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Review

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Action Observation as a Tool for Upper Limb Recovery

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Summary

Background

Action observation (AO) can be defined as a dynamic state during which the observer can understand what the other is doing by simulating the actions and outcomes that are likely to follow from the observed motor act. Its clinical impact on upper limb functional recovery in sub-acute stroke patients has been addressed in several studies.

Methods

In order to explore the differential role of the AO in right versus left hemisphere-damaged stroke patients, a randomized controlled trial has been performed. The study included 67 patients with ischemic lesions purely, who underwent intensive rehabilitation in an inpatient setting, with the addition of 15-minute daily sessions of either experimental (EG) or control treatment (CG), twice per day. EG group was asked to carefully watch footages showing 20 different daily routine tasks (actions) carried out with the upper limb, and then imitate

the task, across 20 daily sessions, for 4 consecutive weeks. At the beginning (T0), and at the end of the treatment (T1), and at 6 months from treatment conclusion (T2), the Fugl-Meyer Test (FM) and Box and Block Test (BBT) scores were measured.

Results

While all subjects showed a significant improvement in arm function after either treatment, those with left hemiparesis exhibited a significantly greater improvement when treated with the AO protocol, than with standard treatment. Conversely, right hemiparetic subjects showed a similar upper limb function improvement independent of group allocation.

Conclusion

Action observation can stimulate and enhance the beneficial effects of motor training on motor memory formation, especially in left hemiparetic patients following an acute ischemic stroke. Future trials on larger samples are warranted, exploiting this add-on therapy through the assistance of telerehabilitation.

Key words: stroke, action observation, limb recovery

Radnja nakon promatranja kao terapija u oporavku gornjeg ekstremiteta

Sažetak

Uvod

„Actionobservation" (AO – radnja nakon promatranja) definira se kao dinamičko stanje tijekom kojeg promatrač može razumjeti što druga osoba radi i simulira radnju i ishode koji slijede iz promatranih motoričkih radnji. Više je studija pokazalo kliničke učinke AO-a na funkcijski oporavak ruke u pacijenata sa subakutnim moždanim udarom.

Metode

Proveden je randomizirani kontrolirani pokus kako bi se istražile različite uloge AO-a (radnje nakon promatranja) usporedivši pacijente s oštećenjem lijeve i desne hemisfere mozga. Studija je uključila 67 pacijenata s ishemijskom lezijom, koji su prošli intenzivnu stacionarnu rehabilitaciju, uz dodatak 15-minutnog dnevnog programa pokusnog ili kontrolnog tretmana, dvaput dnevno. Pokusna je grupa gledala snimke 20 različitih aktivnosti dnevnog života (radnji) s korištenjem ruke, te potom

imitirala radnju, kroz 20 dana u 4 konsekutivna tjedna. Na početku (T0) i krajem tretmana (T1), te nakon 6 mjeseci (T2), izmjerene su vrijednosti Fugl-Meyer Testa i BoxandBlock Testa.

Rezultati

Iako su svi pacijenti pokazali značajni oporavak funkcije ruke nakon tretmana, oni s ljevostranomhemiparezom pokazali su značajno veće poboljšanje uz tretman AO protokola, nego sa standardnim liječenjem. Nasuprot tome, pacijenti s desnostranom hemiparezom pokazali su slično poboljšanje ruke neovisno o uvrštenju u skupinu protokola.

Zaključak

AO (radnja nakon promatranja) može stimulirati i poboljšati povoljne učinke mišićnog treninga u stvaranju motorne memorije, osobito u pacijenata s ljevostranomhemiparezom nakon akutnog ishemijskog moždanog udara. Potrebna su daljnja istraživanja na većem uzorku, koristeći ovu dodatnu terapiju i kroz telerehabilitacijske mogućnosti.

Ključne riječi: moždani udar, radnja nakon promatranja, oporavak ekstremiteta.

The most important motor deficit in the acute stage of stroke survivors is the paresis of the affected side, contralateral to vascular lesion in the brain, and the loss of hand dexterity is a serious common consequence of a cortical lesion due to cerebrovascular disease (1). It's already been demonstrated that the abilities that will be lost or affected by stroke depend on the extent of the brain damage, the type (ischemic or hemorrhagic) and where in the brain the stroke occurred (2). The main goal in rehabilitation is to relearn basic skills like eating, dressing and walking. Ascertaining the effectiveness of rehabilitative interventions on conditions leading to long-term disability, such as stroke, is a complex task because the outcome depends on many interacting factors. Action observation (AO) can be defined as a dynamic state during which the observer can understand what the other is doing by simulating the actions and outcomes that are likely to follow from the observed motor act.The observation of action activates the mirror neuron system (involving the Inferior Parietal Lobule, the premotor cortex and the Superior Frontal Gyrus). Severalpapers have shown that AO can enhance the beneficial effects of motor training on motor memory formation after stroke.

The clinical impact of the AO approach on upper limb functional recovery in sub-acute stroke patients has been addressed in a multicentre study by

Franceschini et al. (3). In that study, a persistently higher improvement in the Box and Block test scores in the experimental group as compared to controls was demonstrated. A subsequent study (4) was aimed at exploring the differential role of the AO in right versus left hemisphere-damaged stroke patients undergoing upper limb training coupled with AO tasks. To this aim, eligible hemiparetic stroke survivors at their first-ever stroke were consecutively recruited. The study included only patients enrolled 30 days (±7) after the event onset, with ischemic lesions purely. The following exclusion criteria were identified: 1) posterior circulation infarction; 2) subaracnoidhemorrhage; 3) severe forms of neglect and anosognosia; 4) impaired comprehension; 5) history of endogenous depression or serious psychiatric disorders; 6) severe visual deficits. Diagnosis was confirmed by means of a CT scan and/or an MRI. The following impairment and functional evaluations were performed at the beginning (T0), at the end of the treatment period after 4 weeks (T1), and at the follow-up visit 6 months from treatment conclusion (T2): Fugl-Meyer Test (FM) (only the upper limb items); Box and Block Test (BBT). All assessments were performed by a trained Occupational Therapist (OT) not involved in the research treatment. All subjects underwent intensive rehabilitation in an inpatient setting, consisting in at least 3 hours/day of physiotherapy, occupational therapy and speech therapy according to individually tailored exercise scheduling. In addition to standard rehabilitation, eligible patients were randomizedto receive 15-minute daily sessions of either experimental (EG) or control treatment (CG), twice per day. Every day, before starting physical training, the patient assigned to the experimental group was asked to carefully watch footages showing 20 different daily routine tasks (actions) carried out with the upper limb. The patient was presented only one task per day, starting from the easiest and ending with the most complex action throughout 20 sessions, the whole treatment period lasting 4 weeks (5 sessions/week). Each action consisted of three different meaningful motor sequences displayed in order of ascending difficulty and lasting 3 minutes each. Tasks were based on some relevant ADLs such as drinking from a glass; combing hair, opening a box, eating an apple and more, all actions being object- and goal-directed. Subjects were askedtocarefully observe thevideo, in order to prepare to imitatethe presented action, whereas the OT consistently held the patient's attention with verbal feedback. At the end of each sequence, the OT prompted the patient to perform the same movement over a time period of 2 minutes, providing help when needed. The patients were asked to perform the observed action with the paretic upper limb at their best convenience with their paretic upper limb, as

many times as they could. Each session had to last about 15 minutes (3-min sequence observation and 2-min action performance for 3 motor sequences), and was repeated twice per day, in two separate sessions, at least 60 minutes apart; during the interval, the patient was requested to rest. Differently from the experimental treatment, a "sham" action observation was used for CG patients. Subjects were shown 5 static images displaying objects, without any animal or human being, for 3 minutes. A cognitive task was required in order to keep the patient's attention focused: for a 3-min sequence, images were separately displayed, each for 30 seconds, and then overlapped all together during the last 30 seconds, as an intrusive image (interloper) that the patient was asked to identify so that his attention span could be checked in real time by the OT. Subjects were then asked to perform limb movements (at their best convenience) for 2 minutes according to a standard sequence, simulating those performed by the EG, in what refers to shoulder and elbow joint mobilization.

Results

A total of 67 subjects were studied, 33 randomly assigned to experimental and 34 to control treatment. Inter-group comparability was tested and proved to be satisfactory for the main independent variables (age, gender Bamford category, interval from stroke and lesion side). Both groups showed a significant improvement in arm function after treatment. However, subjects with left hemiparesis showed a significantly greater improvement in arm function scores when treated with the AO protocol, than with standard treatment. Conversely, right hemiparetic subjects showed a similar upper limb function improvement independent of group allocation. (Table 1)

Discussion

The findings show that action observation can stimulate and enhance the beneficial effects of motor training on motor memory formation, especially in left hemiparetic patients following acute ischemic stroke. Itis hypothesized that observation of action, with the intention to imitate movements, can increase the excitability of the brain motor areas and, in doing so, can stimulate the recovery of motor control. A possible rationale to such results can be found in studies showing that primary motor cortex excitability is increased during action observation (5-8). Fadiga et al. (9) suggest that observation of action has a direct influence on primary motor cortex and muscle activity, and support the idea that observation can prime physical aspects of execution through

common neural processes.

Table 1. Upper limb function score evolution in the experimental (EG) and control (CG) groups; data concerning right and left hemiparetic subjects is provided in separate rows.

Right hemiparetic subjects	EG group Mean (± SD)			Ct group Mean (± SD)			Two-way ANOVA for repeated measures (p-value)
	T0	*T1*	*T2*	*T0*	*T1*	*T2*	
N. cases	*15*	*15*	*12*	*15*	*15*	*13*	
Fugl-Meyer	59,2± 29	79,5 ± 26,3	89,7 ± 25,1	58 ± 18	73,0 ± 24	83,8 ± 27,8	Time effect.: p<,0001
							time x treatment eff.: n.s.
Box Block test	10,0 ± 14,7	20,9 ± 19,7	25,9 ± 19,0	9,3 ± 11,6	18,3 ± 14,4	25,3 ± 16,7	Time effect.: p<,0001
							time x treatment eff.: n.s.
Left hemiparetic subjects	Exp group Mean (± SD)			Ct group Mean (± SD)			Two-way ANOVA for repeated measures (p-value)
	T0	*T1*	*T2*	*T0*	*T1*	*T2*	
N. cases	*18*	*18*	*16*	*19*	*19*	*18*	
Fugl-Meyer	59,1 ± 28,1	77,3 ± 31,0	81,4 ± 34,2	52,8 ± 32,8	59,4 ± 33,1	61,5 ± 33,5	Time effect.: p<,0001
							Time x treatment eff.: p<.01
Box Block test	12,0 ± 13,4	26,3 ± 20,1	29,0 ± 20,2	7,0 ± 10,3	11,7 ± 15,6	14,3 ± 16,9	Time effect.: p<,0001
							Time x treatment eff.: p<,01

In human brain imaging studies, AO has been shown to activate the parietal and premotor areas, the same areas known to be activated during action execution (10). Future research combining neurophysiological recording with data acquired using experimental psychology and brain imaging methods could provide a more comprehensive understanding of how action observation modulates the brain activity and the recovery of motor performance. Future trials on larger samples are advocated, exploiting this add-on therapy through the assistance of telerehabilitation.

Izjava o sukobu interesa

Autori izjavljuju da nemaju sukob interesa.

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