P 2-48

FOVR test: Virtual reality-based technique to assess field of view and field of regard in neglect

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Background and aims

We previously proposed concept of field-of-view (FoV) and field-of-regard (FoR). The FoV refers to the size/angle of the visual field that is visible at any given moment, whereas the FoR is defined as the total range of visual field with moving head or body to view the surroundings. Thus, FoV represents perceptional aspects, while FoR represents perception and exploration. The aim of this study was to evaluate HSN with the concept of FoV and FoR for the first time using virtual reality (VR)-based methods (FOVR test).

Methods

By turning on and off sensor of head mounted device, evaluation of FoV and FoR is possible respectively. In FOVR test, participants were instructed to find the coming up target distributed over a spherical coordinate system as quickly as possible. We assessed the response time for FoV and FoR (FoV-RT and FoR-RT) and centre of the reference frame (CoRF) for FoV and FoR (FoV-CoRF and FoR-CoRF). We enrolled 19 participants with post-stroke HSN (HSN group), 22 participants with stroke but without HSN (Non-HSN group) and 24 participants without stroke (HC group). We used one way ANOVA or $\chi 2$ test for comparisons between three groups and post-hoc comparisons were done in case of significant difference. Comparisons between two groups (HSN vs. other two or HSN vs. non-HSN) were performed using the Mann–Whitney U test and the chi-square test. Pearson's correlation analyses were performed between conventional tests and FOVR-RT to assess the validity of the FOVR test, as well as FoV-RT and FoR-RT to investigate the discrepancy of FoV and FoR. A receiver operating characteristic (ROC) curves was plotted to examine the diagnostic performance and validity of the FOVR test.

Results

The FOVR test demonstrated differences across groups for both FoV and FoR, and it was consistent with conventional tests. (Figure 1) FOVR test showed high diagnostic validity. The FOVR-RT (FoV-RT and FoR-RT) were significantly correlated with the conventional tests ($p<0.001$). ROC curve analysis showed that the AUCs were 0.959 (95% confidence interval [CI]: 0.899–1.000, $p<0.001$) for FoV-RT and 0.970 (95% CI: 0.935–1.000, $p<0.001$) for FoR-

RT. The combination of FoV-RT and FoR-RT impairment had a sensitivity of 100% for HSN. (Table 1) Moreover, 100% of participants in the HSN group showed right-deviated FoR-CoRF. (Figure 2)

Conclusions

The VR-based visuospatial assessment tool, FOVR test was valid for HSN diagnosis. It provided quantitative and comprehensive information about visuospatial function in terms of FoV and FoR, allowing novel index such as FOVR-RT or FOVR-CoRF. Thus, we could present in-depth visuospatial function findings, including HSN heterogeneity, and novel findings for non-HSN participants.

Table 1. Diagnostic accuracy measures of response time of the FOVR test and CoRF.

Diagnostic accuracy	Sensitivity	Specificity	Positive-predictive value	Negative-predictive value
FoV impairment	89.47%	93.18%	85.00%	95.35%
FoR impairment	89.47%	90.90%	80.95%	95.24%
Combination of FoV and FoR impairment	100.00%	86.36%	76.00%	100.00%
FoV-CoRF	84.21%	47.72%	41.02%	87.50%
FoR-CoRF	100.00%	65.91%	55.88%	100.00%

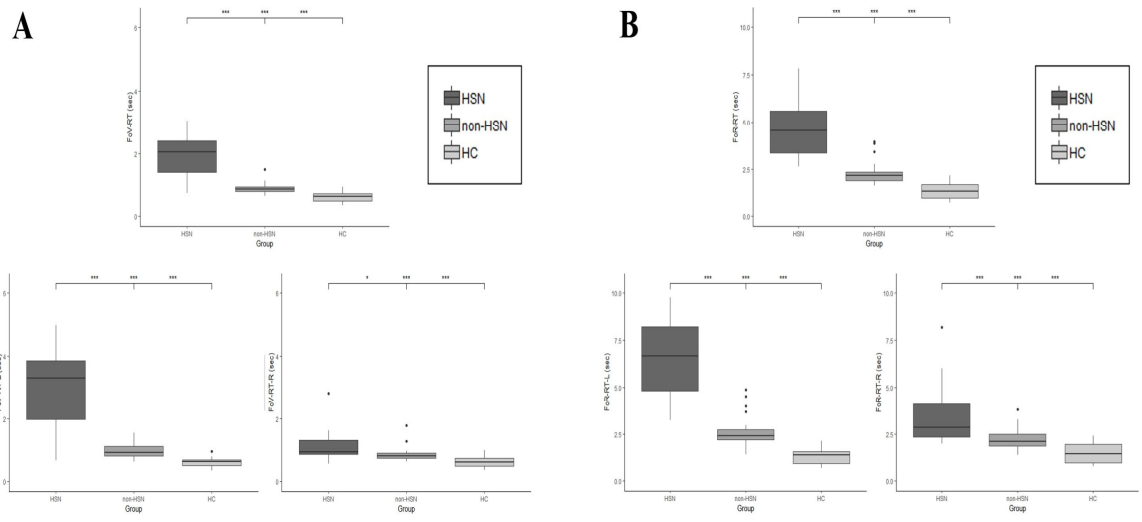

Figure 1. Response time (RT) of FoV (A) and FoR (B) in the entire space (above) and the left and right spaces (below).

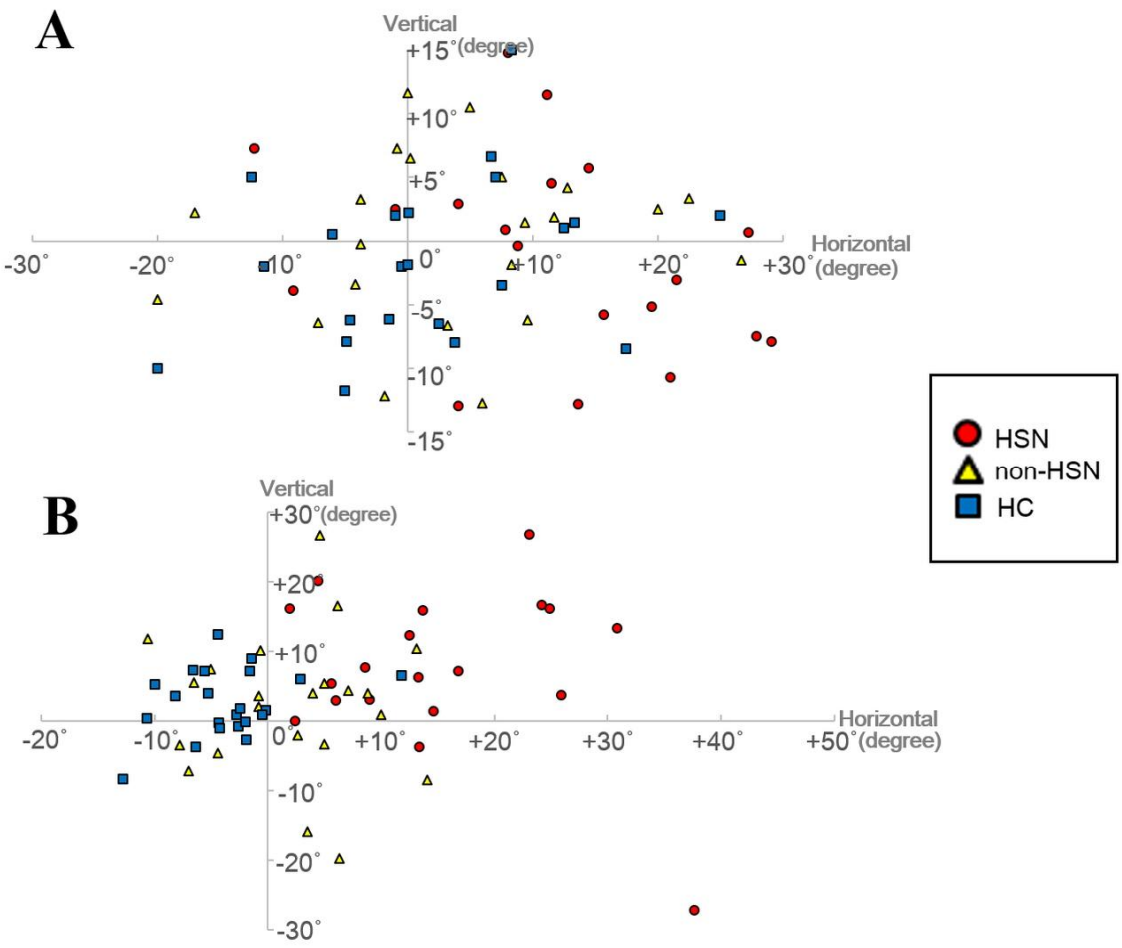

Figure 2. Diagram of the CoRF based on (A) FoV-RT and (B) FoR-RT.