THEORETICAL PORTRAYAL OF VALSALVA MANOEUVRES

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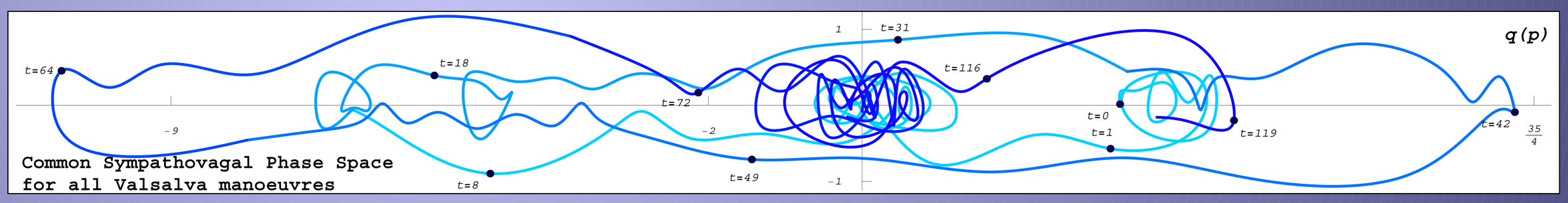
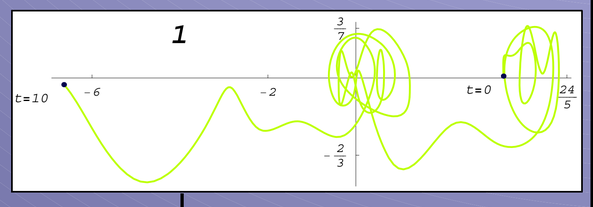
Based on scale covariance, a mathematical method was previously proposed to extract from the ECG, beat-by-beat information on the sympathetic and parasympathetic systems (SP&PSP). The sympathovagal balance is represented as the time evolution of a trajectory in phase space. Calculated indices give degrees of activity of the subsystems locally (i.e. independent non-antagonist measurements), and a measure of autonomic dysfunction is then given as the lack of coupling of these indices. We show elsewhere that such a definition is appropriate.

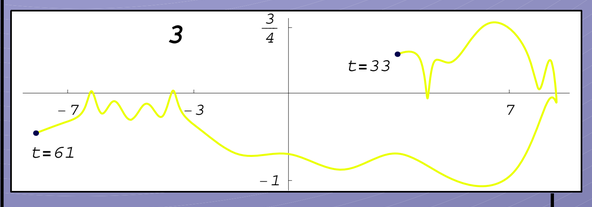
This study now aims at better understanding the Valsalva manoeuvre by consideration of the indices obtained throughout the manoeuvre. From an original study on 30 patients (mean age: 47(+/- 10) years, with recorded enlightened consent) with 4 clearly demarcated groups, we only take consideration of the first two groups, called healthy and early-DAN (Diabetic Autonomic Neuropathy) groups (respectively made of 6 and 7 patients out of 30).

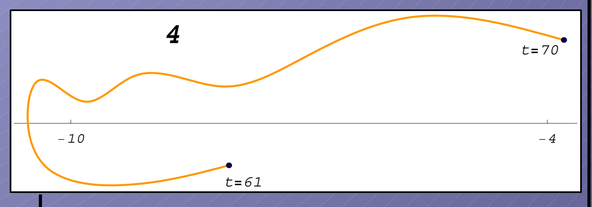
Results indicate that pair-wise averaging of normalized SP&PSP indices is appropriate and sufficient for obtaining the common (analytical intersection) inter-behaviour of these systems for all 13 patients. Whether one would normalize through translation or similitude does not change the outcome using the healthy-DAN group's indices, but usage of the early-DAN indices flattens the average to constant indices when normalizing via similitude:

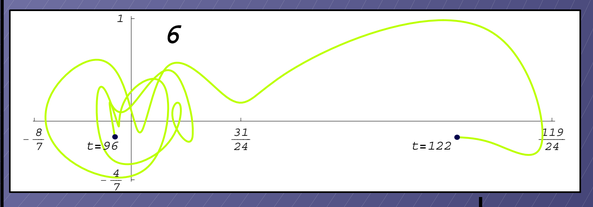
$$\mu_{SP\vee PSP}+\frac{C}{N}\sum^{N}\left(\frac{\mu_{PSP}-\mu_{SP}}{idx^{k}_{PSP}(0)-idx^{k}_{SP}(0)}\cdot\left(idx^{k}_{SP\vee PSP}-idx^{k}_{SP\vee PSP}(0)\right)\right)$$

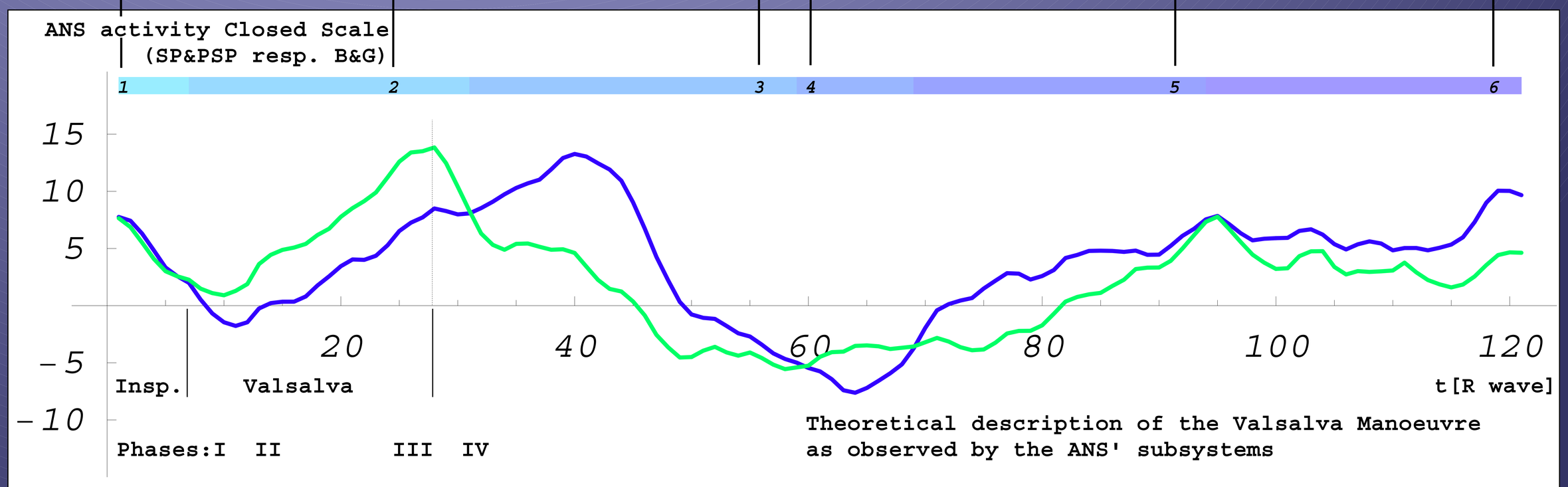












This common behaviour of indices gives a theoretical portrayal of the Valsalva manoeuvre with 5 major phases:

- Confounded decrease of SP&PSP (corresponding to inspiration before forced expiration).
- Increase of SP&PSP with a first increase of PSP, the PSP activity staying above the SP activity.
- After a peak for both PSP&SP (marking the end of the Valsalva), the SP activity first very slightly decreases to then increase and cross above the PSP activity (which monotonously decreased from its peak).
- Following a peak for SP (maximum activity reached throughout the manoeuvre), PSP level of activity becomes constant, yet above a short draw-down and back-up of SP.
- Slight increase of both SP and PSP, with SP above PSP and nearly confounded by two times.

Beyond the neurological and physiological perspectives of such a precise and universal portrayal, we found ground for understanding early DAN patients as loosing their measurement specificity, and observing the transition to this early group as a singularity with asymptotic behaviour.