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EFFECTS OF MENTAL PRACTICES INTERVENTIONS UNDER EXTEROCEPTIVE BODY AWARENESS IN POST-STROKE PATIENTS: SYSTEMATIC REVIEW

Ana Rita Serrano de Figueiredo
Universidade de Évora, Évora, Portugal

Gabriela Almeida
Universidade de Évora, Évora, Portugal

Catarina Pereira
Comprehensive Health Research Centre, Portugal
Universidade de Évora, Évora, Portugal

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RESUMO

Purpose: In recent years, an importance increasing has been given to mental practices additional to motor practices in Stroke rehabilitation. Therefore, this systematic review aims to investigate the mental practices effects in different stroke phases on exteroceptive body awareness and functionality. **Methods:** five electronic portals were searched (PubMed, PEDRo, Science Direct, Web of Science), between January 2000 and July 2020. Selected studies involving mental practices additional to motor practices - conventional therapy, physical training, occupational therapy, motor task and daily activities. The methodological quality and findings evidence of each study were assessed and summarized.
Results: twenty-one studies were selected for analysis. Several interventions used mental practices in stroke patient's rehabilitation: Action observation (n = 7); Motor imagery (n = 11) and Body awareness therapy (n = 3). It seems that interventions with Action observation and Body awareness therapy have more effects in acute post-stroke patient's functionality. However, Motor imagery intervention showed better results in chronic post-stroke patient's functionality. All three interventions showed positive effects in exteroceptive body awareness.
Conclusions: All interventions reported significant improvements in exteroceptive body awareness and functionality rehabilitation in post- stroke patients.

Keywords: Stroke, Rehabilitation, Body-Scheme, Body-Image.

INTRODUCTION

Stroke is the 2nd death cause worldwide, responsible for 5.7 million deaths per year, equivalent to 9.9% of world population (1). When stroke does not cause death, it can lead to severe neurological, sensory, motor and cognitive disabilities (2,3). The most commonly compromised functions in stroke patients occur in exteroceptive body awareness and functionality in different representations - visuospatial and body awareness notion, balance, gait ability, Global ADLs independence (3–5).

In past decades, several systematics reviews have shown an important increasing of Mental Practices (MP) interventions in stroke rehabilitation (6–10). But is also true that other interventions are increasing using robotic therapies (11), computer games (12), and sports (13–15). However, these interventions also neglect the benefits induced by therapist-patient relationship and the living experience during the intervention, that allows to attend to the patient's own speech, beliefs and needs (16,17). Preventing the promotion of tonic dialogue through the emotional, which contributes to stimulate sensory integration and new self-construction (16,17). Interventions with MP additional to motor practices allow bodily and mental experiences (8,18–20), that may have positive effects on exteroceptive body awareness and functionality in the different stroke phases rehabilitation (20–22).

The corporeality concept involves body awareness (23), through methodologies that focus on the entire body, not only in a physical representation (4,23–25), which may have positive effects in neuroplasticity and functionality (26). Gallagher (2006) defines that body awareness integrates body image (interoceptive awareness) and body scheme (exteroceptive awareness), these representations interact with each other (26) according to sensory information encoded in its spatial frame references (27–29). Body image is characterized by body representations, is not used for action, is a perception, attitude and belief system, belonging to a body itself (26,30), however, the body scheme is a sensorimotor capabilities system - balance, proprioception, gait ability, visual--spatial notion, body notion, representing a body functional map (26,30,31). The interoceptive and exteroceptive body awareness integration plays an essential role in building the body's sense of ownership (26). The body must be seen as a synthesis (23,32). To acquire function, must be worked as a whole, planning the motor act - mental practice, followed by motor action execution - motor practice, that's why interventions in stroke rehabilitation must focus on the interaction of both hemi bodies and not only on the affected side (23,28,29,33,34).

Commonly MP interventions are considered complementary therapies to the main therapy (34–36) and have different interventions structures (35,37–39), which makes it difficult to assess specifically their action under exteroceptive body awareness and functionality effects, as follows: (1) programs based on internal/external body mentalization perspective (37); (2) programs based on internal/external body mentalization perspective which additional programs based on internal/external body mentalization perspective (39); (3) programs based on internal/external body mentalization perspective additional to motor practice programs (40); (4) Programs combined mental practice with motor practice additional to motor practice programs (4,24).

Since 1890, the benefits of MP interventions have been reported in literature and enough scientific evidence showed improvements in functionality and neuroplasticity in stroke patients (34). The great variability in the procedures of these practices, from one study to another is a limitation (35). Several systematics reviews report that programs involving MP additional to motor practice programs showed better results in stroke rehabilitation than MP programs by itself (34,41). However, no studies were found systematising the effects of programs involving these practices in the exteroceptive body awareness and functionality. In literature, were found several programs with MP interventions additional to motor practices who stimulates body awareness and functionality: 1- action observation (OA) (35) related to empathic, social and imitative behaviours (41,42). They activate the motor system, like the execution system, by creating a representation of internal action, allowing motor relearning (39). 2- Motor imagery (MI) (36–38) are polysensory and may involve relaxation or focus techniques, during which the skill to be achieved is practiced mentally (38). This type of intervention allows the premotor cortex, basal ganglia and cerebellum regions activation, associated with the planning, execution and movement modulation (36,43). 3- Body awareness therapy (BAT) (4,20,24) is a intervention in focused movement and consciousness is a fundamental element, the patient must realize that he has a body and the bodily sensations are reflected in it (20).

Therefore, the aims of this review are to investigate and systematize the effects of MP interventions additional to motor practice programs on exteroceptive body awareness and functionality, in stroke patient's rehabilitation.

METHODS

A systematic literature review was conducted in electronic databases, using the following inclusion criteria: original English articles, ischemic or haemorrhagic stroke. No limits have been set on lesion location or stroke stage (acute/sub-acute/chronic). Articles applied to rehabilitation, mental practices interventions like action observation, motor imagery, body awareness additional to motor practice programs. Review articles, single case studies, theses, dissertations, and articles with interventions with robotic, electric stimulation, computer games, sports or focused only on the stroke affected side were considered as exclusion criteria. The electronic search was conducted in the following databases: PubMed, PeDro, Web of Science and Science Direct, between January 2000 and July 2020. The descriptors used (stroke, brain injury, cerebrovascular accident, mental practice, motor imagery, action observation, body awareness therapy) were inserted into the Descriptors in Health Sciences. All articles found in the different databases were imported into StArt, a reference managing software. After exclusion of duplicated articles, an analysis in the titles of the studies was carried out; those articles that did not address stroke were excluded. Later, the abstracts of the articles were analysed, and those that were not related to the review goals. The articles that remained after the analysis of the abstracts were read in their entirety, and in the absence of reasons for their exclusion were included in this review. All article selection and evaluation processes were performed independently by two reviewers. Prospero registration CRD42018097221. Included studies were assessed for quality according to Downs and Black Checklist (jech.bmj.com/content/52/6)(42). This assessment was also carried out by two independent evaluators and, in case of disagreement on the score awarded to items, a third evaluation was requested to another independent appraiser. The assessment tool proposed by Downs and Black is composed of 27 questions divided into five sub-scales: 1 - evaluation of appropriate information (10 items); 2 - external validity (3 items); 3 - the internal validity of the detailed measurements and bias outcomes (7items); 4 - confounding factors (6 items); 5- study power (1 item). The maximum score that can be achieved by the instrument is 32 points. Answers were scored 0 or 1, except for one item in the reporting subscale, which scored 0 to 2 and, the last item on power (scored 0 to 5) was changed to a score 0 to 1 (42), this modified version has been used in other studies (43,44). After this modification, total scores ranging from 0 to 28 points were obtained with the checklist. The findings evidence level and methodological quality was rated on a grading system proposed by Marinho-Buzelli *et al.* (44). (Table 2).

RESULTS

A total of 360 studies identified, in a first selection 311 were exclude. This process resulted in 49 retrieved studies, of which 16 were double references (19,20,40,45–49). Twelve of the remaining 33 studies were excluded after reading the full text. After screening, 21 studies have been selected for analysis (figure 1).

The excluded studies were based on several reasons: (1) participants without stroke diagnosis or with other severe pathology; (2) single case reports, (3) observational studies; (3) intervention exclusively at the affected side; (4) therapeutics approaches with computer games, electro-stimulation, home care or exclusively MP.

The 21 studies included in this study received their scoresby assessing their quality using the Downs and Black Checklist, ranging from 14 to 26 points out of 28 possible points to be achieved (average 19.9). Values with a good quality index. Moreover, studies were classified as "week" (3 studies: index < 50%), "regular" (3 studies: index 50%–69%), "good" (6 studies: index 70%-79%) and "very good" (9 studies: index 80%-100%) for methodological quality (table 2). Studies with the high-est score were performed by Franceschini *et al.*(50) with 25 points and Verma *et al.* (45) with 26 points; and studies with lower scores were the Kim *et al.* (51), Page (39) and Kim J-S & Kim K (48) with 14 points each. The quality criteria with lower scores were: lack of an accurate description of confounding factors; not reporting the adverse events; not display-ing information on the environment and care received by the sample; not informing whether the subjects included in the samples were counterparts to those of the general population; not reporting adjustments for confounding factors; not reporting whether there were losses to follow- up, and if this fact was taken into account. Furthermore, none of these studies conducted sample size or power calculations.

Table 1 summarizes the main characteristics of the articles that make up our review study, as well as the scope, methodological procedures, and main results.

The sample size ranged from a minimum of 12 to a maximum of 102 participants. The mean age ranged from 50.3 to 77.2 years. Of the 21 studies included, 8 were carried out in Europe (5,20,46,47,50,52–54), 9 in Asia (4,21,24,45,48,51,55–57) and 4 in America (35,39,40,49). Time since the stroke was expressed in days (5 studies), weeks (3 studies), months (9 studies) and years (4 studies). Regarding the Stroke stage, 9 studies focused their intervention on patients with acute stroke (4,45,47,48,50,52,53,55,56), of which 6 focused on the first stroke event (45,50,52,53,55,56), the remaining 12 studies focused their intervention on patients with chronic stroke (4,5,20,24,35,39,40,46,49,51,54,57), of which 9 focused on first stroke event (5,21,24,35,39,40,46,51,54). Concerning the stroke type (ischemic / haemorrhagic), 16 studies classified the type of stroke; 3 studies include patients with exclusively ischemic stroke (38,52,55), and 13 included patients with ischemic or haemorrhagic stroke (4,5,20,21,35,45,46,48,50,51,53, 54,57). The remaining studies were unclear.

The interventions and protocols characteristics ranged from 2 to 10 weeks. The primary's outcomes measures related to exteroceptive body awareness: balance - static, dynamic, confidence (20,21,24,35,46,51,53,57); gait ability - speed, cadence, single support time, double support time, spatiotemporal gait (21,24,35,45,48,51,53,57); proprioception - step length asymmetry (45,48), stride length (48), reduce pain in upper limb (5); visuospatial notion (4); body notion - motor imagery ability (35,40,46,53), self-perception (40), hand and foot preference (35), motion evoked potential (55), neglect (4).

The secondary's outcomes measures related to functionality: upper limb ADLs independence (40,47,49,50,52,54–56) - voluntary contract (5,47), spasticity (5), fine and distal motor function (39); global ADLs independence (4,5,40,46,55) - foot and leg motor impairment (35), motor task performance (46).

****Insert figure 1 around here****

*****Insert Table 2 around here*****

Effects of MP interventions combined or additional to motor practices approaches, on exteroceptive body awareness and functionality.

Different MP interventions additional to motor programs in stroke patient's rehabilitation were identified (Table 3): 7 studies with AO intervention (21,47,48,50–52,55) based on mirror neuron system stimulation, 11 studies with MI intervention (5,35,39,40,45,46,49,53,54,56,57) based on protocols described by Dickstein *et al.*(58), Simmons *et al.* (59), Liu *et al.* (60) and Page (61), and 3 studies with BAT (4,20,24) based on a protocol described by Lindvall (20). All experimental interventions had additional interventions with conventional therapy (CT) - Bobath, neurodevelopment therapy, motor learning; physical training (PT) – gait training, physical exercise; Occupational therapy (OT); Motor task (MT) - task-oriented circuit class training or Daily activities (DA).

1) The AO intervention with CT, PT or OT showed to induce significant improvements on functionality outcomes, namely in upper limb ADLs independence (47,50,55). AO interventions with PT (treadmill training), CT (neurodevelopment therapy) or PT and CT also showed positive effects on exteroceptive body awareness outcomes, namely in gait abilities (single support time, double support time, velocity, cadence, maximal flexed knee angle in swing phase) (51), balance (dynamic) (21,48,51), proprioception (step length asymmetry, stride length) (48) and body notion (motion evoked potential) (55).
2) The MI intervention with CT (Bobath), OT or PT showed significant improvements on functionality outcomes in upper limb ADLs independence (39,40,46,54) and global ADLs independence (task performance and lower limb improvement) (35). MI interventions with CT (Bobath, neurodevelopment therapy, motor learning); PT (gait training); MT (task-oriented circuit) and OT, also showed positive effects on exteroceptive body awareness outcomes, namely in body notion (imagery ability – global) (53), balance, gait ability (57), proprioception (reduce pain - upper limb, step length asymmetry)(5). However, two studies showed no significant improvements in exteroceptive body awareness outcomes on gait ability - transfer (53) and body notion -

performance self- perception (40).

3) The BAT interventions with MT (motor task) showed significant improvements on functionality outcomes, namely on independence in daily life in global activities (4). BAT interventions with PT (gait training), MT, DA or CT also showed positive effects on exteroceptive body awareness outcomes, namely in visual spatial notion and body notion (neglect) (4); balance (dynamic) and gait ability (20,24). One study showed no significant results in exteroceptive body awareness outcomes in the gait ability after intervention (24).

DISCUSSION

Discussion in terms of methodology, according to the Downs and Black checklist, the assessed articles showed hight scores, and more than half of them awarded a score ≤19,9 from a total of 28 points (42). However, some quality indicators were absent in the lower-scoring articles, which led to a challenge of the findings, which were treated with extreme caution (42).

Exteroceptive body awareness and functionality are often affected by stroke. MP interventions aim at the cognitive action test, causing neuronal and vegetative responses, similar to those aroused during physical practice (54,62). These practices suggest the maintenance of Fit's Law, where movements performed mentally require similar amounts of time to those performed physically (54,62). It seems that MP improves the exteroceptive body awareness and functionality in acute and chronic stroke patients (10,21,25,34,41). A recent review (2019) considered MP was a better intervention in stroke upper limb motor recovery than others CT (10). Others studies seems to reinforce these results (3,22,37,63). Action observation (AO), motor imagery (MI) and body awareness therapy (BAT) are interventions based on the same neural mechanism, they have a dynamic state during which representation of a certain motor action is internally activated (51,64). The different interventions approaches were grouped leading to the following results:

1) AO intervention increases the excitability of the motor areas of the brain motor, stimulating the motor control recovery (52). The mirror

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neuron system technique (MNT) could increase the motor function of the extremities and improve the motor evoked potential, elevated activation of bilateral ventral premotor cortex, bilateral superior temporal gyrus, supplementary motor area and contralateral supramarginal gyrus were found (55). AO based MNT added to a motor practice (CT, PT, OT) showed good results in the recovery of functionality (upper limb ADLs independence) on acute stroke patients with some motor function preserved, but it seems to have negligible effects in recovery of severe stroke arm paresis (5,47,55). However, no effects were found in the chronic phase. AO added to PT or CP showed positive effects in exteroceptive body awareness recovery in acute and chronic stroke patients (48,51) improving gait ability and dynamic balance (48). Different studies have shown that the observation of the action seems to activate the motor system in a similar way to the execution, giving rise to an internal representation of the action, which can stimulate motor relearning (48,65). The neural circuits involved constitute a mirror neurons system that map the sensory signals of the action observation on a similar neuronal substrate involved in the motor programming and execution of what was previous observed (48). It seems that AO interventions have better results in the stroke acute phase recovery.

2) Interventions with MI can stimulate the sensory-motor and pre-motor areas in these patients (66). They have positive effects, even in patients with severe degrees of stroke, promoting learning and programming the motor act (5,53). MI intervention is a simple and low-cost treatment (54). There are different approaches with MI interventions combined or added to motor practice (implicit/explicit images (5), massed MI/ Distributed MI (39), Embedded MI/ Added MI(46), MI internal/ MI external (40)). MI interventions added to PT, CT or OT had positive effects in functionality in upper limb ADLs independence in acute and chronic stroke phase (5,39,54) in coordination, active movements, hand grips and hand function (5,56). However, in the chronic phase also showed improvements in global ADLs independence, in Schuster study with embedded or added MI interventions additional to neu-

rodevelopment therapy and motor learning showed improvements in task performance and benefits in help degree level in chronic stroke patients (46). Also Malouin study showed improvements in foot and leg motor impairment (35). In exteroceptive body awareness it seems

MI interventions have positive effects in both stroke phases. In acute stroke phase improvements were found in proprioception (reduce pain - upper limb) (5), it was demonstrated that MI interventions in a form incorporated or added to PT, produced improvements in the number of movements imagined (body notion) (46,53) and MI with circuit classes additional to PT improves gait ability and balance (45). In a chronic stroke phase it was demonstrated that task MI interventions with PT interventions led to improvements in global imagery abilityand hand and foot preference (body notion) (35), balance and gait ability (57). These types of interventions could be a good approach to severe upper limb recovery in acute and chronic phase.

3. BAT interventions focused on movement according to the Lindvall et al. protocol allow patients to experience movement sensation in their body and how these sensations could help in the integration of movements (22). One of the problems in movement production in stroke patients is caused by muscle weakness, which results from improper motor unit's recruitment, leading to the inability to generate strength (3).BAT interventions with additional task- oriented training showed significant effects in functionality recovery in global ADLs independence (4). The exteroceptive body awareness showed positive effects in acute (visual and body notion) and chronic (balance and gait ability) stroke phases (4,19,21). It seems that these types of interventions are a good approach to recovering global functionality in the acute stroke phase. It also integrates psychomotor skills (visual and corporal notion) in an initial phase, which helps to improve quality in balance and gait abilities.

Limitations of the current review

The findings of this systematic review revealed small studies (subgroups ranging from 12 to 102 participants), wide range of interventions protocols, large amount of heterogeneity in the methodological quality of studies and a great variety of studied outcomes (48,51).

Recommendations for future research

The MP interventions combined or additional to motor practice should be well described and categorized. There is lack of intervention programs assessing specifically the exteroceptive body awareness and functionality. It is important to also assess the interoceptive body awareness in post-stroke patient's rehabilitation; rehabilitation interventions should not only focus on a mechanical level, being essential a new therapeutic approach that explores the interaction between movement and mind. Specifically focusing on exteroceptive body awareness (body scheme), working the visuospatial notion and functionality; and interoceptive body awareness (body image), exploring the sense of ownership in body itself (21,22,76–78). The representations of interoceptive and exteroceptive body awareness interact as the sensory information is encoded in its spatial frame of reference (23,25).

CONCLUSION

This study provided significant evidence that MP additional to a motor practice programs has positive effects on the exteroceptive body awareness and ADLs independence in stroke patient's rehabilitation. All interventions showed positive effects in exteroceptive body awareness and ADLs independence. However, AO and BAT interventions have more effects in acute post-stroke patient's ADLs independence and IM interventions showed better results in chronic post-stroke patient's ADLs independence. All types of interventions (AO, MI and BAT) showed to be effective in exteroceptive body awareness improving on both stroke phases. However, a lack of evidence concerning MP interventions as main therapeutic approach to enhance functionality and exteroceptive body awareness were identified. Future research is warranted considering those promising results after MP interventions combining or additional to motor practice in stroke patient's rehabilitation.

Conflicts of interest

The authors declare no conflicts of interest.

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