Smooth pursuit eye movement training accelerates recovery from auditory/visual neglect and reduces disability and unawareness: results from 2 randomized controlled trials

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Spatial Neglect: Components and Modalities

Seeing Midline

0°

+9°

Hearing Straight

0°

+12°

Gaze orientation

Ipsilesional shift

Fruhmann-Berger et al, 2005

Visual Search

Reading

Der sommergrüne Laub- oder Mischwald bedeckte einst fast ganz Mitteleuropa. Eichen und Buchen, Ulmen, Pappeln und Birken, Eschen und Kastanien bieten vielen Vögeln, Insekten und kleinen Säugetieren Schutz und Nahrung. Der Wald in den Ländern rund um das Mittelmeer heißt Buschwald. Dieser einzigartige Wald…

Omissions in Reading
Unawareness & Poor Rehab Outcome in Neglect

- unawareness impairs neglect therapy
- poor outcome, functional dependency in neglect
- few Randomized Controlled Trials (RCTs) available
- often focus on tests, few functional measures
- no treatments for *auditory* neglect evaluated
- few treatments suitable for early stroke patients („bedside“)
RCT-trial 1: Effects of Smooth Pursuit Training (SPT) vs. Scanning Training on visual/auditory neglect

Flow Diagram

50 RBD stroke patients, 3 months post stroke

Randomization

1 patient lost

SPT-Group, N=24

4 patients lost

Scanning-Group, N=21

2 Baselines

5 Treatments à 50 min

Post-test

Follow-up

1-2 weeks

1 week

2 weeks
RCT-trial 1: Treatments

Visual Scanning Therapy on stationary displays

EyeMove

Software zur Diagnostik und Behandlung visueller Explorationsstörungen bei Patienten mit Hirnschädigung

Smoooth Pursuit Therapy with Leftward Moving displays
## Nelgect Patients RCT-1 trial

<table>
<thead>
<tr>
<th>Sample size</th>
<th>Visual Scanning Training (VST)</th>
<th>Smooth Pursuit Training (SPT)</th>
<th>Statistical comparison (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>n=21</td>
<td></td>
<td>n=24</td>
<td></td>
</tr>
<tr>
<td>Stroke aetiology</td>
<td>17 ischemic, 4 haemorrhagic</td>
<td>20 ischemic, 4 haemorrhagic</td>
<td></td>
</tr>
<tr>
<td>Parietal Lesion</td>
<td>10</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Temporal Lesion</td>
<td>7</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Frontal Lesion</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Occipital Lesion</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Subcortical Lesion (Thalamus, BG)</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Months since Stroke (Mean, Median)</td>
<td>Mean: 5.24 (1-34), Md: 3</td>
<td>Mean: 3.58 (1-10), Md: 3</td>
<td>0.29</td>
</tr>
<tr>
<td>Age (years; range)</td>
<td>59.86 (36-73)</td>
<td>58.50 (37-74)</td>
<td>0.64</td>
</tr>
<tr>
<td>Sex (male/female)</td>
<td>14 m, 7 f</td>
<td>16 m, 8 f</td>
<td>1.00*</td>
</tr>
<tr>
<td>Hemiparesis</td>
<td>19 left</td>
<td>23 left</td>
<td>0.47*</td>
</tr>
<tr>
<td>Visual Field Defect; Field Sparing (°)</td>
<td>15/5°</td>
<td>19/6°</td>
<td>0.55*</td>
</tr>
<tr>
<td>Perceptual Line Bisection (deviation in mm)</td>
<td>+18.99 right-sided (-15 – 65)</td>
<td>+25.15 right-sided (-2 – 94)</td>
<td>0.47</td>
</tr>
<tr>
<td>Visuomotor Line Bisection (deviation in mm)</td>
<td>+15.93 right-sided (-13 – 60)</td>
<td>+19.54 right-sided (-2 – 88)</td>
<td>0.57</td>
</tr>
<tr>
<td>Digit cancellation, single target (omissions left/right, max 10/10)</td>
<td>6.52/2.61 (0-10 / 0-9)</td>
<td>5.98/1.81 (0-10 / 0-9)</td>
<td>0.59/0.30</td>
</tr>
<tr>
<td>Digit cancellation, dual targets (omissions left/right, max 20/20)</td>
<td>11.11/5.00 (0-20 / 0-17)</td>
<td>11.77/4.64 (2-20 / 0-20)</td>
<td>0.75/0.81</td>
</tr>
<tr>
<td>Reading (omissions, max 55)</td>
<td>12.90 (0-44)</td>
<td>12.97 (0-47)</td>
<td>0.99</td>
</tr>
<tr>
<td>Auditory midline (deviation from midline in °, max 90° left/right)</td>
<td>+13.71° rightsided (1-28)</td>
<td>+10.53° rightsided (-3 – 33)</td>
<td>0.13</td>
</tr>
</tbody>
</table>
Measuring the Auditory Midline in Neglect

Auditory Subjective Median Plane

Patient with Headphones

Sound positions (5°-Resolution)

left -90°

0°

right +90°

More details about technique: see Kerkhoff et al, Neuropsychologia, 2006, 2012
RCT-trial 1: Results for visual/auditory neglect

A. Auditory Midline (deviation in °)

B. Paragraph Reading (omissions %)

C. Perceptual Line Bisection (deviation mm)

D. Motor Line Bisection (deviation mm)

= significant change
RCT-trial 1: Results for Cancellation Tasks

A
Single Number Cancellation (left omissions %)

B
Single Number Cancellation (right omissions %)

C
Double Number Cancellation (left omissions %)

D
Double Number Cancellation (right omissions %)

= significant change

↓ = significant change
RCT-trial 2: Effects of Smooth Pursuit Therapy vs. Scanning Therapy on Functional Neglect & Unawareness

Pursuit Eye Movement Training

Visual Scanning Training

Bedside Treatment

Tray Test

0.78m (74.5°)

0.25 m

0.78m (113.3°)

patient
target
distracter
RCT-trial 2: Outcome Measures

**Functional Neglect Index (FNI)**
- Gaze orientation
- Object search on tray
- Picture search
- Stick bisection (1 m)
- Composite rating ("blind")

**Unawareness & Behavioral Neglect Index (UBNI)**
- 6 items on unawareness
- 4 items on neglect in ADLs
- rating by nurses ("blind")

**Barthel Index**
- rated by staff ("blind")

**Help Index**

RCT-trial 2: Effects of Smooth Pursuit Therapy vs. Scanning Therapy on Functional Neglect & Unawareness

Flow Diagram

- 30 RBD stroke patients, 1 month post stroke
- 6 patients excluded

Randomization

- SPT-Group, N=12
- Scanning-Group, N=12

1 Baseline

20 Treatments à 50 min

Post-test

Follow-up

Time

4 weeks

4 weeks
## Neglect Patients RCT-2 trial

<table>
<thead>
<tr>
<th>Code</th>
<th>Treatment</th>
<th>Age, gender</th>
<th>Etiology, days since lesion</th>
<th>Lesion location (right)</th>
<th>Motor Status</th>
<th>Visual field (defect)</th>
<th>Treatment Period [days]</th>
<th>Rehabilitation status</th>
<th>Barthel index</th>
<th>Rehab phase*</th>
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<tr>
<td>DS</td>
<td>VST</td>
<td>65, f</td>
<td>I, 21</td>
<td>F, T</td>
<td>L-paresis</td>
<td>L-QUA</td>
<td>26</td>
<td>50 95 95</td>
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<tr>
<td>MP</td>
<td>VST</td>
<td>71, f</td>
<td>H, 33</td>
<td>BG, Thalamus</td>
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<td>59</td>
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<td>VST</td>
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<td>H, 18</td>
<td>BG</td>
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<td>Normal</td>
<td>25</td>
<td>35 60 65</td>
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<td>I, 17</td>
<td>T, P</td>
<td>L-paresis</td>
<td>L-HH</td>
<td>24</td>
<td>20 40 40</td>
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<td>VST</td>
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<td>I, 66</td>
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<td>18</td>
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<tr>
<td>MI</td>
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<td>F, P, T</td>
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<td>18</td>
<td>0 15 35</td>
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<tr>
<td>DW</td>
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<td>59, m</td>
<td>I, 21</td>
<td>O, P</td>
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<td>L-HH</td>
<td>20</td>
<td>0 0 0</td>
<td>B</td>
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</table>

**Mean**

<p>| | | | | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Mean</td>
<td>64 (SD 3)</td>
<td>37 (SD 5)</td>
<td>27 (SD 3)</td>
<td>15 (SD 5)</td>
<td>26 (SD 8)</td>
<td>32 (SD 8)</td>
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</table>

| IK    | SPT         | 61, f       | I, 51                       | F, T                    | L-plegia     | L-QUA                 | 30                     | 20 30 35              | B             | B            |
| WF    | SPT         | 68, m       | I, 30                       | P, F, T                 | L-plegia     | Normal                | 27                     | 0 15 30              | B             | B            |
| JW    | SPT         | 73, m       | I, 44                       | F, T                    | L-plegia     | Normal                | 31                     | 5 30 30              | A             | B            |
| WH    | SPT         | 63, m       | I, 12                       | F, T                    | L-plegia     | Normal                | 36                     | 0 5 10               | B             | B            |
| RW    | SPT         | 59, m       | I, 16                       | P, F, T                 | L-plegia     | Normal                | 24                     | 0 15 45              | B             | B            |
| ME    | SPT         | 74, f       | I, 24                       | F, T                    | L-plegia     | Normal                | 46                     | 20 30 30             | B             | B            |
| HS    | SPT         | 60, m       | I, 11                       | P, O                    | L-paresis    | Normal                | 21                     | 0 25 25              | B             | B            |
| GH    | SPT         | 50, m       | H, 44                       | F, T                    | L-plegia     | Normal                | 35                     | 0 0 0                | B             | B            |
| PG    | SPT         | 53, m       | H, 56                       | BG                      | Normal       | Normal                | 29                     | 10 40 45             | B             | B            |
| RA    | SPT         | 50, m       | I, 27                       | F, P                    | L-paresis    | L-QUA                 | 50                     | 35 65 85              | B             | C            |
| SN    | SPT         | 60, f       | I, 20                       | F, P, T                 | L-plegia     | Normal                | 35                     | 15 45 70             | B             | B            |
| NS    | SPT         | 84, f       | I, 25                       | F, P, T                 | L-paresis    | L-HH                  | 36                     | 30 40 45             | C             | C            |
RCT-trial 2: Treatments at the patient’s bedside
Visual Scanning Therapy on stationary displays

EyeMove
Software zur
Diagnostik und Behandlung
visueller Explorationsstörungen
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www.medicalcomputing.de

Smooth Pursuit Therapy with
Leftward Moving displays
RCT-trial 2: Results on Functional Measures & Unawareness

**Functional Neglect Index**

- Sign. Interaction by group

**Barthel index**

- No sign. Interaction by group

**Unawareness Behavioral Neglect Scale (UBNI)**

- Sign. Interaction by group

**Help Scale**

- No sign. Interaction by group
Summary and Take-Home Message

Smooth Pursuit Neglect Therapy….

• reduces auditory/visual neglect significantly
• is much more effective than visual scanning therapy (effect sizes)
• is cost-efficient (5-20 treatment sessions yield improvements)
• reduces functional neglect (gaze orientation, finding objects)
• significantly reduces the unawareness of patients with neglect
• is suitable as a bedside therapy for the early treatment of neglect

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