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# Spontaneous Recovery and Intervention in Aphasia

*Chiaki Yamaji and Shinichiro Maeshima*

## Abstract

The recovery of aphasia occurs immediately after the onset of the disease and lasts for several months or more. The speed and degree of improvement in aphasia vary depending on the time since onset, severity of aphasia, and each language modalities. It is assumed that there is a difference in the mechanism of aphasia recovery. The recovery process of the central nervous system observed in the first few days to weeks after the onset of aphasia is thought to involve the disappearance of cerebral edema, the absorption of necrotic tissue, angiogenesis, the development of the collateral circulation, and the resolution of hematomas, leading to the repair of damaged tissue. In the chronic phase, 1) recovery of damaged functional areas, 2) reconstruction of functions in the residual areas, and 3) compensatory functions by the contralateral hemisphere or activation of the contralateral cortex are assumed. In recent years, there have been many reports supporting the effectiveness of speech and language therapy interventions. Speech and language therapy should not only promote improvement of aphasia, but also take a comprehensive approach to improve the QOL of aphasia patients, such as acquisition of compensatory means of communication and family guidance.

**Keywords:** aphasia, spontaneous recovery, recovery process, speech language therapy, rehabilitation

## 1. Introduction

### 1.1 What is spontaneous recovery?

Spontaneous recovery from aphasia implies that impaired language functions improve without speech therapy interventions [1]. Several previous studies have investigated the duration for and degree of spontaneous recovery from aphasia. Culton evaluated the progress of improvement in language functions over a 2-month period four times at 2-week intervals using eight types of language tasks, such as naming and writing, in 11 patients with acute aphasia 2–4 weeks after the onset and in patients with chronic aphasia 11–48 months after the onset. Language therapy was not performed during the assessment period in both the groups. It has been reported that the acute aphasia group showed a more marked improvement. Particularly, the largest differences in the results of the language tasks were observed between the first and the second sessions, which indicated that the degree of improvement was most pronounced about 1 month following the onset of aphasia. It was also reported that improvements continued up to approximately 3 months after the onset [1]. Hartman (1981) evaluated language functions at the first visit and 30 days after the

onset using the Porch Index of Communicative Ability (PICA) in 44 patients with acute aphasia within 2 weeks after the onset. Comparison was made between the early group, which consisted of 20 patients who were administered the PICA within 6 days after the onset, and the late group, which consisted of 24 patients who were administered the PICA 7–14 days after the onset. Speech therapy was not administered in either of the two groups. As 42 of 44 patients showed improvements, it was reported that spontaneous recovery was achieved within 1 month. In particular, the early group showed more improvement in scores, showing most pronounced spontaneous recovery within 1–2 weeks. Moreover, given that the results of the final PICA were positively correlated with those of the initial PICA, it was argued that the degree of spontaneous recovery might be proportional to the severity of aphasia at the time of the onset [2]. Lomas & Kertesz evaluated language functions within 30 days and 3 months after the aphasia onset using the Western Aphasia Battery (WAB) in 31 patients with poststroke aphasia. Based on the initial WAB results, the patients were divided into the following four groups: the non-fluent/poor comprehension group, non-fluent/good comprehension group, fluent/poor comprehension group, and fluent/good the comprehension group. The two good comprehension groups exhibited improvements in general language functions, whereas the two poor comprehension groups displayed great improvements in comprehension and repetition [3]. Maeshima et al. evaluated language functions 1, 3, and 6 months after the aphasia onset using the Standard Language Test of Aphasia (SLTA) in 30 patients with poststroke aphasia who had not received speech therapy. Regardless of the age and gender, the SLTA scores improved 3 months after the onset in 18 patients; particularly marked improvements were noted in patients with moderate/mild aphasia. The SLTA scores improved 6 months after the onset in 14 patients irrespective of the severity. In terms of language tasks, such as writing, speech, and comprehension, improvements were observed in all tasks within 6 months. However, differences in the degree of improvement depending on the type and severity of aphasia were reported. Additionally, they reported that some patients were still followed 9–12 months later and that improvements were noted even in patients with severe aphasia [4]. Lendrem & Lincoln used PICA to evaluate 52 patients with poststroke aphasia who did not receive speech therapy 4, 10, 22, and 34 weeks after the onset. They reported that improvements in language functions continued until 34 weeks with the most pronounced improvement at 4–10 weeks. In particular, the results of the first PICA were correlated with the language functions after 6 months, suggesting that the degree of improvement is proportional to the severity of aphasia at the onset [5]. Sarno and Levita evaluated language functions using the Functional Communication Profile (FCP) in 28 patients with severe poststroke aphasia who did not receive speech therapy within 2 days, at 3 and 6 months after the onset. They reported that, as some subjects passed away, the number of the subjects decreased to 18 after 3 months and 14 after 6 months, and the improvements in the FCP were more pronounced at 3 months than 6 months after the onset [6].

Based on these reports, it is clear that spontaneous recovery from aphasia is possible in some cases. Age and gender do not seem to greatly affect the recovery. Although the degree of recovery differs depending on the severity of aphasia and language functions, improvements may be most pronounced 1–3 months after the onset and continue for 3–6 months or more.

## **1.2 Mechanism involved in recovery of the central nervous system**

The recovery process of the central nervous system for a few weeks after the onset is believed to involve reduction of brain edema, necrotic tissue absorption, hematoma absorption, and formation of collateral circulation. Although recovery

of the central nervous system is limited after a long duration since the onset, language functions may continue to improve gradually.

Regarding the correlation between the recovery of language functions and the central nervous system recovery, Saur et al. conducted a study using functional magnetic resonance imaging (fMRI). They reported the following processes in acute-phase middle cerebral artery (MCA) infarction: First, the activation of the remaining language-associated brain area is reduced, then activation occurs in the brain area related to language function improvement as well as in the surrounding area and the contralateral hemisphere, and finally normal activation ensues. Therefore, the reorganization of the central nervous system progresses in a stepwise manner [7].

Heiss et al., using positron emission tomography, investigated language functions 2 and 8 weeks after the onset in 23 patients with poststroke aphasia. In the group including patients with frontal lobe lesions and in that including patients with subcortical lesions, the right inferior frontal gyrus and the right superior temporal gyrus (STG) were activated at 2 weeks, and the left STG was activated at 8 weeks, showing considerable improvements in the language functions. Among patients with temporal lobe lesions, the left Broca's area and the supplementary motor area were activated at 2 weeks, and the bilateral precentral gyri and the right STG were activated at 8 weeks. However, the left STG did not activate, and improvements in the language functions were negligible. They reported that the recovery of language functions is preceded by compensation in the right hemisphere and that the preservation of the left STG is crucial for the reorganization of the neural network [8].

Mimura et al. performed single photon emission computed tomography (SPECT) to investigate the relationship between cerebral blood flow and language functions in patients with aphasia caused by left MCA lesions within 1 year and 7 years after the onset. They argued that increased blood flow in the left hemisphere was correlated with changes in language functions at 3–9 months and that functional recovery of the left hemisphere was essential for the improvement in language functions within 1 year. Changes in language functions after 7 years were correlated with increases in blood flow in the right hemisphere (especially in the frontal lobe and the thalamus). Functional compensation by the contralateral hemisphere may be involved in the long-term recovery of language functions [9].

These previous reports suggest that the mechanism of recovery involved in central nervous system reorganization may differ depending on the time from the onset. The mechanism for central nervous system recovery may possibly involve the recovery of damaged functional areas, reorganization of neurons in the remaining areas, or compensation by the contralateral hemisphere.

Pani et al. investigated the correlation between the right hemisphere and language functions in patients with chronic aphasia. They reported that fluency of speech was highly correlated with the volume of the middle temporal gyrus, precentral gyrus, and inferior frontal gyrus in the right hemisphere, as well as the volume of the fibers connecting the right and left supplementary motor areas. This may reflect a predisposition toward compensatory functions of the contralateral hemisphere [10].

## **2. Improvement in language functions**

### **2.1 Factors related to improvement in language functions**

#### **2.1.1 Age**

Many reports state that young people are more likely to show greater improvement in language functions than old people [11–14]. The underlying factor for



this difference is believed to be the difference in the plasticity of the brain associated with age. Previous studies using fMRI revealed that the left inferior frontal gyrus was activated in young subjects during verbal fluency tasks. Conversely, old subjects showed activation of the right inferior/middle frontal gyrus and poorer scores. These findings imply age-dependent differences in brain physiology and functions [15].

However, many reports conclude that there are no age-dependent differences in terms of improvement in language functions [1, 5, 16–24]. Therefore, no consensus has been reached on this matter. It is unlikely that language functions are related exclusively to age; hence, other factors, such as etiological causes (post-traumatic aphasia is prevalent in young people) and types of aphasia (Broca's aphasia is prevalent in young people), may also be related to language functions. Therefore, age-dependent differences may not have been apparent in studies that controlled these conditions. While age is an important factor for improving language functions, one must pay attention to the interpretation of correlation.

### *2.1.2 Gender*

There are gender differences in terms of recovery from aphasia, and some reports showed that women were more inclined to recover than men [25, 26]. These differences may be attributed to the gender differences in the functional composition of the brain. Kansaku & Kitazawa conducted a study using fMRI and reported apparent gender-based differences in the activity of the anterior and posterior speech areas in vocabulary and story comprehension tasks, respectively [27]. Likewise, Shaywitz et al. also conducted a study using fMRI in which activation was found to be biased in the left inferior frontal gyrus in men in phonologic tasks, whereas broad areas including bilateral inferior frontal gyrus were found to be activated in women [28]. These reports indicate that gender plays a role in activating the brain areas with respect to language function. However, many reports argued that gender was not a factor for improving language functions [14, 16, 17, 19–21, 29]. Therefore, no definite correlation between gender and improvement in language functions has been established. Besides, other factors may also be related to gender. For instance, women are more susceptible than men to subarachnoid hemorrhage, which is an etiological factor conducive to improvement in language functions.

### *2.1.3 Causative diseases*

Improvements in language functions are greater in patients with traumatic injury and in patients with brain hemorrhage than those in patients with brain infarction, respectively [29, 30]. This is attributable to differences in the extent of damage to the parenchyma in the cortical/subcortical tissue in the brain. Compared with brain infarction cases, brain hemorrhage cases achieve greater improvements through the absorption of hematoma and reduction of edema. However, severe aphasia may persist following traumatic injury and brain hemorrhage. Accordingly, prognoses may differ depending on the severity of brain damage. In addition, because of the differences in indications for thrombolysis or thrombectomy, it is difficult to predict the recovery of language function based on etiology alone today.

### *2.1.4 Dominant hand*

The dominant hand is closely related to the language-dominant hemisphere, and 96%, 85%, and 73% of right-handed, ambidextrous, and left-handed people,

respectively, have the left hemisphere predominantly controlling language functions [31]. The incidence of aphasia caused by damage to the right hemisphere in non-right-handed people is believed to be 20–40% [32, 33]. As with right-handed people, most non-right-handed people develop aphasia triggered by damage to the left hemisphere. It has been reported that left-handed people develop aphasia more often than right-handed people [34, 35]. Smith reported that there were few left handers in patients with residual aphasia in the chronic phase [36].

These reports suggest that left-handed people are more susceptible to aphasia, but they tend to experience quick and larger improvements in language functions. The following are considered to be factors for good prognosis in left-handed patients with aphasia: A larger brain area responsible for language functions is conducive to restoring any remaining functions, and the presence of areas controlling language functions in both the hemispheres facilitates the activation of compensatory functions in the intact hemisphere [37, 38]. Meanwhile, some reports documented that left-handed patients with aphasia caused by damage to the left hemisphere had poor prognosis [39, 40]. Accordingly, there may be individual differences in the hemispheric dominance of language functions in non-right-handed people.

Among right-handed patients, some may have potential predispositions for left-handedness, such as a history of forced adjustment and familial factors. Information needs to be collected thoroughly in this regard.

#### *2.1.5 Severity of aphasia at the onset*

Many reports stated that the severity of aphasia at the onset affects prognosis [5, 11, 16, 17, 19–21, 23, 29, 41, 42]. All these reports argued that the language functions improve slowly and quickly in patients with severe and mild aphasia at the onset, respectively. As some reports indicate that the severity of aphasia is proportional to the severity of stroke, there is a possibility that the severity of brain damage also determines the severity and prognosis of aphasia.

Meanwhile, Lazar et al. reported that many patients with severe aphasia could still improve and that there were considerable variations in the degree of improvement in language functions and severity of aphasia 90 days after the onset. Therefore, they concluded that estimating prognosis based on the initial severity alone may be difficult [18]. Mohr et al. investigated language functions in three patients with global aphasia for 5 years and reported that improvements were observed in all the functions, except naming [43]. All reports indicated that language functions may improve even in patients with severe aphasia at the onset. They also suggested that the period required for improvement may differ depending on the patient.

#### *2.1.6 Types of aphasia at the onset*

While some reports state that types of aphasia affect the improvement in language functions, others indicated that there is no relationship between them [24]. Kertesz and McCabe reported that Broca's aphasia showed the largest improvement, followed by conduction aphasia. They stated that amnesic aphasia did not achieve large improvements because it was mild at the onset. Regarding long-term prognosis, patients with global aphasia showed poor prognosis, whereas patients with Broca's and Wernicke's aphasias exhibited moderately poor prognosis. Complete recovery was achieved in many patients with amnesic aphasia, conduction aphasia, and transcortical aphasia [29]. Demeurisse et al. investigated prognosis 6 months after aphasia onset in patients with three different types of aphasia: global, Broca's, and Wernicke's. They reported

that patients in the global aphasia group exhibited poorer improvements than those in the other two aphasia groups [41]. Bakheit et al. classified 75 patients with aphasia into the following groups based on the WAB classification: Broca's, Wernicke's, global, amnesic, and conduction aphasia, and administered the WAB at the onset and 4, 8, 12, and 24 weeks after the onset. Consequently, the Broca's aphasia group showed greater improvements than all the other groups, with the greatest improvement from the time of onset to 4 weeks after the onset [44]. Kertetsz reported that the rate of recovery differed depending on the type of aphasia, and patients with Broca's aphasia achieved the greatest improvement [19]. All these studies commonly reported that patients with Broca's aphasia had good prognoses, whereas patients with global aphasia showed poor prognoses. However, it should be noted that although patients with amnesic and conduction aphasias who had good WAB scores at the time of admission appeared to achieve less improvements due to a ceiling effect, their final scores tended to be higher than those of patients with Broca's aphasia who were known to show better improvements.

In a review, Watila and Balarabe cited the location and size of lesions, types of aphasia, and severity as the most critical factors for determining the recovery from aphasia. They concluded that, as all these factors are related each other, it would be difficult to investigate the independent factors [20]. The type of aphasia is somewhat consistent with the severity (e.g., amnesic aphasia is mild and global aphasia is severe). The location of lesions for non-fluent aphasia is different from that for fluent aphasia (anterior or posterior to the boundary of the central sulcus). Therefore, differences in aphasia types may be a factor encompassing these differences.

### *2.1.7 Location and size of lesions*

Watila & Balarabe [20] and Plowman et al. [21] cited the location and size of lesions as factors contributing to the improvement in language functions in patients with poststroke aphasia. Maeshima et al. [45] investigated hemorrhage volume and language functions in 92 patients with putaminal hemorrhage. Consequently, they discovered that repetition difficulty was developed when the hemorrhage volume exceeded 20 mL, and non-fluent aphasia occurred when it exceeded 40 mL. The aforementioned causes of aphasia affect prognosis. However, prognosis may also differ depending on the location and size of lesions in the cortex or subcortex.

Regarding the location of lesions, Marchina et al. emphasized the importance of the arcuate fasciculus, stating that the degree of damage to the arcuate fasciculus is correlated with the improvement in spontaneous speech and naming [46]. The size of lesions represents the degree of damage to the area responsible for controlling language functions itself in the cortex. In the subcortex, improvements in language functions may be poor, despite the lesions being small, when the arcuate fasciculus is damaged.

As discussed above, many studies investigated factors contributing to the recovery of language functions, and all the cited factors were observed to interact and intertwine with each other. Because conditions were not controlled in previous studies, it is not easy to compare each of the factors; thus, no definite theory has been formulated. As most previous studies included patients who underwent speech therapy, it was difficult to clarify whether this was also related to spontaneous recovery.

## **2.2 Effects of speech and language therapy interventions**

One of the effects of speech and language therapy interventions is the improvement in language functions, which is better than the improvement achieved by spontaneous



recovery. Nowadays, because speech therapy is provided worldwide to such patients, it is difficult to clearly distinguish between speech therapy-induced recovery and spontaneous recovery. To assess the efficacy of speech and language therapy, previous studies comparing trained and non-trained cases serve as good references.

There are few negative reports on the effectiveness of speech and language therapy. Lincoln et al. investigated changes in language functions in the speech therapy group and the no-therapy group 22 and 34 weeks after the onset. The results showed that language functions improved in both the groups and that no significant differences were observed in the degree of recovery between the two groups [47]. Levita compared improvements in language functions between the group that received speech therapy for 8 weeks and the no-therapy group in patients with aphasia 4–12 weeks after the onset. No differences were found between the two groups [48].

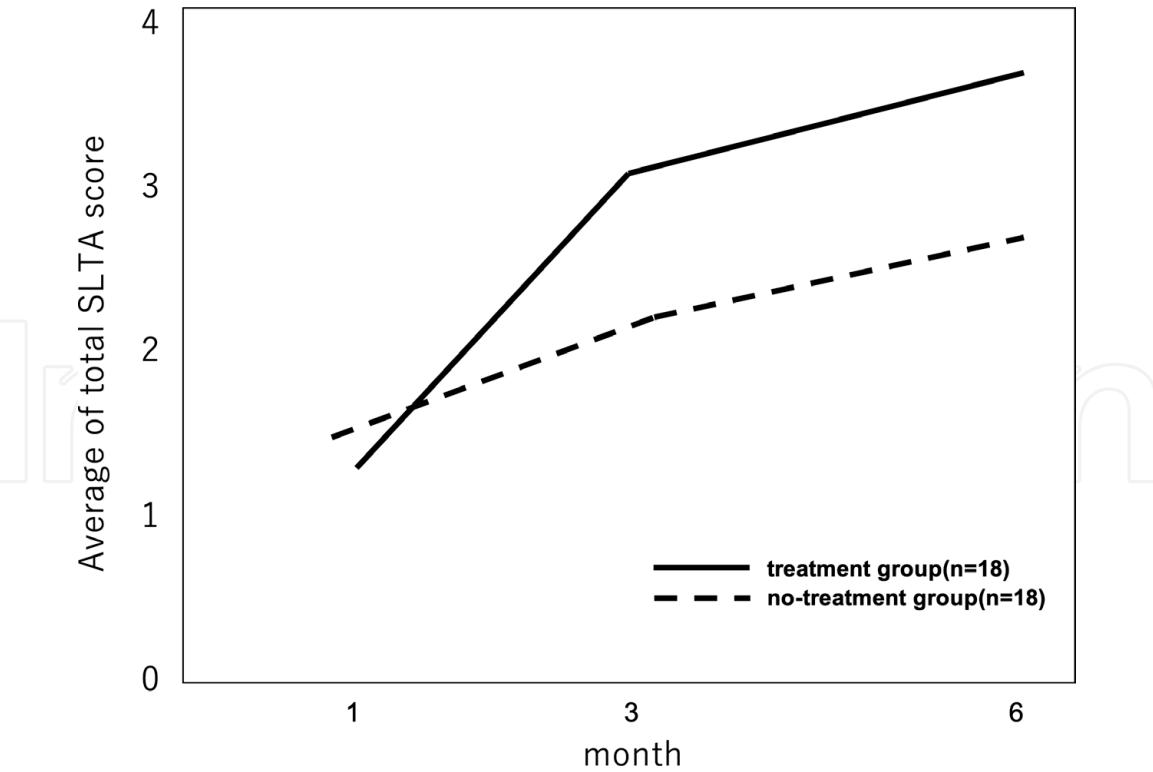
Many reports support the efficacy of speech and language therapy. Wertz et al. compared improvements in language functions in the following three groups: a group of patients who received speech therapy by speech therapists from the onset to week 12 and did not receive any therapy from week 12 to 24; a group of patients who received language practice by volunteers until week 12 and did not receive any practice from week 12 to 24; and a group of patients who did not receive any therapy until week 12 and received speech therapy by speech therapists from week 12 to 24. The results showed that, as of week 12, significant differences were observed between the groups that received language therapy by speech therapists until week 12 and the group that did not receive any language therapy until week 12 and that no significant differences were observed among all the groups at 24 weeks. They concluded that language therapy by speech therapists promotes improvements at the onset, and delayed interventions are still conducive to improvements [49].

Basso et al. investigated the factors affecting the improvement in the four language functions of speech, comprehension, reading, and writing, in the speech therapy group, which consisted of 162 patients who underwent speech therapy and the no-treatment group, which consisted of 119 patients who did not. In this study, although the duration from the onset to language function evaluation varied greatly, they compared the results of the language function evaluation for the first time and after 6 months, and reported that the implementation of language therapy was a factor responsible for improvements in all the language functions [24].

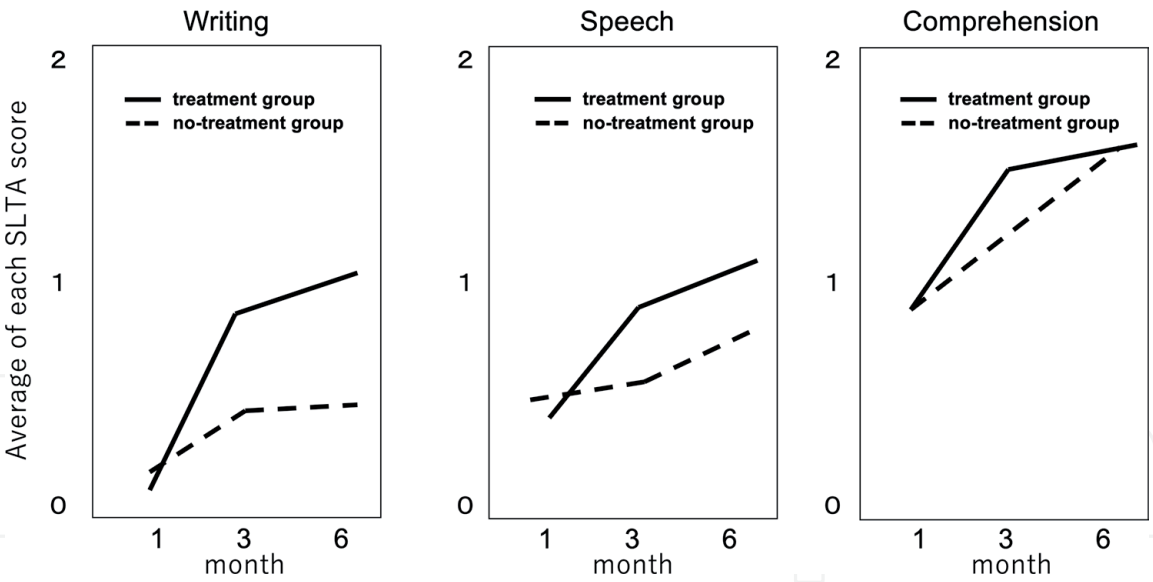
Maeshima et al. examined the language functions (writing, speech, and comprehension) in the speech therapy group, which consisted of 18 patients who received language therapy and the no-treatment group, which consisted of 18 patients who did not. They compared scores for each function and also compared the comprehensive language function scores calculated by summing each function scores between the two groups, 1, 3, and 6 months after the onset. No significant differences were observed in the language functions at 1 and 6 months after the onset between the two groups. However, many patients in the speech therapy group showed significant improvements at 3 months after the onset (**Figure 1**). Based on language function, many patients in the speech therapy group improved with regard to speech and writing at 3 months after the onset (**Figure 2**). These results indicate that improvements beyond spontaneous recovery may be achieved at an early stage following speech therapy interventions. In particular, it is easier to obtain the effects on the expressive aspect of language functions [50].

These reports suggest that early administration of speech therapy facilitates the recovery process beyond spontaneous recovery. The intervention effects may include improvements not only in passive language functions but also in active language functions that cannot be easily facilitated by daily voice–language communication.





**Figure 1.** Many patients in the speech therapy group showed significant improvements of language at 3 months after the onset.



**Figure 2.** Many patients in the speech therapy group improved with regard to speech and writing at 3 months after the onset.

In a literature review, Cicerone et al. stated that there was evidence supporting the efficacy of speech and language therapy for aphasia [51]. Conversely, while acknowledging the effectiveness of speech and language therapy, Mimura et al. argued in a review that scientific evidence was still insufficient because of the lack of evaluation of practice content’s individuality and the effects in the no practice group [52]. In a Cochrane review, Brady et al. similarly stated that there was evidence supporting the effectiveness of speech therapy in improving functional communication, reading, writing, and expressive language, suggesting the efficacy of frequent and long-term speech therapy. However, they also argued that evidence

was still insufficient because of small sample sizes and disunified practice methods [53]. Pickersgill and Lincoln (1983) asserted that although speech therapy interventions were expected to lead to early recovery, they would not expand the degree of final recovery. They appealed the early intervention effects of speech therapy, while simultaneously casting doubts regarding the argument that the interventions would also promote long-term recovery [23].

### **2.3 Significance of speech therapy interventions**

As mentioned above, speech therapy interventions for aphasia improve language functions more than those by spontaneous recovery. Another significant effect is that these interventions help patients acquire communication techniques utilizing the remaining functions, thereby improving their quality of life.

Speech therapy approaches for aphasia are as follows: the therapeutic approach for functional deficits, the compensatory approach for disabilities, and the environment improvement approach for social disadvantages.

Examples of therapeutic approaches include Shuell's stimulus-facilitation approach [54], deblocking method [55], functional reorganization method [56], cognitive neuropsychological approach [57], semantic therapy [58], and melodic intonation therapy (MIT) [59]. They are considered effective for improving aphasia itself.

Meanwhile, examples of compensatory approaches for disabilities include acquisition practices for compensatory means, such as gesture practice, drawing practice, and practice for using other strategies, as well as practices for using compensatory means, such as the use of promoting aphasics' communicative effectiveness (PACE) and augmentative and alternative communication (AAC). In group therapy, patients with aphasia practice communicating effectively with other patients using available language and nonlanguage means [60, 61]. For patients with aphasia having communication difficulty at the onset, speech and language therapists must establish means of communication at early stages [62, 63].

Moreover, in addition to communication difficulty, patients with aphasia have various secondary problems in their daily lives, including difficulties in social connection, such as using financial institutions, public offices, public transportation systems, and commuting to the hospital. They also face problems, such as restrictions, in going to places for communicating with others and participating in leisure activities [64]. Simmons-Mackie et al. argued that encouraging the acquisition of communication partners promotes social participation among patients with aphasia and improves their communication skills. To resolve social and psychological issues among patients with aphasia, it is essential to promote family counseling and interactions with communication partners [65].

For rehabilitating patients with aphasia, it is desirable to appropriately approach the factors hindering communication and provide rehabilitation with a focus on life in the future.

### **Conflict of interest**

The authors declare no conflict of interest.

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### **Author details**

Chiaki Yamaji\* and Shinichiro Maeshima  
Graduate School of Rehabilitation, Kinjo University, Hakusan, Japan

\*Address all correspondence to: [yamaji-c@fujita-hu.ac.jp](mailto:yamaji-c@fujita-hu.ac.jp)

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