

# Post-stroke aphasia management – from classical approaches to modern therapies

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## ABSTRACT

Post-stroke aphasia is an important topic in clinical rehabilitation neurology, affecting a significant number of stroke patients worldwide each year. Although the anatomical basis of aphasia has been explored for over a century, a revision of disease classification has led to a broader understanding of the subject and has stimulated the field of drug development to yield novel therapies. In this context, the authors commence the current narrative review by presenting the widely accepted aphasia classifications and the corresponding management practices. Subsequently, speech-language therapies are presented, with a focus on the widely preferred patient-centered approach. We conclude with a brief discussion regarding adjunctive treatment options such as pharmacological intervention, non-invasive brain stimulation techniques, and virtual reality rehabilitation.

**Keywords:** aphasia; stroke; Boston classification; speech and language therapy; non-invasive brain stimulation

## Abbreviations

CC – conversational coaching

CIAT – constraint-induced aphasia therapy

CNS – central nervous system

MIT – melodic intonation therapy

NIBS – non-invasive brain stimulation

PACE – Promoting Aphasics’ Communicative Effectiveness

rTMS – repetitive transcranial magnetic stimulation

SLT – speech and language therapy

tDCS – transcranial direct current stimulation

TMS – transcranial magnetic stimulation

## INTRODUCTION

Stroke is a public health problem, affecting an increasing number of people worldwide each year [1]. While the mortality related to stroke is diminishing thanks to modern available therapies, the majority of stroke patients suffer from important comorbidities which have a significant impact on their quality of life [2]. Along with motor deficit, a great burden on daily living activities, stroke patients associate other important symptoms, including sensory disturbances [3], mood disorders such as depression [4], and aphasia [5].

Aphasia, a term that describes the partial or total impairment of language, occurs as a result of lesions in different areas of the cerebral cortex [6]. Typically, these destructions occur post-stroke, but other pathologies such as brain tumors, infections, and the modifications associated with dementia can also cause language impairment [7]. Different regions of the central nervous system (CNS) are responsible for each of the language components, i.e., expression, reception, reading, and writing [8]. Thus, damage to one or more of the language areas may result in a range of deficits, manifesting with considerable

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individual variability, all organized under the concept of “aphasia”.

Although the term “aphasia” alone lacks specificity, it was and continues to be of great importance for neurologists to characterize more precisely the language deficit encountered in a specific patient in order to undertake tailored rehabilitation therapies [9]. In this context, the first aphasia classification that dates more than a century ago was based on correlations between the affected anatomical area and the speech disorder found in patients [10]. This classical-localizationist approach has been used for a long time, being relevant even today. However, associating major types of aphasia with some specific limited locations in the brain has led to many debates over the years [11]. The main limitation of this classification relies on the idea of oversimplification. Or, in recent years, extensive research has been supporting the fact that speech and language disorders are related to the damage of multiple cortical and subcortical regions, some of them only recently discovered [12]. Thus, the currently desired aphasia classification, with important clinical-therapeutic implications, is the Boston classification, which is based on the assessment of the patient’s deficit and secondary on the affected brain structure [13].

The first aim of the current paper is to review and compare two of the most widely used aphasia classifications: the classical-localizationist and the Boston classifications. Subsequently, the most relevant facts related to speech-language therapies are reviewed, with a focus on the more patient-centered approaches. Finally, the authors highlight the emerging adjunctive aphasia therapies, with an emphasis on pharmacological therapies and non-invasive brain stimulation techniques.

#### **From the classical-localizationist to the modern aphasia classification**

According to the localizationist approach, aphasias are classified based on the clinical characteristics resulting from specific cortical region damage. Despite being controversial, the localizationist approach remains an accepted classification system, including Broca’s and Wernicke’s aphasia and other rarer types of aphasias, forming a rather heterogeneous group [14].

A frequently encountered type of aphasia is expressive aphasia, also called motor aphasia or Broca’s aphasia, depending on the location of the lesion in the anterior portion of the dominant hemisphere, specifically, pars opercularis and pars triangularis of the inferior frontal gyrus (Broca’s area). Patients suffering from Broca’s aphasia have difficulties in expression, and fragmented speech, while verbal understanding is relatively preserved [15].

Another example of the earliest described aphasias is receptive aphasia, also called sensory aphasia or Wernicke’s aphasia, in which speech remains fluent, however, with great difficulties in comprehension. Although fluent, speech is impaired, in the sense that the patient frequently makes grammatical and syntactic errors, sometimes inventing words and expressing meaningless sentences. This type of aphasia occurs in the case of damage to the posterior left temporal cortex, more precisely the superior temporal gyrus of the dominant hemisphere (Wernicke’s area) [16].

Other language impairments may also be found in clinical practice, one example being global aphasia, encountered in patients who have suffered an extensive stroke affecting both the Broca’s and the Wernicke’s areas [17]. Moreover, other anatomical structures, when destroyed, can generate specific subtypes of aphasia. An example is the impact of the arcuate fasciculus, a connecting structure between the Broca’s and Wernicke’s areas, which in case of alteration generates conduction aphasia. In this case, the patient maintains comprehension and is fluent in spontaneous speech, but has difficulty when asked to repeat longer words or phrases [18].

Considered in some classifications as a main type of aphasia, anomia is believed to be an underdiagnosed, neglected condition. With a disturbance in lexical retrieval, patients suffering from this disorder may experience difficulties in the construction of coherent phrases, producing narratives with lowered speech rate, reduced mean length, and less complex grammatical structures and sentences [19].

Also worth mentioning, although infrequent, are the transcortical motor, sensitive, and in rare cases mixed aphasias, in which the ability to repeat words remains unaltered, in a disproportionate manner to the rest of the language deficits [20]. All types of aphasia reviewed above are summarized in Table 1 in a systematic manner. One must also take into consideration that about 10% of aphasias remain unclassifiable (thalamic aphasias, capsule-striatal aphasias) [21].

Despite offering insight into the affected cerebral areas that may result in various speech and language impairments, the classical aphasia classification appears to face competition in light of the newer Boston classification, which is based primarily on the acquired deficit, and less on affected brain structure [22]. Three major elements are of interest for the therapist in the Neoclassical Model: the patient’s ability to speak fluently, hence dividing speech impairments into two broad categories of fluent and non-fluent aphasia; the ability to understand spoken language and, lastly, the ability of repetition, these last two questions generating a total of 8 dis-

TABLE 1. Aphasia – types and characteristics

Type	Abnormal / impaired language functions	Relatively / partially preserved language functions	Damaged brain area
<b>Broca's aphasia</b>	<ul style="list-style-type: none"> <li>○ Spontaneous speech (non-fluency, slow output, agrammatism)</li> <li>○ Word repetition</li> </ul>	<ul style="list-style-type: none"> <li>• Verbal and written comprehension</li> </ul>	Broca's area (frontal lobe)
<b>Wernicke's aphasia</b>	<ul style="list-style-type: none"> <li>○ Language comprehension</li> <li>○ Word repetition</li> </ul>	<ul style="list-style-type: none"> <li>• Fluent speech (logorrhea, paraphasia, neologisms)</li> </ul>	Wernicke's area (Brodmann area 22, temporal lobe)
<b>Conduction aphasia</b>	<ul style="list-style-type: none"> <li>○ Fluent spontaneous speech (but paraphasia)</li> </ul>	<ul style="list-style-type: none"> <li>• Word repetition (poor for polysyllabic words)</li> <li>• Language comprehension</li> </ul>	Arcuate fasciculus
<b>Global aphasia</b>	<ul style="list-style-type: none"> <li>○ Language expression (major deficit to aphasic mutism)</li> <li>○ Severe impairment of oral comprehension</li> </ul>	–	Both Broca's and Wernicke's areas (most typical in middle cerebral artery occlusion)
<b>Anomic aphasia</b>	<ul style="list-style-type: none"> <li>○ Word finding (in spontaneous speech and naming, circumlocutions)</li> </ul>	<ul style="list-style-type: none"> <li>• Spontaneous speech</li> <li>• Language comprehension</li> <li>• Word repetition</li> </ul>	Various parts of the parietal lobe or the temporal lobe
<b>Motor transcortical aphasia</b>	<ul style="list-style-type: none"> <li>○ Spontaneous speech (non-fluency, hypophonia, perseveration, echolalia)</li> <li>○ Word finding</li> </ul>	<ul style="list-style-type: none"> <li>• Oral comprehension</li> <li>• Word repetition</li> </ul>	Anterior superior frontal lobe of the language-dominant hemisphere
<b>Sensory transcortical aphasia</b>	<ul style="list-style-type: none"> <li>○ Word finding</li> <li>○ Language comprehension (especially for unusual nouns; semantic impairment usually associated)</li> </ul>	<ul style="list-style-type: none"> <li>• Spontaneous speech (paraphasia, circumlocutions)</li> <li>• Word repetition</li> </ul>	Inferior left temporal lobe
<b>Mixed transcortical aphasia</b>	<ul style="list-style-type: none"> <li>○ Spontaneous speech (non-fluency, palilalia)</li> <li>○ Comprehension</li> <li>○ Word finding</li> <li>○ Alexia</li> <li>○ Agraphia</li> </ul>	<ul style="list-style-type: none"> <li>• Word repetition</li> </ul>	Deep to and posterior to Wernicke's area in either the temporal or the parietal border zone
<b>Subcortical aphasia</b>	<ul style="list-style-type: none"> <li>○ Comprehension (transient)</li> <li>○ Word finding (transient)</li> </ul>	<ul style="list-style-type: none"> <li>• Word repetition</li> <li>• Spontaneous speech (hypophonia)</li> </ul>	Subcortical brain areas

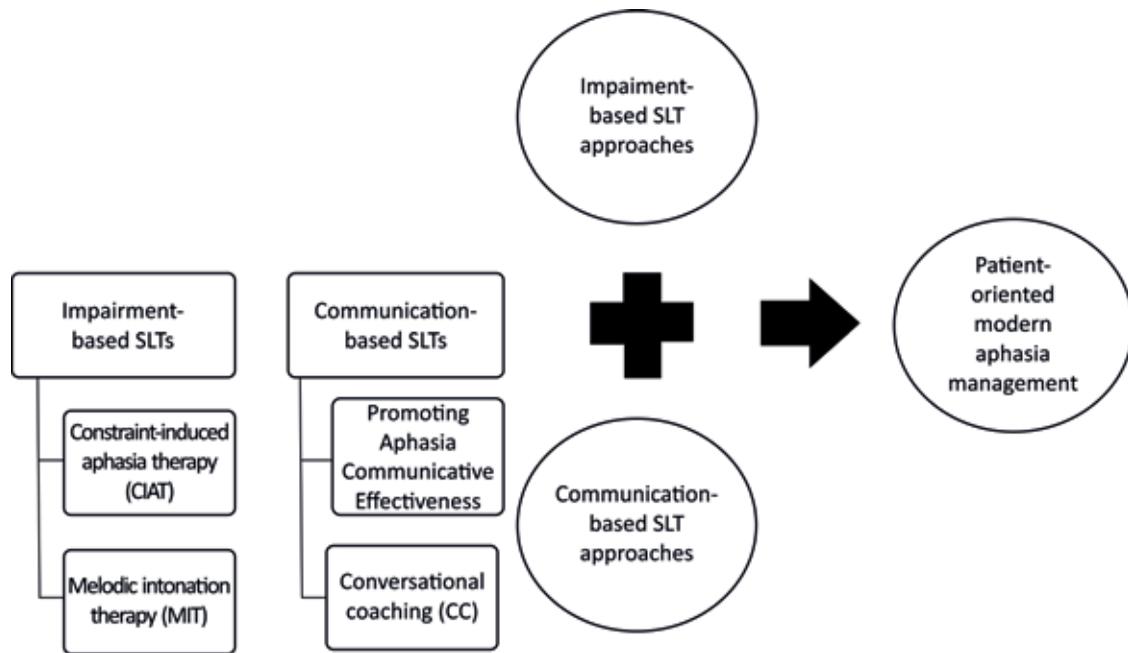
tinct types of aphasia. The main advantage of this newer classification for future therapeutic approaches can be clearly observed, as it offers the opportunity to tailor the therapeutic approach to the patient's individual needs [23].

### Modern speech and language therapies

Currently, there is a multitude of approaches designed for language impairment rehabilitation, with aphasia management occupying a central place in post-stroke recovery therapy [24]. Given the abundance of currently existing methods, the authors decided to focus mainly on the innovative approaches and to summarize only some of the most commonly used in practice speech and language therapies (SLTs) which may be a good starting point for the personalized rehabilitation process. The main aphasia management methods included in this manuscript are summarized in Figure 1.

Current methods can be divided into two groups, depending on the theoretical assumptions about the nature of the language deficits encountered in aphasia, the learning and recovery mechanisms, and therapeutic goals [25]. In the first group, the techniques are based on cognitive neuropsychological models or language theories and address language impairment directly, while the second group includes approaches based on socio-pragmatic models and focuses on communicative resources and the social consequences of the impairments. A personalized and modern approach requires a combination of both types of approaches and varies depending on the stage of recovery, the needs, and the individual capacity of the patient to relearn while focusing on facilitating the transfer of language skills for everyday life situations.

In order to fully understand the impact of impairment-based therapies, a good example is a patient with Broca's aphasia who has difficulties in



**FIGURE 1.** Speech and language therapies (SLTs) in patient-oriented modern aphasia management most frequently used in Romania

verbal expression. In line with the impairment-based therapy principles, the speech pathologist provides during the rehabilitation program pronunciation exercises, naming, starting from initially simple sentences towards increasing in complexity. Modern technologies may be very helpful when relating to such language exercises, “homework” done with the help of dedicated computer programs and phone apps can complete the relatively short sessions that the patient follows with the therapist [26].

The group of impairment-based therapies is however quite heterogeneous, thus, for the purpose of the current review, the authors limited the scope of the study to include the constraint-induced aphasia therapy (CIAT) and the melodic intonation therapy (MIT), both frequently used in Romania. According to CIAT principles, which are also successfully applied in other areas of post-stroke rehabilitation, the patient is forbidden to use mimics and other nonverbal behavioral elements upon the desire to express an idea, thus being encouraged to vocalize [27]. It is a practice completely opposite to the compensatory strategy used sometimes involuntarily by patients. Another advantage of this type of therapy is its ability to be administered in intensive programs, as is already the case in some European countries. Originally invented by Pulvermuller et al. [28], the method has undergone modifications in recent years, but the three basic principles have remained the same: 1. Strong encouragement of the patient to use only verbal communication, without gestures; 2. Intensive training, the original protocol cumulating 10 days of 3 hours/day; 3. Staging the

sessions, with increasing the difficulty of the tasks depending on the patient’s response. From the enumeration of these principles, however, controversies arise, especially regarding the degree of constraint and “high-intensity” of the CIAT applied in various clinical trials. Indeed, several systematic reviews were conducted during the last 5 years addressing several aspects related to CIAT, the most recent one strengthening the effectiveness of CIAT in aphasia rehabilitation, suggesting some directions of good clinical practice [27]. Thus, the ideal duration of a high-intensity program is between 2 and 3 hours per day, daily for almost two weeks, with a focus on appointments, but also on periodic assessment via the best assessment tools available. Similarly, another study demonstrating the effectiveness of CIAT when administered additionally in a second separate period in the chronic stage of aphasia, reported data suggesting multiple doses of high-intensity treatment may bring significant language gains in chronic aphasia patients [29].

MIT, although an older approach to aphasia management, is currently experiencing a legitimate renaissance, being an alternative technique used by speech pathologists worldwide. MIT is based on the idea that some patients having non-fluent aphasia express themselves more easily by singing, or by rhythmic syllabification, rather than by simply trying to speak words [30]. The technique is useful for those with a preserved understanding, with a penchant for melodic intonation. The theoretical anatomical basis is based on the fact that regions of the right hemisphere specific for music processing

could, through neuro-plasticity, take over from the functions of injured areas in the dominant hemisphere, only when they are properly stimulated, for example by musical intonation [31]. Different studies have tried to highlight the functional changes that occurred after the administration of MIT, but the heterogeneity of the protocols did not generate unitary conclusions. Currently, the importance of right brain circuits in both the areas of the cortex and the basal ganglia or cerebellum remains under discussion [32].

There also exist variations of MIT, however, in the sense of reducing the program to different forms of intoned-speech facilitating techniques, such as phonemic cueing, semantic cueing, and simultaneous imitation of speech. Although these methods have a rapid effect, MIT is much more complex, encompassing along with these facilitation techniques intoned speech and rhythmically emphasized prosody and other individualized measures depending on the patient's need [33]. Two major variations of the classical MIT are more frequently employed: The French variation called melodic and rhythmic therapy, in which the patient uses singing to overcome speech limitations, and the palliative variant, through which patients with importance in case of severe Broca's aphasia can produce some short and essential commands in daily activities.

When the early chronic stage of recovery is reached, the impairment-specific treatment should be complemented by introducing communication-based therapies that augment the patient's social participation and consolidate the gains made so far [34]. The common feature of these approaches is greater freedom in communication, which ideally flows as naturally as possible and mimics everyday real-life situations, also having a supporting role for aphasic and their relatives. Among the currently used techniques, we mention PACE therapy (Promoting Aphasics' Communicative Effectiveness), which is a variation of the basic picture-naming drill and enjoys great popularity in Europe [35]. PACE is a type of multimodal therapy, including several types of language aspects (spoken, written, drawn, even facial expressions), having the great advantage that it can be adapted according to the severity of the aphasia. Another benefit is the variability of roles in the conversation, the therapist and the patient naturally change the roles of speaker and listener, in a faithful replica of a true conversation.

Another approach developed and intensively studied by Hopper et al. [36] is conversational coaching (CC). Via this approach, the patient is encouraged to communicate new information using alternative verbal and non-verbal strategies in order to stimulate further interactions. The difference be-

tween CC and other approaches is in providing a conversational format to both conversation partners, one suffering from aphasia. Basically, the template on which this method is based includes the exposition of a single main idea at a time, initially with helpful attempts through questions, then, using several means of communication such as drawing, writing, and speaking, the exchange of ideas being facilitated [37]. The results, although in a few reported cases, are encouraging, however analysis of data in larger patient groups and comparisons with other types of SLTs should guide future research.

The last technique tailored for the chronic stage of aphasia management discussed in this paper is supported conversation for adults with aphasia. The central principle of this therapeutic tool is to train therapists, or in the case of Kagan's study, volunteers of an aphasia rehabilitation center, by bringing new communication skills and competencies [38]. The authors found that aphasic patients performed better when interacting with previously trained individuals compared to the ones supervised by the group of untrained volunteers. Moreover, additional benefits were reported suggesting the importance of the social aspect in the case of post-stroke management, especially the rehabilitation of aphasia.

### **Adjunctive aphasia therapies**

In a significant number of aphasia patients, SLTs alone do not suffice. The need for adjunctive therapeutic approaches is essential in both the acute and the chronic phases of aphasia rehabilitation, improving the outcome of SLTs.

In this context, several drugs were associated with different aphasia rehabilitation protocols, however, a definite conclusion cannot be drawn as of yet. We mention some promising results for piracetam administered in high doses (4800 mg daily), especially in the subacute phases of post-stroke aphasia. Several older studies have shown benefits over placebo in the written language and spontaneous speech production component, however, the effects of this medication are limited in time according to a recent systematic review [39]. More recent research has focused on the impact of anti-dementia drugs in post-stroke aphasia rehabilitation. For example, Davila et al. [40] demonstrated the positive influence of Donepezil in repetition, naming, and spontaneous speech. Precaution in the use of Donepezil is nonetheless mandatory, as moderate side effects such as insomnia, headaches, dizziness, and muscle cramps were encountered in the studied patients. Memantine, an uncompetitive NMDA receptor antagonist used in moderate and severe forms of Alzheimer's disease demonstrated beneficial effects

in aphasia recovery up to 6 months after therapy, improving aphasia severity [41].

In recent years, advances in non-invasive brain stimulation (NIBS) techniques have led to a shift in paradigm, with current studies focusing on the impact of transcranial direct current stimulation (tDCS) and transcranial magnetic stimulation (TMS) in aphasia rehabilitation. Regarding tDCS, although there is increased variability of protocols used in clinical studies, a recent systematic review shows that this NIBS approach boosts the effect of SLTs when applied as an adjuvant procedure in the chronic phase of post-stroke aphasia, with no improvement during the acute or subacute phases [42]. The exact impact of tDCS on language impairments remains incompletely explored, studies analyzing only specific language aspects such as naming, fluency, and reading when assessing a patient's performance instead of evaluating communication in real-life situations.

TMS, with its variant of repetitive stimulation protocol (rTMS) with long-term therapeutic impact, is another powerful tool used in many disorders, including enhancement of aphasia rehabilitation. Both low and high-frequency rTMS were employed, as specific cortical areas require either inhibition or stimulation within the complex neural circuit of language. Thus, low-frequency (inhibitory) stimulation of the right lower frontal gyrus and also of other regions of the right hemisphere was shown to improve outcomes in both subacute [43] and chronic phases of post-stroke aphasia [44]. High-frequency (stimulatory) rTMS was effective when applied in key regions in both hemispheres such as the left inferior frontal gyrus or the right inferior temporal gyrus in specific groups of patients [45]. Still, the lack of sufficient evidence and of a good clinical practice protocol has limited this technique to reach large-scale deployment.

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## CONCLUSION AND FUTURE RESEARCH DIRECTIONS

With the increasing prevalence of stroke and post-stroke aphasia worldwide, it is imperative that the currently available SLTs are improved and that new adjunctive methods are introduced in daily clinical practice. According to modern aphasia rehabilitation principles, the therapeutic approach should be patient-oriented, starting from a detailed assessment of the language impairment and subsequently employing the most appropriate rehabilitation techniques.

The promising results of tDCS and rTMS along with their non-invasiveness and few contraindications make these methods highly desirable. It remains essential to establish safety protocols for the maximization of their impact in all phases of post-stroke aphasia management. Finally, efforts in research and development in the area of pharmacology should continue to be made, as drugs could increasingly become more efficient in adjunctive therapy and play an overall role in the improvement of post-stroke management.

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### Conflict of Interest

The authors state that there was no conflict of interest.

### Data Availability

The authors declare that data supporting the findings of this study are available within the article.

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