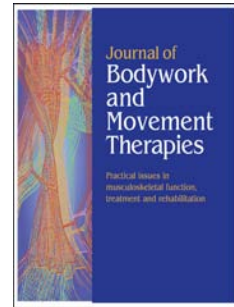


# Accepted Manuscript

Inadvertent Recovery in Communication Deficits Following The Upper limb Mirror Therapy in Stroke: A Case Report

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PII: S1360-8592(14)00012-6

DOI: [10.1016/j.jbmt.2014.02.005](https://doi.org/10.1016/j.jbmt.2014.02.005)

Reference: YJBMT 1104

To appear in: *Journal of Bodywork & Movement Therapies*

Received Date: 12 December 2013

Revised Date: 8 February 2014

Accepted Date: 19 February 2014

Please cite this article as: Arya, K.N., Pandian, S., Inadvertent Recovery in Communication Deficits Following The Upper limb Mirror Therapy in Stroke: A Case Report, *Journal of Bodywork & Movement Therapies* (2014), doi: 10.1016/j.jbmt.2014.02.005.

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Running title: Mirror therapy for communication deficits

Title – Inadvertent Recovery in Communication Deficits Following  
The Upper limb Mirror Therapy in Stroke: A Case Report

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**Abstract**

Broca's aphasia is the most challenging communication deficit in stroke. Left inferior frontal gyrus (IFG), a key region of the mirror-neuron system, gets lesioned in Broca's aphasia. Mirror therapy (MT), a form of action-observation, may trigger the mirror neurons. The aim of this study was to report a case of poststroke subject with Broca's aphasia, who exhibited an inadvertent and significant improvement in speech after MT for the paretic upper limb. The 20-month old stroke patient underwent MT through goal-directed tasks. He received a total absence of spontaneous speech, writing, and naming. After 45 sessions of task-based MT for the upper limb, he showed tremendous recovery in expressive communication. He had fluent and comprehensive communication; however, with a low pitch and minor pronunciation errors. He showed a substantial change (from 18/100 to 79/100) on the Communicative Effective Index, particularly, on items such as expressing emotions, one-to-one conversation, naming, and spontaneous conversation.

**Key words:** Action-observation, Aphasia, Broca's area, Mirror neuron, Mirror therapy, Task-based therapy

## Introduction

Broca's aphasia is the most common and challenging poststroke deficit. It is characterized by impairment in expression, articulation, and fluent speech. Further, it exhibits poor production of normal grammatical sentences and melodic lines (Fazio et al., 2009). There is no universally accepted method for the management of Broca's aphasia.

The left inferior frontal gyrus (IFG) is the responsible area of expressive language.(Fazio et al., 2009) IFG is a vital area for coordinating mirror-neuron system. Although the Broca's area is chiefly responsible for speech production, the area also gets triggered off due to the hand motor activity via the mirror neuron system (Fazio et al., 2009; Sale & Franceschini, 2012). Mirror therapy (MT), being a form of action-observation, has the basis of mirror neurons (Bhasin, Padma Srivastava, Kumaran, Bhatia, & Mohanty, 2012; Ramachandran & Altschuler, 2009).

Although there is a connection between the lesioned area (Broca's aphasia) and neuronal activation by MT, no work has been performed to ascertain the effect of MT for speech deficits. The present study reports an inadvertent finding of speech improvement in a poststroke hemiparetic subject with Broca's aphasia who underwent task-based MT for the paretic upper limb.

## Case description

A male subject in his late thirties, management graduate, who was an editor, had an episode of the stroke. He had severe paresis of the right body-side. He was chronic hypertensive, smoker and alcoholic prior to the episode. Stroke with Broca's aphasia was diagnosed by a neurologist.

His MRI findings revealed left gangliocapsular bleed with hyperdense and air foci in the left frontal and parietal region. He underwent left fronto-temporal-parietal craniotomy for evacuation of haematoma. Post surgical MRI findings also showed encephamalacic changes in the left frontal lobe. Poststroke, he had taken home-based physiotherapy for a few months. He also took 10 conventional speech therapy sessions; however, discontinued the therapy due to no change in the communication ability.

He reported to the occupational therapy unit of the study site 10 months post stroke with chief complaints of inability to use his right upper limb in daily functions, impaired walking, and no verbal and written communication. The subject was on hypertensive medication and had quit smoking and alcohol. He had been given conventional occupational therapy management for the next 10 months. The management could induce minimal motor recovery while no change in communication abilities.

Considering the stagnation in motor recovery, the task-based MT along with the conventional occupational therapy was introduced. *The protocol (Box-1) was based on the previous work of the authors of the present study (Arya & Pandian, 2013).* The subject underwent 45 therapy sessions over the period of 3 months.

**Box 1: Tasks and associated movements used in the task-based mirror therapy**

Task	Key movements
Lifting a glass: hand to mouth	Shoulder flexion-extension and abduction, elbow flexion-extension and forearm pronation

Rotating a cylindrical can	Shoulder adduction, elbow flexion and forearm pronation-supination
Lifting a cubical block	Forearm pronation, wrist dorsiflexion and radial-ulnar deviation
Wiping table using a duster by wrist	Forearm pronation, wrist radial-ulnar deviation and mass finger flexion and thumb opposition
Grasping / releasing a soft ball	Wrist extension, mass finger flexion-extension and thumb palmar abduction-adduction and opposition-reposition
Picking up U-clips	In-hand manipulation and finger prehension

90

91 Pre-intervention, the subject had no visual and hearing deficits. His cognitive and perceptual  
92 abilities were recorded within normal limits. He exhibited Brunnstrom recovery stage (BRS) of  
93 3 (spasticity at peak with strong flexor and extensor synergy) and 2 (little or no active finger  
94 flexion) for arm and hand, respectively. His Fugl-Meyer assessment (FMA): upper limb score for  
95 the right side was 13/66. His clinical language evaluation showed total absence of spontaneous  
96 speech and writing. Nonetheless, he had receptive communication and reading abilities. He could  
97 not name the familiar objects (comb, book), place (residential address) or persons (spouse,  
98 children). He expressed his day-to-day communication by gestures alone. The family members

had adequate comprehension for the gestures; however, no efforts were made to explore other means of communication.

**Box 2:** Brunnstrom recovery stages and Fugl-Meyer's assessment

Brunnstrom recovery stages (BRS) range from no voluntary movement (stage-1) to isolated voluntary movement (stage-6); higher stage indicates positive motor recovery.

Fugl-Meyer's assessment (FMA) is an objective measure of poststroke motor recovery. 9-item upper extremity subsection (FMA-UE) is scored from 0 (no motor recovery) to 66 (complete motor recovery).

Pre- and post-MT, the functional communication was assessed by using the Communicative Effective Index (CETI). The CETI has 16 items (assessing scored on a 10 cm visual analogue scale) subject's ability to communicate in various functional contexts. The measure is a reliable ( $r= 0.73$  to  $0.94$ ), valid (Western Aphasia Battery,  $r=0.61$ ) and responsive tool for stroke patients (Code, Torney, Gildea-Howardine, & Willmes, 2010; Lomas et al., 1989). The assessor of the present study had significant experience in using CETI.

Post-intervention, the subject achieved BRS 4 (spasticity reduces with fair motor control) for the arm with no change for the hand. FMA upper limb recovered to 19 from a score of 13. Unexpectedly, the study reported a tremendous improvement in speech ability without speech therapy. On post-assessment, he demonstrated a remarkable change in expressive communication. He could speak fluently with minor errors in pronunciation. His speech was clear, audible, and comprehensive. Similarly, he could write with minor grammatical errors. The

content of communication was in order and appropriate; however, the pitch was low with some pauses. Further, he was not able to utter long sentences and sustain prolonged communication.

Before MT, his CETI score was 18/100. However, post-MT, he showed a great achievement of 79/100. The subject demonstrated remarkable improvement on all the items, especially, expressing his emotions (from 0 to 8), one-to-one conversation (from 0 to 9), naming (from 0 to 9), and spontaneous conversation (from 0 to 8).

## Discussion

Although the objective of the task-based MT was to induce upper limb motor recovery, the present case reported an astonishing recovery of verbal communication. Aside from clinical and standardized assessments, the inadvertent changes in speech was also reported and confirmed by the other family members and friends. Importantly, the changes were observed 20 months post-stroke without any speech therapy.

It is assumed that the activation of mirror-neuron system (IFG) by task-based MT not only induced the upper limb motor recovery but also enhanced the speech production. The task-based MT has visuo-motor-proprioceptive component. Broca's area (mirror neurons) gets triggered when the goal-directed tasks are performed, heard or seen (Casile, 2013; Kohler et al., 2002). The mirror-neuron system may be exploited for the treatment of post-stroke; however, the evidence is still awaited.

There is a functional connectivity between the cortical representations of hand motions and voice communication. The connectivity is recommended to be explored for the management of aphasia (Meister et al., 2006). Further studies should be done by incorporating functional communication components (variety of hand movements for gesture) and expanding MT protocol to enhance greater language recovery. Although the findings of the present study were observed after many months of stroke onset, the changes may be a chance of occurrence which needs to be validated in a case series.

Since the observations of the study were inadvertent, fMRI could not be planned. Similar neuroimaging tools can further explore changes at the neural level in future studies.

## **Conclusion**

In a post-stroke subject, task-based MT provided for the paretic upper limb, led to unpredictable and remarkable improvement in expressive communication. The achievement could be attributed to MT-induced activation of the mirror-neuron system, centered in the Broca's area.

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