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ORIGINAL ARTICLE

Tactile Perception for Stroke Induce Changes in Electroencephalography

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electroencephalography;
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Summary *Objective/Background:* Tactile perception is a basic way to obtain and evaluate information about an object. The purpose of this study was to examine the effects of tactile perception on brain activation using two different tactile explorations, passive and active touches, in individuals with chronic hemiparetic stroke.
Methods: Twenty patients who were diagnosed with stroke (8 right brain damaged, 12 left brain damaged) participated in this study. The tactile perception was conducted using passive and active explorations in a sitting position. To determine the neurological changes in the brain, this study measured the brain waves of the participants using electroencephalography (EEG).
Results: The relative power of the sensory motor rhythm on the right prefrontal lobe and right parietal lobe was significantly greater during the active tactile exploration compared to the relative power during the passive exploration in the left damaged hemisphere. Most of the measured brain areas showed nonsignificantly higher relative power of the sensory motor rhythm during the active tactile exploration, regardless of which hemisphere was damaged.
Conclusion: The results of this study provided a neurophysiological evidence on tactile perception in individuals with chronic stroke. Occupational therapists should consider an active tactile exploration as a useful modality on occupational performance in rehabilitation training.

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Introduction

Stroke is due to a cerebral vascular accident that can induce motor and sensory dysfunctions in individuals (O'Sullivan, Schmitz, & Fulk, 2014). Major impairments following a stroke event include muscle weakness, sensory dysfunction, spasticity, cognitive dysfunction, visual spatial dysfunction, and reduced survival. The individuals who survive a stroke often have perceptual impairments and motor dysfunction, which make their participation in rehabilitation difficult (Go et al., 2014). Specifically, 50—85% of patients with poststroke sensorimotor hemiparesis encounter impaired tactile processing and proprioception (Van de Winckel et al., 2012). Tactile perception generally occurs when touching and grasping an object, and is a basic way to obtain and evaluate information about an object (Juravle, Deubel, & Spence, 2011). Therefore, normal tactile perception is necessary for activities of daily living (ADLs) involvement, as well as sociability and recreational activities.

Tactile perception is one sense composing touch, a complex system, with pain perception, temperature perception, proprioception, and kinaesthetic perception (Klatzky & Lederman, 2011; Lederman & Klatzky, 2009). In addition, rehabilitation training for stroke patients involves both actively or passively guided somatosensory discrimination tasks, such as texture, shape, and length discriminations (Fernandes & Albuquerque, 2012). Passive touch refers to conditions in which objects are moved by the experimenter or by a mechanical device against the participant's skin to allow the participant to perceive relevant cues about the object during this passive movement, without any active movement on the part of the participant. Passive touch perception relies only on the cutaneous senses. By contrast, active touch involves voluntary movement from the participant, and uses proprioception, kinaesthesia, and the cutaneous senses. Several studies have compared the exploratory nature of active touch to the receptive nature of passive touch, and have argued that active touch is not equivalent the simple addition of passive touch and kinaesthesia (Fernandes & Albuquerque, 2012; Gibson, 1962; Guclu & Murat, 2007; Richardson, Symmons, & Accardi, 2000; Richardson, Wuillemin, & MacKintosh, 1981; Simoes-Franklin, Whitaker, & Newell, 2011).

Neurophysiological research is in progress to evaluate the effectiveness of tactile perception, including the addition of active movement (Godde, Stauffenberg, Spengler, & Dinse, 2000; Pleger et al., 2003; Richardson, et al., 1981). Godde and colleagues (2000) studied coactivation-based cortical plasticity at psychophysical level in humans, using a tactile stimulation protocol during simultaneous spatial two-point discrimination performance to investigate Hebbian learning for the induction of brain plasticity. Their results demonstrate the potential role of sensory input for the induction of cortical plasticity without the involvement of cognitive factors, such as attention or reinforcement (Godde, et al., 2000). Richardson and colleagues (1981) compared tactile learning of a maze, where the participants in the passive touch condition learned the correct maze path much faster than the participants in the active touch condition. They suggested that the active touch disadvantage translated into a cognitive limitation but was not a haptic system limitation. They also reported that the active touch condition did not show a performance advantage (Richardson, et al., 1981). Guclu and Murat (2007) also demonstrated that active touch did not produce better performance compared to passive touch in a counting task.

As mentioned, previous studies have examined the dynamic effects of the types of tactile exploration on brain activation and movement learning in healthy children and the adult population (Guclu & Murat, 2007; Juravle, et al., 2011; Simoes-Franklin, et al., 2011). However, there is insufficient evidence to support the effects of tactile exploration on brain activation or motor learning in neurological diseases, such as stroke, traumatic brain injury, traumatic spinal cord injury, Parkinson's disease, and cerebral palsy (Valenza et al., 2001; Van de Winckel et al., 2012, 2013). In particular, therapeutic task programmes can involve actively or passively guided somatosensory discrimination tasks, such as texture, shape, and length discriminations, in rehabilitation settings for stroke populations. Different types of tactile perception have differential benefits on sensory and motor recovery because various tactile perceptions can induce different activations in the same body parts (Van de Winckel et al., 2012).

This study examined the effects of tactile perception on brain activation using electroencephalography (EEG) on two different tactile exploration methods—passive and active touches, in individuals with chronic hemiparetic stroke, and compared the differences of brain responses between those with right and left brain damages. We hypothesized that there would be a significant difference in the two different tactile perception on brain activation during movement, and that the brain activation of the impaired side of the brain (e.g., right or left) would be affected by the two different tactile explorations during movement in the chronic hemiparetic stroke population.

Methods

Participants

Twenty people who were diagnosed with stroke (8 right brain, 12 left brain) participated in this study. The inclusion criteria included: (a) adults who have received a diagnosis of hemiparetic stroke; (b) the onset was $>$ 1 year previously; (c) adults who received 23 points or more on the Mini-mental State Examination (MMSE) (Folstein, Folstein, & McHugh, 1975); and (d) adults who were in Stage 3 or higher in the Brunnstrom's hand function recovery stage. Since the participants were evaluated with the MMSE, the individuals were excluded from this study if they met the following exclusion criteria for the EEG: (a) epilepsy; (b) mental disorders; and (c) sensory impairments. This study was approved by the National Rehabilitation Center Institutional Review Board (IRB management number: NRC-2012-01-003) in the Republic of Korea. All participants provided a written consent after being informed about the study purpose and its procedures.