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BEHAVIOR (H. KIRSHNER, SECTION EDITOR)

Aphasia in Multilingual Patients

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Abstract

Purpose of Review We summarize recent published work concerning assessment and treatment of aphasia in bilingual and multilingual people and review current related models of treatment outcomes. As well, we discuss studies that address the recently debated topic of cognitive processes in bilingual individuals with aphasia, with a focus on the effects of bilingualism on aphasia recovery and its potential protective effects.

Recent Findings Providing assessment and treatment tools that best serve multilingual individuals with aphasia and unpacking the variables and mechanisms that underlie response to treatment have emerged as goals of several recent studies. Additionally, while findings are still contradictory, some empirical studies reported that aphasia may manifest less severely in multilingual individuals and may improve faster compared to in monolingual counterparts.

Summary The findings of recent studies with the focus of aphasia in multilingual individuals are crucial to understanding theoretical and clinical aspects of brain-related language impairment in multilingual people and to the study of language representation and processing in the brain.

Keywords Bilingual · Language · Assessment · Treatment models · Cognitive reserve

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Introduction

Aphasia is an acquired language disorder, typically affecting both language comprehension and production, albeit to different degrees [1]. Impairments range from mild to severe, with great heterogeneity of symptoms across individuals. The hallmark symptom of aphasia is anomia, or word finding difficulty. Language deficits associated with aphasia affect people's ability to communicate and limit their life participation. The cause of aphasia is acquired brain injury, most commonly a stroke, as well as a closed-head injury or a tumor. Aphasia can also be associated with neurodegenerative disorders, such as fronto-temporal dementia and dementia of the Alzheimer's type. In most cases, damage to the left hemisphere cortical and subcortical regions results in aphasia, although in a minority of people, aphasia can result from damage to the right hemisphere. Communication abilities affected by aphasia often improve with time and with language intervention. The investigation of the association between the regions and networks in the brain affected by the acquired lesion, and the manifestation of language deficits provides insight into the much-studied topic of brain-language relations [2].

Approximately 13.7 million individuals suffer from stroke per year globally [3]. It is claimed that one-third of stroke patients endure aphasia symptoms [4]. With more than half the world's population being bilingual and multilingual, there is a need to understand the characteristics of aphasia symptoms in bilingual individuals and proper assessment and treatment plans that are unique to this population. Moreover, the consequences of a single, focal lesion to the brain of multilingual individuals are of particular interest as they can shed light on the underlying instantiation of multiple languages in the brain and contribute to neurolinguistic investigations.

There is a great heterogeneity among people who are multilingual in terms of their proficiency in each of their languages, their frequency and patterns of language use, the age and circumstances at which they became multilingual, and in the linguistic distance of their languages. Moreover, multilingualism is a dynamic construct, and many multilingual

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individuals shift their levels of proficiency and use over time [5]. Numerous psycholinguistic and neurolinguistic investigations have examined the question of how multiple languages are processed in the minds and brains of multilingual individuals [6–9].

A comprehensive review of all studies related to multilingualism and aphasia is beyond the scope of this paper; here, we will mostly review studies published in the last 3 years. We will use multilingual and bilingual terminologies interchangeably to refer to people who speak more than one language.

Assessment and Treatment of Aphasia in Multilingual People

In recent years, the question of whether all languages of a multilingual individual will be affected to the same extent following a single lesion [10] has been extended to one about the variables and circumstances under which languages will demonstrate similar or differential impairments in multilingual people who acquire aphasia [11•]. These variables include multilingualism-related ones, such as age of acquisition, degree of pre-stroke proficiency and language use before and after the aphasia onset, as well as aphasia-related variables, including the characteristics of the brain lesion and the severity of the aphasia [12••].

Numerous efforts to improve assessment and treatment practices for people with aphasia who are multilingual have been seen in the literature, including several papers published in recent years. Recent examples include the adaptation of an aphasia test, and of treatment protocols, and an increase in the variety of languages reported in the literature [13, 14••, 16, 17]. Ballard et al. [13] offer guidelines for constructing naming tests, based on the oft-used Boston Naming Test (BNT), in languages for which a test is unavailable, and for optimizing its versions to test bilingual people with aphasia [18]. Following guidelines suggested by Ivanova and Hallowell [19], Ballard et al.'s study illustrates the importance of constructing tools that are linguistically and culturally appropriate to the population being tested [13, 19]. Utilizing appropriate assessment tools is critical for the now accepted practice of assessing — to the extent possible — all the languages of a multilingual person with aphasia [20].

Two recent studies remind us of the importance of assessing patterns of impairment and recovery of all the languages of multilingual people with aphasia [16, 17]. Van Zyl et al. assessed six multilingual participants with aphasia speakers of Sepedi, a Bantu language, and English, in both languages using versions of the Western Aphasia Battery-Revised (WAB-R) and the BNT [17, 21]. The authors provided detailed information about the language background of their participants, including the relative dominance of each language. Their results demonstrated comparable performance in the two languages (including overall accuracy rates and error types), despite self-reported differences in dominance. The authors took their results to suggest that the typological dissimilarities between the two languages did not affect relative performance.

Another recent study demonstrates the idea of profiling, as the authors term it, of two languages of a Kannada-English speaker with aphasia [16]. The WAB-R versions in English and Kannada, a Dravidian language, were used to assess the person's performance, demonstrating a differential pattern of impairment in the two languages after the intervention. As many earlier studies, results are difficult to interpret considering a number of variables, such as age of language acquisition and pre-stroke language proficiency, not fully reported in this study. In their study, the treatment, devised by the authors, was provided in the participant's first language, Kannada.

Indeed, treatment protocols need to be appropriate to the languages of a multilingual person with aphasia. The study by Grasso et al. examined the efficacy of VISTA, an online version of script training — an evidence-based approach that has been used by clinicians and researchers — when employed with a multilingual person [14••]. The authors conducted a single-subject multiple-baseline study — a common design in aphasia treatment studies — and administered treatment in each of the participant's two languages, English and Spanish, sequentially. They found that both treatment phases benefited both languages. They also observed a cognate effect, with scripts with multiple cognates proving less effective in facilitating cross-language effects compared to scripts with few cognates. Cognates are translation equivalents that share form in addition to meaning across languages. Previous studies have found both facilitation and inhibition effects of cognates [22, 23].

Multiple efforts to enhance treatment efficacy in bilingual people with aphasia have been seen in recent years. Kiran and colleagues have been instrumental to these efforts [24–26]; most recently, Sandberg, Gray, and Kiran published a treatment protocol offering an interactive online tool for clinicians [15]. The website they constructed includes treatment protocols and materials aimed to benefit clinicians working with people with aphasia of various backgrounds and languages. A unique aspect of aphasia treatment in people who are multilingual is having to consider whether treatment in one language would benefit the untreated language(s). Goral, Lerman and colleagues examined cross-language treatment effects in several individuals, emphasizing the importance of measuring a variety of language outcomes, of considering pre-stroke language proficiency and use and language attrition [27, 28•, 29]. One finding that has emerged is that not all language aspects treated or

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measured will uniformly show cross-language effects. These recent studies add to a growing body of literature reporting a range of findings regarding treatment efficacy in multilingual people [30, 31].

Models of Treatment Outcomes in Aphasia in Multilingual People

People with aphasia vary in their response to treatment. Moreover, the heterogeneity characterizing multilingual people exacerbate the difficulty predicting treatment outcomes in multilingual people with aphasia. One avenue to advance treatment for multilingual people with aphasia is to develop models that can predict treatment outcome and help decide which language(s) should be treated to increase the chances of treatment benefit in the treated and untreated languages. Such models need to take into account a number of variables that have been implicated in treatment-related language change in multilingual people with aphasia. These variables, mentioned above (e.g., age of language acquisition, language exposure and use, and typological similarities between the languages), have been found to play a role in the representation and processing of multiple languages in the brain and in the manifestation of aphasia in multilingual people.

Age of language acquisition has been at the focus of many investigations about multilingual language representation in neurologically healthy individuals and people with aphasia [32, 33]. It has been suggested that earlier age of acquisition may be associated with better preserved abilities post-stroke. This could imply a possibly differential underlying representation and processing of earlier versus later acquired languages, a matter of ongoing debate in the literature [9, 31, 34]. Moreover, the role of age of acquisition is often difficult to investigate on its own as in most cases, earlier acquired languages are also the most used and most proficient [28•]. Differentiating the effect of age of learning from that of proficiency and use is difficult in those cases, but there are instances in which later acquired languages become more used and more proficient than the early acquired language(s). In these cases, evidence from both neuroimaging studies and aphasia studies suggests that language exposure and use could underlie better performance [11•, 35–37]. Typological similarities and differences between the languages in question can further affect cross-language effects post-treatment, as can affective considerations, such as motivation and attitude [38, 39].

Several models have been developed in recent years with the aim of considering these variables in aphasia treatment. Peñaloza, Barrett, and Kiran examined specifically the role of pre-stroke proficiency on post-stroke performance [40]. The authors employed principal component and regression analyses to examine the relationship between the self-rated proficiency and frequency of use of 27 Spanish–English bilingual people with aphasia and their performance on a naming test (the BNT) and subtests of the Bilingual Aphasia Test (BAT) [41] in their L1 and L2. The majority (22 of 27) of the participants demonstrated better performance post-stroke in the language for which they reported higher proficiency pre-stroke. Peñaloza, Kiran, and colleagues generated a computational model — BiLex — to examine the role of a number of bilingualism-related variables on naming performance [11•]. Their initial model used data from healthy bilingual participants and the authors are currently expanding their model to predict treatment outcome in bilingual people with aphasia [42].

Another model, largely conceptual, was developed by Goral and Lerman [12••]. The authors' Treatment Effects in Aphasia in Multilingual people (TEAM) model lays out three types of variables — multilingualism related, aphasia related, and treatment related — and their interactions with activation and inhibition processes that could explain the mixed patterns of results reported in the literature on treatment outcomes. The authors present examples from the literature to illustrate findings related to each of the variables they discussed and consider theories of relative language activation and inhibition put forward in this literature (the competing mechanisms theory and the lingering suppression theory) [26, 35]. The TEAM model cannot offer an immediate way to compute and predict treatment outcomes but can help identify what variables may play a role for each individual and what potential outcomes they can expect.

A third model, the population encoding, was discussed by Nadeau [31]. The author argues that the effects of variables, such as language proficiency and age of acquisition, can be accounted for within the model. Nadeau's aim is to contribute to our understanding of how the brain supports the functioning of multiple languages. The paper provides support to the assumption that multiple languages are instantiated in the same neuronal networks.

The model discussed in Nadeau' paper captures not only treatment effects but also differential impairment in multilingualism. In another recent attempt to model differential impairment and recovery patterns, Sajid and colleagues targeted one pattern that has been described in the literature on aphasia recovery patterns in multilingualism: alternate antagonism and paradoxical translation [43]. In such cases, a person experiences alternating patterns of accessibility of one language or another, but whereas language A is more accessible for production, translating from language B to language A is impaired and translation to language B is possible while production in language B is impaired (hence the term paradoxical translation) [44, 45]. The Bayesian model described in Sajid et al., which assumes that optimal inference is maintained but that sensory information is compromised following brain damage, was able to simulate

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performance on three language tasks: picture naming, word repetition, and word translation. The authors demonstrated fluctuation in performance by the lesioned model, in which sensory precision was manipulated, simulating performance compatible with alternate antagonism and paradoxical translation. The results suggest that impaired neuromodulation can account for patterns of impairment and recovery in aphasia in multilingual individuals.

Paradoxical translation is related to another factor that is crucial for language recovery in multilingual individuals with aphasia, that is, the phenomenon of language mixing (i.e., the use of more than one language in an utterance or a conversation). Patterns such as alternating abilities in the different languages and involuntary switching between languages have led researchers to hypothesize that the underlying impairment may be that of language control or related cognitive processes.

Cognitive Processes in Bilingual Individuals with Aphasia

Instances of paradoxical translation and other types of language mixing have stirred some controversy early on as to whether the brain lesion associated with aphasia impairs multilingual people's ability to control which language to select for production [46, 47]. More recently, Goral and colleagues examined the claim of "pathological switching," that is, the idea that people with aphasia mix their languages due to a failure to control language mixing [48]. The authors demonstrated that language mixing during testing of 11 multilingual people with aphasia largely reflected patterns of word-finding difficulties. For example, their results demonstrated greater mixing frequency among people who have more severe as compared to mild aphasia, and while attempting to respond in the weaker than a stronger language. There was little evidence of inappropriate mixing (such as using a language that is not known by the interlocutor). Consistently, bilingual people with aphasia as a group were found to voluntarily switched their languages with the same frequency as did a group of neurologically healthy bilingual adults, and both groups experienced language switch cost (i.e., increased response times for language switched trials compared to trials where the language remained the same) [49]. Some of the individuals with aphasia, however, showed decreased abilities of bilingual language control, consistent with other studies reporting that some individuals with aphasia do appear to mix their languages unintentionally [50]. An impaired control mechanism, be it specific to language selection or of cognitive abilities more generally, may account for such findings.

Aphasia has traditionally been defined as a language-domain deficit with preserved cognitive competences. However, studies that have focused on impaired and spared executive functions in individuals with aphasia indicate that these individuals exhibit also executive function impairments [51, 52]. Two recent studies add to this debate [53, 54]. Calabria et al. found a selective lexical-retrieval impairment in the non-dominant language of Catalan-Spanish bilingual individuals with aphasia when compared to monolingual counterparts [53]. The authors explained that considering the role of executive control in lexical retrieval, the impairment they observed may be due to deficits in managing the inhibitory control and in efficient suppression of the dominant language when using the non-dominant language. Arantzeta et al., on the other hand, found that Basque-Spanish bilingual individuals with aphasia and healthy bilingual adults performed comparably and as accurately as monolingual adults in sentence comprehension tasks requiring inhibitory control [54]. Additionally, eye-tracking data implied that bilingual individuals (both with aphasia and healthy) benefited from enhanced cognitive inhibitory mechanisms when compared to monolingual individuals (with aphasia and healthy) [54].

While potential cognitive control impairments in aphasia can lead to language control impairment in bilingual people with aphasia, there is evidence for the potential cognitive benefits of bilingualism. Thus, bilingualism could provide an advantage to people with aphasia, as compared to monolingual people with aphasia. Studies have shown that bilingualism can enhance the inhibitory control mechanism and overall cognitive control processing, likely due to the constant suppression of non-target language and monitoring two languages [55]. Moreover, in the last two decades, many studies have revealed a robust link between cognitive reserve and life-long bilingualism [56]. Nonetheless, research on cognitive benefits of bilingualism is yet inconclusive, where some studies found no bilingual advantage and some found limited bilingual advantage and only in specific contexts [57]. It is worth mentioning that these studies are highly variable in their methodologies and are inconsistent in controlling for various factors (such as age of acquisition, language dominance, frequency of use, immigration status, and linguistic distance; see [58]).

The term cognitive reserve mainly has been used in the context of bilingualism and healthy aging and as the resilience to cognitive decline that delays the manifestation of degenerative diseases such as Alzheimer's disease [56, 59]. During more recent years, cognitive reserve has been studied for its effects on aphasia recovery in bilingual individuals [60–62].

In one such study, Lahiri et al. reported that bilingual individuals generally showed greater recovery when compared to monolingual individuals after stroke and irrespective of any type of strokes [63••]. Participants were tested twice with the Bengali Western Aphasia Battery (BWAB)

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[64], during the first week and between 90 to 100 days post-stroke. Although participants responded similarly to the stroke with comparable BWAB scores in the first testing point, bilingual participants performed significantly better in the follow-up testing [63••]. Moreover, individuals who were diagnosed with more severe stroke based on the size of lesion and the lower scores in the initial testing showed better recovery if they were in the bilingual group. The heterogeneity in the samples and the analyses used by the authors, however, warrant further study. In another study, better improvement in processing speed, as measured with event-related potential (ERP) tasks, was reported for bilingual compared to monolingual participants after post-stroke rehabilitation [65•]. These findings are consistent with previous studies and further support the positive effects of bilingualism on post-stroke language recovery [59].

Moreover, the work by Paplikar et al. indicates that aphasia symptoms often manifest as less severe in bilingual individuals post-stroke when compared to monolingual individuals [66]. The authors investigated aphasia severity in 38 bilingual and 27 monolingual individuals who were diagnosed with aphasia. The severity of the participants' aphasia was determined based on their scores on the Addenbrooke's Cognitive Examination-Revised (ACE-R), a brief bedside battery to evaluate cognitive domains. Results revealed that bilingual individuals, in general, showed less severe aphasia. Furthermore, the authors discussed the education level and immigration status of participants as possible confounding variables affecting the aphasia severity and found these factors to be independent from the severity of aphasia. Thus, they concluded that bilingualism seems to be the main variable determining participants' performance prost-stroke. Whether bilingualism also modulates language difficulties associated with aphasia or mostly cognitive deficits is yet to be established.

Consistent with the findings of cognitive advantage, bilingual individuals with aphasia have been shown to perform better in cognitive control tasks when compared to monolingual individuals with aphasia. This finding persists when executive function and language measures, which account for aphasia severity, are matched among monolingual and bilingual individuals with aphasia. For instance, in the study by Dekhtyar and colleagues, 18 English monolingual and 18 English–Spanish bilingual individuals with aphasia performed a cognitive control task which included congruent and non-congruent tasks [62]. Bilingual adults with aphasia outperformed monolingual individuals in these tasks, providing support for cognitive reserve in bilingual individuals with aphasia. However, monolingual and bilingual healthy controls performed comparably. The authors postulated that healthy individuals may reach the maximum executive control capacities and bilingual advantage is only revealed for performance in clinical population. This can account for the null finding of an advantage in studies with healthy bilingual adults.

Task characteristics may be another explanation for the mixed results reported. Gray and Kiran considered the degree of task complexity when assessing the inhibitory control mechanism and found a dissociation between linguistic and non-linguistic domains in bilingual individuals with aphasia but only for the more complex tasks they employed; they did not observe such effects in healthy bilingual controls for the simple or complex conditions [51]. Carpenter et al. also suggested that bilingual individuals with aphasia compared to monolingual ones perform less successfully when tasks involve greater cognitive demands [67]. The different task types and inhibition types across tasks may explain contradictory results from various studies on inhibitory control mechanism in bilingual individuals with aphasia.

Conclusions

Multilingual individuals with aphasia exhibit various patterns of impairment across their languages, from comparable abilities in all languages to differing degrees of impairment in each language. This depends on a number of variables, such as age and manner of language acquisition and frequency of language use, as well as on the integrity of the underlying neuronal organization in the brain, and, possibly, degree of cognitive deficits. People with aphasia may respond differently to language treatment, depending upon these variables, and adapting evaluation and treatment tools to various languages is critical for the assessment and management of multilingual people with aphasia. Based on our review of most recent models, we conclude that in general, bilingual individual with aphasia may recover better in the language they learned earlier in life and had more exposure throughout their life. Additionally, relative language skills (proficiency pre-stroke and abilities post-stroke) are another important determinant of recovery patterns in bilingual individuals with post-stroke aphasia. Language mixing is also a factor that may affect language recovery in multilingual and bilingual individuals with aphasia. Evidence from the study of healthy bilingual individuals suggests that there is a concurrent activation of all languages in multilingual and bilingual individuals; thus, efficient mechanisms of control may be required to avoid unintentional language mixing and need to be considered when choosing treatment strategies. Theoretical, simulation, and computational models of impairment and recovery in multilingual people with aphasia are emerging as fertile ground for future research.

Although empirical research on cognitive benefits of bilingualism in individuals with aphasia is scarce, available studies suggest that bilingual individuals with aphasia

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benefit from less severe aphasia and faster recovery. Additional research is important because the cognitive benefit associated with bilingualism and more specifically in individuals with aphasia is not supported by all studies. Additional behavioral and neuroimaging studies are needed to better understand the cognitive mechanisms in bilingual individuals with aphasia and to provide further information about the potential constraints or benefits of bilingualism in these individuals.

Investigations in the field of aphasiology in multilingual individuals will advance our understanding of theoretical questions about the patterns of impairments and their implications for typical language organization and processing in multilingual and monolingual individuals, as well as clinical efforts to establish best practices for assessment and intervention in this population.

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