# Method

### Participants

Nine patients with right parietal damage who had shown clinical symptoms of neglect in previous testing were recruited from the Neurological patient database (tk). Two patients were unable to return for the second phase of the experiment because of extenuating circumstances, and a third participant was removed from the study because of extensive cerebellar damage. The remaining six, (tk male, tk female) patients completed the task. The group had a mean age of tk (), and tk were right handed. The study was approved by the relevant hospital and institutional ethics review boards. All patients were tested at least tk months post-stroke. One participant was not able to perform the spatial working memory task (giving a single response to all trials), and was therefore removed from that component of the analysis.

TODO: Dig up age, handedness and gender and time-post-stroke on the patients.

### Apparatus and Procedure

Patients participated in at least two sessions. The two sessions were intended to differ only in the presence or absence of prism adaptation. One patient discontinued their first session due to fatigue but was able to complete testing in a second session.

As in the previous chapter, patients were tested for symptoms of neglect using four standard clinical measures. These were line bisection, figure copying, and two cancellation tasks: "stars" and "bells". The four tasks were completed during every session. Line bisection was also performed twice during sessions involving prisms, before and after adaptation. Coding and analysis of the tasks were performed in the same way as in Chapter 1. The results of the clinical measures are depicted in figure tk.

#### Spatial Working Memory Task

The spatial working memory (SWM) task is a similar, simpler relative of the visual working memory task used in the last chapter (Ferber & Danckert, 2006). Patients were seated at a viewing distance of approximately 60 cm, with their head and body axes aligned (no chin-rest was used, optical angles presented below are therefore approximate). The task was programmed in tk (by tk), and displayed on a tk computer with a tk inch display. The task was the same as described in @Ferber2006 and @Striemer2013. At the beginning of each trial, patients fixated a red central cross. Once fixated, the experimenter began the trial by depressing a key and the cross turned green. After 1 second, three targets were presented 2º to the right of fixation, vertically aligned. The targets were squares subtending 1.5º, and could appear in any of six positions, however, targets were always separated from one-another by at least 2º.

The targets remained on-screen for 2 seconds which was followed by a delay of 3 seconds. A probe stimulus (a circle of the same size as the target squares) appeared at one of the 16 possible locations. The probe remained on the screen until a response was entered via the keyboard (figure tk). The patients were asked to remember the locations of the target squares across the delay interval and then verbally report to the experimenter whether or not the probe appeared in one of the locations previously occupied by a target. A total of 120 trials constituted a single session. In 50% of trials, the circle appeared in the same position as one of the preceding squares.

#### Temporal Estimation Task

The Temporal Estimation (TE) task was displayed on the same computer as the SWM task, but was programmed in E-Prime (Psychology Software Tools). As with the SWM task, patients gave verbal responses, and the experimenter entered those responses and controlled the task via the keyboard. The task was the same as @Danckert2007. When a trial was initiated by the experimenter, an illusory motion stimulus was presented that consisted of eight open circles (each subtending 3.5º), arranged in a larger circle around the centre of the screen (radius of 8º), with each circle being filled, one at a time, in a clockwise direction (figure tk).

This created the illusion of a filled-circle moving around the outer circle. Rather than a fixation, the centre of the screen periodically displayed a number (numbers 1-9, presented for 300ms, 1.5º in size), which the participant was asked to verbally report as they appeared. This effectively maintained central fixation for the patients and provided a check that participants were attending to the task. In addition, this component was added to the task to prevent participants from sub-audibly counting out the interval duration. To avoid problems with responses, certain constraints were placed on the appearance of the numbers. They would not appear less than 500ms from the beginning or end of the trial, or another number. The interval between numbers was also never more than 1500ms. At the conclusion of the trial, the circles disappeared and the participant was asked to indicate, verbally, the duration of the interval in whole seconds. The intervals were randomly chosen from 5, 15, 30, and 60 seconds with 5 trials per duration.

### Data Analysis

As in chapter one, line bisection bias was coded as a percentage of line-length, and star- and bell-cancellation tasks, based on the percentage of left-side targets that were omitted. All measures were computed pre- and post-prisms, and where multiple sessions were performed, values were averaged (Table tk).

For the spatial working memory task, there were two trial types, those where the probe appeared in the same location as one of the targets, and those in which probes appeared in a non-target location. Based on the two trial types, responses were categorized as true- and false-positives, and true- and false-negatives (positive and negative indicating the responses, and true and false indicating whether the response was correct). A single sensitivity metric was calculated for each patient, pre- and post-prisms, by subtracting false-positives from true-positives (i.e., "hits" - "false alarms"). Normative performance in healthy individuals from pre-existing research with this task was used to provide context to these values.

The temporal estimation task analyzed the time interval estimates the patients reported. For each patient, a mean of reported times was calculated for each time interval, both for pre and post prisms data. An ANOVA, and direct comparisons of the means for each time interval were performed to examine the effect of prisms. In addition, linear models were computed for each individual across the time intervals, and the group mean slopes for pre and post prisms were compared.

# Results

### Spatial Working Memory Task

As a group, SWM performance does statistically improve when a one-sided test is used (presuming prisms would not decrease performance, , ). When consulting figure tk, it becomes obvious, however, that there is not a consistently large improvement across all patients, and even those who did improve did not demonstrate performance in the range observed in healthy individuals (Figure tk). Patient 27, who did not show evidence of neglect on any of the clinical measures, performed well within the range observed in healthy, and non-neglecting right brain damaged patients in the past. All four patients showing clinical signs of neglect still showed large deficits post-prisms, compared with the performance of non-neglecting right brain damaged patients previously examined on this test (z-scores between 3.4 and 7.2). When compared with performance of neurologically intact controls (the lighter region in figure tk), patient 171 does cross into a region statistically indistinguishable from normative performance (), but the others remain well outside ().

FIXME: In the figure, I use bands of 2 SD, rather than the 95% CI used the previous studies. It looks less impressive, but I think it's more appropriate.

FIXME: Above should probably have Crawford results in addition to z-scores, but I'll leave it for now.

### Temporal Estimation Task

As can be observed in figure tk, the five patients who showed clinical signs of neglect massively underestimated the time intervals (Patient 27 underestimated to some degree pre-prisms, and responded very accurately post-prisms. tk). As a result, analysis was done both with and without including Patient 27, and results did not differ. What is presented here is the data excluding patient 27. An analysis of variance performed, with both prisms and trial duration included as fixed factors, did not identify a significant effect of prisms, or an interaction involving prisms (table tk). While trial duration produced a significant effect on response magnitudes, the theoretical importance is negligible. Because of this, an alternative analysis using ANCOVA, with trial duration as a covariate was employed, and, even here, there was no indication of an effect of prisms (, $=0.4).

FIXME: Individual t tests at each interval also fails to show prisms effect.

FIXME: I could also include something that demonstrates the severity of the deficit, but it's pretty obvious from the figure.

### Line bisection

As a group, the neglecting patients showed a significant change in line bisection bias after prism adaptation in the direction traditionally seen in the research, provided a one-sided test is used (patient 27 removed, , ).

Individual t tests on the sets of line bisections for each patient (see table tk? or inline in next sentences). All patients showed significant change post prisms except 163 and 408 (with the latter not quite reaching significance due to extreme trial-to-trial variability). As can be seen in figure tk, the changes were universally leftward except for patient 27, the non-neglecting patient.

TODO: Add error bars to figure.

As a group, the neglecting patients did not improve on either bell (, ), or star cancellation (, ), and, as can be seen in table (tk clinical results table), only one patient showed improvement on figure copying (Patient 171).

FIXME: We should discuss if a figure should be made for cancellation tasks, and how the table of clinical results, if at all, should look.

FIXME: Not sure if there are any direct comparisons between tasks that should be done. If so, they will go here.