

Effects of Cognitive Aging on Phonological and Morphological Speech Production and Speech Errors among Bilingual Speakers: A Literature Review

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Abstract— Today's new norms have made communication between and among individuals from different languages and cultures inevitable. As such, studies concerning bilingualism – their effects to an individual and the speech community, among others – have increasingly pivotal to language educators and researchers which are reflected in a plethora of research articles and books across nations. Many have put their interest in exploring how bilingual speakers learn to produce word in at least two languages at once or simultaneously, and how other factors may affect their speech production. Viewing on the same lens, this paper provides a comprehensive review of studies which explored the effects of cognitive aging on the phonological and morphological speech production and speech errors of bilingual speakers. Through this, language educators and researchers, as well as parents, will be able to explore different opportunities that can champion an individual's learning and use of languages.

Keywords— Bilingual Speech Production, Cognitive Aging, Speech Errors.

I. INTRODUCTION

The words “bilingual” and “bilingualism” have diversified meanings depending on the contexts they are employed in. They can include “the knowledge and use of two or more languages, the presentation of information in two languages, the need for two languages, the recognition of two or more languages, and so on” (Grosjean, 2013, p. 5). Bilinguals need to process information in either of their two languages and switch between them to establish and maintain effective communication in diverse contexts (Zhang et al., 2020). Previous studies have shown that when bilinguals employ one language (i.e., the target language), the other language (i.e., the non-target language) is also activated, spontaneously (Costa & Caramazza, 1999; Miwa et al., 2014; Morford et al., 2011; Thierry & Wu, 2007; Zhang et al., 2011; Zhang et al., 2020). However, one common misconception in the concept of bilingualism is that bilinguals master two languages fluently (Grosjean, 2013). Some people see bilinguals as two monolinguals in a single persona. In many cases, majority of bilinguals do not have a uniform fluency in their languages, many have dominance in at least one of their languages, and many acquired those languages in their later years. In a greater sense, bilinguals employ their languages in multitude of contexts for different purposes, in different spheres, to attain different goals. Their fluency in a particular language immensely depends on their need for that language.

On the aspect of aging, major age-linked wanes occur in a broad array of production tasks, such as everyday word retrieval and production of a target word from its definition (e.g., Burke et al., 1991) or from its initial letter and semantic category (e.g., McCrae et al., 1987); reading and producing isolated words under time pressure (e.g., Schmitter-Edgcombe et al., 2000); naming pictures, objects, and actions (e.g., Au et al., 1995); producing pronouns in sentences (e.g., Kemper, 1992); and producing the spelling of familiar, irregularly spelled words (e.g., MacKay et al., 1999). However, MacKay and James (2004) avouch that aging seems to impair lower (phonological) levels of language production more than higher (semantic) levels (see Burke et al., 2000, for a review). Speech errors, on the other hand, happen when a speaker intends to produce a familiar word but inadvertently misproduces one or more speech sounds in the word, as when one intends to say “box of flowers” but instead says “blocks of flowers,” anticipating the /l/ in flowers (MacKay & James, 2004). Such errors provide an aperture into the mechanisms fundamental to everyday language production and have received a great deal of attention in the cognitive sciences over the past 100 years (ibid.). Descriptive studies involving large collections of naturally occurring errors in young and middle-aged adults (e.g., Fromkin, 1973; Meringer & Mayer, 1895) and children (e.g., MacKay, 1970) have cross-classified errors on the basis of two factors: the type of process and the level of the units produced in error (MacKay & James, 2004).

Thus, the goal of this paper is to develop a comprehensive understanding of how aging affects the production of phonological and morphological aspects of speech, as well as different types of speech errors among bilingual speakers, based on the results of relevant studies conducted. This further aims to serve as a baseline information for teachers in Basilan Province to curate the linguistic needs of learners, thus creating a language-free and language-friendly learning environment.

II. LITERATURE REVIEW

A. Bilingual Speech Production

Researches involving adult bilinguals have focused predominantly on psycholinguistic facets of language use. Thus, most of these researches have investigated only bilingual participants to compare processing in the two languages (Bialystok et al., 2004). A few studies on lexical

processing that have included between-groups comparisons have reported bilingual disadvantages on some tasks, such as lexical decision (Ransdell & Fischler, 1989; Bialystok et al., 2004) and semantic fluency (Gollan et al., 1992; Bialystok et al., 2004). Albeit some researches have examined the role of cognitive processes such as working memory in the acquisition of a second language (Harrington & Sawyer, 1992; Miyake, 1998), very little research has investigated whether those processes are modulated by bilingualism (Bialystok et al., 2004).

Researches with children have addressed the cognitive influence of bilingualism more instantaneously (Bialystok et al., 2004). Activities showing a bilingual advantage are typified by the presence of ambiguous or confusing (usually perceptual) information and the need to choose between different competing response options. Tasks based more heavily on analytic knowledge or detailed representations of knowledge presented without a misleading context are solved evenly well by monolinguals and bilinguals. This difference corresponds to the difference between control and representational processes, respectively (Bialystok et al., 2004). The functions contributing to control include selective attention to relevant characteristics of a problem, inhibition of attention to misleading information, and switching between competing alternatives. On the other hand, the functions involved with representation include encoding problems in sufficient detail, accessing relevant knowledge, and making logical inferences about relational information. Research by Bialystok (1993; 2001) has shown that bilingual children develop control processes more readily than monolingual children, but the two groups progress at the same rate in the development of representational processes.

Moreover, evidence from psycholinguistic studies of adult language processing delineates that the two languages of a bilingual remain continuously active while processing is carried out in one of them (Brysbaert, 1998; Francis, 1999; Gollan & Kroll, 2001; Kroll & Dijkstra, 2002; Smith, 1997; Bialystok, 2004)). The shared activity of the two systems needs a mechanism for keeping the languages separate so that fluent performance can be attained without interferences from the unwanted language. Green (1998) proposed a model based on inhibitory control in which the nonrelevant language is suppressed by the same executive functions used by and large to control attention and inhibition. If this model is correct, then bilinguals have had massive practice in exercising inhibitory control – an experience that may then generalize across cognitive domains (Bialystok et al., 2004). If the spur given by childhood bilingualism is sufficiently strong, bilingualism may continue to influence certain control processes throughout one's life span. As avouched by Bialystok et al., (2004), two questions follow from this possibility. First, whether the advantages found for young children in executive processes are also present in adult bilinguals. Second, whether such advantages are maintained in older adulthood and protect bilingual adults from the normal decline of these processes that occurs with age.

B. Cognitive Aging

According to Kroll and Stewart (1994), a bilingual speaker learns words in a second language by forming new connections with current vocabulary and semantic knowledge in the first language, and this increased vocabulary learning prompts neurostructural changes in bilingual speakers (Grogan et al., 2012; Mechelli et al., 2004; Abutalebi et al., 2014). Together, these changes may protect against cognitive decline with aging and certainly behavioral studies indicate that bilingualism is a protective factor against the onset of cognitive decline in Alzheimer's dementia (Bialystok, 2009; Bialystok et al., 2007; Craik et al., 2010; Abutalebi et al., 2014) and other forms of dementia (Alladi et al., 2013).

Likewise, there exists an immense dissimilitude in the level of bilingual functioning or degree of bilingualism characterizing people who speak two languages. Factors such as age of acquisition, language exposure, language dominance, language proficiency, frequency of intra-sentential and inter-sentential code-switching, etc. are all possibly to attune the degree of bilingualism and, successively, affect cognitive resilience in throughout one's lifetime. Some studies (Verreyt et al., 2016; Yow & Li, 2015) have shown that bilinguals with balanced proficiency in their first and second languages and a rich experience of language switching tend to have enhanced executive function as compared to less balanced bilinguals (Zhang et al., 2020). Research which explored the latent advantages of bilingual acquisition on general cognition has proposed that bilingualism amplifies executive functions (Chamorro & Janke, 2020). Executive function skills refer to domain-general cognitive abilities which include inhibition of specific information or responses, switching of attention between tasks, and monitoring and updating of information in working memory (Chamorro & Janke, 2020; Miyake and Friedman, 2012; Miyake et al., 2000). Since language control appears to make use of domain general executive functions (Craik & Bialystok, 2006; Green & Abutalebi, 2013), bilingual speakers may transfer this ability to non-linguistic cognitive domains and thus outperform monolinguals on tasks requiring inhibitory control or attentional switching (Chamorro & Janke, 2020). With that, one explanation for the significant and beneficial effect of bilingualism is that using two languages on a regular basis serves as implicit training for the cognitive control system. According to Zhang et al. (2020), in view of this training-like experience, elderly bilinguals should be more cognitively resilient as compared to age-matched monolinguals. Consistent with this argument, bilinguals with terminal brain diseases show a later onset of the symptoms and suffer to a lesser extent from associated cognitive deficits (Zhang et al., 2020). Furthermore, using multiple languages from early life appears to protect individuals against mild cognitive impairment, a sign of cognitive decline often observed before Alzheimer's disease (AD) diagnosis (Perquin et al., 2013). In parallel, studies have shown that bilinguals with AD tend to manifest greater brain atrophy than monolinguals when cognitive performance is matched across groups (Schweizer et al., 2013; Schweizer et al., 2012; Zhang, 2020).

As Bialystok et al. (2004) pointed out, researches in cognitive aging has advanced tremendously in the past

decades, producing detailed studies and sophisticated models of age-related changes in cognitive functions (see chapters in Craik & Salthouse, 2000). Most of these researches involve English-speaking participants, and conclusions have been drawn with little or no regard to the possibility that the participants might also speak another language. Yet, existing evidence strongly suggests that bilingualism has an effect on cognitive processing, at least for children and younger adults (see chapters in de Groot & Kroll, 1997, and Harris, 1992). What has not been examined is whether these effects persist over the life span and continue to affect changes in cognitive processing in bilingual older adults (Bialystok et al., 2004). Consequently, a number of people across the globe experience some form of bilingualism either by education, immigration, or home environment (Romanowski & Jedynak, 2018). In the United States, 17.9% of Americans reported that they spoke a language other than English at home, and it is a reasonable assumption that most of them also speak English (U.S. Census Bureau, 2003; Bialystok et al., 2004). Given the pervasiveness of bilingualism and/or multilingualism in the Philippines, specifically in Basilan Province where individuals speak more than one language, it is important to establish its precise effects on cognitive processing and the way in which these effects are modulated by aging.

It is well entrenched that the representational functions that depend on well-learned knowledge and habitual procedures, i.e. “crystallized intelligence”, hold up well in the later adult years, whereas abilities that depend on executive control processes, i.e. “fluid intelligence”, show a marked decline in efficiency. In the former category, vocabulary levels (Park, 2000; Salthouse, 1991), general world knowledge (Salthouse, 1982), and language use (Wingfield & Stine-Morrow, 2000) all show little age-related decline. In contrast, executive control functions undergo declining efficiency with aging (Bialystok et al., 2004). In perceptual processing, older adults are less able to ignore unrelated stimuli (Rabbitt, 1965) and to attend selectively to important aspects of the environment. Less effective attentional processes result in less efficient detection, discrimination, and selection of wanted stimuli, reduced resistance to interference, and impaired inhibition of information that is unimportant or irrelevant (McDowd & Shaw, 2000; Bialystok et al., 2004). Hasher and Zacks (1988), cited in Bialystok et al. (2004), argued that much of the observed downturn in cognitive functioning is the result of a downturn in the effectiveness of inhibitory processes, although that general conclusion has been called into question by the results of more recent studies (e.g., Kieley & Hartley, 1997; Kramer & Strayer, 2001) and modified and refined by Hasher and Zacks themselves (Hasher et al., 1999; Zacks et al., 2000). What does seem clear is that older adults show a decline in the effectiveness of executive control processes in many situations unless task performance depends on strongly ingrained habits (Hay & Jacoby, 1996, 1999; Bialystok et al., 2004) or is well supported by the environmental context (Craik, 1986; Bialystok et al., 2004). In summary, then, children’s cognitive development is characterized by a growth in both control of attention and representational complexity, whereas aging leads to a decline in the effectiveness of attentional control but not

in the ability to employ habitual procedures and representational knowledge. Bilingual children, therefore, experience an improvement in the development of the types of cognitive processing that predominantly diminish with aging.

Moreover, perhaps paradoxically, little is known about the manner and extent to which speaking, which is one of the complex fine motor skills, progresses throughout a lifespan, notwithstanding the huge functional importance of speaking in everyday life (Tremblay et al., 2018). Much of the researches on language production in aging have zeroed in on cognitive functions, such as semantic processing, lexical retrieval or working memory. While semantic processing seems relatively preserved (e.g. Macoir et al., 2016), several studies have documented a decline in performance during lexical decision (e.g. Lima et al., 1991), word reading aloud (e.g. Balota & Duchek, 1988; Moers et al., 2017) and verbal fluency tasks (e.g. Britt et al., 2016; Meinzer et al., 2009; Meinzer et al., 2012), suggesting a decline affecting lexical processes in speech production (Tremblay et al., 2018). Furthermore, older adults frequently exhibit a decrease in accuracy and an increase in vocal reaction time during naming tasks (e.g. Bowles et al., 1987; Britt et al., 2016; LaGrone & Spieler, 2006; Newman & German, 2005). For example, LaGrone and Spieler (2006) found an age-related increase in vocal reaction time during a picture naming task, especially for pictures with low naming agreement. Because low naming agreement is analogous with high lexical competition, this finding suggests an age-related decline in lexical selection mechanisms (LaGrone & Spieler, 2006).

C. *Speech Errors*

Speech errors or slips of the tongue are involuntary deflections from the intended form of utterances, often in the form of exchanges or other misplacements of speech sounds, morphemes, or words (Nooteboom & Quené, 2020). Some examples, taken from Fromkin (1973), are a Canadian from Toronto instead of a Canadian from Toronto, heft lemisphere instead of left hemisphere, a language needer learns instead of a language learner needs, take him to the lab first instead of take him to the lab last (cited in Nooteboom & Quené, 2020). Speech errors have been studied since the late nineteenth century by phoneticians, linguists, psycholinguists, neurologists, neuropsychologists and psychoanalysts mainly because they provide a window on the mechanisms fundamental to speech. Given the complexity of these mechanisms, human speech is remarkably fluent and errors of speech are relatively infrequent (Nooteboom & Quené, 2020). Garnham et al. (1982), counting speech errors in a corpus of spontaneous speech of 175, 000 words, found one speech error in every 900 words. Rossi and Peter-Defare (1998), in their study, counted speech errors in a number of conversations lasting 45 minutes each, found that the frequency of speech errors varied over conversations from one per 680 words to one per 1700 words, with an average of one per 900 words.

Furthermore, a number of studies have shown that the tip of the tongue phenomenon, a momentary inability to retrieve the phonological form of a word, is more common in the elderly than in younger adults which suggests a decrease in phonological encoding mechanisms during word production in

aging (e.g. Brown & Nix, 1996; Burke et al., 1991; Rastle & Burke, 1996). Other studies have documented the effect of aging on the number of morphological and phonological errors using word reading tasks that require participants to manipulate phonemes (MacKay & James, 2004). Clearly, the production of spoken language undertakes pivotal changes throughout aging, influencing lexical access and phonological word form encoding (for a review, see Mortensen et al., 2006).

III. CONCLUSIONS

The studies mentioned above had indubitably investigated and explored speech production of bilingual speakers, how cognitive aging affects individual's language and utterances, and how speech errors occur in young and older speakers. Using the lenses of the studies mentioned, language educators or language researchers may look into the case of bilingual speakers in their locality, for instance, in Basilan Province, where the presence of bilingualism and/or multilingualism is evident, how aging affects their speech production, and how speech errors occur in different age groups – where it is more apparent. In the Philippine context, mother tongue is used as medium of instruction from kindergarten to third grade of primary education, while Filipino and English, being the two official languages of the country, are employed and taught in later years of a child's school life (Belvis et al., 2019).

Furthermore, learning a specific language frequently commence with learning to understand bits of it. This is where bilingualism starts too: it starts when an individual has learned to understand bits of at least two languages. It should be noted that bilingualism from childhood through adolescence is shaped by opportunities or missed opportunities for language learning, most remarkably arising from the child's life-central experience at home and at school, as well as the beneficial and powerful force society plays in validating the languages children speak or desire to speak. In general, children's opportunities to learn a specific language occur through direct and meaningful interactions with adults and peers within the proximal systems of their homes and schools. As such, it is crucial for educators, as well as parents, to explore multiple opportunities and learning avenue so as to curate multitude of possibilities for a child to be equipped with a specific language, apart from what he learns at home and in other social contexts.

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