and include many cognitive and linguistic advantages, as well as providing a protective factor against the onset and progress of dementia and the cognitive impairments after stroke.

Key words: Bilingualism, aging, language, dementia

8.1 Introduction:

Clearly, bilinguals of every age have an advantage over monolinguals in terms of communication because they can communicate in two languages, and therefore with more people and in more diverse situations. However, the questions that we try to answer in this chapter relate to specific cognitive and linguistic abilities, and whether advantages or disadvantages are observed in aging bilinguals when compared to both aging monolinguals and young bilinguals. Both normal and abnormal aging will be discussed: for the purposes of this paper, normal aging can be defined as changes in communication ability among those -- bilinguals and monolinguals -- who continue to function in daily life (Obler, Albert, & Lozowick, 1986). Abnormal aging, by contrast, includes individuals suffering a variety of processes and diseases that affect successful functioning. Of these, we will first focus on dementia in monolinguals, for the purpose of comparison to bilinguals, followed by a brief discussion of other abnormal aging processes, all in relation to normal aging.

8.2 Language abilities during the normal aging process:

8.2.1 Monolingual language abilities:

In monolingual adults, language abilities appear to change relatively subtly over the adult lifespan, with some areas of language well maintained in healthy older adults, and others diminishing with old age. For example, vocabulary knowledge, word recognition ability, syntax, and comprehension skills of non-complex material have all been observed to be preserved in old age (Burke, 1997; Goral, 2004; Goral, Libben,

Obler, Jarema, & Ohayon, 2008; Kavé & Nussbaum, 2012; Nicholas, Obler, Albert, & Goodglass, 1985), with vocabulary definition increasing over the lifespan, at least up to the age of 50 years (Nicholas et al., 1985), which is thought to be a result of continued exposure to new words throughout one's lifetime (Hartshorne & Germine, 2015). Similarities have also been found between older (70-85 years) and younger (20-40 years) adults during picture description tasks (in which adults are asked to describe in detail a picture of a simple or complex scene) in measures of total word output, percentage of noun types (nouns mentioned at least once) and percentage of noun tokens (total nouns mentioned) (Kavé, Samuel-Enoch, & Adiv, 2009).

On the other hand, lexical retrieval in production has consistently been shown to be problematic for older adults when compared with younger adults, especially for nouns but also for verbs to a lesser degree, with a sharp group decline over the age of 70 years (Au et al., 1995; Conner, Spiro, Obler, & Albert, 2004; Goral, 2004; Kavé et al., 2009; Nicholas et al., 1985). Word-finding difficulties in older adults appear to be the result of a deterioration in the ability to locate the phonological shape --the word-form--of the words rather than in lexical knowledge per se. We infer this for a number of reasons. First, older adults (here, those above age 70) respond well to phonemic cues (i.e., providing the first sound or syllable of a target word) in order to aid retrieval (Kavé et al., 2009; Nicholas et al., 1985). Likewise, when tested on category- and letter-fluency tasks in which participants are asked to list as many items as they can in a semantic category (e.g., animals, clothing items) or starting with a specific letter (often F, A and S) in one minute, some studies have suggested that older adults perform worse on category-fluency when compared to younger adults, but not on letter-fluency (Crossley, D'arcy, & Rawson,

1997; Goral, 2004; Mathuranath et al., 2003). Letter-fluency tasks are a type of phonemic cue, and therefore these studies are consistent with the notion that semantics is better preserved with advancing age than is retrieval from the phonological lexicon.

Second, older adults experience more Tip of the Tongue (TOT) states than younger adults, suggesting difficulty specifically with accessing the phonological forms of words (Burke, MacKay, Worthley, & Wade, 1991). Finally, during naming tasks older adults produce more circumlocution errors (i.e., instances where they define a word rather than speaking it, e.g., for 'radiator', 'one of those things near the wall that gives heat') when compared to younger adults, indicating that their semantic knowledge is relatively preserved (Au et al., 1995; Goral, 2004).

With regards to narrative production, in which participants are asked to tell the story of what's going on in a picture, or to tell what happened during a specific event such as a vacation, differences in the patterns of language use have also been documented in older adults when compared to younger adults, with greater lexical diversity often being noted in older adults (Kavé & Nussbaum, 2012; Obler et al., 2014). This diversity does not appear to result from an outdated lexicon when compared to younger adults, but rather from a certain deviation from the pictures being described. This deviation does not in itself imply weak linguistic skills; rather older adults have a different idea as to what makes a good story and they focus on different topics from those younger adults focus on (Burke, 1997; Kavé & Nussbaum, 2012; Kavé et al., 2009). Alternatively, Heller and Dobbs (1993) noted that during narrative production, older adults (60 - 76 years) labelled fewer objects correctly and explained or qualified their choice of labels more than younger adults (28-59 years) - these most commonly took the form of self-hedges,

referring to themselves while labelling (e.g., “I guess it is a sunken ship”) or qualified hedges (e.g., "some kind of a…" or "some type of a…".)

8.2.2 The connection between cognition and language:

It would be impossible to continue to describe language abilities without also looking at the broader picture of cognition which interlinks with and/or underlies the abilities necessary for processing language (Kohnert, 2013). General cognitive abilities, as well as those more specifically required for language, change throughout the lifespan, and there is no one age at which people perform at peak on all tasks measuring cognition (Hartshorne & Germine, 2015). Similar to the language abilities described previously, some cognitive abilities remain stable over the post-childhood lifespan and some decline in aging (Hartshorne & Germine, 2015). For example, performance on tasks involving knowledge that is learned incrementally over the lifespan, such as standard intelligence quotient (IQ) tasks like vocabulary definition, arithmetic and explaining how two items are similar, tends to peak later than tasks which require explicit strategies in order to perform them, such as letter-number sequencing, discrimination of pre-exposed faces from novel faces, and memorizing sets of word pairs (Hartshorne & Germine, 2015).

Furthermore, declines in working memory have been suggested to be the underlying cause of reduced linguistic abilities in adults aged 65-80 years old, affecting comprehension of grammatical complexity and verbal processing (Williams, Holmes, Kemper, & Marquis, 2003). Similarly, Burke (1997) suggested that tasks requiring working memory are performed worse with age, whereas those which do not require retention of information are performed evenly across the lifespan, and therefore the

deficit in aging is not in understanding language but rather in remembering language long enough to understand it. Taken together, the link between memory aspects of cognition and language across the lifespan is clear, although the link between other aspects of cognition (e.g., executive functions such as planning and organizing) and language is only in the early stage of discovery (e.g., Goral et al., 2011).

Still within the boundaries of healthy aging, a variety of health burdens have been suggested as one reason why cognitive processing declines in older adults (Conner et al., 2004). While still successfully functioning within healthy limits, groups of older adults with risk factors for cerebrovascular disease have evidenced increased deterioration of cognitive functions such as verbal fluency, working memory, and memory retrieval compared to those without such risk factors (e.g., Brady, Spiro, & Gaziano, 2005; Conner et al., 2004). This pattern of reduced ability with increased risk factors has been explained by the *cognitive reserve hypothesis*, which is based on looking at changes in the neural substrate in brain areas relating to cognition. Whereas brain reserve is a physical measurement of brain size and neuronal count, cognitive reserve refers to the flexibility and effectiveness of using this brain reserve (Tucker & Stern, 2011). When a cognitively active lifestyle is embraced, greater neural efficiency and capacity develop (or are retained), including the potential for recruiting compensatory pathways and regions, and therefore some protection to the neural substrate is offered (Tucker & Stern, 2011). Conversely, the more risk factors, the greater the damage to brain reserve, and thus to cognitive reserve. A cognitively active lifestyle can include, among other factors, high levels of intelligence, education (Conner et al., 2004) and, arguably, bilingualism (Bialystok, Martin, & Viswanathan, 2005), which either provide high levels of cognitive

reserve thereby directly reducing negative effects of aging, or enhance the ability to compensate for them throughout the lifespan (Conner et al., 2004).

8.2.3 Bilinguals, cognition and language

While it is true that there is a strong connection between cognition and language in monolinguals, as described above, in bilinguals there is an additional connection in the form of *language control*. Choosing which language to use at any given time may seem automatic to many bilinguals, but for the aging brain these processes are often more of a challenge than is first appreciated. The processes involved are among those of executive functions: inhibition (i.e., suppression) and monitoring the communicative process.

Language control arguably requires using areas of the brain less typically used in language processing, including areas of the pre-frontal cortex also used for general cognitive processing, such as non-linguistic interference suppression and online monitoring (e.g., Abutalebi & Green, 2007; Bialystok, Craik, & Luk, 2012, 2008; Bialystok, Craik, & Ryan, 2006). Older adults' lifetime of practice monitoring two languages appears to simultaneously result in increased cognitive abilities in non-linguistic cognitive tasks that are known to rely on pre-frontal cortex: selective attention, inhibitory control, and monitoring two streams of information, with a proportionally larger advantage being observed in older adults than in younger adults when compared to older and younger monolinguals (Bialystok, Craik, Klein, & Viswanathan, 2004; Bialystok, Craik, & Ruocco, 2006; Salvatierra & Rosselli, 2011). In addition, Bialystok, Craik, and Ryan (2006) found enhanced functioning of the anterior language area (Broca's area), as measured by functional magnetoencephalography (MEG) in bilinguals

when compared to monolinguals while carrying out a non-linguistic cognitive task. Taken together, the association between language and improved cognition in bilinguals appears to be based on improved neural connections in bilinguals in some of the classic brain areas of both language and cognition.

However, not all studies have observed such a bilingual cognitive advantage across the lifespan (e.g., de Bruin, Bak, & Della Sala, 2015; Zahodne, Schofield, Farrell, Stern, & Manly, 2014) and there is still some discussion in the literature regarding which age groups and which tasks show the greatest advantage, if any. On the one hand, several studies support the view that a bilingual advantage exists across the lifespan in cognitive tasks measuring selective attention, inhibitory control, or monitoring two streams of information. For example, Bialystok, Craik, and Ryan (2006) found that 68 year old adults were slower than 20 year old adults in performing a task designed to test response suppression, inhibitory control and task-switching (in this case, the ability to switch between languages in response to a cue), but the change across age was less extreme in bilinguals than it was in monolinguals. More specifically, Salvatierra and Rosselli (2011) found that 60 year old bilinguals were better than 60 year old monolinguals at inhibitory control but only under a simple task condition (e.g., the Simon task, which involves two different colored squares on either side of the screen, and participants hit a button on the left or right side of the keyboard depending on the color shown, rather than on the squares' location), and not under a complex condition (e.g., the Simon task as above, but with four different colored squares). However, they suggested that in a much older bilingual group a difference may be found even under the complex condition when compared to monolinguals, since bilingual cognitive advantages are subtle across the

lifespan, and nominally older adults may not show the same advantages as considerably older adults (Salvatierra & Rosselli, 2011).

Another example of a bilingual advantage found only in specific age groups comes from Bialystok et al. (2005) who found that bilinguals performed better than monolinguals in the Simon task (in the simple, 2-color condition) across the lifespan in early childhood, adulthood and later adulthood, but not in early adulthood (20-30 years old). They attributed this effect to the *cognitive reserve hypothesis*, whereby the positive influence of bilingualism as a boost to development or as protection against decline is most obvious at the age where children are still acquiring these skills, or when adults are losing these skills, but not when cognitive control is at a stable peak in early adulthood (Bialystok et al., 2005). Following this, Bialystok et al. (2012) suggested that a bilingual advantage for young adults may be more noticeable in complex cognitive tasks rather than simple ones.

By contrast, in a longitudinal study, Zahodne, Schofield, Farrell, Stern, and Manly (2014) found that cognitive function deteriorated at a similar rate over time for both older adult monolinguals and bilinguals, and no single cognitive domain showed a rate of change over time that was associated with bilingualism. Similarly, de Bruin, Bak, and Della Sala (2015) found no differences between active bilinguals, inactive bilinguals and monolinguals, all over the age of 60 years old, in their executive control abilities after carefully matching for lifestyle, socioeconomic status, education, IQ, age and gender. Bialystok et al. (2012) acknowledge that at all ages across the lifespan there are some studies that have reported similar performance between monolinguals and bilinguals on complex cognitive tasks (e.g., conflict tasks, in which participants must ignore conflicting

stimuli in order to carry out the task, such as ignoring visual distractors when completing nonverbal problems). There are also some tasks that show a trend towards a bilingual advantage but it is unclear whether this advantage is replicable. For example, with regards to working memory, a clear deterioration has been seen in older adults when compared to younger adults, but only minor differences were observed between monolinguals and bilinguals (Bialystok et al., 2012).

Another aspect of cognitive function that has been reported in the literature is the deterioration of the ability to resist interference from competing languages as bilinguals get older (Ardila & Ramos, 2008; Kohnert, 2013; Mendez, Perryman, Pontón, & Cummings, 1999). Although resisting interference from a competing language is a skill that improves during childhood and remains stable in adulthood, after the age of 65 years it starts to deteriorate (Kohnert, 2013). Ardila and Ramos (2008) explain that older bilinguals mix their languages more than younger bilinguals because older bilinguals are less able to correctly select the appropriate language at a given time or in a certain situation, and to switch when required. This weakened control of the dual language system in older bilinguals may also contribute to the finding that cued switching (i.e., switching the language during a naming tasks as a response to a specific cue) between two languages is harder for older bilinguals than for younger bilinguals (Kavé, Eyal, Shorek, & Cohen-Mansfield, 2008; Kohnert, 2013), and older adults find it much harder to keep track of the language they should be responding in when the switches are cued (Gollan & Ferreira, 2009). However, Gollan, Sandoval, and Salmon (2011) found that non-cued switching (i.e., the bilingual chooses when to switch rather than being told when to) did not show differences between the age groups, and they attributed this to the

fact that non-cued switching is common in bilinguals, since switching costs are relatively small compared to the potential benefits of pragmatically switching languages in order to aid communication when necessary.

It should be noted that, as discussed above, research has pointed to both better inhibitory control over the lifespan in bilinguals due to practice and increasing interference of the two languages as bilinguals get older - not in daily life, but rather in cued switching tasks. This apparent conflict may be due to inhibitory control often being tested non-verbally, and interference being tested during linguistic tasks. Alternately, the inhibition advantages may be real and the apparent decline on cued switching tasks may result from efforts to keep up with the task under the general cognitive slowing that people like Salthouse have documented (e.g., Salthouse, 1996).

Finally, in relation to cognition and languages in normal aging, Kavé, Eyal, Shorek, and Cohen-Mansfield (2008) revealed a strong link between cognitive performance and number of languages spoken in 75-95 year olds. They conducted a longitudinal study over 12 years and concluded that knowing and using multiple languages predicts cognitive performance, whereby the more languages spoken (one to four or more) the better the performance on cognitive tasks (Kavé et al., 2008). Their research determined that the number of languages that participants spoke predicted their performance on two cognitive screening tests (the Mini Mental State Examination – MMSE, and the Katzman cognitive screening test) even when other variables (testing age, age at immigration, or years of education) were accounted for. They also found that the strength of prediction of cognitive scores based on number of languages spoken was even stronger in the non-educated group than the educated group. From this they

suggested that multilingualism may have protected both educated and non-educated older adults from cognitive decline, but the prediction factor was weaker in the educated group because of the positive influence that education itself has on cognition over the lifespan.

Kavé and her colleagues (2008) further suggested that those whose second (L2) or third language (L3) was their most proficient, as opposed to their first language, are likely to be individuals who had compelling reasons for learning the L2 (i.e., immigration, that required them to invest more cognitive effort into learning the new languages throughout their lifespans than those learning another language out of choice). They argued that this extra effort to learn another language may have increased their cognitive reserve in old age more than those who chose to learn another language (Kavé et al., 2008). Similarly, Zahodne et al. (2014) suggest that there is not enough evidence to date regarding whether bilingualism itself causes superior cognitive skills or whether superior cognitive skills aid the acquisition of a second language. They proposed that for the late bilinguals (i.e., those that learned the L2 late in life) that they studied, both a higher level of education and good premorbid cognitive abilities may have influenced their cognitive advantage more than their bilingualism did (Zahodne et al., 2014, p. 10).

8.2.4 Language changes in the normal aging process of bilinguals:

The two languages of a bilingual are not stable over the lifespan, both due to aging effects of language and cognition, as well as changes in lifestyle. In some older bilingual populations, a tendency for older people to withdraw into single language use, even if they were bilingual for all or most of their lives, has been noted. For example, Ardila and Ramos (2008) propose that this is because an L2 is more associated with

work and schooling and during retirement there is a shift back to one's home life and family, where the L1 is more commonly used. In addition, due to the difficulties faced by aging bilinguals with regard to control of the dual language system, as discussed above, by reverting back to one language these control challenges can be avoided (Ardila & Ramos, 2008; Mendez et al., 1999). Ardila and Ramos (2008) argue that bilinguals typically prefer to use their L1 in old age, and L2 usually declines at a faster rate than L1. However, they also clarify that age of acquisition of the L2, reason for acquisition (e.g., migration, for work), proficiency and daily usage will all affect language changes across the lifespan.

Therefore it comes as no surprise that other researchers have found different patterns of language in aging bilinguals. For example, Rosselli et al. (2000) studied Spanish-speakers in the U.S. who learned English as an L2 during childhood or early adulthood, and found that those who used both their languages daily did not perform worse in either language at age 50-70 years old, when compared to monolinguals. Likewise Goral et al. (2008) found that for older bilinguals who lived in their L2 environment, decisions regarding whether a string of letters is a word (lexical decision) in L1 were much slower than in L2. They concluded, however, that since only one language was affected, L1 attrition was the cause of a slower response, rather than a more general decline of language due to aging (Goral et al., 2008). This could also be true for bilinguals who retreat into their L1 as they age and then experience attrition of L2 due to reduced use. The pattern of language change described by Goral et al. (2008) follows the opposite pattern to that described by Ardila and Ramos (2008), but in both studies the bilinguals are using one language less than the other (e.g., after retirement, migration, less

opportunity to socialize etc.) which might appear to lead to attrition in the other language (either L2 or L1, depending on which language is used less). It should be noted that attrition is a dynamic process of a slow decline of language abilities over time and could manifest itself as difficulty in retrieving a word, or changes in the representation or organization of the lexicon (Goral, 2004). Language changes in aging also follow a dynamic process (e.g., De Bot, Lowie, & Verspoor, 2007) but, as described previously, the difficulties appear to be more phonologically based than founded on semantic weakness. Aging and reduced language use, however, are not exclusive of one another, since both age and proficiency level interact in such a way that they jointly affect the progression and the rate of language attrition (Goral, 2004, p. 42).

In order to understand specific language changes in older bilinguals, we may compare them to changes in older monolinguals. As discussed above, a number of areas of language are preserved in old age in monolinguals, including comprehension skills, vocabulary knowledge, and word recognition ability, whereas lexical retrieval abilities are repeatedly seen to decline in old age. Older, proficient bilinguals generally perform to a similar level as older monolinguals on a variety of language tests, including free spontaneous fluency tasks (in a picture description task), letter-fluency and sentence-repetition tasks (Rosselli et al., 2000), and there are similarities in performance between the two languages of the bilingual (Obler et al., 1986). As with monolinguals, bilinguals also deteriorate in their lexical retrieval skills as they get older, but the pattern of change is complex.

First, when tested in one of their languages, bilinguals have lower lexical retrieval skills than monolinguals generally, usually attributed to bilinguals having less experience

with each language, as well as a necessity to inhibit the language not being used in order to produce words in the target language (Bialystok et al., 2008). Gollan, Montoya, Cera, and Sandoval (2008) developed their *weaker links hypothesis* to explain their finding that both older and younger bilinguals show slower naming than older and younger monolinguals, and that this difference was larger for low-frequency words where reduced language use would be more likely to affect words' retrieval than for high-frequency words. Similarly, they found that differences in naming times between the dominant and the non-dominant language of younger and older bilinguals were more evident during naming of low-frequency words (that are rarely encountered in daily life) than those that are high-frequency (relatively often encountered). In older bilinguals, when using their non-dominant language, age-related slowing of naming occurred only for high-frequency words. They argued that because bilinguals speak and hear any given word less than the respective monolinguals, the links between the phonological shape of a given word and its meaning are weaker for the bilingual than for the monolingual as posed by the weaker links hypothesis. Moreover, since frequency effects of naming were more pronounced in the non-dominant language than the dominant one, for their participants, this is further consistent with the hypothesis (Gollan et al., 2008).

Second, the specific tests and stimuli used to examine word retrieval abilities in bilinguals may be problematic, since many items from word naming tests, such as the Boston Naming Test (BNT; in which participants are asked to name a set of black-and-white line drawings of more familiar items (e.g., bed, tree) and later less-familiar items (e.g., protractor, trellis)) are more likely to be learned in a school environment than at home. If tested on these items in their home language, bilinguals are likely to be at a

relative disadvantage compared to monolinguals who did all their schooling in one language, even when tested in old age (Acevedo & Loewenstein, 2007). Similarly, bilinguals named pictures better if the words were cognates (related in the two languages both in sound/spelling and in meaning, e.g., English 'camel', Spanish 'camello') in their two languages than if they were not (Gollan, Fennema-Notestine, Montoya, & Jernigan, 2007), which would therefore differently affect naming scores in bilinguals with different pairs of languages. Type of lexical retrieval task (e.g., list-generation vs. picture-naming) could also affect naming ability, for example category-fluency has been suggested to be more negatively affected in bilinguals than letter-fluency (Gollan, Montoya, & Werner, 2002; Portocarrero, Burright, & Donovick, 2007). Bilinguals have been seen to retrieve fewer words in semantic, letter and proper name categories than monolinguals, but the semantic category-fluency showed the largest differences between groups, and it has been suggested that this effect carries over into older adults as well (Rosselli et al., 2000). However, Salvatierra, Rosselli, Acevedo, and Duara (2007) found the opposite, whereby healthy aging bilinguals performed better on category-fluency than letter-fluency.

Third, language proficiency may also affect the naming skills of older bilinguals, whereby a high proficiency in spoken abilities in L2 can reduce age-related decline in lexical retrieval in L1 (Ashaie & Obler, 2014). Although this reduction of age-related decline in older adults is closely related to education level in the Ashaie and Obler study, in uneducated bilinguals this advantage still remains strong.

As can be seen from the discussion above, advantages and disadvantages exist for bilinguals (relative to monolinguals) in the realms of cognition and language, but they are not altogether consistent over the general population of bilinguals. Small differences or

changes in language background, proficiency, age of acquisition and language use will affect the abilities of a bilingual in specific tasks, and therefore when comparing abnormal aging populations to normal, healthy bilinguals, these small changes must be taken into account when using norms for cognitive and linguistic tests. If they are not, it becomes highly detrimental to try to diagnose abnormal aging based on unreliable norms for the normal bilingual population.

8.3 Bilingual language abilities during the abnormal aging process:

Abnormal aging can manifest itself in a variety of ways, both sudden, such as in a stroke or sudden illness, and progressive, such as in dementia and Parkinson's disease, where decline is more gradual over time. In this section we will begin by discussing language changes in dementia, and dementia onset, followed by Parkinson's disease (the only other progressive disease discussed in the literature to date in terms of bilingual language abilities). Finally we will briefly discuss bilingualism and stroke, since an in-depth discussion of bilingualism and aphasia is presented in chapter 10.

8.3.1 Dementia:

Dementia is a neurodegenerative disease that has several subtypes. The most common type of dementia in the elderly population is Alzheimer's disease (Roman, 2003; Stevens et al., 2002). Alzheimer's disease in older adults can be characterized by "a progressive decline of episodic and working memory, followed by language deficits" (Manchon et al., 2015, p. 91). Other subtypes of dementia which directly involve or are closely related to language loss include (1) vascular dementia, defined as "loss of

cognitive function resulting from ischemic, hypoperfusive, or hemorrhagic brain lesions due to cerebrovascular disease or cardiovascular pathology…caused by …multiple strokes …or by a single stroke" (Roman, 2003, p.S296); and (2) Primary Progressive aphasia (PPA) - semantic dementia subtype, which causes gradual damage to the semantic system over time, resulting in the loss of semantic memory for both words and real objects (Mendez, Saghafi, & Clark, 2004). Other subtypes of dementia, such as frontotemporal dementia and dementia with Lewy bodies, are less associated with language impairment.

The question has been asked whether language deterioration in dementia is due to an inaccessibility of an intact language system, the loss of that system as brain atrophy progresses or the combination of both (Hyltenstam & Stroud, 1994) and to date there is no definitive answer. Clinically, language in dementia usually manifests itself initially with word retrieval difficulties, progressing to deficits in oral production and a reduction in discourse quality and quantity, and at the later stages affecting language comprehension and written language (Manchon et al., 2015; Mendez et al., 1999; Obler & Albert, 1984). People with dementia show increasing difficulty with language over time -- both semantic and lexical information, as well as pragmatic information -- during communication (Hyltenstam & Stroud, 1994). On the other hand, more automatic forms of language, such as counting and sentence repetition, are preserved for longer (Manchon et al., 2015).

8.3.2 Bilingual dementia:

Bilinguals who suffer from dementia follow similar patterns to normal aging bilinguals but much more pronounced, such that (1) many researchers, although not all, have documented a shift towards L1 use over L2 use, with a faster decline in L2 than L1, (2) word finding difficulties are one of the first symptoms of bilingual dementia, and (3) language control is compromised, so that cross-language influence is more pronounced in dementia, producing more interference and codeswitching from the non-target language than in normal aging (Ardila & Ramos, 2008; Gollan, Salmon, Montoya, & da Pena, 2010; Mendez et al., 1999). We shall now discuss these findings in more detail.

It has been argued that language deteriorates more rapidly in L2 than in L1, in bilinguals with dementia (Ardila & Ramos, 2008), and much research supports this. For example, Mendez et al. (1999) described how caregivers of people with dementia reported that their patients all preferred using their L1 over their L2, and when they did use their L2, there was considerably more codeswitching from their L1 into L2 than from L2 into L1. They explained this finding using the *last in, first out theory* in dementia, whereby more recent linguistic information, assumed to be based more on declarative knowledge (i.e., facts or grammatical rules one can articulate) is less retained than linguistic information learned in childhood which is assumed to be based more on procedural (automatic) knowledge (Mendez et al., 1999); declarative knowledge is supposed to be more affected by dementia than procedural knowledge (Mendez et al., 1999). In addition, Mendez et al. (1999) suggested that a retreat to L1 use could also be due to the exacerbation of cross-language difficulties seen in normal aging of bilinguals.

In another study which found better lexical naming in L1 than in L2 for four bilingual patients with Alzheimer's disease, Meguro et al. (2003) supported the theory

that Alzheimer's disease affects declarative knowledge more than procedural knowledge based on the patterns of language deterioration that they observed: in both languages tested (Japanese and Portuguese), irregular items, which are learned rather than derived from a set of rules, (i.e., Kanji in Japanese, irregular words in Portuguese) were seen to be more impaired than regular items (i.e., Kana in Japanese, regular words in Portuguese) (Meguro et al., 2003).

Studies of patients with PPA-semantic dementia subtype have shown a similar pattern, with one study showing better linguistic skills in L1, even though it was used less during adulthood than L2 (Larner, 2012), and another study concluding that lexical naming was progressively more impaired in L2 and L3 when compared to L1 (Mendez et al., 2004).

Ardila and Ramos (2008) also support the *first in, last out theory*, suggesting that a retreat to L1 further reduces L2 abilities due to lack of use. In addition, they point out that when assessing bilinguals with dementia for cognitive impairment, it is recommended to test in L1, if not both L1 and L2, since people with dementia appear to function better cognitively in an L1 environment (see also Terrazas-Carrillo, this volume); this also extends to choosing a caregiver based on the language or languages they speak (Ardila & Ramos, 2008).

However, other studies have contradicted these findings, showing that there are few or no differences between the two languages of a bilingual with dementia. For example, Manchon et al. (2015) found that in a group of patients with Alzheimer's disease, L1 and L2 were similarly impaired at the levels of semantic, lexical, and syntactic processing, when compared to a control group with similar language

backgrounds. Compared with this control group, patients with Alzheimer's disease performed worse on all language tests except those that tested more automatic skills, such as counting and sentence repetition – similar to previous findings in monolinguals with dementia (Manchon et al., 2015). They explained that a deterioration in both L1 and L2 supports the view that cortical representations of the two languages of a bilingual overlap, and therefore brain atrophy caused by dementia affects both languages in a similar way. A study by Gómez-Ruiz, Aguilar-Alonso, and Espasa (2012) supports this hypothesis, since they found that in a group of Catalan-Spanish bilinguals with Alzheimer's disease, a parallel impairment in L1 and L2 was seen in lexical retrieval, vocabulary richness (as measured for spontaneous speech with a type/token ratio), and abilities in comprehension of complex grammatical structures. Again, as with monolinguals in the initial stages of Alzheimer's disease, automatic linguistic skills were preserved in both languages, along with comprehension of words and simple syntactic structures (Gómez-Ruiz et al., 2012).

Similarly, Costa et al. (2012) found that Alzheimer's disease appears to affect both languages of early, highly proficient bilinguals to a similar extent. They also noted the parallels to healthy, aging bilinguals, whereby cognate and frequency status affected word retrieval in the following ways in bilinguals with and without Alzheimer's disease: (1) cognate and high-frequency words were retrieved more than non-cognates and low-frequency words, (2) these effects were more pronounced in the non-dominant language than in the dominant one, and (3) as the cognitive decline increased, the cognate and word-frequency effects also increased (Costa et al., 2012).

Other researchers have suggested that order of acquisition is not the driving factor behind language loss in one language over the other in bilingual dementia; rather

language dominance or recency of language use is. For example, Machado, Rodrigues, Simoes, and Santana (2010) described a case of a 56 year old bilingual with PPA-semantic dementia subtype who lived in Portugal until age four, then moved to France and lived there or in other French-speaking countries until age 42, and then moved back to Portugal. Although he was proficient in both languages, his French deteriorated at a much faster rate than his Portuguese as his semantic dementia progressed. The researchers argued that the recency of use determined the deterioration, more than order of acquisition: although the language less used at the onset of dementia symptoms was not the first language, both languages were acquired in childhood to high/native-like proficiency, yet the less recently used language was considerably more affected by the dementia (Machado et al., 2010). Meguro et al. (2003) also suggested that the language of the environment might deteriorate less in bilingual patients with dementia since consistent, daily use of that language may help prevent its deterioration early on in the disease.

In the same way, language dominance has also been suggested as a factor in the loss of language in bilingual dementia. For example, Gollan et al. (2010) tested Spanish-English bilinguals with Alzheimer's disease and found that the non-dominant language deteriorated faster than the dominant language. They argued that this is consistent with the hypothesis that the dominant language has stronger semantic representations than the non-dominant language has, since semantic representations are one of the predominantly affected domains in Alzheimer's disease.

Another aspect of language deterioration prominent in bilingual dementia is that of language control and the pragmatic use of each language, which can greatly affect the

communicative interactions and the social integration of people with Alzheimer's disease (Hyltenstam & Stroud, 1994). Choosing the correct language for the interlocutor and maintaining that choice become challenging for many bilinguals with dementia (De Santi, Obler, Sabo-Abramson, & Goldberger, 1990; Hyltenstam & Stroud, 1994), and the patients are often not aware that the interlocutor does not understand the language they have chosen to use (Hyltenstam & Stroud, 1994). De Santi et al. (1990) emphasize that, although dementia severity is correlated with language choice abilities and codeswitching problems, those bilinguals with dementia who acquired their L2 simultaneously with or shortly after their L1 appear to have fewer problems with language-choice abilities than those who acquired their L2 later in life. In addition, Hyltenstam and Stroud (1994) found that patients who were highly proficient in their L2 were better able to control their language choices through into the later stages of dementia than those whose L2 was not highly proficient before the onset of dementia. The authors suggested that those with higher L2 proficiency before the onset of the dementia required fewer resources to activate the L2 and inhibit their L1.

In terms of codeswitching, Hyltenstam and Stroud (1994) noted that the extent of language deterioration was not an indication of the amount of inappropriate codeswitching. Friedland and Miller (1999) found that some, but not all, bilinguals with dementia show inappropriate codeswitching, and that codeswitching is most pronounced from L1 into L2 when proficiency of L2 is low.

Overall it can be seen that in bilinguals with dementia there is a deterioration of language skills that follows a similar pattern to that of healthy aging bilinguals, but is more pronounced, especially in areas such as choosing which language one will speak

and maintaining use of that language, and regression into L1 or into the language of the environment to the detriment of the other language. Similarly, although healthy bilinguals can often benefit from the knowledge of two languages by using one to fill in for the other when necessary, bilinguals with dementia are unable to use their two languages to their advantage during communication (Ardila & Ramos, 2008). One other area concerning bilingual dementia is the relationship between bilingualism and dementia onset. We will now address that question in detail and discuss the relevant literature to date.

8.3.3 Advantage as a delay to the onset of dementia

The idea of cognitive reserve, whereby a greater brain reserve exists as well as an efficient use of this reserve occurs when a cognitively active lifestyle is embraced (Conner et al., 2004; Tucker & Stern, 2011) fueled the hypothesis that bilingualism, as one of the possible definitions of a cognitively active lifestyle, may delay the emergence of dementia (Fischer & Schweizer, 2014; Perani & Abutalebi, 2015). Since the neural basis for bilingualism is accepted to be more extensive than once speculated, based on a broad neural network, this neural basis should be able to resist neurodegeneration or compensate for it (Fischer & Schweizer, 2014). As mentioned above, Kavé and her colleagues have demonstrated, moreover, that knowledge of multiple languages should delay cognitive decline in accordance with the number of languages.

Bialystok, Craik, and Freedman (2007) were the first to test out the hypothesis that bilingualism delays the onset of dementia, and they found that in bilinguals who acquired the L2 before early adulthood, dementia onset was on average 4.1 years later

than monolinguals. Since then their findings have been supported by a series of studies. Most recently, they took an obverse approach, studying the amount of brain atrophy in monolinguals and bilinguals with Alzheimer's disease. In monolingual and bilingual patients matched on age, cognitive level, and other factors, the bilinguals had more Alzheimer's pathology on computerized tomography (CT) scans than monolinguals (Schweizer, Ware, Fischer, Craik, & Bialystok, 2012), suggesting that bilinguals symptomatically continue to cope and to function better than monolinguals, even after the disease has already started to atrophy the brain.

Since Bialystok et al.'s (2007) pioneering study, a growing body of research has been added to this field, identifying a number of factors that confound the result of a delay of dementia onset in bilinguals. For example, education level has been suggested to be related to a cognitively healthy lifestyle (Ashaie & Obler, 2014; Conner et al., 2004; Kavé et al., 2008), and if an upper limit of cognitive reserve is reached due to education (or other factors), bilingualism may not have any further effects (Ashaie & Obler, 2014). Correspondingly, Gollan, Salmon, Montoya, and Galasko (2011) found that the relative benefit of bilingualism to a later dementia onset held true only for Spanish speaking immigrants to the US who had a low level of education, whereas those with an average or high level of education were not protected by their bilingualism against the development of dementia, suggesting that maximum cognitive reserve had already been reached with high levels of education.

Immigration has also been suggested as another influencing factor on bilinguals' apparent delay in the onset of dementia. For example, Chertkow et al. (2010) studied non-immigrant bilinguals, immigrant bilinguals, and immigrant multilinguals and found

no bilingual advantage to later onset of Alzheimer's disease in the non-immigrant group when compared to monolinguals, whereas for immigrants a delay of dementia onset of up to 5 years was observed. They found a correlation between the number of languages spoken and dementia onset, whereby those who spoke more languages had a later age of onset of symptoms and diagnosis, accordingly. They concluded that multilingualism delays the onset of dementia, along with bilingualism in immigrants (Chertkow et al., 2010). Therefore bilingualism itself might not be considered enough of an active cognitive lifestyle without an added factor of effort (e.g., from immigration or a third or fourth language (Chertkow et al., 2010). As described above, Kavé et al. (2008) suggest that those who have been forced by circumstances to acquire another language, such as after immigration, rather than for interest, may have invested more cognitive effort while learning, or continually using, another language than those who chose to learn one, and this may have been the reason that immigrants' cognitive reserve was larger than non-immigrants', and therefore more protective against deterioration as they aged.

On the other hand, immigrants do not constitute a random sample of any given population, and they cannot be compared to bilinguals living in an L1 environment, since immigrants in an L2 environment bring with them potentially confounding factors to bilingualism (Perani & Abutalebi, 2015; Woumans et al., 2015). For example, first- and second- generation immigrants may have differences in many environmental factors, such as lifestyle, education, attitudes to health and access to health services etc. when compared with the native population, as Perani and Abutalebi (2015) point out. Also, immigrants in the studies discussed so far are mostly adult learners of the L2, as opposed to the simultaneous or early bilinguals described in Bialystok et al.'s (2007) first study.

Early and late bilinguals likely require different cognitive efforts when acquiring their L2, and this could potentially affect cognitive reserve levels (Perani & Abutalebi, 2015).

Therefore, two more recent studies were conducted in places where non-immigrant bilingual populations were available, in order to ascertain whether a bilingual advantage in dementia onset delay exists in non-immigrant bilingual populations. The first study, by Alladi et al. (2013), was conducted in Hyderabad, India, where all the participants were drawn from the same environment. They found a 4.5-year delay not only in the onset of Alzheimer's disease, frontotemporal dementia and vascular dementia, but also trends towards a delay of onset in dementia with Lewy bodies and mixed dementia. The researchers argued that in this part of India the use of two or more languages was daily, with many participants being illiterate, so confounding effects of increased education correlating with increased proficiency of bilinguals was not a concern (Alladi et al., 2013). They concluded that, due to the nature of this population and the bilinguals' high proficiency over the lifespan, no additional benefit was necessary for them to reach maximum cognitive reserve (Alladi et al., 2013). A second study by Woumans et al. (2015) conducted in Belgium found similar results, even when controlling for confounding variables such as sex, education, occupation level, and initial Mini Mental-State Examination (MMSE) scores, whereby bilingualism delayed the onset of symptoms of Alzheimer's disease by 4.6 years, and the age of diagnosis by 4.8 years. This delay was evidenced for both early and late bilinguals (L2 age of acquisition 0-25 years). The researchers concluded that bilingualism contributes to cognitive reserve when bilinguals are non-immigrants and living in an L1-dominant environment, in addition to

those immigrants and non-immigrants living in an L2 environment, as other authors have previously reported (Woumans et al., 2015).

To summarize, it appears that a bilingual advantage of 4-5 years in dementia onset delay does exist for both immigrants and non-immigrants; those living in an L1 environment and those in an L2 one; those with high and low education levels (although not in a parallel manner); for early and late bilinguals; and not only for Alzheimer's disease but for other types of dementia as well.

8.3.4 Bilingualism and Parkinson's disease

A related phenomenon to the dementias described above is Parkinson's disease, which itself results in dementia in at least one-third of cases (Aarsland, Zaccai, & Brayne, 2005). A small number of studies have been conducted on language abilities of bilinguals with Parkinson's disease, a degenerative disease known to cause mild to moderate language deficits, including speech dysarthria and morpho-syntactic impairments (Zanini et al., 2004). In two studies of Friulian-Italian bilinguals with Parkinson's disease, morpho-syntactic deficits were found to be significantly more pronounced in L1 than in L2, when compared to healthy controls, both in comprehension and production, after linguistic errors in L2 were taken into account for both groups (their L2 errors were similar across groups) (Zanini et al., 2004; Zanini, Tavano, & Fabbro, 2010). This finding has been replicated in a study of Azari-Farsi bilinguals with Parkinson's disease, where those with Parkinson's disease had a more pronounced syntactic deficit in L1 than L2 – a finding which was not observed in the healthy control group (Johari et al., 2013). These findings have been explained based on neural evidence, which suggests that the procedural learning process is recruited more when acquiring morpho-syntax in L1, and

which involves the basal ganglia, among other regions, to do so. On the other hand, declarative learning is recruited in order to acquire the grammatical rules of L2 which, along with lexical-semantic processing of both L1 and L2, is mainly subserved by the temporal cortex and temporo-parietal regions (Johari et al., 2013; Zanini et al., 2004; Zanini et al., 2010). Since Parkinson's disease is known to primarily affect subcortical structures, including the basal ganglia, this would explain why morpho-syntax is more affected by the Parkinson's disease in L1 than in L2 (Zanini et al., 2004).

8.3.5 Stroke and bilingualism

Having a stroke can affect cognitive and linguistic abilities in a variety of ways. One study, by Alladi et al. (2016) found that bilingualism affects the chance of having a cognitive impairment because of the stroke, in that 77% of monolinguals had some cognitive impairment after a stroke (note that they included participants with vascular dementia and vascular mild cognitive impairment), compared with 49% of bilinguals. They attributed this result to bilinguals having better cognitive reserve than monolinguals, which helped their post-stroke recovery.

Incidence of aphasia after stroke is similar between bilinguals and monolinguals (10.5% and 11.8% respectively) ((Alladi et al., 2016). However, recovering language patterns may be parallel in L1 and L2 (the more common pattern), or they may recover differentially in each language (Albert & Obler, 1978; Mendez et al., 1999; Paradis, 1993). When Obler and Albert (1977) considered a set of 106 cases of bilingual in the literature to see whether age at aphasia onset had an effect on the language patterns of aphasia, they found that, in differential aphasia recovery, the language of the environment recovered better than chance for individuals up to age 65, but after that age neither the

most-used language nor the first-learned one recovered predictably. How the two or more languages of a multilingual recover depends on a number of factors which interact with each other, including order of acquisition, proficiency levels, language use and the language of the environment (Mendez et al., 1999). This complex relationship is discussed in detail in Chapter 10 - Dissociated language disorders in bilinguals: aphasia, alexias, dyslexia, dysphasia, dementia.

8.4 Conclusion:

When aging is imposed on a bilingual or multilingual brain, the normal language changes seen in older monolinguals are affected in various ways, and additional phenomena specific to bilingualism have been reported. Bilingualism researchers have focused more on the lexical retrieval problems commonly reported with advancing age in monolinguals than they have on the difficulties comprehending complex syntax. Lexical retrieval is slower and/or less accurate in older bilinguals – and in younger ones – compared to monolinguals, because the bilinguals have used each individual words less than their monolingual counterparts.

Among bilingualism-specific advantages, the language-switching that is used in bilingual populations to greater or lesser extent has been linked to more general cognitive advantages that extend beyond language, such as inhibition, or to those that underlie more language-specific behaviors, such as codeswitching. Those that are more natural seem not to change with age, whereas those that are less natural (e.g., cued switching) decline with advancing age, perhaps due, we have argued, to general cognitive slowing.

The biggest cognitive advantage that has been reported for bilinguals, of course, is the delay of 4 or 5 years in onset of dementia behaviors, and, by the report of Alladi and her colleagues (2016), cognitive performance in individuals with stroke and related brain lesions. Advantages on cognitive testing can be seen even in late bilinguals who learned their L2 in school and remained in the L1 environment (Bak, Nissan, Allerhand, & Deary, 2014). Substantial cognitive advantages pertain to bilingualism in healthy older adults as well, especially for inhibition, according to many studies. The advantages of bilingualism in older adults, we conclude, extend well beyond the ability to communicate with more people, as we mentioned originally in our introduction to this paper.

8.5 Acknowledgements:

We would like to thank Dr. Mira Goral for her helpful suggestions on an earlier draft of this chapter.

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