inventis
Audiology & Balance

academia

# Caloric module

PRODUCT INSIGHTS

author:
**Enrico Armato, Dr.**

This document provides a comprehensive overview of how to perform Caloric tests using the NYSTALYZE system in conjunction with the SYNAPSYS VNG Module software. Unique for its adaptability, NYSTALYZE offers both a wireless mask and a wired version, catering to the diverse needs and preferences of users.

## GENERAL CONCEPTS ABOUT CALORIC TEST

The caloric tests can be carried out with the classic Fitzgerald-Hallpike method (water temperature 30 and 44 °C, duration 40 seconds and volume 250ml). The ears should be inspected carefully before the test. If there is cerumen blocking the ear canal, it should be removed before the irrigations. Similarly, the ear inspection should note any evidence of tympanic membrane perforation, middle ear fluid, or otitis externa. Irrigation is always performed following a predetermined order, without this ever-producing visible sequence effects. On every occasion it is advisable to record the trace of the eye position in the position taken by the patient before performing the irrigations: this is particularly useful if there is a spontaneous-positional Ny. In fact, by comparing the pre-caloric Ny velocity curve, which is considered as a "baseline", with those obtained after stimulation (post-caloric Ny) it will be easy to verify the influence of the labyrinthine activity induced by the thermal tests.

As in rotatory tests, albeit to a lesser extent, the peak value of the slow phase velocity of the thermal VOR is influenced by the patient's alertness and/or stress level.

The provided parameters are absolute reflectivity, relative hypovalence and directional preponderance, which can be calculated for both the horizontal and vertical component of caloric Ny.

From the analysis of the evolution of the velocity curve of the slow phase it is possible to note the difference in shape duration and epoch of culmination between hot stimulations (higher peak values, faster ascent, earlier culmination) and cold stimulations (reduced peak values) up to 30%, slower ascent, later culmination as well as between the horizontal component (earlier culmination, higher peak values) and vertical component (later culmination, peak values between 10 and 50%) of caloric Ny.

## PATIENT INSTRUCTIONS ABOUT CALORIC TEST

Before starting the exam with NYSTALYZE system the examiner should explain the procedure to the patient

in an honest but nonthreatening manner. The patient should then be placed in the supine position with the head raised up about 30 degrees. Standard recommendations are:

The parameters that are taken into consideration by postural acquisition are:

- Do not move the head during irrigation
- Avoid any head tilt, pitch, roll before and during the test
- Keep your eyes wide open
- Keep your eyes centred unless specifically requested
- Try to keep your mind occupied with a flow of thoughts
- Avoid blinking

## INTERPRETATION OF CALORIC TEST

This paragraph describes the major features the Caloric test provides.

- **Unilateral Weakness or Canal Paresis** is expressed as a percentage, not in relation to the ear on the opposite side, but in relation to the sum of both ears. For example, a right/left difference or unilateral weakness of 50% appears after application of the Jongkees formula, as a 33% unilateral weakness. This has no consequence on our ability to distinguish the normal population from the pathological. For those who are interested in unilateral weakness where one ear is compared to just the opposite ear, this can be calculated or observed by comparing the respective lengths of the right and left wings of the butterfly.

- **The absolute Directional Preponderance**, in the Freyss diagram, represents a calculation of the nystagmus intensity preponderance, expressed as a velocity rather than a percentage. The directional preponderance may have several origins: vestibular or extra-vestibular, for instance cervical or central.

- **The Total Reflectivity** is dependent on the stimulus parameters. It is possible to establish the statistical limits of the normal variation for the caloric response to a standard stimulus. However, it is not possible, for a given patient, to predict the degree of thermal coupling between the middle ear and the lateral canal, and therefore it is impossible to measure the gain of the response. It is reasonable to use kinetic tests to estimate sensitivity with gain measurements and use the caloric tests to distribute this measurement of global sensitivity between the left and right ears.

For the bithermal caloric tests it is necessary to identify the causes that determine the velocity curves of the slow phase with an irregular but not pathological appearance (such as deviations from the primary position of the gaze, excessive persistent or sporadic cortical inhibition, blinking and closure of the eyes) or the simultaneous presence of relative hypovalence and directional preponderance in the absence of spontaneous-positional Ny (such as irrigation not coaxial to the duct, incorrect water volume, incorrect water temperature and excessive variation in conditions of cortical inhibition between the various stimulations).

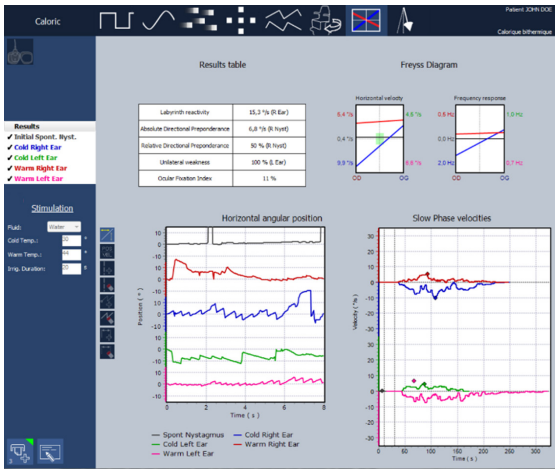
Among the technical solutions adopted for the correction of these drawbacks it is important to remember, for example, the use of an anaesthetic eye drops if the blinking phenomena strongly contrast with the execution of the tests. Furthermore, when the phenomena of central inhibition strongly interfere with the evocation of oculomotor reflexes (for example during the execution of rotatory tests and / or thermal tests), it is essential to try to condition the patient, repeatedly inviting him to perform simple mental exercises of a disinhibitory type (perform a calculation or a numerical count, imagine a landscape, etc.)

## GENERAL PRESENTATION OF CALORIC MODULE

The Caloric module is represented by the icon.

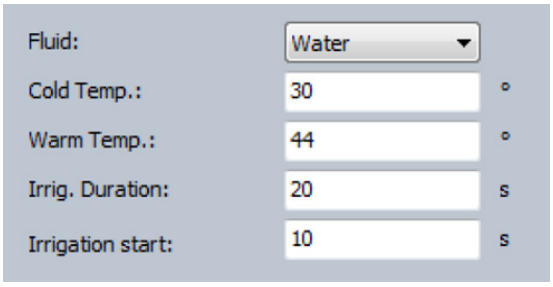
This module allows the following to be analyzed:

- The bithermal caloric: consists of 4 traditional caloric tests, together with the nystagmus test, that is, the state of the vestibular-ocular-motor system prior to any stimulation.




## STIMULATION PARAMETERS

With NYSTALYZE system, in this module, the user will be able to set type of fluid, temperatures, and delay of starting irrigation.




Fluid used for stimulation: water or air

Cold temp: Temperature of fluid during cold tests

Warm Temp: Temperature of fluid during hot tests

Irrigation duration: Period of irrigation

Irrigation start: Time between start of input and start of irrigation

The American National Standards Institute (ANSI, 2009) and British Society of Audiology (BSA, 2010) recommend performing irrigations in the bithermal caloric test in a specific order. Warm irrigations are to be performed first, followed by cool irrigation in both standard. Right ear must be irrigated first for both warm and cool temperatures.

## SETTING DEFAULT TEST

In this module, there is no setting default.

## DISPLAY OF RESULTS

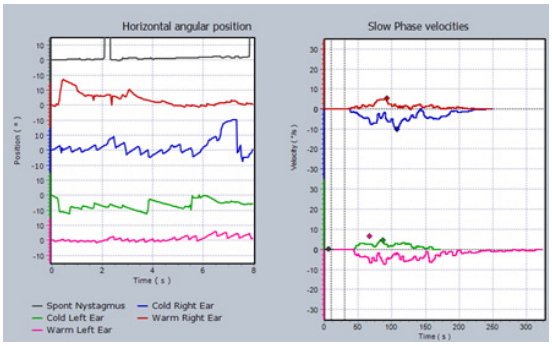
The results are displayed:

- in the position & slow phase velocity
- in a table
- in the Freyss' diagram

- **Position & Slow Phase Velocity**

The position graph shows the horizontal and vertical components of the nystagmus.

The slow phase velocity shows how it changes during time: ascent phase, culmination, and descent phase. The culmination is the most representative point of the entire nystagmic response. It is determined automatically but can easily be corrected manually if the operator deems its positioning to be unsuitable.



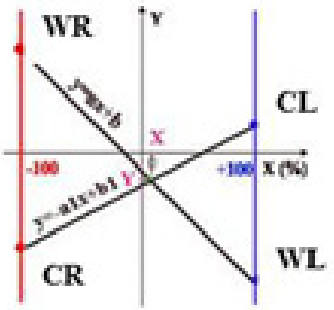

- **Results table**

It provides all the numerical parameters that characterize the caloric response.

| | |
|---|---|
| Labyrinth reactivity | 15,3 °/s (R Ear) |
| Absolute Directional Preponderance | 6,8 °/s (R Nyst) |
| Relative Directional Preponderance | 50 % (R Nyst) |
| Unilateral weakness | 100 % (L Ear) |
| Ocular Fixation Index | 11 % |

- **Freyss' diagram**

Dedicated to the bilateral bithermal caloric examination, the Freyss' diagram, also known as the "Freyss Butterfly", shows on the same graph the intensity of the nystagmus and at least two fundamental results, namely the relative deficit and the absolute preponderance.




Very generally, the Freyss Graph is centred on an orthonormal reference point the ordinate axis of which is graduated within the intensity variable unit of the nystagmus, while the x-axis is graduated in percentages. This reference point has two straight lines (blue and red).

The results relating to the right nystagmus are signed positively, while those relating to the left nystagmus are signed negatively. The red straight line shows the results concerning the right ear, while those concerning the left ear are distributed on the blue line. The two points that correspond to the measurements of intensity during a cold or hot bilateral isothermal test are thus linked, defining a straight line of equation y=ax+b, normally with positive gradient for cold tests and negative gradient for hot tests.

When the four tests are carried out, and if the terms WR and CR are used to describe the intensity of the reactive nystagmus to the tests carried out on the right side (hot and cold respectively) and the terms WL and CL are used to describe similar tests on the left side, the X and Y projections of the point of intersection of the two previous straight lines show results, which are:

- In the vertical projection, the value of the unilateral weakness or canal paresis (X), expressed in percentage and can be calculated from the formula:

$$\frac{[(WR-CR+WL-CL)*100]}{(WR-CR-WL+CL)}$$

If the direction of the nystagmus for each of these four tests is as expected, then we can use the traditional Jongkees' formula:

$$\frac{(WR+CR)-(WL+CL)*100}{(WR+CR+WL+CL)}$$

Note: It is essential to sign the values in the hypofunction formula; this is not the case for the Jongkees' formula.

- In horizontal projection, the absolute preponderance (Y) is calculated using the formula:

$$\frac{(WR*CL)-(CR*WL)}{(WR-CR-WL+CL)}$$

## SPECIAL CALORIC ICONS

In addition to the usual icons, also present in the other modules, we can find some specific ones:

- **OFI measurement**

These icons  are used to perform the ocular fixation test, i.e., the red LED inside the VNG mask turns on immediately after the velocity curve of the slow phase of the caloric Ny has visually reached its highest value elevated (culmination) for about ten seconds. This allows you to automatically calculate the % inhibition of nystagmus. When nystagmus is fully suppressed, the fixation index will be 0%. When nystagmus is partially suppressed, the fixation index will be between 0% and 100%. When nystagmus is enhanced, the fixation index will be greater than 100%.

- **Manually modify the culmination point**

When the difference between the velocity curve of the slow phase of the caloric Ny and the position of the cross indicating its maximum value, automatically calculated by the software, is judged excessive or incorrect by the test executor, the cross position can be modified.

With NYSTALYZE system the user will be able to select the curve to which the culmination peak belongs.

Click on  .

Left click on the graph to position the culmination peak.

## NORMATIVE VALUES ABOUT CALORIC TEST

With NYSTALYZE system for the Caloric module when the visualization of normative data is enabled, reference tables appear. It is important to underline how the normative data can in fact be modified by the user and are associated with the patient's age groups. The tabular results of the tests, if the "Highlight normal/ abnormal

values" option is enabled from the VNG settings, appear in green or orange, depending on the normative data that have been set.

The normative parameters of the VNG were drawn from the volume "*Balance function assessment and management – third edition – Gary P. Jacobson, neil T. Shepard*".

PI - Caloric module_Rev01 • Date: 2024.105.20

inventis
Audiology & Balance

**INVENTIS S.r.l.**
CORSO STATI UNITI, 1/3
35127 PADOVA – ITALIA
TEL: +39.049.8962 844
FAX: +39.049.8966 343
info@inventis.it
www.inventis.it