EFFECT OF MICROGRAVITY ON SEVERAL VISUAL FUNCTIONS DURING STS SHUTTLE MISSIONS

VISUAL FUNCTION TESTER - MODEL 1 (VFT-1)

LT COL MELVIN R. O'NEAL, O.D., Ph.D.
H. LEE TASK, Ph.D.
COL LOUIS V. GENCO, O.D., M.S.
PURPOSE (VFT-1)

- Previous visual acuity studies at different test distances and may be affected by age and lighting

- Determine effect of microgravity on distance visual acuity over mission duration

- Use high contrast acuity targets in small size increments under set lighting conditions

- Expand assessment to several other visual functions
METHODS (VFT-1)

SUBJECTS
- 26 STS Astronauts
  -- 5 subjects with only 1 pre- and 1 on-orbit eliminated
  -- 1 Toric-SCL with on-orbit problem eliminated
  -- n = 20; 1 HGP CL, 1 SCL, 1 Toric-SCL included
  -- Repeat data on 2 subjects

APPARATUS
- Visual Function Tester - Model 1 (VFT-1)
  -- Small, hand-held, battery powered
  -- Seven vision tests:
    - Acuity in small steps to 20/7.7
    - Stereopsis to 10 sec-of-arc
    - Lateral phoria, Vertical phoria, Cyclophoria
    - Critical flicker fusion
    - Retinal rivalry
METHODS

PROCEDURE

• Pre-mission briefing and tester familiarization
• Vision assessed
  -- 2x pre-flight at 14 days (L-14) and 7 days (L-7)
  -- Daily after wake-up on-orbit
  -- 3x post flight at landing, 3 days (L+3) and 7 days (L+7)

DATA ANALYSIS

• Calculated difference between mean of two pre-flight sessions (taken as baseline) and each subsequent measurement for each subject
• Non-parametric statistical analysis (Wilcoxon signed-rank)
RESULTS

GROUP DATA

• Corresponding data days are:
  -- L-14 days = Pre-flight 1
  -- L-7 days = Pre-flight 2
  -- On-orbit = Hours of mission elapsed time (MET)
  -- Landing = Post-Flight 1
  -- L+3 days = Post-flight 2
  -- L+7 days = Post-flight 3

• Size of dots represent number of subjects with same performance

• Variability between subjects in baseline pre-flight data is typical of psychophysical vision data
### VFT-1 GROUP DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean Pre-Flight</th>
<th>Mean Change</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VISUAL ACUITY</strong></td>
<td>0.61 min arc (20/12.2)</td>
<td>+0.06 min arc (to 20/13.4)</td>
</tr>
<tr>
<td><strong>STEREOPSIS</strong></td>
<td>19.8 arc sec</td>
<td>-4.9 arc sec</td>
</tr>
<tr>
<td><strong>LATERAL PHORIA</strong></td>
<td>-2.08 $\Delta$ (ESO)</td>
<td>+0.36 $\Delta$</td>
</tr>
<tr>
<td><strong>VERTICAL PHORIA</strong></td>
<td>0.04 $\Delta$</td>
<td>-0.07 $\Delta$</td>
</tr>
<tr>
<td><strong>CYCLOPHORIA</strong></td>
<td>-1.14 (ENCYCLO)</td>
<td>-0.02</td>
</tr>
<tr>
<td><strong>FOVEAL FLICKER</strong></td>
<td>52.43 Hz</td>
<td>-0.06 Hz</td>
</tr>
</tbody>
</table>
RESULTS

CHANGE DATA

- Difference between mean of two pre-flight sessions (baseline) and each subsequent measurement for each subject was calculated

- Size of dots represent number of subjects with same amount of change

- No apparent trend in change for lateral and vertical phorias, cyclophoria, and critical flicker fusion; nor retinal rivalry (no figure)
RESULTS

STEREOPSIS CHANGE

- Slight trend toward smaller sec-of-arc stereopsis on-orbit (i.e., improvement), not apparent at landing or after

- On-orbit change from pre-flight baseline
  -- Mean change at subject’s first and last data = -5.0 arc sec

- Mean group change in stereopsis on-orbit was -4.9 arc sec from baseline; nearly significant (p = 0.07)

- Post-flight, change was only -0.8 arc sec at landing and was +1.1 arc sec by second post-flight (L+3 days) session
RESULTS

VISUAL ACUITY CHANGE

- Definite trend toward larger min-of-arc resolution on-orbit (i.e., decreased acuity), not apparent at landing or after

- On-orbit change from pre-flight baseline
  -- Mean change at first on-orbit data = +0.04 min arc (p = 0.13)
  -- Mean change at last on-orbit data = +0.07 min arc (p = 0.001)
  -- No significant difference between first and last data (p = 0.15)

- Significant mean group change of 0.06 min arc in visual acuity on-orbit from baseline (p = 0.005)

- No change from pre-flight baseline at landing or after (p=0.90)
VFT-1 (PERCENT CHANGE FROM PRE MEAN)

ACUITY (MIN OF ARC)

MISSION ELAPSED TIME (HR)

POST FLIGHT
DISCUSSION

- No group changes on-orbit in lateral and vertical phorias, cyclophoria, critical flicker fusion, and retinal rivalry

- Mean group visual acuity loss on-orbit of only +0.06 min arc; corresponds to only slight change in Snellen acuity from 20/12.2 at baseline to 20/13.4 on-orbit

- Mean percent loss in acuity on-orbit = 7.5%; single data points ranged from 40% loss to 20% improvement
DISCUSSION (Con't)

- Mean group stereopsis improvement on-orbit of only 4.9 arc sec. Some subjects with marked improvement.

- Two repeat subjects, in general, confirmed their initial results. Both subjects had large improvements in stereopsis on-orbit. Also found at the second mission (although one on-orbit data point varied for each).