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Experience can increase prism fusion range

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Abstract

Aim: **Differences in near prism fusion ranges (PFR) were assessed in 4 groups of participants who differed in experience of exposure to such testing. The effect of encouragement in the two least experienced groups was also tested.**
Methods: **The near base in (BI) and base out (BO) fusional amplitudes (FA) were measured in four groups of 10 participants, all with normal or corrected to normal vision. One group was naïve to such testing, being non-orthoptic students, the other three groups consisted separately of Year One, Two and Three student orthoptists. The two most inexperienced groups, Naïve and Year One student orthoptists, were also tested a second time with encouragement to try as hard as possible to increase their fusion amplitudes.**
Results: **Year Two and Year Three students had significantly ($p < 0.001$, often over 20^{Δ}) larger BO FA than naïve students or Year One orthoptic students. No such differences were seen for BI measures. Encouragement also significantly ($p < 0.01$), but modestly ($<6^{\Delta}$), increased BO FA and slightly (about 1^{Δ}, $p < 0.05$) increased BI FA.**
Conclusions: **Experience did increase PFR but this was mainly in BO fusion amplitudes and was far greater than obtained by encouraging participants. The experience needed to obtain this increase appeared to be the exposure occurring in one year of training to be an orthoptist. Further experiments could help clarify the factors involved in this improvement by tracking any increase throughout this first year and also look for changes in performance in other orthoptic tests.**

Key words: Experience, Fusion, Prism, Range

Introduction

Horwood and Riddell[1] have shown differences in vergence and accommodative responses between naïve and expert observers. Expert observers tend to show gains significantly closer to 1.0 for both vergence and accommodation to targets when compared to naïve observers. These findings are important as it is often the case that research carried out in this area uses experienced observers, often university students, as participants.[1,2] However, it is often unclear how applicable the results from such studies are to a naïve population, let alone a clinical population.

Horwood and Riddell[1] suggested that ‘attention, practice, voluntary and proprioceptive effects may enhance responses in experienced participants when compared to a more typical general population’ (p. 152).

In the experiment we describe here, near prism fusion range (PFR) was tested and outcomes compared from different experimental groups with a range of experience from naïve to ‘expert’. This would allow further exploration of factors that may influence any performance differences. It is well known such amplitudes can increase with explicit training regimes.[3–9] However our experienced groups, like those in the Horwood and Riddell[1] study, were not explicitly trained. Our participants had the usual exposure to prism fusion testing of students on an orthoptic course; this included clinical procedures practice and also participation in research projects that involve such clinical testing. This experiment, therefore, tests whether this more implicit training can increase PFR when compared to the naïve and Year One, untrained groups. It was also tested whether encouraging the inexperienced groups in their performance could increase PFR.[10,11]

Methods

The departmental ethics committee approved the experiment.

Participants

Forty participants took part in this study. Thirty were student orthoptists: 10 first year students (7 female (F) / 3 male (M) mean age 19.6 years), 10 second year students (7F/3 M mean age 20.0 years) and 10 third year students (7F/3 M mean age 21.8 years). A naïve group of 10 University of Sheffield students was recruited from friends of the first author (6F/4 M mean age 20.4 years) who were not on the orthoptic course. Visual acuity was assessed for each eye with a 4 m logMAR chart and no observer had a visual acuity less than 0.08 in any eye. Any inter-ocular differences in visual acuity were generally small, with the largest difference being 0.16 logMAR. Ocular movements were assessed using a pen torch. All participants demonstrated bifoveal binocular single vision when tested with 4^{Δ} prism whilst viewing a 6/6 reduced Snellens letter at 0.33 m in the primary position. All wore any refractive correction required

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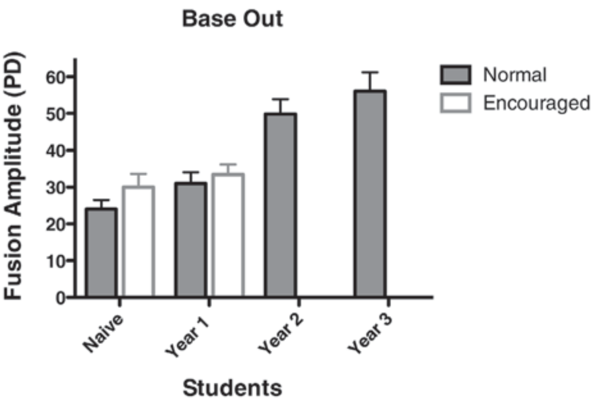

Fig. 1. Mean near BO fusion amplitudes. The error bars are ±1 standard error of the mean.

Table 1. Summary of Bonferroni multiple comparison tests between different groups in (a) BO and (b) BI data

(*a*) BO data

Group	Mean (SD)	Year One	Year Two	Year Three
Naïve	24.1 (7.6)	–	***	***
Year One	31.0 (9.6)		**	***
Year Two	49.9 (12.7)			–
Year Three	56.1 (16.3)			

(*b*) BI data

Group	Mean (SD)	Year One	Year Two	Year Three
Naïve	10.0 (3.0)	–	–	–
Year One	12.4 (2.5)		–	–
Year Two	10.2 (2.4)			–
Year Three	13.0 (3.7)			

The mean data for each group are shown with standard deviations (SD) in parentheses.
The level of difference between each group is indicated in the corresponding box: $p < 0.001$ (***), $p < 0.01$ (**) and not significant (–).

during testing. Heterophoria was assessed with a prism cover test with all deviations being small, maximum of 6^{Δ}.

Design and procedure

The experiment was a mixed measures design. There were four independent groups: students naïve to orthoptic tests, and students from the first, second and third year of the B.Med.Sci. (Orthoptics) course at the University of Sheffield. All measures were repeated across each group. The first participant in each group had their base out (BO) fusion amplitude (FA)* measured before their base in (BI) FA; for the second participant the order was reversed. The order then alternated within each group such that each group had 5 participants with the order BO followed by BI and five BI then BO. Order of testing has been shown to be important.[12] One possible confounding variable of this study was that the experimenter, the first author, was a Year Three student and friends with all participants in that group. Any differences between groups could therefore be due to any effects this friendship may have on performance. The Naïve group were, therefore, recruited not only as a control group who had no experience of PFR measurement but because they were also friends of the experimenter and of a similar age to the Year Three group. Testing with encouragement was introduced[10,11] to test further the possibility that any better performance by the Year Three group, and possibly the Year Two, was due to the participants trying harder for the experimenter because he was known to them. Therefore, for the Naïve and Year One group only, once all tests had been completed, the PFR was reassessed but with the experimenter giving verbal encouragement.

Once the participant had read the participant information sheet and given written consent, their visual acuity and ocular motility were measured as above. Horizontal fusional amplitudes were assessed to the nearest 2 prism dioptres ($^{\Delta}$) using two Gulden prism bars with the technique described in Narbheram and Firth[13]. Only near PFR was assessed. The participant was instructed to report the occurrence of diplopia whilst fixating the 6/60 letter on a reduced Snellen stick in the primary position at 0.33 m. The 6/60 letter was used to ensure that it could be seen well even when viewed through large prisms. Parkinson *et al*.[14] found no significant effect of target size on fusional amplitudes at near; only distance convergent (BO) range was affected. One prism bar was introduced in front of the right eye until the 20^{Δ} was reached; if a participant could continue a second prism bar was introduced over the left eye and increased to 20^{Δ}. If a participant could continue, then the prism strength over the right eye was increased to 30DS whilst simultaneously reducing the left eye to 10^{Δ}. This procedure was repeated until diplopia was reported. For the Naïve and Year One groups only, PFR was then reassessed with encouragement. The experiment took about 10 minutes for each participant.

*We use the term fusional amplitudes to refer to the separate BO and BI components of prism fusion range[16].

Statistical analysis

Data were analysed and graphed using Prism 5 (GraphPad Software, Inc, USA).

Results

The effect of experience

The filled columns of Fig. 1 show the mean near BO FA for the four groups under normal testing conditions and the two unfilled columns mean BO FA for the Naïve and Year One group after encouragement.

As can be seen from Fig. 1, Year Two and Three students appear to have larger BO FA than the Year One and Naïve students. A one-factor independent groups ANOVA was conducted which showed a significant overall group effect, $F_{3,36} = 15.970$, $p < 0.0001$. A Bonferroni multiple comparison test was conducted to find which differences between groups were causing the significant effect: this is summarised in Table 1a. This clearly shows no significant differences between the Naïve and Year One groups, although Year One have slightly higher BO values. Similarly there was no significant difference between Year Two and Year Three student orthoptists, although the mean for the

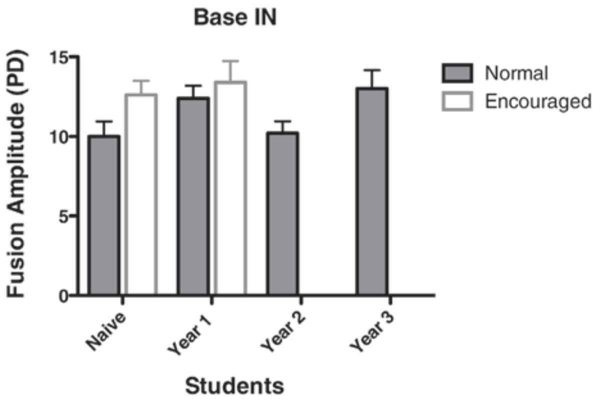

Fig. 2. Mean near BI fusion amplitude for the four groups of students under normal testing conditions. The error bars are ±1 standard error of the mean.

Year Three is larger than that of Year Two. The main differences are between the groups (Years Two and Three) who have had exposure to prism use during their course and those who have not (Naïve and Year One).

The mean and standard deviations for the Naïve and Year One groups for BO FA in Table 1a are comparable to those reported from a larger group by Antona *et al.*[15] with a mean of 28.91$^{\Delta}$ and standard deviation of 9.09$^{\Delta}$. The means for our Years Two and Three groups are clearly much higher, being more than two of these standard deviations greater.

Fig. 2 plots the mean BI FA values, following the same format as Fig. 1. As can be seen from Fig. 2 there appear to be fewer marked differences between the groups. This was confirmed by a one-factor independent groups ANOVA which showed no overall significant group effect, $F_{3,36} = 2.712$, $p = 0.0593$. Table 1b shows that none of the Bonferroni multiple comparisons between groups were significant.

The mean and standard deviations for all groups for BI FA in Table 1b are comparable to those reported from a larger group by Antona *et al.*[15], with mean 12.14$^{\Delta}$ and standard deviation 3.35$^{\Delta}$.

The effect of encouragement

Figs. 1 and 2 show that mean data obtained for both the Naïve and Year One students when encouraged (unfilled bars) seem to be higher than their first testing under normal conditions (filled bars) for both BO and BI measurements. Paired scores *t*-tests showed that all differences were significant at least at the $p < 0.05$ level: on average Naïve group BO FA increased from 24.1 to 30.0$^{\Delta}$ ($t = 3.766$, df $= 9$, $p = 0.0044$), Year One students BO FA increased from 31.0 to 33.4$^{\Delta}$ ($t = 3674$, df $= 9$, $p = 0.0051$), Naïve group BI FA increased from 10 to 12.6$^{\Delta}$ ($t = 2.899$, df $= 9$, $p = 0.0176$), Year One group BI FA increased from 12.4 to 13.4$^{\Delta}$ ($t = 3.000$, df $= 9$, $p = 0.0150$). Although significant, these increases were modest and Fig. 1 in particular shows that encouragement did not cause the Naïve group or Year One student orthoptists to obtain values anywhere near those of Years Two or Three students. Further Bonferroni tests, not included here, showed that the significant differences between the experienced (Years Two and Three) and inexperienced (Naïve and Year One) groups shown in Table 1a were still present when data obtained after encouragement were used.

Discussion

Experience appears to increase PFR. However, it appears that this increase occurs mainly in BO fusion amplitudes. Fig. 1 and Table 1a show that the experienced (Years Two and Three) groups had significantly higher near BO FA than the inexperienced groups (Naïve and Year One students). These differences, on average over 20$^{\Delta}$, would also be regarded as clinically important. Indeed the values for Year Two and Year Three students are outside the normal range.[13,15,16] These changes did not seem to be due to the more experienced students trying harder for the experimenter, as even with encouragement to try harder both the Naïve and Year One students could not, on average, obtain values close to that of the experienced groups. For both the Naïve group and Year One student orthoptists the effect of encouragement did significantly increase both BO and BI FA. Although statistically significant, these changes were clinically modest, being around 6$^{\Delta}$ for BO and 1$^{\Delta}$ for BI. It cannot be concluded that it was the encouragement that led to any increases in PFR, as control groups were not included for comparison, only participants who did the tests twice but with encouragement in the second test. It is not known, therefore, whether the changes found here were simply due to practice effects in the inexperienced groups, and further testing of this is required. However both increases are larger on average than those found in a study testing the repeatability of PFR measures, which found about 2$^{\Delta}$ for BO FA and no change for BI FA on second testing.[15] Also our finding is consistent with literature on children showing measured visual acuity improvement following encouragement.[11]

The Naïve group were chosen as they, like the Year Three group, were friends of the experimenter. The large significant differences between these two groups for BO values, as shown in Fig. 1 and Table 1a, imply that these are due to the experience obtained during the orthoptics course. The large Year Three group data are therefore not due to friendship with the experimenter. Also with encouragement the Naïve group data was still significantly lower than the Year Three group data.

Fig. 2 shows that the differences between groups were not present for the BI FA. This difference in findings for BO and BI may reflect that for most participants BI measures are close to 'ceiling' and, therefore, are difficult to increase. Against this idea is the finding that encouragement did seem to significantly, if modestly, increase BI values in the inexperienced groups. An alternative explanation is that when student orthoptists are practising their clinical skills they practise the measurement of BO more frequently than BI; this could be explored in a future study. However, it could simply be that because BO measurements always have larger values than BI, and if both are equally practised it will be the case that the observer will be exposed to more BO prisms than BI. Again this could be explored experimentally.

It is of interest that from both Fig. 1 and Table 1a it seems that whatever experience over their years of study student othoptists have gained, it is mostly obtained by the end of their first year. This is because the experiment was conducted early in the academic year so Year Two students had not had much more practice with prism bars since the end of Year One, but they still showed large differences from inexperienced Year One students. Also there was no significant difference between Year Two and Year Three students. It would have been useful to collect more detailed data from each participant about their exposure to prism bars, but self-report would probably not have been a reliable data source. An alternative approach would be to ask first year students to keep a log of their experience throughout their first year and then measure their PFR ranges at regular (monthly) intervals. Such an approach may allow us to find out the relative importance of the factors outlined in the Introduction[1] that are thought to lead to improvement with experience.

It would also be interesting to track improvements in performance in student orthoptists in other tests, such as RAF rule or the near Frisby stereotest, to see if they show similar improvement with experience.[1]

Conclusion

Our findings are consistent with previous literature showing increases in PFR following training [3–9] and the effect of experience, without explicit training, may have on such measures.[1] The increases found were mainly for BO. Care may, therefore, need to be taken when conducting experiments on PFR with experienced participants, especially if the aim is to extrapolate findings to naïve or clinical populations.[1] Further experiments could help clarify the factors involved in this improvement by tracking any increase throughout this first year and also look for changes in performance in other orthoptic tests. PFR also seemed to be improved with encouragement, but the design of this experiment did not allow a simple practice effect to be excluded as an explanation of this result.

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