Afterthoughts on the calculation of the Romberg's Quotient

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Introductin

Vladimir Usachev and Victor Belayev have opened a serious critical chapter in the analysis of the stabilometric signal by showing that the basis of many of our parameters is shaky! ... The mean position of the center of pressure [CoP] - which is used for the calculation and the definition of X-mean, Y-mean, Area, LFA, VFY - is indeed likely to migrate from one minute to the next during a recording, as revealed by their long recordings duration - up to seven minutes. Given this experimental evidence, these Russian authors have, in particular, advised to modify the way we calculate the Romberg's Quotient using the ratio of parameters whose value is insensitive to the duration of the recording, for example the mean speed of the displacements of the CoP, according to Usachev.

Interest of the Latin base of stabilometric data

The 222 recordings that Sofia Olivia Calvo Moreno has just made according to the "Normes2013" protocol, a "first" of our stabilometric database, provide us with the opportunity to verify experimentally the validity of this advice of the Russian authors. Is the mean CoP displacement speed the correct parameter for calculating the Romberg's Quotient?

Recall that «Normes13» provides 3 successive recordings of thirty seconds of the same subject in the same situation, here three recordings in open eyes situation and three recordings in situation closed eyes. The 30-second recording time gives a chance, not evaluated, of escaping the recording of a CoP migration. The 222 recordings thus concerned 74 subjects whose size, age, sex and the situation of recording eyes open and closed eyes are known; they are the cornerstone of the future Latin base of stabilometric data.

Principal component analysis

Using these few data from the database we carried out a principal component analysis with two factors: open eyes [&] and closed eyes [%] on 8 independent variables: Surface of the confidence ellipse containing 90% of the CoP sampled positions [P], Surface of the confidence ellipse containing 90% of the CoG sampled positions [G], CoG shift velocity [VG], CoG acceleration [C], CoP displacement mean velocity [V]], ballistic interval [B], Percentage of the amplitude of the X oscillations in the 0.2 Hz frequency band [X], Percentage of the amplitude of the Y oscillations in the 0.2 Hz frequency band [Y] .

After verifying the normality of distributions of these variables by the normality tests, we accepted the representation of the PCA on axes 1 & 2 which accounts for 80% of the variability (which is acceptable, without more).

The result is quite spectacular (Fig. 1): The & and the % separate clearly along the axis 1 which is correlated to 0.957 with the variable P and to 0.935 with the variable G, but negatively correlated, -0.202, with the variable V.

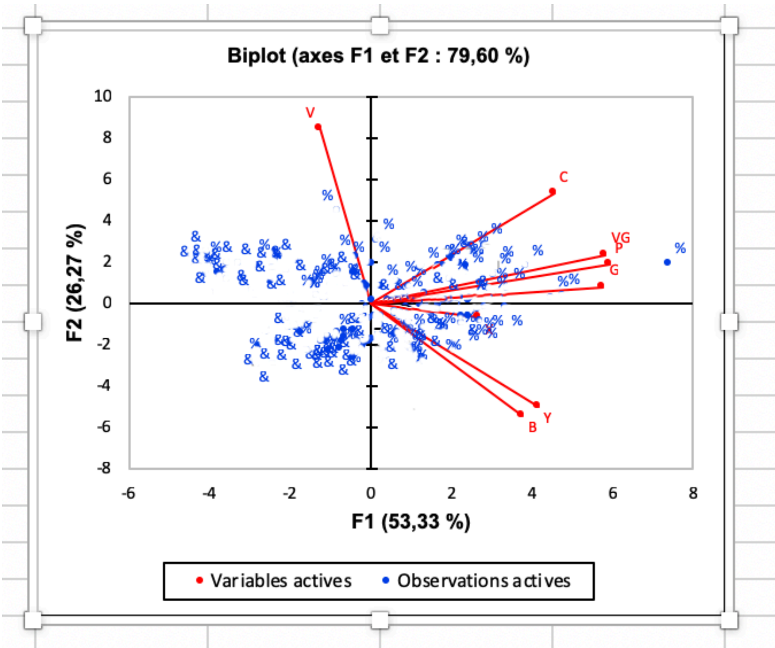

Figure 1. PCA on axes 1 & 2.
Both factors: eyes open [&] and eyes closed [%] and the 8 independent variables: Surface of the confidence ellipse containing 90% of the sampled positions of the CoP [P], Surface of the ellipse of confidence containing 90% sampled positions of CoG [G], CoG shift velocity [VG], CoG acceleration [C], CoP displacement velocity [V], ballistic range [B], Percentage of X-wave amplitude in the frequency band 0.2 Hz [X], Percentage of the amplitude of the Y oscillations in the 0.2 Hz frequency band [Y].

Variable V being strongly correlated with axis 2 (0.961), a new PCA on axes 2 and 3 (Fig. 2) is carried out to check that the YO and YF situations are poorly separated by variable V.

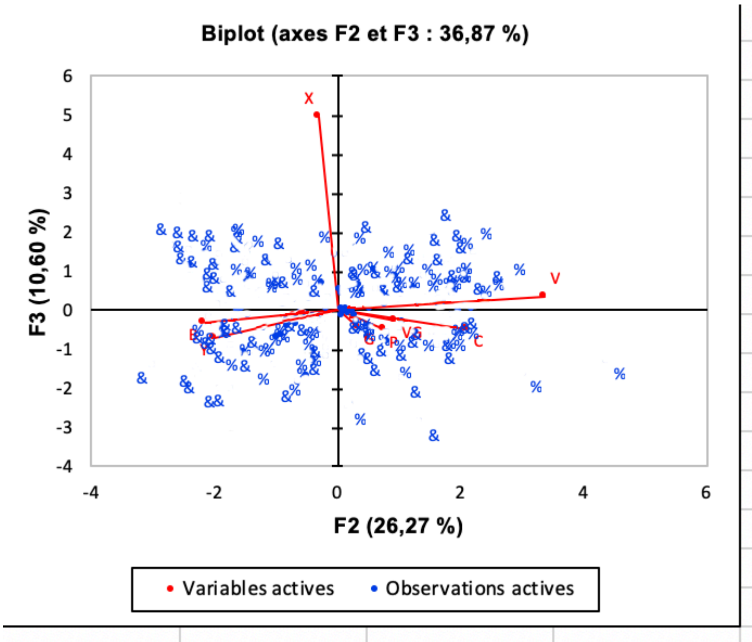

Figure 2. PCA on axes 2 & 3.
Both factors: eyes open [&] and eyes closed [%] and the 8 independent variables: Surface of the confidence ellipse containing 90% of the sampled positions of the CoP [P], Surface of the ellipse of confidence containing 90% sampled positions of CdG [G], CdG shift velocity [VG], CdG acceleration [C], CoP displacement velocity [V], ballistic range [B], Percentage of X-wave amplitude in the frequency band 0.2 Hz [X], Percentage of the amplitude of the Y oscillations in the 0.2 Hz frequency band [Y].

Discussion

This first experimental check of the interest of the mean speed of the movements of the CoP to calculate the Quotient of Romberg concerns a reduced number of 74 subjects, so it should not be attributed to it an exceptional value. Further studies are needed before we can conclude. The very practical point of view of the use of this speed for a calculation of the Romberg's Quotient is incidentally secondary.

It is much more interesting to note that the results of these PCA would be in agreement with another result obtained by the analysis of this beginning of database: the quotient of the Romberg calculated using the ballistic interval is equal to 0.83. This may mean that the presence or absence of visual information in the operating of the orthostatic postural system has no effect on the reaction time of the system. This notion is obviously too important for us to be able to do anything else here than to mention it, other work is needed.

Conclusion

As a tentative conclusion, it seems that the conventional method of calculating the Romberg Quotient using the surface of the confidence ellipse containing 90% of the sampled positions of the CoP is the best method, provided that it avoids a possible migration of the CoP during the duration of the recording by using the average of the values obtained during three successive recordings in the same situation.

Thanks

To Sofia Olivia Calvo Moreno who opened the ball of the Latin base of stabilometric data.

It's up to you to play, now, enter the dance of 'big data'! ...