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REVIEW/MISE AU POINT

Effect of sensorial stimulations on postural disturbances related to spatial cognition disorders after stroke

Effet des simulations sensorielles sur les troubles de l'équilibre liés à des troubles de la cognition spatiale après accident vasculaire cérébral

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Summary Balance disorders related to disturbances in perception of spatial reference systems are common especially after right hemispheric stroke. Mental misrepresentation of bodily orientation in space is then often superimposed upon other factors affecting imbalance such as motor and sensory impairments. Traditional rehabilitation for balance recovery has not been specifically designed to improve balance disorders related to spatial cognition. The traditional approach, consisting of stimulating the conscious perception of body orientation in space, is demanding and laborious. The approach based on sensorial stimulation is completely different. The relevance of this method lies in the fact that, firstly it is specifically active in the cognitive component of balance disorders; and secondly, it can passively be applied with minimal patient participation, which is of particular importance for this patient group characterized by disorders of attention and concentration. These techniques, such as proprioceptive, visual or vestibular stimulation, have been found to correct spatial neglect but also postural bias. Clinical and data from functional neuro-imaging suggest a direct central action on cortical structures involved in

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the elaboration of spatial representation. These are promising techniques for the rehabilitation of postural disturbances related to spatial cognition disorders but are as yet at the stage of preliminary results.

MOTS CLÉS
Équilibre ;
Cognition spatiale ;
Stimulation sensorielle ;
Accident vasculaire cérébral ;
Rééducation

Résumé Les troubles de l'équilibre liés à des troubles de la perception des systèmes de références spatiales sont communs en particulier après un AVC de l'hémisphère droit. La mauvaise représentation mentale de l'orientation du corps dans l'espace est alors souvent superposée à d'autres facteurs tels que le déséquilibre moteur et des déficiences sensorielles. Les techniques de rééducation actuelles pour la récupération de l'équilibre n'ont pas été spécifiquement conçues pour améliorer les troubles de l'équilibre liés à la cognition spatiale. L'approche traditionnelle, consistant à stimuler la perception consciente de l'orientation du corps dans l'espace, est exigeante et laborieuse. Les stimulations sensorielles sont une approche complètement différente. Leur intérêt réside dans le fait que, d'abord elles sont spécifiquement actives dans la composante cognitive des troubles de l'équilibre et, d'autre part, elles peuvent passivement être appliquées avec une participation minime du patient, ce qui est d'un intérêt particulier pour ce type de patients porteurs de troubles de l'attention et de la concentration. Ces techniques, telles que la stimulation proprioceptive, visuelle ou vestibulaire qui ont été d'abord utilisées pour corriger le biais spatial dans la négligence spatiale, paraissent actives sur le biais postural. Les données cliniques et de l'imagerie fonctionnelle suggèrent une action directe sur le centre de structures corticales impliquées dans l'élaboration de la représentation spatiale. Elles sont prometteuses pour la rééducation des perturbations posturales liées à des troubles de la cognition spatiale, mais sont encore au stade des résultats préliminaires.

Introduction

Balance recovery is a prognostic factor for autonomy, transferring and walking recovery [7,23]. Postural disorders can be explained by motor or sensory deficits [26,58], but spatial cognition deficit causing a distortion of the mental representation of space and body in space could also contribute to balance disturbance [54]. Disorders of spatial cognition observed after brain injury are more frequent after right brain injury and would explain the predominance of balance disorders after injury affecting the right hemisphere [12,46,54]. Data from the literature show that left hemiplegia caused by right brain injury is associated with poor prognosis in terms of balance and autonomy [46]. With comparable motor and sensory loss, balance disorders predominate in right brain versus left brain damage [46,54]. The hypothesis to explain the prognostic differences between left and right lesions is the presence of more severe disorders of spatial cognition when the brain injury is situated in the right hemisphere, which is devoted to spatial cognition [29].

Despite this overriding issue of the management of balance disorders related to spatial disorders, only a few authors have studied techniques for specifically treating this cognitive component of imbalance. Sensorial stimulations have been shown to be effective in correcting spatial bias found in cases of neglect [41]. It would seem to be of interest to test these techniques (comprising vestibular, visual or proprioceptive stimulations) for imbalance due to cognitive disorders after stroke, because of the closed cerebral mechanisms leading to biases in neglect and in postural impairment.

Representation of space and spatial references

Representation of space comes from the convergence of vestibular, visual and proprioceptive inputs and intrinsic knowledge about the spatial geometry of the body. This knowledge is partly innate, and partly acquired from sensorimotor experiences. Multiple mental representations of space are elaborated, interposed between sensory input and motor output, by using signals from the modulation process of sensorial information encoded in different frames of reference [1,3]. The environment in which we operate is thus perceived through several spatial referentials, including the allocentric frame and egocentric frame of reference. The allocentric referentials, such as the gravity reference frame, are extracted from the environment. The egocentric referentials are centered on the body and move with it [70].

Many brain regions are involved in the elaboration of representations of space. The parietal cortex plays a key role, since it facilitates the transformation of spatial coordinates extracted from sensorial information collected from the periphery, and the coordinates of the movement of the body, within a coherent framework [31]. For example, a visual input signal encoded in an allocentric retinotopic coordinate system (centered in the retina) can be gradually transformed into self-centered reference frame centered on the head and on the body due to the inclusion of proprioceptive information from neck and extraocular muscles. Misperception of the body in space and spatial reference system disorders can be measured by evaluating subjective estimation of the direction of the vertical (gravity reference frame) and the subjective estimation of the direction of the axis of the body