# The Visual Scanning Test: a Neuropsychological Tool to Assess Extrapersonal Visual Unilateral Spatial Neglect

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**Protocol**

86 healthy subjects took part in the study (61 females), with a mean age of 52.8 (SD=17.0, range 25-85) and a mean of 14.0 years of education (SD= 5.2, range 3-31). The distribution of demographic data is shown in Table 2. Subjects with past or present neurological or psychiatric diseases were excluded from the study, as well as subjects with visual disturbances. The presence of myopia or astigmatism did not represent an exclusion criteria if they were corrected by the use of glasses. All participants took part in the study on a voluntary basis after having provided their written informed consent and without receiving any reward.
Each VST was administered twice to each participant, with an interval of two weeks, in order to analyze the test-retest effect.

The Visual Scanning Test (VST) involved a visual search for a target between similar visual distractors, projected in the far space. The VST required the presence of a blank wall and a projector and, to be carried out, participants must be positioned in a manner to reproduce a visual field of 52° x 45 °.
Overall, the VST is composed by four trials of 20 cases, each made up by 20 stimuli (see fig 1). On about the 80% of cases, the test provided the presence of target in the left, center or in right hemispace. In the remaining 20% of cases, the test provided the presence of a catch trial ("CT", absence of the target), to assess the presence of frontal disturbances or malingering. The test is constructed according to an increasing attentional load for the target on the left-hemispace.
Firstly, participants were required to look at a fixation point to always ensure the same starting position. After the start provided by the experimenter, participants were required to actively and free explore the visual field to search for the visual target. During the visual search, they were instructed to detect the presence of a target and naming its identification (saying YES or NO). Two types of errors could be made:

- Saying "NO" during the visual search in cases where the target was present;
- Saying "YES" during the visual search in the CT condition.

The experimenter recorded the reaction times (RTs) from the beginning of the visual search until participant's answer and the accuracy (HITs), through a dedicated response form. Specifically, the experimenter was required to draw a sign in case of error.
From the recorded data it may be possible to obtain several indexes, mainly related to the reaction times and to the accuracy on VST.
Indexes for *reaction times* (RTs) were related to :

- The total VST RTs (**RTs Total**)
- mean visual searching time for left hemispace (**RTs left**);
- mean visual searching time for right hemispace (**RTs right**)
- the time between the presentation of the visual field and the wrong non-identification of the target (answer "NO", where the target exists, **RT misses**);

- *Catch trials* RTs, that is the time between the presentation of the visual field and the wrong identification of the target (answer "YES", where the target doesn't exist, **CT- RTs**);
- The time between the presentation of the visual field and the identification of targets in the left hemispace in Trial A (**RTs Trial A left**);
- The time between the presentation of the visual field and the identification of targets in the right hemispace in Trial A (**RTs Trial A right**);
- The changes from mean RTs in trial A to mean RTs in trial D for left hemispace, which reflect and implicit learning of target position to the left (i.e. Learning index, **LEI *left*);**

- The changes from mean RTs in trial A to mean RTs in trial D for right hemispace, which reflect and implicit learning of target position to the right (i.e. Learning index, **LEI *right*);**
- Space Asymmetry index due to time (**SAI Time**), where RT total represents the RTs average value over the four trials.

Indexes for *accuracy* (HITs) were:

- The total VST HITs (**HITs Total**);
- The accuracy for left hemispace (**HITs left**);
- The accuracy for right hemispace (**HITs right**)
- The number of non-existing targets identified (answer "YES", where the target doesn't exist, **CT-HITs**);
- Space Asymmetry index due to accuracy (**SAI HITs**), where HITs total represents the accuracy average value over the four trials.

**Statistical analysis Plan**

Data were analyzed using SPSS version 25 (SPSS Inc., Chicago, IL, USA). A multiple linear regression model was first applied to test the independent effects of age, sex, and education on the above mentioned indexes. The best fitting linear model for each index was sought to adjust original scores according to the demographic variables found to be associated with each index ($p<0.05$). The effect of education level was explored after logarithmic, quadratic and reciprocal transformation, while age was included in the models after logarithmic transformation: "log(100-age)", as suggested by Capitani et al [1]. Corrected scores were calculated by adding (or subtracting) the contribution of each variable for each age group (25-45, 46-65, 66-85) and/or education level (≤5 years, 6-13 years, ≥14 years) [2]. Based on the obtained results, correction grids were created. No adjustment was made to the top end of the scale, to avoid errors due to the fixed upper limit of the test scores. Adjusted scores were then ranked, and by means of a non-parametric procedure [3] tolerance limits (both outer and inner one-sided) were defined. Above the outer tolerance limit, it is expected to find at least 95% of the normal population (with 95% confidence), while above the inner tolerance limit, it is expected to find at most 95% of the population (with 95% confidence). The scores falling between the outer and inner tolerance limits are defined "borderline scores" because a controlled judgment cannot be expressed. Given our sample size, outer and inner tolerance limits were fixed, respectively, based on the values of the first and ninth ranked scores, after demographic adjustments. Finally, after having tested the adjusted scores for normality, differences between LEI left and LEI right, CT HITS and HITS total, and RTs trial A left and RTs trial a right, were evaluated by using a paired t-test or a Wilcoxon Signed Ranks Test, accordingly. A significant level of $p<0.05$ was used in all tests. CT-RTs, RTs total and RT misses values were compared by using a repeated measures ANOVA followed by Bonferroni's multiple comparison tests, if the ANOVA test showed significance ($p<0.05$).

**References**


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