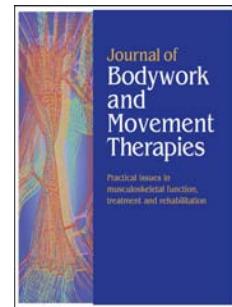


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Inadvertent Recovery in Communication Deficits Following The Upper limb Mirror Therapy in Stroke: A Case Report

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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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25 **Abstract**

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

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

39 **Task-based therapy**

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48 **Introduction**

49

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

54

55 The left inferior frontal gyrus (IFG) is the responsible area of expressive language.(Fazio et al.,
56 2009) IFG is a vital area for coordinating mirror-neuron system. Although the Broca's area is
57 chiefly responsible for speech production, the area also gets triggered off due to the hand motor
58 activity via the mirror neuron system (Fazio et al., 2009; Sale & Franceschini, 2012). Mirror
59 therapy (MT), being a form of action-observation, has the basis of mirror neurons (Bhasin,
60 Padma Srivastava, Kumaran, Bhatia, & Mohanty, 2012; Ramachandran & Altschuler, 2009).

61

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

67

68 **Case description**

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

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

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

84

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

89 **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

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

101

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

103 Brunnstrom recovery stages (BRS) range from no voluntary movement (stage-1) to
 104 isolated voluntary movement (stage-6); higher stage indicates positive motor recovery.
 105 Fugl-Meyer's assessment (FMA) is an objective measure of poststroke motor recovery.
 106 9-item upper extremity subsection (FMA-UE) is scored from 0 (no motor recovery) to 66
 (complete motor recovery).

107

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

114

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

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

123

124 Before MT, his CETI score was 18/100. However, post-MT, he showed a great achievement of
125 79/100. The subject demonstrated remarkable improvement on all the items, especially,
126 expressing his emotions (from 0 to 8), one-to-one conversation (from 0 to 9), naming (from 0 to
127 9), and spontaneous conversation (from 0 to 8).

128

129

130 **Discussion**

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

136

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

141 The mirror-neuron system may be exploited for the treatment of post-stroke; however, the
142 evidence is still awaited.

143

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

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

153

154 **Conclusion**

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

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