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Kinetic module

PRODUCT INSIGHTS

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This document provides a comprehensive overview of how to perform Kinetic 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 KINETIC TEST

Kinetic tests are the only chance to evaluate the vestibulo-oculomotor reflex (VOR) at medium labyrinth stimulation frequencies.

It is necessary to keep the profiles of the chair's movement clearly distinct from the reflexes that can be assessed by kinetic tests.

A sinusoidal movement profile with constant period and variable amplitude (Sinus) will be used for assessing the Vestibular-Ocular Reflex (VOR), performed with the head moving in solidarity with the trunk, and for the Cervical-Ocular Reflex (COR), performed with the head steady in space and trunk moving with the chair. Both reflexes require the absence of a visual signal. If the visual signal is not inhibited, it will be assessed a visuo-vestibular interaction, which may be of the integrative type (Visual Vestibular-Ocular Reflex - VVOR) or of the inhibitory type (Vestibular-Ocular Reflex Fixation - VORFIX or Vestibular-Ocular Reflex Suppression - VORS). Both last two tests are performed with the head moving in solidarity with the trunk.

A movement profile with decreasing period and amplitude (Multi-period or Sweep), with square back and forth stimulation (Créneaux) or with an abrupt stop (Step) are suitable for VOR analysis.

The oculomotor response to the kinetic tests is evaluated by means of some parameters that are, at least in part, related to the profile of the stimulation movement. The most significant are the gain, the directional preponderance, the phase, and the time constant (see below).

The VVOR analysis is the mirror of the overall quality of the Ny recording in VideoNystagmoGraphy. In fact, it evaluates the accuracy of both the visual calibration and the calibration of the chair. The unit gain of the VVOR presupposes a correct calibration of the aiming frame, a sufficient foveal vision of the "master" eye and a normal conjugation of the movements of the "slave" eye.

The rotatory VOR gain is influenced by the patient's alertness and/or stress level, as pure vestibular

stimulation is extremely sensitive to central inhibitory control influences. The repetition of the VOR (test and retest) allows to differentiate the "true" peripheral hypo-reflectivity from those linked to a transient central inhibition. In this latter circumstance, in fact, there is a significant increase in gain upon execution of the retest.

The evocation of the COR is strictly correlated to the conditions for carrying out the test (manipulation of the patient's head and instructions to be given regarding the direction of the gaze) and to the usual smallness of the gain of the reflex itself. The phase opposition (180°) with respect to the evocative stimulus makes it possible to differentiate the real oculomotor response linked to cervical proprioception (COR) from that of a vestibular nature evoked by a movement of the head (VOR); in the latter, in fact, stimulus and response are normally in phase concordance (<2°).

PATIENT INSTRUCTIONS ABOUT KINETIC TEST

Before starting any kinetic stimulation with NYSTALYZE system, the patient must be equipped with head support, footrest and the safety belt locked. Ensure that no wires or other objects hinder the chair's movement.

The examiner should explain the procedure to the patient for profile of any chair movements. The patient must be placed on the chair in the seated position with the head tilted down about 30°. Standard recommendations are:

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

The distracting manoeuvres are the same ones adopted in other VNG tests and consist of having a countdown performed, starting from an initial number, and subtracting 3 or 7 digits at a time depending on the difficulty desired, imagining a panorama that scrolls while the chair is swinging and so on.

INTERPRETATION OF KINETIC TEST

These are the parameters that Kinetic test performed with Nystalyze system provides.

- **Gain:** it is the ratio between the angular velocity of the eye and the angular velocity of the stimulus that causes the eye movement itself. It can be normal or reduced, rarely it is increased.
- **Directional Preponderance:** it expresses a significant asymmetry of the nystagmic response when it is evoked by a stimulation of symmetrical intensity. It is expressed in degrees/second (°/sec) and always refers to the direction of the nystagmus. By convention, the upper left and vertical preponderance are directed upwards while the lower right and vertical ones are directed downwards. It means a defect in symmetry of Ny genesis, without any causal and/or topographical presumption.
- **Phase:** it expresses the anticipation or delay of the response with respect to the stimulus; its unit of measurement is the degree (°). To simplify the reading of the graphs, it is conventional, with respect to ENG, to invert the direction of the movement of the chair in relation to that of the eye (Right-decreasing, Left-increasing); a comparative superimposition is possible between movement of the chair and the cumulation of the slow phases, in the VVOR and VOR modes. In COR mode this comparative superimposition is not possible as physiologically a phase inversion (180°) of the reflex is determined.
- **Time Constant:** it is the time necessary for a 37% decrease to occur (e^{-1}). It is strictly correlated to phase as $TC=(1/2\pi)*(f*\theta)$ where f is frequency of oscillation and θ is the phase.

Each movement profile performed with Nystalize system has pros and cons.

- **Sinus**: it is well suited for the identification and prevention of central inhibition. But it is too long to proceed frequency by frequency.
- **Multi-period or Sweep**: it tests a frequency band and the evolution of phases; it lends itself to disinhibition a little better than step. It does not test PD as it is an asymmetric profile.

- **Step**: it tests a frequency band, but the inhibition could be difficult to neutralize. The post-rotation nystagmic response allows the calculation of the Time Constant (TC), i.e. the time necessary for a 37% decrease to occur (e^{-1}). A constant > 20 sec is an index of centrality. A constant < 5 sec is an indicator of peripheral deficit.

GENERAL PRESENTATION OF KINETIC MODULE

The Kinetic module is represented by the icon:

This module allows the reactive nystagmus to a kinetic stimulation to be recorded and analyzed.

STIMULATION PARAMETERS

With NYSTALYZE system, for each movements profile there are different stimulations parameters.

In order to see in detail “test name”, “chair movement” and “type of associated analysis” you can consult table 1 in the appendix.

For any test some labels help identify each segment of test and give it an associated description (VVOR, VOR, COR, VORFIX). The labels can be positioned in real time during the test if the protocol is pre-defined, or in deferred time. If a MED4 Electronic Chair is used, the chair is piloted by the VNG in accordance with the title of the test and the labels may be placed automatically.

SETTING DEFAULT TEST

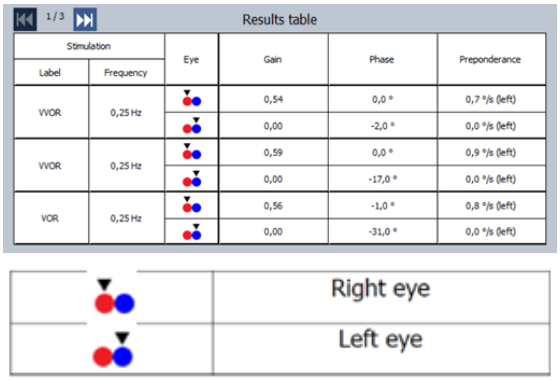
In this module, there is setting default for each movement profile.

DISPLAY OF RESULTS

The results are displayed in the position & slow phase velocity, in a table, and in specific diagram according to the movement profile chosen.

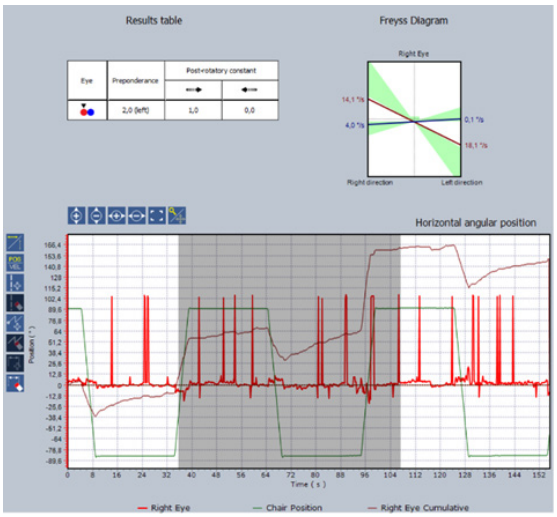
- **Expression of results for sinus stimulation**

It is important to note that analysis of the sine wave applies to the periodic signals of constant frequency. Selection must be operated over at least 3 periods.



- **Expression of results for square back and forth stimulation by the Freyss graph**

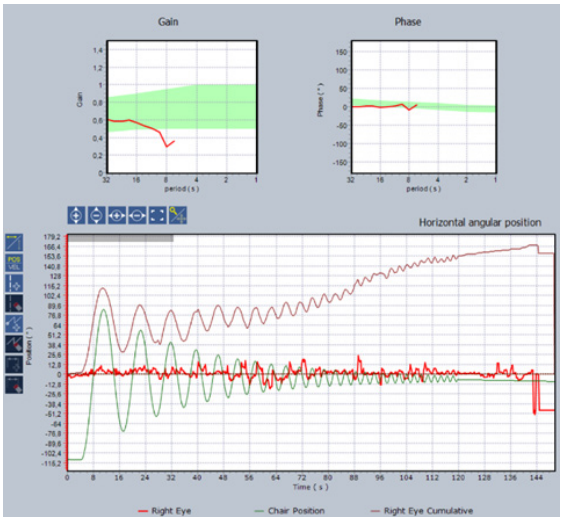
It provides all the numerical parameters that characterize the caloric response.



The points that correspond to the intensity of the acceleration impulses are connected to each other, forming a normally negative straight slope known as the “acceleration straight line” (coloured red), while the points that corresponds to the intensity of the responses

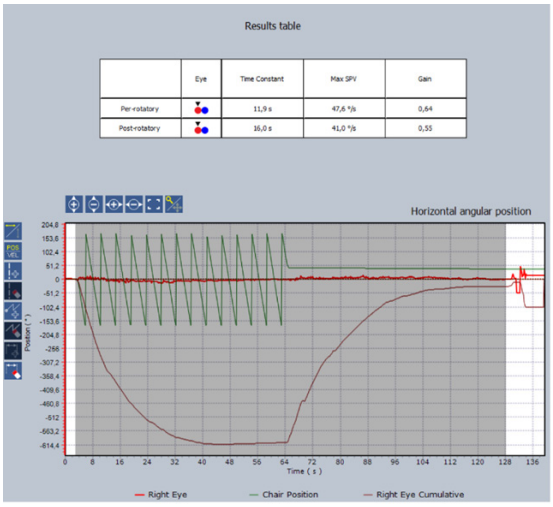
to deceleration impulses form the "deceleration straight line" (coloured blue), usually with a zero or positive. Under these conditions it is clear that the projection of the straight lines' intersection point on the ordinate axis corresponds to a quantitative expression of the preponderance of the nystagmus intensity – what we usually call "a directional preponderance".

- **Expression of results for the multi-period or sweep stimulation**



This type of analysis applies to signals containing several frequencies. Application of the Fourier transform to such signals breaks down the frequency spectrum that makes them up, and simultaneous application of this transform to the signals from the chair and from the ocular response help establish the development diagrams for the gain and the phases according to the period (or frequency). Only the gains and phases from periods acknowledged as having a significant presence in the signal from the chair are represented on the graphs.

- **Expression of results for step stimulation**



	Right eye
	Left eye
Time constant	Constant characteristic of VOR measured during and after rotation
Max SPV	Maximum slow phase velocity observed during and after rotation
Gain	Gain measured as ratio between maximum SPV and rotation speed of chair for during and after rotation.

NORMATIVE VALUES ABOUT KINETIC TEST

With NYSTALYZE system for the Kinetic 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*".

Test Name	Chair movement	Type of associated analysis
BURST 1	8 groups of sinusoidal waves, duration 4 seconds. Each group consists of 7 increasing and then decreasing oscillations of maximum amplitude of 30°. A group lasts for approximately 32 seconds. Insertion of automatic marker VVOR, VOR, COR, OFI at 0s, 32s, 64s and 97s	Sinusoidal analysis (fundamental frequency of stimulation)
BURST 2	Identical to previous test but without automatic marker insertion	Identical to previous test
SQUARE BACK & FORTH 1	"Square back and forth" type of stimulation. The chair makes a right half-turn in about 5.5s followed by a pause of 30s. The cycle is repeated to the left. This sequence is carried out four times.	Analysis by Freyss Graph
SQUARE BACK & FORTH 2	Identical to previous test	Analysis by Freyss Graph
Multifrequency SWEEP	Stimulation with variable frequency: In 2 minutes, the chair makes a sinusoidal turn the duration of which passes from 15s to 2s. The amplitude also decreases.	Analysis using frequency sweep.
Decreasing Sinus T = 20s	Decreasing sinusoidal, period 20s. Start at 170°, duration 160s	Sinusoidal analysis (fundamental frequency of stimulation)
STEP VELOCITY 80°/s L	Continuous left rotation at 80°/s lasting 60s	Analysis of time constant
STEP VELOCITY 80°/s R	Continuous light rotation at 80°/s lasting 60s	Analysis of time constant
SHA Sine 0.1 Hz	Constant sinusoidal duration 10s	Sinusoidal analysis (fundamental frequency of stimulation)
SHA Sine 0.04 Hz	Constant sinusoidal duration 25s	Sinusoidal analysis (fundamental frequency of stimulation)
SHA Sine 0.08 Hz	Constant sinusoidal duration 12.5s	Sinusoidal analysis (fundamental frequency of stimulation)
SHA Sine 0.16 Hz	Constant sinusoidal duration 6.25s	Sinusoidal analysis (fundamental frequency of stimulation)
SHA Sine 0.32 Hz	Constant sinusoidal duration 3.125s	Sinusoidal analysis (fundamental frequency of stimulation)
SHA Sine 0.64 Hz	Constant sinusoidal duration 1.5625s	Sinusoidal analysis (fundamental frequency of stimulation)
SQUARE 9s	" Square back and forth" type of stimulation. The chair makes a right half-turn in about 5.5s followed by a pause of 30s. The cycle is repeated to the left. This sequence is performed four times.	Analysis using Freyss Graph
Manual	No movement directed by the computer. The user is free to use the remote command in order to steer the chair manually.	Sinusoidal analysis (fundamental frequency of stimulation)

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