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Analysis of the impact of a cognitive task on the posture of elderly subjects with depression compared with healthy elderly subjects

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HIGHLIGHTS

- Center of pressure movements in depressive elderly subjects are greater than in healthy elderly subjects.
- The dual-task alters postural control to a greater degree in healthy elderly subjects than in depressive elderly subjects.
- The greater postural sway observed in depressive elderly subjects may be a cause of a greater risk of falls.

ABSTRACT

Objective: While previous studies have demonstrated that depressive elderly subjects (DES) experience difficulties in the processing of simultaneous cognitive tasks, few have examined the coupling of cognitive tasks with seemingly 'automatic' tasks, such as standing upright. Current patient management focuses on pharmacological treatments and cognitive-behavioral therapies.
Methods: Healthy elderly (HES) and non-treated DES were included. Postural sway in DES was compared with that in HES while in single-task and dual-task conditions. The single-task consisted of standing upright. For the dual-task, the subjects recalled various items from memory or counted while standing upright. Postural sway was evaluated by computing the center of pressure (CoP) area and path length.
Results: DES showed greater postural sway than HES in all conditions. The HES showed a greater CoP area in the dual-task than in the single-task conditions. In DES, the CoP area in the single-task condition was similar to that in the dual-task condition.
Conclusions: The greater postural sway observed in DES may be a cause of a greater risk of falls. We showed that even seemingly automatic tasks, such as maintaining an upright posture, are affected by depression.
Significance: These results are important for the management of DES.

1. Introduction

Depression is a serious public health problem affecting both young and elderly people (American Psychiatric Association, 2013). Indeed, depression affects up to 25% of women and 12% of men (Gelenberg, 2010). In the elderly, in addition to physiological changes (e.g. loss of muscular mass, slowing of neurophysiological signals, decrease in the ankle's articular moment, ...) (Lord et al., 1991), depression increases this risk of falling (Whooley et al., 1999; Turcu et al., 2004; Afifi, 2006; Mun-San Kwan et al., 2012; Kvelde et al., 2013, 2015; Prizer et al., 2016). Moreover, alterations in various brain areas have been observed in these patients, e.g. in

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the prefrontal and anterior cingulate cortex (Drevets et al., 1997; Mayberg, 1997), hippocampus (Neumeister et al., 2005), and basal ganglia (Lafer et al., 1997; Drevets and Furey, 2009). Indeed, anomalies in the basal ganglia would be expected to induce alterations in basic motor activities such as the maintenance of postural stability. The basal ganglia play an important role in non-voluntary motor activities such as posture (Bloem and Bhatia, 2004; Visser and Bloem, 2005) and proprioceptive motor integration (Konczak et al., 2009). However, current patient care focuses on pharmacological treatments, some of which may increase the risk of falls (Sterke et al., 2012), and cognitive-behavioral therapies. This relegates the risk of falls and physical therapy for prevention to a secondary position (American Psychiatric Association, 2011).

Previous studies have demonstrated increased postural sway among subjects with mood disorders. For example, Bolbecker et al. (2011) showed this to be the case in subjects with bipolar disorder. Doumas et al. (2001) found increased sway in subjects with major depressive disorders. However, both of these studies were carried out in younger subjects with a mean age of less than 50 years. Moreover, several studies comparing single-task and dual-task responses also indicated that depressive subjects had difficulties with multitasking (Hartlage et al., 1993; Lemelin and Baruch, 1998; Thomas et al., 1999; Doumas et al., 2001; Wright et al., 2011), hence revealing limited attentional resources (Caligiuri and Ellwanger, 2000; Nebes et al., 2000; Elderkin-Thompson et al., 2003; Herrmann et al., 2007). Many of these studies, however, focused only on concurrent cognitive tasks and did not explore the relationship between cognitive tasks and motor tasks, even tasks as simple as maintaining an upright position. Can these automatic postural tasks also be affected by difficulties in multitasking?

Because we wanted to understand how depression, which could lead to falling, acted on the relationship between cognition and postural control, we conducted a study to compare non-treated depressive elderly subjects (DES) with healthy elderly subjects (HES) regarding their ability to maintain static postural equilibrium. We hypothesized that, due to limited attentional resources and in a context of multitasking, even seemingly automatic tasks such as maintaining a static posture would be impaired in this population.

2. Methods

2.1. Subjects

The study involved two groups: DES and HES. All of the subjects underwent a detailed medical history and physical examination prior to the study. Their age, weight and height were recorded, and their Body Mass Index (BMI) was calculated. Psychological assessments were done with the Geriatric Depression Scale (GDS) (Yesavage and Sheikh, 1986). The GDS is a 30-item self-report assessment used to diagnose depression in the elderly. Cognitive evaluations were carried out using the Mini-Mental State Examination (MMSE) (Folstein et al., 1975). In adults, whatever their age, an MMSE score >24 indicates the absence of dementia (Lezak et al., 2004). Activities of Daily Living (ADL) (Katz et al., 1970) and Instrumental Activities of Daily Living (IADL) (Lawton and Brody, 1969) were also assessed for both groups. Dementia, untreated orthopedic disease, severe malignant or non-malignant disease, neurological problems (including polyneuropathy), a fall within the last 6 months, and a history of alcohol or drug abuse were criteria for study exclusion. All subjects were able to stand upright alone, follow instructions correctly, and hear and see properly.

The DES group consisted of 11 individuals (6 women, 5 men). None of these subjects had begun any antidepressant or psychotropic treatment, and it was the first depressive event diagnosed.

The HES group was composed of 18 individuals (14 women, 4 men) free from depression.

All of the characteristics of the two groups are given in Table 1.

This study was approved by the local ethics committee, and was conducted according to the principles expressed in the Declaration of Helsinki. Written consent was obtained from all subjects or their guardians.

2.2. Static posturography

Postural sway was analyzed using a 45 × 45 cm force platform (Techno Concept, France) with three dynamometric load cells measuring the forces exerted by the subjects on the support surface. The signals were amplified and collected by a computer with a sampling frequency of 40 Hz. Changes in the instantaneous center of pressure (CoP) were calculated using WinPosture v. 3.1.7 software (Podo Technology, Atlanta, GA).

2.3. Postural and cognitive tasks

All subjects carried out a single-task and a dual-task. The single-task was a postural task in which the subjects were asked to step onto the force platform and to remain upright with their arms alongside the body. They were instructed to stand still, keep their eyes open and to look straight ahead at a point located 2 m away. They were to stay in this position for 30 s before getting off the platform. The single-task was followed by the dual-task, during which subjects performed the same actions as in the single-task, and in addition a sequence of cognitive tasks. Together with the motor task of standing upright they were asked to: (1) list as many cities as possible from memory, named dual-task 1; (2) list as many flowers as possible from memory, named dual-task 2; and (3) count backwards from 100, subtracting 5 each time, named dual-task 3. There were three trials for each phase, i.e. single-task and dual-task. This sequence of dual-tasks, from 1 to 3, was identical in all subjects. Subjects were invited to rest on a chair after each single-task or dual-task, before starting the next trial. The displacement of the CoP was recorded for each trial. The sequences and durations of the single-tasks and dual-tasks are indicated in Fig. 1.

2.4. Data analysis

We compared the BMI, GDS, MMSE, ADL and IADL scores of DES and HES. Then, the CoP displacement was characterized using CoP area and path. The former corresponds to the surface of the ellipse covering 90% of the computed CoP points during each trial. The CoP path length corresponds to the length of the CoP displacement trajectory. The CoP area and the path were normalized for each subject's height (Winter et al., 1998). For each subject, we calculated the mean CoP area and path in both the single-task and dual-task conditions over three trials. From the mean CoP area and path of each subject, we calculated for each group (DES and HES) the mean CoP area and path during the single-task and dual-task.

In addition, we performed a Fast Fourier Transform (FFT) in order to see whether the DES showed frequency-specific differences from normal subjects on the one hand, and whether the dual-task showed frequency-specific differences from the single-task in the DES on the other hand.