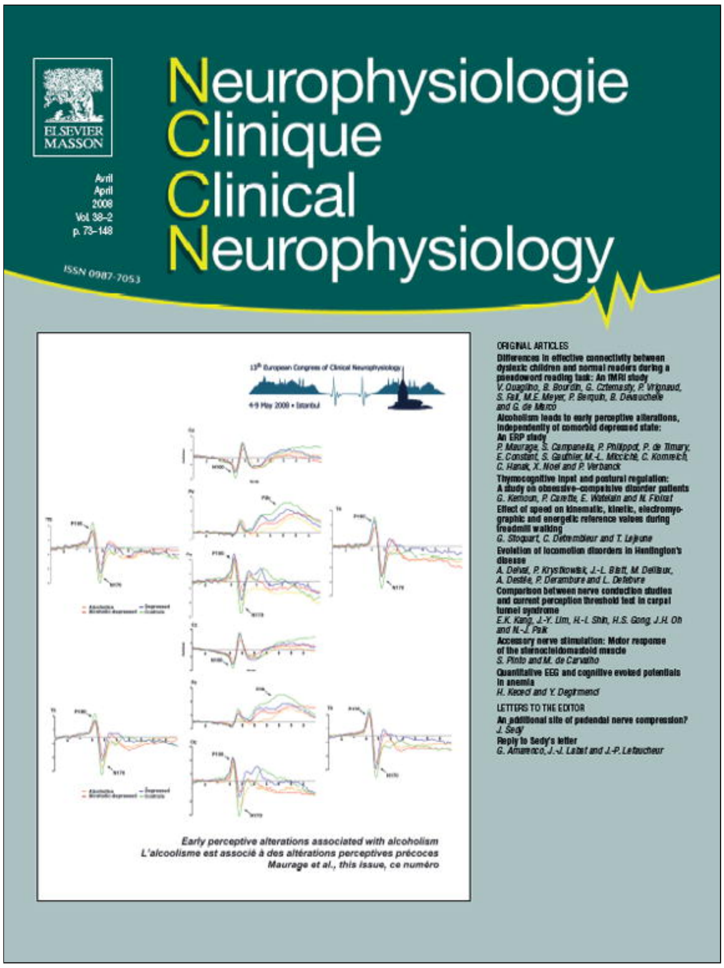
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Thymocognitive input and postural regulation: A study on obsessive—compulsive disorder patients

Afférence thymocognitive et régulation du système postural : à propos d'une étude sur une population souffrant de troubles obsessionnels compulsifs

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Summary
Context. — To show that emotional and cognitive information acts upon the postural balance system in a way comparable to that of the other known inputs (vision, vestibular, proprioception).
Method. — Controlled case study on 90 subjects. One group was composed of 45 subjects suffering from obsessive-compulsive disorder (OCD) in accordance with the Yale-Brown scale, while the other was the control group. All of the subjects underwent recording of their orthostatic posture on a force platform with eyes open and eyes closed.
Results. — As regards to the postural findings, the two groups appear to be quite different. The OCD patients present a considerably reduced area and velocity of sway regardless of whether their eyes are open or closed.
Conclusion. — These results are coherent with regard to those of other studies establishing the link between postural balance and psychological status. Recent morphological studies likewise tend to confirm the existence of neuronal networks common to postural regulation and cognitive and emotional functioning. When interpreting symptoms, these interactions should be taken into account.

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MOTS CLÉS
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TOC ;
Anxiété ;
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Neuropsychiatrie cognitive

Résumé
Contexte. — Montrer que les informations émotionnelles et cognitives agissent sur le système de l'équilibre postural au même titre que les autres afférences connues (vision, vestibule, proprioception).
Méthode. — Étude cas-témoins sur 90 sujets. Un groupe est constitué de 45 sujets atteints de troubles obsessionnels et compulsifs (TOC) selon l'échelle de Yale-Brown, l'autre groupe est le groupe témoin. Tous les sujets bénéficient d'un enregistrement de leur posture orthostatique sur plateforme de force les yeux ouverts et les yeux fermés.
Résultats. — Les deux groupes apparaissent très différents en ce qui concerne les données posturales. Les patients TOC ont une surface et une vitesse d'oscillation considérablement diminuées, que ce soit les yeux ouverts ou les yeux fermés.
Conclusion. — Ces résultats sont cohérents avec d'autres études établissant le lien entre l'équilibre postural et le statut psychologique. Des études morphologiques récentes vont également dans le sens de l'existence de réseaux neuronaux communs à la régulation posturale et au fonctionnement cognitif et émotionnel. On devrait donc tenir compte de ces interactions dans l'interprétation des symptômes.

Introduction

Recent studies of healthy subjects and/or subjects with anxiety disorders [1—4] demonstrated that postural and balance performance is affected by anxiety and modified by emotional stimuli. Moreover, studies of healthy subjects showed that the psychological state modifies control of postural sway [5,6]. A study of the neurophysiological bases of the association between balance control and anxiety allowed more precisely apprehending thymocognitive phenomena in terms of their widely construed sensorimotor expression [7]. This study mentioned a form of comorbidity involving balance disorders and anxiety-related disorders, which is most likely mediated by these central neuronal circuits that concomitantly regulate vestibular processes, vegetative functions, emotional responses and the anxiety state. Noteworthy, the postural system has been classically considered as making reference to a purely systemic conception that takes into account only the influence of the different external inputs (eye, plantar receptors, vestibule) and internal inputs (oculomotricity and proprioception), that is, a conception that in no way takes into account the psychological profile of the subjects. As far as we know, the postural characteristics of patients presenting with an obsessive—compulsive anxiety profile have never been studied. In this population, both psychic rigidity and anxiety may be measured psychometrically [8,9] and objectified through analysis of the stabilometric parameters.

The aim of this study is to render evident a possible link between stabilometric parameter (the sway area of the center of pressure exerted by a person standing motionlessly on a standardized force platform [10]) and OCD. Our main hypothesis is that postural behavior is constantly influenced not only by the external and internal inputs, but also by a thymocognitive component. Given their specific psychological profiles, what we are expecting in OCD patients is an excessively controlled posture, which would entail major variations (either a pronounced decrease or increase) of statokinesigram values for surface area in comparison with control subjects.

Population

This controlled study was performed on two groups of subjects. One group was composed of 45 patients suffering from true DSM-IV Axis-1 OCD, whereas the other was the control group. Included patients were all volunteers who had been sent by the local psychiatry network. The control group was constituted of hospital employees who participated on a voluntary basis and were selected in according to both inclusion and exclusion criteria. Inclusion criteria were as described below:

- to be an 18 to 65-year-old male or female;
- to be able to unrestrictedly maintain a stable standing position, eyes open and eyes closed, heels 1 cm apart, feet forming a 30° angle to the anteroposterior axis;
- not to be affected by any patent and documented pathology modifying postural balance.

Exclusion criteria were as listed below:

- presence of a pathology affecting a sensory organ and interfering with the treatment of sensory information;
- presence of a central and/or peripheral neurological pathology;
- presence of a progressive infectious and/or inflammatory pathology;
- medication entailing modifications in tonus or perception (antalgic, sedative, hypnotic, muscle relaxants).

Methods

Psychometric assessment

The entire population was evaluated with the French version of the Yale-Brown test [8]. This equilibrated 10-item scale is aimed at assessing the severity and the type of symptoms in patients suffering from OCD. Among other things, it is designed to measure the time taken up by the disorders, interference with normal social activities and the degree of suffering, resistance and control. This scale was conceived in order to compensate for the shortcomings of other OCD assessment grids that measure the severity of OCD symptoms without considering the types of obsessions and compulsions. A score higher than 15 out of 40 on the Yale-Brown scale corresponds to obsessive–compulsive anxiety disorders of moderate to high intensity [9]. In this study, the average scores for the control group and the OCD group were 1.8 ± 2.2 (range: zero to seven) and 18.8 ± 3.3 (range: 16 to 28), respectively.

Recording devices and experimental set-up

We used a Dynatronic® force platform with three strain-gauge force transducers supporting weights exceeding 100 kg and providing a two-dimensional analysis of the displacement of the center of pressure. The rigid plate constituting the upper part of the force platform measured 480 mm × 480 mm × 65 mm. This force platform was positioned in an analysis cubicle closed on three sides (front, right and left), which eliminates all horizontal and vertical visual indexes and allows for stabilization of the impact of visual input [11] at 2 m (depth), 1 m50 (width) and 2 m40 (height). The force platform is included in an analysis area 60 cm long and 40 cm wide, the aim being to avoid any muscle reactions induced by a movement equivalent to the gesture of going up a step. A movable device is located behind the feet so as to position the subject in standardized conditions. This set-up imposes a 30° forward open angle between both feet, in keeping with the convention of postural analysis [10]. A visual target lit up at 200 lux in foveolar vision was placed 90 cm from the force plate. The auditory environment remained stable so as to avoid that any noise distracts the subject during the examination [12]. Transducer calibration was performed prior to each series of recordings and the platform was systematically inspected once a week.

Stabilometric and anthropometric assessment

The subject is barefooted positioned on the force platform back to the experimenter. The recording procedure is triggered as soon as the movable reference device behind the feet is withdrawn. The subject is instructed to quietly stand and fixate the lighted target throughout the recording phase without moving. Explanations and a phase of familiarization with the experimental set-up were provided to each subject prior to the series of final recordings.

As it could be expected that anxiety would modulate integration of visual information [13], two conditions were considered: eyes open (EO) and eyes closed (EC). Recordings were systematically repeated twice and performed in a random order, with a sample frequency of 5 Hz. The duration of each recording was set at 50 s, which suffices to ensure data reliability [14].

Collection of posturographic data

The force platform allows collecting both the ground reaction force components and stabilometric data. Ground reaction force components were collected along the two axes of the orthostandardized horizontal plane, that is, mediolateral and anteroposterior axes. Stabilometric parameters were collected through recording of the displacement of the center of pressure, that is, the length and the mean velocity of displacement and the covered area (95% confidence ellipse area). These three parameters were collected in both EO and EC conditions, which gave rise to a total of six parameters.

Statistics

Gender comparison between both groups was performed with the χ^2 test and their anthropometric data (age, weight, height) compared with the Student's t-test. The minimal significance level was set at 5% ($p < 0.05$).

Descriptive analysis of the different stabilometric data consisted in performing cluster analysis (Ward method, Euclidean distance calculations), subsequent to their centering and reduction. Afterwards, the Hartigan test and the R-ratio were used to determine whether or not the identified clusters were representative of the different subject classes. While this method of descriptive upward hierarchical classification defines the individuals according to clusters, it does not allow for specification of the discriminatory parameters of these cluster-based groupings. In order to address this issue, we went on to analyze the six stabilometric parameters with a single-factor ANOVA and a post hoc Tukey (HSD) test (significance level set at $p < 0.05$).

Results

Both anthropometric (age, weight, height) and gender parameters are displayed in Table 1. There were no significant group differences.

Table 1 Anthropometric data (mean ± standard deviation) and male/female distribution of both groups.

$n = 90$	Age	Height (cm)	Weight (kg)	Male/female
Control ($n = 45$)	43.3 ± 14	165.6 ± 19.5	63.5 ± 11.4	30/15
OCD ($n = 45$)	45.3 ± 11.4	167.6 ± 20.3	60.4 ± 10.8	20/25
t Student*/χ^2 **	NS*	NS*	NS*	NS**

OCD: obsessive-compulsive disorders
*, **(NS = $p > 0.05$).

By contrast, a clear distinction between both groups emerged from the cluster analysis based upon the different stabilometric parameters (length, speed, area in both EO and EC conditions). The aggregation distance of both subject populations was 93.91, as opposed to 31.05 and 18.76 for the subpopulations of ''non-OCD'' and ''OCD'' subjects, respectively, which is indicative of both homogeneity inside each subpopulation and major differences between the two populations. The existence of two clusters is confirmed by both the Hartigan test and the R-ratio.

A more subtle analysis of the parameters was then performed by variance analysis (ANOVA) in order to determine which parameters were making the strongest contribution to group formation. Both groups presented significant differences for each one of the stabilometry parameters (Table 2). The ''area'' parameter was the one that mostly differed between both groups, whatever the condition: under the EO conditions, a factor 3 difference in favor of the control group ($98.3\,mm^2 \pm 18.7$ versus $27.4\,mm^2 \pm 7.9$) in the EO condition and a factor 4 difference in favor of the control group ($229.0\,mm^2 \pm 96.6$ versus $48.6\,mm^2 \pm 20.5$) under the EC condition. Similarly, the other parameters were significantly and markedly decreased in OCD patients in comparison with controls, under both EO and EC conditions.

Table 2 Values (mean ± standard deviation) of area, mean velocity and length of displacement of the center of pressure for the two subject populations in both eyes open (EO) and eyes closed (EC) conditions.

	Area EO (mm^2)	Average velocity EO (mm/s)	Length EO (mm)	Area EC (mm^2)	Average velocity EC (mm/s)	Length EC (mm)
Controls	98.3 ± 18.7	5.4 ± 1.3	273.1 ± 63.8	229.0 ± 96.6	9.7 ± 2.8	478.0 ± 145.6
OCD	27.4 ± 7.9	3.5 ± 0.8	175.8 ± 41	48.6 ± 20.5	5.2 ± 1.4	262.4 ± 74.9
ANOVA and post hoc Tukey (HSD)	$p < 0.001$	$p < 0.01$	$p < 0.01$	$p < 0.001$	$p < 0.01$	$p < 0.01$

Discussion

Both postural behavior and stabilometric performance of OCD subjects turned out to be fundamentally different from those of controls.

To our knowledge, the association between psychocognitive parameters and posture modifications has only been studied in anxiety-related and phobic disorders [7,15,16] and no OCD study has yet been published. But associations between some balance disorders and some mood swings have been described [17]. Yardley et al. [18] not only observed signs of postural instability in subjects suffering from anxiety disorders, but also noted balance disorders that were associated with extravestibular dizziness sensations, the latter being associated with anxiety states [2]. This study underlines the existence of cognitivo-behavioral processes that play a role in restoration of stability. Actually, it suggests that the favorable evolution of balance disorders may well be influenced by psychological factors of cognitive, emotional and behavioral natures. In subjects with mood and anxiety-related disorders, Bolmont et al. [19] suggested that ''anxious'' responses and mood swings lead to a lower capacity to use somesthetic, visual and vestibular influences in order to maintain balance. Kitoaka et al. [3] showed that the mood states were significantly correlated with both latency and amplitude of anticipatory postural adjustments and suggested a possible relationship between ''dynamic'' postural control and psychological factors.

In this study, the significant restrictions of stabilometric performances (small area, length, speed) in OCD subjects demonstrate the existence of permanent changes in their postural stability system. The significant restriction of the sway area, whatever the visual conditions (EO or EC), is particularly noticeable and appears directly linked to the disorders affecting our group of patients. The other studied parameters (velocity and length) behave similarly to the statokinesigram area. Our results are in contradiction with those of other studies. Thus, in order to examine whether anxiety was correlated with the parameter of balance control, Ohno et al. selected 20 students aged 19 to 33 years in whom anxiety was assessed and postural sway recorded through use of a force platform. Their results show that, in the EO condition, an increased anxiety level is significantly correlated with an increased sway area, but that the correlation disappears in the EC condition. By contrast, our study demonstrated differences between OCDs and controls in both EO and EC conditions. This may indicate a different way of coping with emotional factors in an OCD or an anxious student population, as described before [20] and support the hypothesis that anxiety modulates the integration of visual information. We could also consider that most of the precedent studies focused on an anxiety ''state'' whereas this study focused on a ''trait''. Anyway, the postural attitude is peculiar to our OCD population when compared to other anxiety-prone populations that were studied in different contexts. Our findings relate to the quest for control of anxiety and mood that has been classically described in this population [20]. It corroborates the idea of a thymocognitive influence playing a role in the regulation of orthostatic posture; this influence would be continuous and, by reducing the natural sways of the balanced body taken in its entirety, would lead to excessive postural control. It would have been interesting to separately analyze both anteroposterior and mediolateral components, as was done in the study by Wada et al. [6]. These showed that in anxious yet nonpathological students, the degree of anxiety modifies the frequency components of postural sway along the anteroposterior axis. Similarly, Ohno et al. demonstrated that an increased anxiety level is significantly correlated with an increased maximum length of the anteroposterior axis.

Should this thymocognitive influence be considered as a factor interfering with central control or as an equivalent to sensory afferent? Hillman et al. [4] drew upon five preceding studies pertaining to postural behavior and emotion, and demonstrated the influence of emotionally ''loaded'' images on postural adjustment. In their study, the most pronounced changes in the movements of the center of pressure were observed during a task consisting of the observation of disagreeable photos. This suggests that the postural changes connected with emotions would be more marked in response to stimuli prompting ''flight'' responses. Emotional stimuli would thereby seem to modify posture and act in the same way as the other afferent systems. This leads us to consider the thymocognitive influence as a supplementary afferent system.

Regarding neurophysiological bases, several studies suggested that emotion, anxiety, vestibular information processing and vegetative control may have several neuronal networks in common [6,21,22]. More particularly, connections between the vestibular nucleus and the parabrachial nucleus provide a direct link between the vestibular system and these neuronal networks that are involved in the expression of anxiety and emotions. The parabrachial nucleus has reciprocal connections with these prosencephalic structures that have frequently been considered as playing a role in anxiety or panic-related disorders and in changes pertaining to the affect and conditioned emotional responses. Moreover, recent neuroanatomical and neurobiological studies suggest that the OCD symptoms might arise from dysfunction of networks involving the orbitofrontal cortex, basal ganglia and thalamus [23,24]. Therefore, a reciprocal link between posture disorders and psychiatric symptoms appears anatomically conceivable. The systematic and continuous restriction of posturographic performance at the level of the sway area in OCD subjects supports the hypothesis of thymocognitive input in the regulation of orthostatic posture. It consequently appears advisable to take these interactions into account when interpreting postural and/or psycho-cognitive symptoms.

Conclusion

Studies combining psychological assessment and stabilometric measurement in subjects suffering from anxiety disorders of the obsessive—compulsive type support the hypothesis that thymocognitive input might exert continuous and significant influence on postural control. Such action on postural control is a measurable and quantifiable data, which can be obtained by means of psychometric scales in conjunction with measurements taken on a force platform.

The influence of the psyche and, more specifically, of these types of disorder and dysfunction should be taken into account in future studies of orthostatic posture. It will be just as important to consider that thymocognitive information should be integrated with visual, vestibular and somatosensory information in postural regulation.

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