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Prisms for non-strabismics: Is the vergence position of rest stable?

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ABSTRACT. We determined the Vergence Position of Rest (VPR) in two sessions, one to six weeks apart. Each session contained 8 trials. Twenty observers with normal eyes looked through Risley prisms that allowed a continuous modulation of their strength. We asked the observers to look at fully fusionable pictures, and to adjust the prisms such that viewing appeared most relaxing. RESULTS. The intraindividual variation among the 8 trials of each session was rather wide. 12 of 20 observers changed their preferred prism from the first to the second session by more than 1.0 prism diopter [cm/m], up to 3.3 prism diopters. CONCLUSIONS. The prismatic strength estimated as being most relaxing can be very variable. Before considering a prescription, the practitioner should determine whether the preferred prismatic strength remains reasonably stable. To ascertain this constancy, more than one session is necessary.

1 INTRODUCTION

Keeping the eyes aligned can cause asthenopic symptoms. Prisms are an established remedy: they allow the eyes to take up their Vergence Position of Rest (VPR).

How should the VPR be determined? Traditional tests for heterophoria are inappropriate for this purpose, because they require the images of the two eyes to be different; an extreme example is a complete occlusion of one eye. Such unnatural viewing conditions can cause artefacts (Otto, Kromeier, Bach & Kommerell, 2008a; Otto, Bach & Kommerell, 2008b). To avoid such artefacts, we suggest that the VPR should be found when the patient views a natural scene and is instructed to choose the prismatic strength that makes viewing most relaxing. A convenient instrument for this task is a continuously variable prism. This so-called Risley prism is attached to many phoropters.

Is the prism selected under natural viewing conditions ready to be prescribed? Certainly not. There are many preconditions for recommending prisms to non-strabismic patients. Here we concentrate on just one precondition: the VPR should be reasonably stable. In other words, the patient should choose a similar prism on repeated examinations.

Surprisingly, this aspect has received little attention in the literature, and for that reason we studied the variability of the VPR.

2 METHODS

Twenty non-strabismic observers, recruited irrespective of whether they had asthenopic symptoms, had to look at a fully fusionable display presented at 400 cm (our data obtained at a viewing distance of 50 cm are not included in this report). The observers had to set variable Risley prisms such that viewing appeared most relaxing. To avoid any bias from the experimenter, we recorded the procedure with a potentiometer and analysed the data offline.

To assess reproducibility, we examined the observers in two sessions, 1 to 6 weeks apart. Each session contained 8 trials.

3 RESULTS

Most observers started with rather bold searching excursions and refined the tuning gradually (Fig. 1). After about 20 seconds, most observers reached a prismatic power which they felt was most relaxing for them. Accordingly, we used the later values for further analysis. We limited to 30 seconds the time available to the observer, to prevent prism adaptation. After intervals of 60 to 120 seconds we repeated the procedure 7 times, always starting at 0. Thus we collected 8 recordings.

The curves varied considerably. From the 8 recordings we calculated the mean and the standard error of the mean of the final 10 seconds.

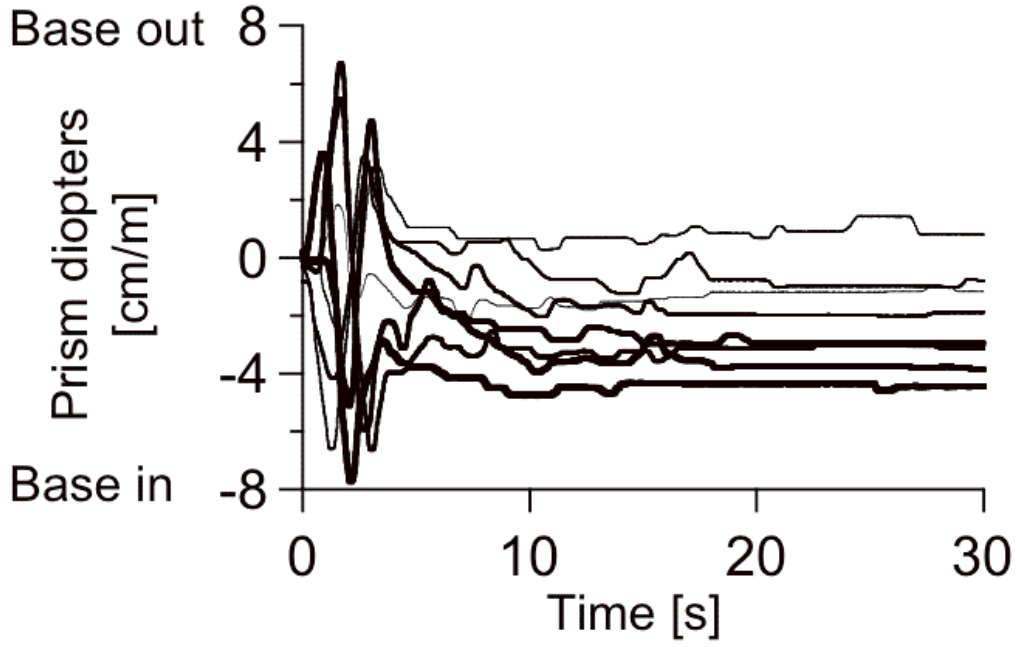

Fig. 1. Eight trials of the first session for observer #10. Before each trial, the experimenter set the prism to zero. Then the observer adjusted the variable prism such that viewing appeared most relaxing. In this example, the mean out of the 8 trials during the last 10 seconds was 2.1 prism diopters [cm/m] base in = Exo

In the second session, 1 to 6 weeks later, many subjects chose a quite different prism as being most relaxing (Fig. 2). Ten of the 20 observers changed their preferred prism from the first to the second session by more than 1.0 prism diopter [cm/m], up to 3.3 prism diopters ($p<0.05$).

Figure 3 depicts the range obtained from the eight trials of the first session. We thought that the mean of the second session would be inside this range. However, this was not universally the case: in the second session, 8 of the 20 subjects found the most relaxing prism outside the range of the first session.

4 DISCUSSION

We used a method that allows determining the VPR under natural viewing conditions: the observer chooses the most relaxing prism while looking at fully fusionable images.

We found that the VPR can be very variable. Instability of the VPR is rather the rule than the exception: we observed reasonable stability in only one of the 20 observers (# 5 in Figs. 2 and 3). The marked variability is not specific to our method. Traditional determinations of the dissociated and associated heterophoria yield similar instability (Otto, Kromeier, Bach & Kommerell, 2008a; Otto, Bach & Kommerell, 2008b).

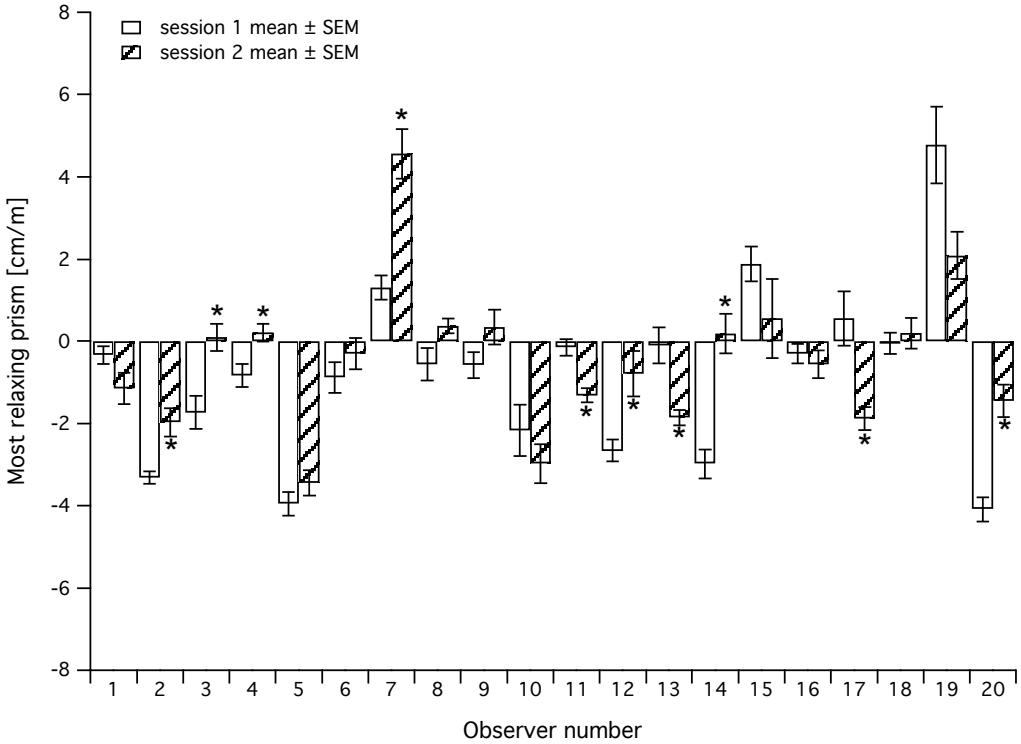

Fig. 2. Mean ± standard error of the mean of 8 trials, first and second session, 20 observers. * = significant difference between the two sessions

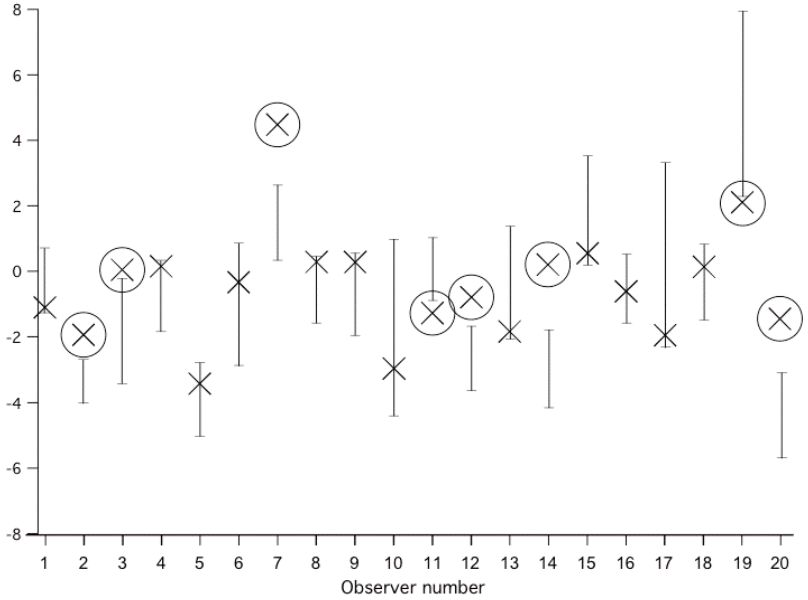

Fig. 3. Bars = range of the 8 trials in the first session. Crosses = mean of the second session; circles mark those outside the range in the first session

The reason for the instability is that the VPR is determined by opening the feedback loop for fusional vergence. Feedback loops in biological systems have the task of stabilising certain parameters, and opening the feedback loop typically leads to instability. The function of the fusional feedback loop is to stabilise the eyes at a certain angle, using disparity as the error signal. When dissociated heterophoria is determined, e.g., by occluding one eye, it is easy to understand that the feedback loop is open: fusionable contours are absent, and hence there is no disparity error signal. When the VPR is determined by allowing the observer to select the most relaxing prism while viewing fully fusional images, any disparity error produced by a tendency of the eyes to deviate from the orthovergence position is promptly nullified by repeated prism adjustment. Hence, the fusional feedback loop cannot stabilise the vergence angle. Rather, the fusional feedback loop is out of function, and replaced by another feedback loop whose error signal is discomfort.

Were the differences found between the first and second sessions clinically relevant? Following research evidence (Jenkins, Pickwell & Yekta, 1989), many practitioners prescribe prisms from about 1.0 prism diopter upwards (O'Leary & Evans, 2003). Accordingly, we identified observers who displayed a difference between the first and second session greater than 1.0 prism diopter. This was the case in 10 of the 20 observers (up to 3.3 prism diopters).

We avoided using relief from asthenopic complaints as a criterion for the choice of the most relaxing prism, because this approach would have required prolonged wearing of various test prisms, including placebo, in a controlled design, to face four problems. First, a causal relationship between heterophoria and asthenopia is hard to establish, because the prevalence of both conditions is high in the general population, so that coincidence by chance can easily occur. Second, wearing prisms for hours or days leads to adaptation, so that the patient may later value even prisms that he or she initially disliked. Third, most asthenopic symptoms wax and wane, and therefore it is very likely that patients seek remedy at a time when their symptoms are relatively intense. Hence a subsequent improvement may well be due to a spontaneous regression to the mean (Yudkin & Stratton, 1996), rather than to a prism in the spectacles. Fourth, relief from symptoms may be brought about by the supportive behaviour of the therapist (placebo).

Although we did not use relief from asthenopic complaints as a criterion, we suggest that our findings relate to the prescription of therapeutic prisms for such patients.

5 CONCLUSIONS

- The Vergence Position of Rest is commonly unstable.
- To ascertain a reasonable stability of the Vergence Position of Rest that might warrant a prescription of prisms, sessions on different days are required, because the variability in a single session does not indicate the long-term variability.

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