**The effects of visuomotor feedback training on the recovery of hemispatial neglect symptoms: assessment of a two-week and follow-up intervention.**

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**Abstract**

In patients suffering from left unilateral neglect, their right-biased attention to the phenomenal world can be ameliorated, short-term, by making motor responses to left-right extended objects (rods) that immediately reveal to them that their phenomenal world is in fact skewed. In this study the extent to which more intensive experiences of this type produced enduring and useful improvements in neglect, was assessed by first examining the effect of a 3 day experimenter-administered practice of rod lifting, then by examining the effects of a self-administered practice for a further 2 week period and a further one month post-training. Despite the fact that by the time the patients were able to undergo the intervention they had progressed to the chronic neglect stage, significant improvements of the intervention over the control group were found for a third of the tests given after the three day practice. Additionally, at the one month follow-up the intervention group again showed significantly better results in 46% of the direct neglect tests. As far as we are aware this is the first time that significant long–term improvements have been shown in a rehabilitation approach with neglect patients with a mean time of more than 12 months post stroke and visuomotor feedback training can thus be seen as a most encouraging paradigm for future attempts.

**Introduction**

Hemispatial neglect (the inability to respond to the left side of space) is the best single predictor of poor recovery from stroke [8,35], yet it is notoriously difficult to rehabilitate. In early rehabilitation attempts [18,40] investigators worked on increasing the 'awareness' into the deficit by left sided cueing techniques. Although some of these attempts proved successful [16,25] these approaches ask patients to voluntarily maintain attention oriented to the left space, a requirement which a lot of

them find difficult in everyday life. Other rehabilitation techniques have attempted to *indirectly* affect lateralised neglect performance by improving sustained attention [29] or using active [27] or passive [17] movements of the contralateral limb. Instead of proprioceptive, other investigators have also used sensory stimulation [13,38] to enhance the patients' performance in the contralateral space. However, with the exception of a very recent study by Schindler et al. [36] most of these studies used only a single application of the sensory manipulations and the improvements therefore lasted only for a few minutes. Moreover such techniques cannot be performed by the patients themselves and thus do not lend themselves to an integration in the patients' everyday routine.

Recently Rossetti et al. [32] have shown that only a short period of visuomotor adaptation to a right prismatic shift of the visual field is enough to significantly ameliorate neglect and related studies run since have shown that the effect can last for a day [6] or even weeks [7]. An even simpler technique, so far only shown to be effective in the short term, has been described by Robertson et al. [28]: firstly, they found that bisection of a rod was significantly more central when neglect patients were allowed to grasp the rod, as if to pick it up, to find its centre rather than asked to point to its centre. Secondly, [30] when asking neglect patients to 'grasp and lift' a metal rod at its centre over repeated trials, significant positive effects were found for twenty minutes after the intervention on two out of four perceptual tests. There are good arguments as to why a simple rod lifting exercise may significantly ameliorate neglect symptoms: Robertson et al. [30] suggest that 'prehensive movements towards objects may improve access to information about their spatial extent, by means of an unaffected stream of information available for motor-manipulative responses'. By drawing a patient's attention to any dissociation within

the same task, it might be possible to 'bootstrap' perceptual judgements onto better visuomotor performance through the intention to act and subsequent feedback. This explanation fits well with Milner and Goodale's [23] theory of neglect. They argue that a disruption in spatial allocentric representations, after object identification is at the core of neglect symptomatology. Indeed two functionally and anatomically separate streams, the dorsal and ventral visual pathways, were first identified in the monkey cortex by Underleider and Mishkin in 1982 [37]. Since that time, a large body of evidence has amassed suggesting that these streams also exist within the human cortex and serve to process different aspects of visuo-spatial processing: the 'occipito-temporal' ventral stream is considered to have evolved to process allocentrically the enduring perceptual characteristics of objects, while the 'occipito-parietal' dorsal stream alternatively captures instantaneous and egocentric features of objects necessary for the guidance of particular forms of goal-directed actions [23]. Milner [22] claims that in humans the dorsal stream is inferred to pass superiorly within the parietal lobule and adjacent parts of the intra-parietal sulcus. In contrast the inferior regions of the parietal lobe are known to be the common area of 'overlap' in neglect patients and indeed more recently Karnath and colleagues [15] have argued that lesions to the superior temporal lobe are most critical for neglect. Milner [22] thus argues that the dorsal stream may be relatively spared and that neglect patients should have fewer problems with information coded in purely egocentric co-ordinates. This has now been found in a number of studies [11,14,26].

*Rationale for the presented intervention*

The present study aimed to assess the potential short and long-term effects of the rod lifting procedure initially performed by Robertson and colleagues [28,30] with good short term results. We were hoping that it might be possible to 'bootstrap'

patients' perceptual judgements onto the better visuomotor performance through the intention to act and the subsequent feedback of this. We used an *adapted simplified* form of the Robertson et al. [30] paradigm. The intervention group was asked to reach, lift and balance rods at the centre, *readjusting until satisfied with the judged central grip*, whilst patients in the control group reached and lifted the right-hand side of the rod only. The intervention group therefore received proprioceptive as well as visual feedback on how well they had grasped the centre of the rod, however, both groups received a comparable amount of motoric experience of reaching and lifting rods. We also increased the intervention exercise both in terms of the number of target trials per session and the number of sessions. The immediate effects of the programme were measured using three perceptual tests that were administered directly preceding and succeeding three experimenter led intervention sessions. This also ensured that the patients could gradually learn to follow the intervention procedure to a satisfactory level.

The tests used for the immediate assessment were selected because they have either traditionally been used in neglect assessment, proved to be specially sensitive to neglect, or allowed testing for neglect biases in an ecological behaviourally relevant way. Furthermore, the use of these measures before and after three intervention sessions was thought to provide a more reliable assessment of immediate effects as Robertson et al. [30] looked at the efficacy of the intervention on one occasion only. Participants, having mastered the exercise in these three days, then embarked on a home based intervention of two weeks and here long-term effects were investigated with a battery of direct neglect tests but also more general behavioural tests as we hoped that the treatment may have more widespread effects. Improvements on these neglect related tests were hoped for but not necessarily

expected. Finally, as long term impact is a crucial component of all rehabilitation attempts, we assessed the potential of the visuomotor feedback training after an extended period of intervention as well as at a one month follow up.

**Method**

*Patients*

Fourteen patients (eight male, four female, mean age: 69 years, SD: 9.3) with hemispatial neglect were recruited consecutively and allocated to either the intervention or control group pseudorandomly in so far as an attempt was made to match the two groups at baseline. The extent of their hemispatial neglect was assessed with both the Balloons Test [5] and the conventional subtests of the Behavioural Inattention Tests (BIT, [41]) which include line bisection, line, letter and star cancellation, figure and shape copying and representational drawing as sub-tests.

Not all patients fell below the cut-off scores on both tests (<45% Balloons, 129 BIT) but each intervention and control group contained either three or four very impaired (<10% Balloons, <70 BIT) and two only mildly impaired patients (above or on cut-off on both) when the results of both tests were taken into account. The mildly impaired patients (DS, JR, IC, ER) had all fallen below the BIT cut-off shortly after their stroke onset but were were too incapacitated to undergo the intervention at that stage (see Table 1 for individual patient scores on both tests). More crucially, with the exception of one object in the real objects test, *no significant group differences before intervention were found in any of the assessment tests used* (see A) Experimenter lead intervention and B) Home based intervention for an exact description of the tests used). Moreover, no significant differences were found between the intervention and control groups in respect to years spent in education, age or time between stroke onset and testing nor their performances on the verbal as

well as the performance subtests (Information, Vocabulary, and Digit Span, Picture Completion, Block Design and Object Assembly) of the WAIS-R [39].

Two out of seven patients in each the intervention and control group were only able to perform half of the designated number of rod lifting trials each day.

All patients had suffered from a cerebrovascular attack within the previous 5 to 25 months. Five of them were hemianopic (see Table 2) and all had a left hemiparesis. They were all right handed [1] and free of any other confounding neurological deficits or intellectual impairments. Lesion location and other neurological details as well as group allocation can be found in Table 2.

*Intervention Materials*

Three wooden rods 1.1cm diameter, 0.63 g/cm in weight and either 50, 75, 100 cm in length were used. Each rod was presented horizontally on a test mat in front of the patient, with the middle of the rod in line with the patient's body midline. Additionally, to reduce the possibility that patients reached for rods according to a fixed external reference in the background environment, rods were also presented to the left and right of the body midline with a deviation of 10cm. Centres of different length rods were aligned. The test mat (160cm by 30cm) indicated the correct rod positions for each spatial location of each rod (central, right and left).

*A) Experimenter led intervention*

A three-day intervention assessed the immediate effects of rod lifting training via three quick neglect tests run before and after each daily session. After assessment with both the Balloons Test [5] and the BIT conventional subtests [41] patients were allocated into a control or intervention group. They were told that the study was investigating the potential of a relatively new rehabilitation technique that may help them to notice things around them better, especially on their left side.

*Test Instruments*

*The Line Bisection Test* (adapted from Schenkenberg et al. [34]) consisted of 6 horizontal black lines (20cmx1mm) presented 4cms apart on an A4 sheet. The patient was asked to mark the centre of each line which was presented individually via the use of an overlaying black card with a 'window' (24cmx4cm) so that performance on each trial could not be compared against previous bisection marks.

In *The Landmark Test* (adapted from Harvey et al. [10]) patients were presented with 6 horizontal black lines (20cmx1mm) that had already been centrally transected by a vertical mark (6mmx1mm), labelled the 'landmark'. They were asked to judge which end of the line was closer to the 'landmark'. Six additional lines with 'landmarks' of 2, 3 or 5 mm to the left and right of the true centre were also included. Lines were presented on individual sheets of A4 paper. To reduce practice effects, two versions of this test were used (administered before and after the intervention) with trials presented in reversed order.

*The Real Objects Test* was in essence an 'everyday' version of the line bisection task. Patients were asked to reach and grasp the centre of three symmetrical household objects of varying lengths: a rolling pin (40cmx6.5cm), a towel rail (60cmx1cm) and a roll of wrapping paper (70cmx6cm). Patients grasped each object three times in total and objects were administered in a random order. Deviations from the true centre were measured by the experimenter using a metre rule. Once the patient had grasped the object in the place they thought the centre was, the experimenter (sitting immediately in front) grasped the object at the same location in order to take the measurement.

*Procedure*

Once patients were diagnosed with the two neglect tests and allocated to either the intervention or control group, the rehabilitation rod lifting exercise was introduced and administered on three consecutive daily sessions that lasted approximately an hour each and followed steps 1-3 outlined below.

*Step 1*

The line bisection, landmark and reaching for real objects experimental tests were administered with the order counterbalanced as completely as possible across patients and groups, taking approximately ten minutes in total.

*Step 2*

The main paradigm was adapted from the Robertson et al. [30] study. In the intervention group patients tried to reach, lift and balance the rods at the centre, readjusting until satisfied with the *judged central grip*, whilst patients in the control group reached and lifted the right-hand side of the rod only. The intervention group therefore received proprioceptive as well as visual feedback as the rod would tilt if not grasped in the centre, however, both groups received a comparable amount of motoric experience of reaching and lifting rods. The rods varied in length and spatial location and reaches were repeated 8 times in each session creating 72-rod lifts. All patients used their right hand only.

*Step 3*

Step 1 was repeated, this time using a different version of the landmark test to reduce practice effects.

**Results**

*Analyses*

We tested whether changes occurred immediately after the intervention on a) the line bisection test in terms of the mean deviation from the true centre, b) the

landmark test in terms of the total number of identically sized lines for which the left half was perceived as shorter and c) the real objects test again in terms of the mean deviation from the true centre. 2x2 ANOVAs with group (intervention versus control) as a between and time (tests administered prior versus post 3 day intervention) as a within factor were performed on each test. We anticipated a main effect of time as well as a time by group interaction, with intervention test means improving over and above the control means.

*The Line Bisection Test.* No main effect of time nor a significant interaction of group by time was found. Rightward deviations from the true centre of the line did not significantly decrease following the intervention.

*The Landmark Test.* Although there was no main effect of time, a significant group by time interaction (F [1,12]=4.887, p=0.047) was found: following the three day training, the intervention group made fewer left judgements (i.e. showed a reduction in perceiving the left part of the line as subjectively shorter than the right half) than the control group (Figure 1).

*The Real Objects Test.* An analysis on the real object test was performed for two out of the three objects (rolling pin, towel rail) only as for the wrapping paper, the control and intervention group baseline data differed largely. No main effect of time nor a time by group interaction were found on either object indicating that the rightward biases did not significantly decrease following the intervention.

*B) Home based intervention*

In addition to the immediate experimenter lead intervention, a six week extended rod lifting intervention was run assessing the effects with a larger test battery that was performed at baseline (before any intervention) and re-administered *in part* after the three day experimenter present session and in full, following a further

ten days of a home based intervention and again at a one-month follow-up. This section thus describes the experimental sequence preceding and succeeding the sessions described under *A*).

*Step 1*

Following neglect diagnosis with the six BIT conventional subtests and the Balloons Test (before any intervention had taken place, see also *A*)), the six behavioural subtests of the BIT [41] as well as other more general behavioural measures of functional recovery were administered. These included an abbreviated form of the *Test of Everyday Attention* [31] which measures sustained attention capacity using the 'elevator counting' and 'lottery' sub-tests; the *Barthel Functional Evaluation Index of Activities of Daily Living* [19] which measures functional dependence on ten everyday activities [20] and the standardised *Patient/Staff/Relative rating scale* of neglect behaviour [2] which assesses anosognosia in everyday situations. Although we hoped to see improvements on these functional tests they were not necessarily expected.

The Test of Everyday Attention (TEA) is likely to be influenced by fatigue and was thus always administered first whereas the rating scale was given last as it may transiently increase self-awareness of neglect and thus confound the other test scores. The tests were administered over two sessions.

*Step 2*

Step 2*A* above described the training given. On the last day of this three day intervention, patients were re-tested with the Balloons Test and the BIT conventional sub-tests. It was considered unfeasible to administer the whole battery (Step 1) at this stage due to this being too demanding on the patients.

*Step 3*

After the three day intervention period with the experimenter present, patients repeated the training independently for ten days over a two week period. Depending on their ability, patients performed the sequence of nine-rod lifts either 4 or 8 times daily. To control correct execution of the exercise, participants were asked to note the completion of each daily session on a specially designed record sheet and the experimenter monitored the progress of the program via regular telephone contact and 1-2 home visits. Health care workers or primary carers often also controlled execution of the training.

*Steps 4 and 5*

At the end of this period all tests used at baseline (Step 1) were re-administered over two sessions. Wherever possible, alternative test versions were used. All tests (Step 1) were again repeated at a one-month follow-up to assess sustained recovery.

**Results**

*Analyses*

We assessed potential therapeutic changes after a) the last experimenter lead session), b) the last home based session and c) a one month follow up. However, only the conventional subtests of the BIT and the Balloons Test were administered following a) due to time limits and patient fatigue. Tests were analysed with either 2x4 or 2x3, group (intervention versus control) by time (baseline, testing a (were applicable), testing b, testing c) ANOVAs. The dependent measures were:

**Direct Neglect Tests**

*1) BIT conventional scores*

No significant main effect of time was found on the 2x4 mixed ANOVA although there was a significant time by group interaction ($F[3,30]=4.367$, $p=0.01$).

Paired t-tests indicated a significant effect between the end of the home based training and the one month follow-up: the intervention group scores improved significantly whereas the scores of the control group did not differ between the end of the training and the follow-up (Figure2). On this test a higher score indicates a smaller laterality bias

*2) BIT behavioural scores, 3) Laterality bias from the Balloons Test*

In contrast to the conventional scores, no simple main effect of time nor a time by group interaction was found for the 2x3 ANOVA run on the BIT behavioural scores. Also, no simple main effect of time nor a time by group interaction was found following the 2x4 ANOVA of the laterality bias of the Balloons Test.

**Indirect Neglect Tests**

*4) Elevator and lottery sub-tests of the TEA, 5) Barthel Indexes, 6) The Patient and Carer Neglect Rating Sores*

No simple main effects of time nor time by group interactions on the 2x3 ANOVAs where found for any of these measures.

*Summary of the main results*

We found a significant time by group interaction on the BIT conventional subscores which revealed a significant improvement for the intervention group only between the end of the intervention and the one-month follow up. This test is based on six subtests and although we failed to find improvements on the six behavioural subtests and the Balloons test this still presents an improvement on 46% of the direct neglect tests. Unfortunately, no improvements were found on the other indirect tests such as the TEA, the Barthel or the patient/carer ratings.

**Discussion**

In this study extended effects of visuomotor feedback training were examined

following three experimenter led, ten home based intervention sessions and a one-month follow-up.

*Immediate effects*

Significant behavioural improvements for the intervention group were found on one of the three measures (bisection, landmark, real objects) that were administered immediately before and after the experimenter led intervention. The question now arises as to why significant positive effects were found on the landmark test [10] alone. The task itself required patients to make a perceptual length judgement and may be considered less similar in nature to the intervention exercise. We have no explanation as to why no improvements were found on the two tasks that were more similar to the intervention, however, Robertson et al. [30] encountered a similar pattern of results as their significant effects were also on the two tasks that were considered to be less intervention specific. Regarding the landmark test Harvey and Milner [12] have argued that this task might be more a test of 'what the subject sees' rather than a test of their ability to 'perform correctly' (i.e. place the bisection mark in the correct place). Therefore the task may be better able to indicate the true perceptual experience of neglect patients than the traditional bisection task. They further speculated that if these arguments were correct, then it may be that use of the landmark test would allow more reliable estimates to be made of a patient's course of recovery over time than the traditional bisection task. This may be exactly what we have found here: it seems that the landmark test picked up even slight perceptual biases and indeed their recovery.

*Long-term effects*

A positive therapeutic effect was found for the conventional Behavioural Inattention Tests (BIT) which revealed a significant improvement for the intervention

group only between the end of the intervention and the one-month follow up. Although we failed to find improvements on the six behavioural subtests and the Balloons test this still presents an improvement on 46% on the direct neglect tests. The fact that the effect appeared between the end of the intervention and the follow-up is likely to be a sleeper effect. Such an effect has been reported in the therapeutic literature [9] and may represent consolidation of learning after training related to the phenomenon of 'reminiscence learning' [3,32]. Indeed Frassinetti et al's [7] neglect patients also showed larger improvements in their BIT scores the bigger the post treatment interval after prism adaptation training proved to be (1 day to 5weeks).

Although we had hoped for some generalisation to everyday life, it is well known that patients have poor insight into neglect and the staff/carer rating scale we used was standardised with hospital staff and may not be easily or reliably applied to relatives (as it turned out too few ratings were available for this in any case). In the same vein although the Barthel Index is a measure of self-care it is rather insensitive and, although one may hope, it is not surprising that cognitive rehabilitation does not affect it.

It also has to be born in mind that the sample size of both the intervention and control group in this study was relatively small, yet significant effects were still found for a third of the immediate assessment measures and almost half of the long-term neglect tests. It is likely that a larger study would have lead to even bigger effects, however it was impossible to recruit more patients into the project. Additionally, the patients in the current study all had chronic neglect with a mean time from stroke onset of over 12 months. Although some very recent studies have also found positive rehabilitation effects with chronic neglect patients [6,7,36] none of these included patients as far post stroke as the groups tested here.

Moreover, there are ways in which the described intervention may be more specifically tailored to specific neglect patients. In the present study it was not possible to choose patients by lesion location and although the lesion evidence of some patients suggests a potential sparing of the dorsal stream, the numbers are simply not large enough to allow a meaningful comparison. However Milner et al. [24] have argued that the essence of neglect lies in the disruption of representational networks which receive inputs from the ventral stream and we thus predicted that the higher level of efficiency of coding in the dorsal stream, may result in a bootstrapping effect on the processing of perceptual (ventral) characteristics of objects. In future it may thus be interesting to test patients with fairly well localised lesions as greater benefits may be found in those patients whose lesions do not impinge on the human homologue of the dorsal stream. Indeed the very good rehabilitation results found by Frassinetti and colleagues [7] with neglect patients being repeatedly exposed to a right prismatic shift of their visual field might be explained by a similar process. Michel et al. [21] argue that although the anatomical structures involved in prism adaptation are not well known, PET studies have shown activation of the posterior parietal cortex during reaching with displacing prisms [4]. It is thus possible that both visuomotor feedback training and prism adaptation work via the activation of spared parietal cortex areas.

In relation to the last point it would also have been useful to have included a condition where the patients pointed to the rod's centre as well as gripped the rod in the centre as this would have provided a measure of the patient's perception of where the centre of the rod might be. A comparison of the participant's deviation when symbolically indicating their perception of the centre and their deviation when grasping and lifting the rod would have provided an indication of any initial

discrepancy between perceptual (ventral) and visuomotor (dorsal) systems i.e. whether the dorsal system was relatively more spared. Inclusion of such a condition would have indicated whether the lesion damage in any given patient was extensive enough to affect their visuomotor control. If this were the case, then one may argue that the dorsal system of such a patient may not have been working at a higher level of efficiency in comparison to the perceptual system, thus impeding visuomotor feedback. However, an inclusion of such a condition would have extended the assessment sessions even more and was not deemed feasible for the groups tested here.

Finally in their paper, Robertson et al. [30] argued that the improvements they found may have been due to an induced sensory conflict. This was hypothesized to arise when a neglect patient's phenomenological visual representation of rods is discrepant with their sense of unbalance and sight of the rod tipping, when they attempt to pick up the rod at what they think is the centre but invariably is not. It was also hypothesized that this may have caused participants to scan more to the left. Given that the control patients in our study had a similar level of motoric experience but did not experience any visual or proprioceptive feedback (as they lifted just one end of a rod), the proposed sensory conflict experienced by the intervention group may indeed be regarded as a likely explanation of both our own and the Robertson et al [30] findings. In conclusion, although we failed to find that visuomotor feedback training generalised to everyday life, the short and long-term improvements found for the more conventional neglect tests can be seen as most encouraging, in particular as this approach can be incorporated very easily and cost-effectively into a patients daily routine. This is especially relevant as the results were achieved with very chronic neglect patients suggesting that this treatment should still be effective once the

patients are released either to their homes or nursing care.

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**Figure Legends**

Figure 1:    Number of times (out of 6) that the left half of two identical halves was subjectively judged as shorter (landmark test) both before the experimenter lead intervention (Pre) and after the three days (Post).

Figure 2:    Scores achieved on the six subtests of the conventional BIT [61] before intervention (baseline), after the experimenter lead intervention (3 sessions), after the home based training (10 sessions) and the one-month follow-up.
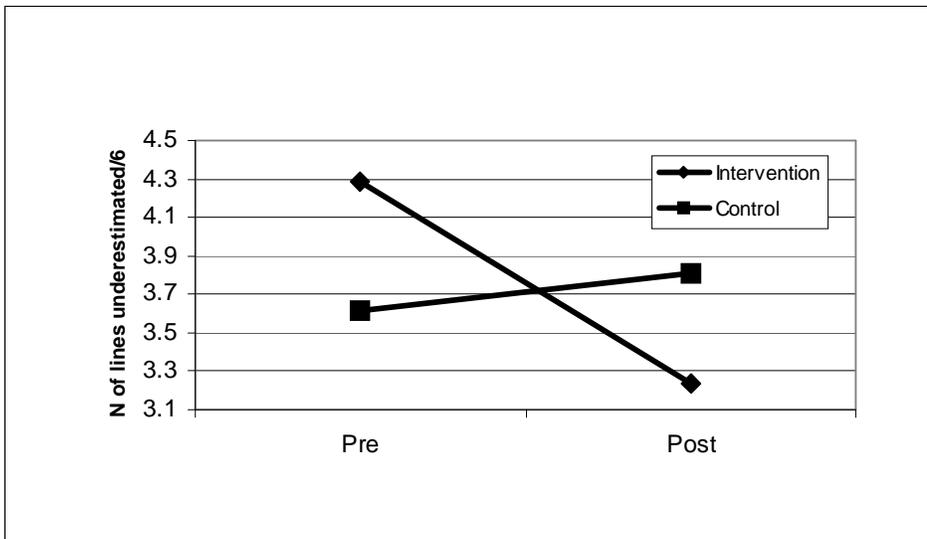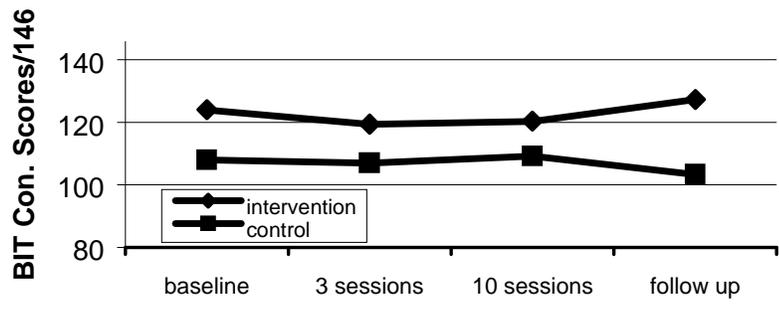
Table 1. Performance of the Neglect Patients (Intervention and Control group) on the Balloons Test and the conventional subtests of the BIT.  See text for further description of tests.

| Patient no. | Condition | Balloons | BIT |
|---|---|---|---|
| 1. DS | Intervention | 46% | 135 |
| 2. JM | Intervention | 0% | 115 |
| 3. JR | Intervention | 63% | 134 |
| 4. KA | Intervention | 7% | 95 |
| 5. PH | Intervention | 0% | 132 |
| 6. JE | Intervention | 6% | 124 |
| 7. SB | **3   Intervention** | 28% | 133 |
| 8. IC | **4   Control** | 62% | 137 |
| 9. BM | Control | 0% | 85 |
| 10. ER | Control | 52% | 129 |
| 11. DD | Control | 16% | 60 |
| 12. RA | Control | 38% | 122 |
| 13.MW | Control | 0% | 119 |
| 14. RF | Control | 30% | 121 |

Table 2. Clinical Details of the Neglect Patients (Intervention and Control group).

| Patient No. | Condition | Age (years) | Time from CVA (months) | Hemi-anopia | Aetiology | Lesion Location |
|---|---|---|---|---|---|---|
| 1. DS | Intervention | 79 | 22 | No | Infarct | R fronto-parieto-temporal |
| 2. JM | Intervention | 69 | 10 | * | Hem. | R anterior parietal |
| 3. JR | Intervention | 73 | 12 | No | Infarct | R temporo-parietal |
| 4. KA | Intervention | 73 | 16 | Yes | Infarct | R posterior fronto-temporo-parietal |
| 5. PH | Intervention | 57 | 5 | No | Infarct | R frontal, occipital |
| 6. JE | Intervention | 70 | 8 | No | Infarct | R middle cerebral artery |
| 7. SB | Intervention | 57 | 8 | No | Infarct | R fronto-parietal L occipital |
| 8. IC | Control | 78 | 8 | No | Hem. | R temporo-parietal |
| 9. BM | Control | 75 | 25 | Yes | Infarct | R fronto-parietal |
| 10. ER | Control | 84 | 18 | Yes | Infarct | R temporal |
| 11. DD | Control | 75 | 14 | Yes | Infarct | R fronto-parietal |
| 12. RA | Control | 54 | 5 | No | Infarct | R middle cerebral artery |
| 13.MW | Control | 62 | 8 | Yes | Infarct | R middle cerebral artery |
| 14. RF | Control | 63 | 9 | No | Infarct | R middle cerebral artery |

*Not possible to test would not fix gaze centrally.