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REVIEW/MISE AU POINT

Posture and cognition in the elderly: Interaction and contribution to the rehabilitation strategies

Posture et cognition chez le sujet âgé : interaction et contribution aux stratégies de réhabilitation

L. Borel*, B. Alescio-Lautier

Aix-Marseille Université, CNRS UMR 7260, FR 3C Case B, 3, place Victor-Hugo, 13331 Marseille cedex 03, France

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Summary In this paper we review the effects of aging on sensory systems and their impact on posture, balance and gait. We also address cognitive aging and attempt to specify which altered cognitive functions negatively impact balance and walking. The role of cognition in postural control is tested with dual-task experiments. This situation results in deleterious effects due to an attentional overload. Given the human cognitive system has limited capacities, we propose that simultaneously performing two tasks depends on the capacity of each individual to perform these tasks on a continuum between automatic execution to highly controlled performance. A level of maximum control exceeds the subject's attentional capacity, which makes it impossible to perform both tasks simultaneously. The subject therefore prioritizes one of the tasks. We use representative dual-task studies from the literature to illustrate the relationship between the different cognitive components and their impact on the control of posture and gait in elderly subjects with altered cognitive capacities and with elderly subjects who are fallers or who have altered sensory-motor capacities. Recently this postural-cognitive relationship was addressed with a new approach. We report how cognitive training can improve dual-task management and we attempt to define the cognitive mechanisms that may be responsible for better postural balance.

MOTS CLÉS
Sujets âgés ;

Résumé Dans cet article, nous passons en revue les effets du vieillissement sur les systèmes sensoriels et leurs conséquences sur les performances de posture, d'équilibration et de marche. Nous abordons également le vieillissement cognitif et tentons de préciser,

* Corresponding author.
E-mail address: liliane.borel@univ-amu.fr (L. Borel).

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parmi les fonctions cognitives altérées, celles qui peuvent participer à la détérioration de l'équilibre et de la marche. L'implication cognitive dans le contrôle postural est traitée par l'approche expérimentale des double-tâches posturo-cognitives. Cette situation présente un effet délétère du fait du surcoût attentionnel. Le système cognitif humain ayant des capacités limitées, nous proposons que la réalisation simultanée de deux tâches dépend de la capacité de chaque sujet de réaliser ces tâches selon un continuum compris entre une réalisation automatique jusqu'à une réalisation hautement contrôlée. Un niveau de contrôle maximal dépasse les capacités attentionnelles du sujet rendant la réalisation simultanée de ces deux tâches impossibles. Le sujet priorise alors une des deux tâches. Parmi la vaste littérature sur les double-tâches, nous décrirons ici des travaux représentatifs des relations entre différentes composantes cognitives et leurs conséquences sur le contrôle de la posture et de la marche, au cours du vieillissement, chez des sujets chuteurs ou dont les capacités sensorimotrices sont altérées, et chez des personnes dont les capacités cognitives sont altérées. Récemment, cette relation posture-cognition a été envisagée de façon nouvelle. Nous décrivons ici comment un entraînement cognitif est capable de favoriser une meilleure gestion de la double-tâche et tentons de préciser les mécanismes cognitifs qui seraient responsables d'un meilleur équilibre postural.

Effects of aging on the sensory systems and posture, balance and gait

Age-related changes to the sensory systems

Maintaining balance and preserving the rhythm and stability needed for walking requires a complex system of control that is able to adapt to internal and external changes. This system of control depends on the cooperation between sensory systems, which are able to detect the position and movement of the body and the visual environment, and effectors, which create appropriate postural and kinetic reactions. The vestibular system, which detects the movement of the head, provides information on the changes of the orientation of the body in space and movement. The vestibular system uses compensatory reflexes that play a major role in maintaining balance. The afferent visual sensory system makes it possible to integrate the information relative to objects in the environment. Vision also makes it possible to gather information on movement of the subject in relation to the environment. Proprioceptive and tactile information (muscle spindles, Golgi tendon organs) provide information on the position of the body and the different parts of the body in relation to each other and to the surrounding space. Each sensory input has its own domain of action. In this way, visual and proprioceptive modalities have a threshold for stimulation that is low enough to perceive slow movements and oscillations while standing. Conversely, the vestibular system has a primary role in the detection of rapid movements due to its anatomy and physiology. These sensory modalities are complementary and have partly overlapping functions. The complementary information that is a result of the overlapping functions makes it possible to improve perception and the coding of movements. The integration of this sensory information participates in the elaboration of an internal model of the representation of orientation and movement. This multisensory integration helps generate appropriate motor responses adapted to situational constraints (especially environmental constraints such as obstacles and light...) (e.g. [49,63]).

Aging is associated with many physiological changes of the different sensory systems (Table 1). The main changes that affect the vestibular system affect the hair cells in the semicircular canals, the maculae of the saccule and the utricle, the primary and secondary vestibular neurons, as well as the central vestibular structures [14,43]. Modifications of the visual system consist of a reduced sensitivity to contrasts, a disruption in the perception of depth (which is particularly important when confronting obstacles), and a deterioration of dynamic visual acuity when the subject or target moves [59]. The somatosensory system creates points of reference that are important for balance. Tactile information from feet and their contact with the ground can deteriorate. In the same way, the capacity to detect position and direction of the joints movements is reduced [80,92]. In the motor system, the most significant effect of age concerns the changing characteristics of muscles: reduced muscle strength tied to both the muscular fibers that are decreased in number and size, and the changes in the central motor commands [28,74]. Reaction time increases and the muscle contraction speed decreases. All of this can prevent elderly subjects from using adequate force and reacting quickly to postural disturbances [14].

Age-related changes in posture, balance and gait

In general, posture and balance have been compared in different conditions with static or dynamic tests and during walking in young adults, middle-age adults or older non-fallers (with optimal physiological capacities), and populations at risk of falling (having fallen at least once in the previous months).

Changes in the posture (orientation of the body in relation to vertical gravity) have been identified as one of the main factors that contribute to falling in elderly populations [90]. With age, the subjective postural vertical becomes less precise, especially for very old subjects. A postural vertical that is tilted backwards has been proposed as an explanation for retropulsion that is often observed in elderly subjects