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Assessment of the accommodative facility training with flippers between sessions

Rosa Calo-Santiago[a], Hugo Pena-Verdeal[a], Carlos Garcia-Resua[a], Eva Punin Dorrio[a], Maria J. Giraldez[a]
[a]Departamento de Física Aplicada (Area de Optometría), Universidade de Santiago de Compostela, Santiago de Compostela, Spain

ABSTRACT

Purpose: Accommodative anomalies are a group of different visual problems that reduce the efficiency of the visual system. Binocular accommodative facility (BAF) therapy is used to train the ability of the eye to repeatedly change its accommodative state when changing focus between two focal planes during periods of time. The aim of this study was to evaluate the effect of BAF training with standard flipper dioptric treatments on a group of non-symptomatic young adults. **Material and methods:** 67 subjects were recruited among students attending the Optometry Clinic of the Optometry Faculty (USC, Spain). All of them had good general health and were free of any accommodative or binocular problems. Subjects were scheduled to four session one-week apart. In each session, they were requested to measure the BAF in cycles/minute (cpm) with a ±2.00D flipper while focusing a near test at 40 cm. Patients were also requested to point the difficulty for clearing with the minus, plus or with none pair of lenses. **Results:** There was found a statistical difference on BAF between the first and the final session when the whole sample was analysed (paired t-test: $p < 0.001$), and when the sample was grouped by lens clearing difficulties (paired t-test: all $p \leq 0.005$). BAF showed a statistically significant difference between results obtained in each session (ANOVA: $p = 0.002$), and between the results of contiguous paired sessions (paired t-test: all $p \leq 0.047$). **Conclusion:** The present study showed the positive effect of traditional dioptric training in amplitude flexibility improvement.

Keywords: Optometry, Accommodative anomalies, Dioptric Flipper, Binocular accommodative facility, Visual training

1. INTRODUCTION

Accommodative and vergence anomalies are a common group of visual problems that cause accommodative and binocular dysfunction, and thus reduce the efficiency of the visual system [1, 2]. The ability of the eye to accurately and repeatedly change its accommodative state when changing focus between two focal planes during a certain period of time is essential for a correct performance in the near tasks. This ability is clinically measured using the flippers accommodative facility test [2-4]. Binocular accommodative Facility (BAF) training therapy makes use of a so-called "flipper" holding one pair of minus lenses and one pair of plus lenses with similar or different power [2, 5, 6]. They are used to force or change the eye accommodative system from a relaxed to a stimulated position and vice versa in order to training this capacity [5]. The aim of this study was to evaluate the effect of accommodative facility training by dioptric treatments with a standard flipper on the accommodative facility on a group of non-symptomatic young adults.

2. MATERIAL AND METHODS

2.1 Sample and study sessions

An initial group of 110 voluntary participants who fulfilled the study's inclusion established for the study was recruited from students and subjects attending the Optometry Clinic of the Optometry Faculty (USC, Spain). All of them were young (between 20 and 23 years old), have good general health and were free of any accommodative or binocular problems. Before inclusion, all participants were informed of the procedures and gave their written consent to take part in the study. All the procedures followed the Declaration of Helsinki and the protocol was reviewed and approved by the Ethics committee of the USC. Qualified subjects were scheduled for four-session one-week apart. All sessions were performed at the same time of the day for each subject. For the final analysis of the study, only subjects who completed the four sessions successfully were included. Therefore, from the initial group of 110, only 67 who completed all the sessions planned on the study (21.32 ± 3.10 years) were used during the statistical analysis.

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2.2 Binocular Accommodative Facility training by flipper lens technique

BAF training therapy makes use of flipper holding one pair of minus lenses and one pair of plus lenses. Participants were instructed to focus through one pair of lenses at a near distance until the object was clearly focused, then they were requested to perform a rapid change to the other pair of lenses to focus again [2-6]. This sequence was repeated; at the instance of clearing both the plus and minus lenses was counted as one cycle, and recording was done in cycles per minute (cpm). Patients were instructed to wear their own refractive correction during this process [2-5].

On the present study, a flipper of ±2.00 D was used in all session. In each one of the four-session, patients were requested to use the flipper while focusing a 0.8 VA test at 40 cm for 1 minute [2-4, 6] (Figure 1). The training was performed by the patient at the Optometry Clinic of the Optometry Faculty, and the performance was controlled by an expertise optometrist. Patients were also requested to point the difficulty for clearing with the minus, the plus or with none pair of lenses.

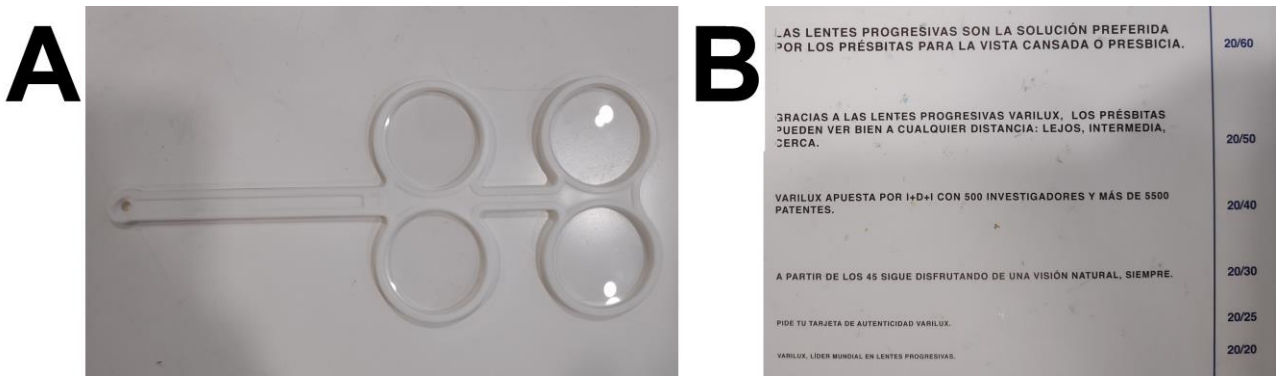

Figure 1. Material employed during the Binocular Accommodative Facility training A) Flipper of ±2.00 D; B) Near test used for the study.

2.3 Statistical analysis

SPSS statistical software v.19.0 for Windows (SPSS Inc., Chicago, IL) was used for data analysis. Significance was set at a $p \leq 0.05$ for all statistical tests. Previous to analysis, the normal distribution of the data was checked using the Kolmogorov-Smirnov test [7]. BAF showed a normal distribution ($p > 0.05$). Differences between the mean values obtained and the normative values assumed by the literature were assessed by a one-sample t-test. Inter-session differences were calculated by a paired t-test for comparison between results in two different sessions, while ANOVA was used to analyse the difference between sessions. In addition, Bland-Altman procedures were used for the comparison between pairs of sessions. This method describes the correlation or similarity between two variables, representing averages versus differences [8]. The 95% limits of agreement (95% LoAs) were also calculated (Mean difference ± 1.96 x SD), as well as the exact 95% Confidence Intervals (95% CI) for Upper and Lower LoAs considered as a pair (Mean difference ± $c_{t0.025}$ x SD; Mean difference ± $c_{t0.975}$ x SD) [7, 9].

3. RESULTS

Table 1 shows the descriptive statistics of BAF results in each session. When mean results obtained in each session were compared to the normative of 10 ±5 cpm value commonly assumed by the literature for diagnostic [1], only the session 1 showed no difference with this value (one sample t-test: $p = 0.346$), while the other comparison showed a statistically difference (one sample t-test: all $p \leq 0.001$).

Table 1. Descriptive statistics of the binocular accommodation flexibility (BAF) obtained in each session. All data in cycles/min (cpm). n = 67 subjects. SD = Standard Deviation.

	Mean	SD	Maximum	Minimum
Session 1	10.40	3.47	2	17
Session 2	11.66	4.08	2	20
Session 3	12.38	4.74	3	23
Session 4	13.04	4.43	4	22

3.1 Comparison between the first and final session

The total evolution of the BAF was analysed by comparing the results of the first and the final session, first in the whole sample and then by grouping the sample by the difficulty for clearing the different pairs of lenses. There was found a statistical difference on the BAF value between the results obtained on the session 1 and the session 4 (t-test: $p < 0.001$) when the analysis was performed on the whole study sample (Table 1). Figure 2 shows the Bland-Altman plot of means against the differences between the BAF obtained on the first and the final session.

Table 2. Differences (paired t-test) and 95% LoAs between values obtained in sessions 1 and 4. Data in cycles/min (cpm). n = 67 subjects. SD = Standard Deviation. LoAs = Limits of Agreement. CI = Confidence Interval.

Mean Difference ± SD	p	95% LoA		95% CI of LoA	
		Lower	Upper	Lower	Upper
2.64 ± 3.08	< 0.001	-3.40	8.60	-2.55/-4.70	7.83/9.98

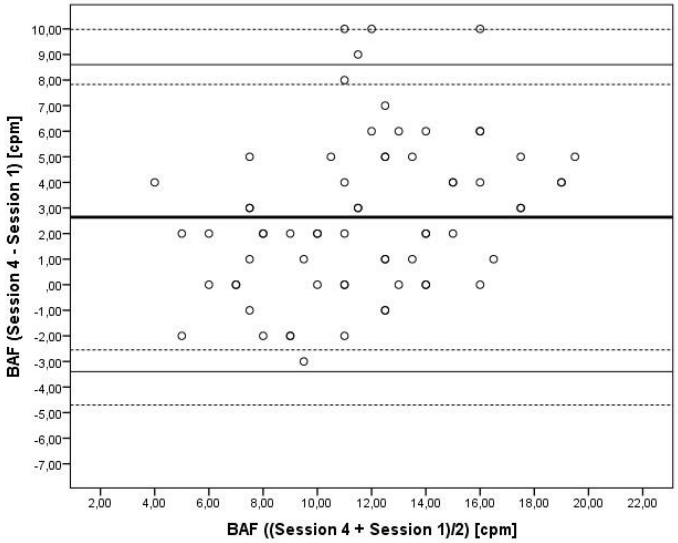

Figure 2. Mean versus differences (Bland-Altman plot) between the values obtained in sessions 1 and 4 in n = 67 subjects. The thick solid horizontal line indicates mean difference while thin solid horizontal line the 95% LoAs (Mean difference ± 1.96xSD). The dashed horizontal lines indicate the 95% CI of the LoAs. LoAs = Limits of Agreement. CI = Confidence Interval.

From the 67 participants, 14 reported difficulty for clearing with the minus lenses (20.9 % of the participants), 38 with the plus lenses (56.7 % of the participants), and only 15 reports no problems to clearing any pair of lenses (22.4 % of the participants) (Table 3). Differences between the sessions 1 and 4 were analysed in each clearing difficulty subgroup. As in the previous analysis in the whole sample, it was found a statistical difference on the BAF between sessions in each subgroup (t-test: all $p \leq 0.005$). In addition, the values of Mean Difference ± SD were very similar between subgroups (from 2.47 ± 3.16 to 3.06 ± 3.23, Table 3).

Table 3. Differences (paired t-test) and 95% limits of agreement between measurements recorded in sessions 1 and 4 in the sample grouped by the difficulty of clearing on a pair of flipper lenses. All data in cycles/min (cpm). SD = Standard Deviation. 95% LoAs = 95% Limits of Agreement. 95% CI = 95% Confidence Interval.

Pair of lenses	n	Session	Mean ± SD	Mean Difference ± SD	p	95% LoA		95% CI of LoA	
						Lower	Upper	Lower	Upper
None	14	Session 4	13.42 ± 4.52	2.65 ± 2.89	< 0.001	-3.02	8.30	-1.57/-6.85	6.85/12.13
		Session 1	10.82 ± 3.29						
Plus Lenses	38	Session 4	12.52 ± 4.25	2.47 ± 3.16	0.005	-3.72	8.66	-2.66/-5.57	7.60/10.51
		Session 1	10.00 ± 3.44						
Minus Lenses	15	Session 4	14.33 ± 3.80	3.06 ± 3.23	0.003	-3.27	9.39	-1.55/-8.18	7.67/14.30
		Session 1	11.41 ± 3.80						

3.2 Comparison of the evolution between sessions

In a second step, the evolution of the BAF value was analysed session by session. BAF showed a statistically significant difference between results obtained in each session (ANOVA: $p = 0.002$). When the differences were analysed by pairs between contiguous session, it was a found a statistical difference (t-test: all $p \leq 0.048$) (Table 4). Figure 3 shows the Bland-Altman plot of means against the differences between the BAF obtained on each contiguous sessions. While there was found a statistical difference between the pairs of sessions analysed, it can be seen that the Mean Difference ± SD values decrease as the sessions advanced in time (from 1.25 ± 2.25 to 0.66 ± 2.67; Table 4).

Table 4. Differences (paired t-test) and 95% LoAs between values recorded in contiguous sessions. Data in cycles/min (cpm). n = 67 subjects. SD = Standard Deviation. LoAs = Limits of Agreement. CI = Confidence Interval.

Pair of sessions	Mean Difference ± SD	p	95% LoA		95% CI of LoA	
			Lower	Upper	Lower	Upper
Session 2 vs. Session 1	1.25 ± 2.25	< 0.001	-3.17	5.66	-2.55/-4.12	5.04/6.61
Session 3 vs. Session 2	0.73 ± 3.08	0.047	-5.31	6.77	-4.46/-6.61	5.92/8.07
Session 4 vs. Session 3	0.66 ± 2.67	0.048	-4.57	5.89	-3.84/-5.70	5.16/7.02

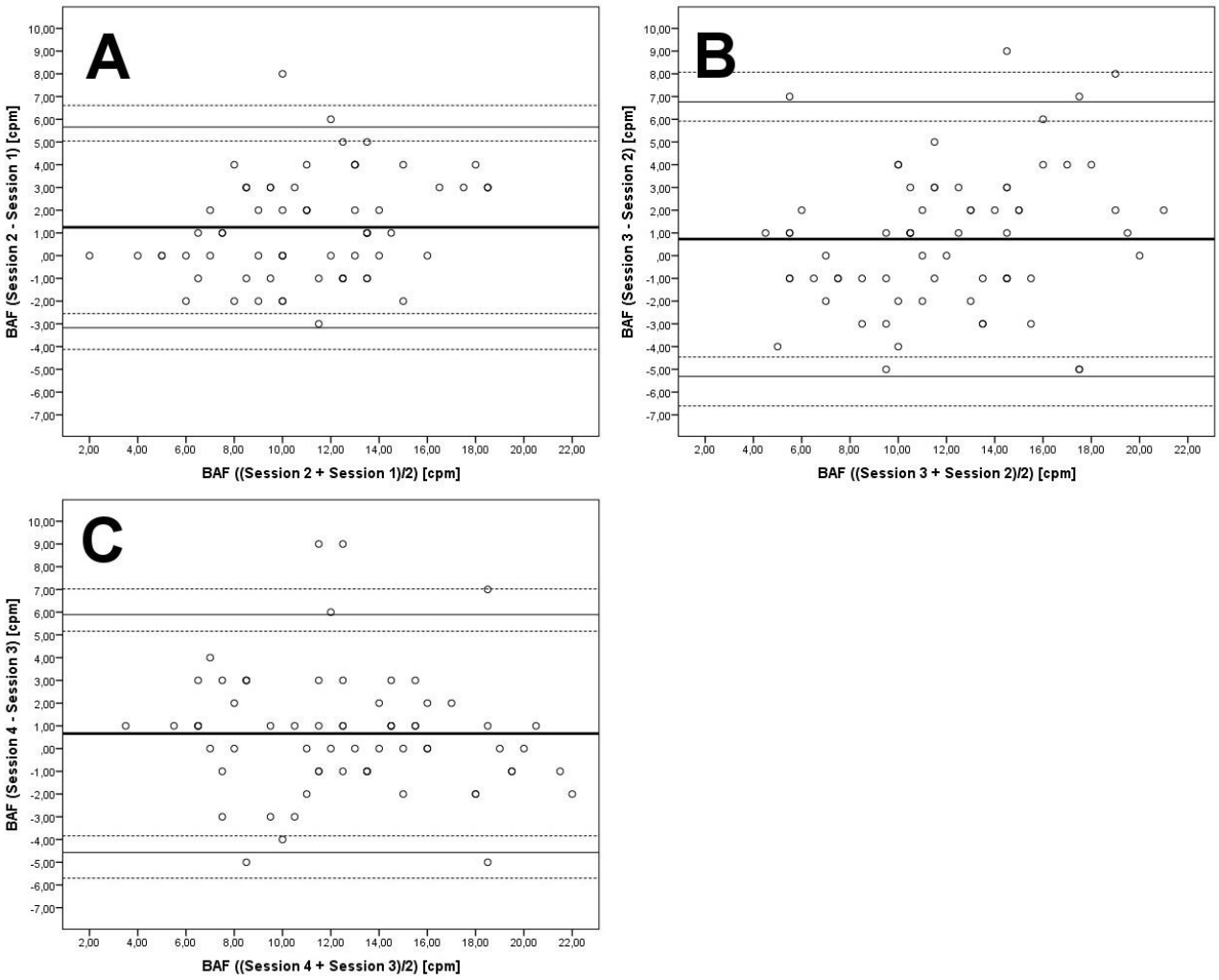

Figure 3. Mean versus differences (Bland-Altman plot) between the values obtained in contiguous sessions. The thick solid horizontal line indicates mean difference while thin solid horizontal line the 95% LoAs (Mean difference ± 1.96xSD). The dashed horizontal lines indicate the 95% CI of the LoAs. A) Session 1 vs. Session 2; B) Session 2 vs. Session 3; C) Session 3 vs. Session 4. LoAs = Limits of Agreement. CI = Confidence Interval.

4. CONCLUSION

The aim of this study was to evaluate the effect of accommodative facility training by dioptric treatments with a standard flipper on the accommodative facility on a group of non-symptomatic young adults. As in previous studies [2], comparison of our results with Scheiman and Wick's norms, except for session 1, showed significant differences between BAF and the normative values [1]. These differences could be generated by the subjective nature of the test where differences in evaluation techniques or instructions can cause measurement discrepancies.

There was found a statistical difference on the BAF value between the results obtained on the first session and the final session when the analysis was performed on the whole study sample (Table 1, Figure 1). It can be noted that the Mean Difference ± SD was positive, with a value of 2.64 ± 3.08 cpm: the ability to make rapid focus changes between two focal planes during periods of time raises in the participants during the study. Those results are in concordance with previous studies where accommodation speed was increased with visual therapy [10-13]. On the other hand, regarding clearing problems, more than half of the participants (56.7 %) reported problems on the plus lens pair of lenses (Table 3). It seems that most of the patients showed some difficulty to "relax" their accommodative system. However, there was found a statistical difference between the first and final session BAF results with independence of clearing problems (Table 3), as well as similar Mean Difference ± SD on each subgroup (from 2.47 ± 3.16 to 3.06 ± 3.23); it can be hypothesized that difficulties to relax or stimulate the accommodative systems are not related to the positive or negative progression on the flipper therapy effectiveness.

While there was found a statistical difference between the pairs of sessions analysed, it can be seen that the mean difference values decrease as the sessions advanced in time (Table 4). Therefore, while we previously concluded that the ability to change the focus has an enhancement with flipper flexibility, this therapy loss effect when the difficulty level was at the same point. Future studies must repeat the process using different lens power flipper between sessions.

In summary, the present study demonstrates the positive effect of traditional dioptric training in the amplitude flexibility improvement therapy.

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REFERENCES

[1] M. Scheiman, and B. Wick, [Clinical Management of Binocular Vision: Heterophoric, Accommodative, and Eye Movement Disorders], Philadelphia(2017).

[2] A. Yekta, M. Khabazkhoob, H. Hashemi *et al.*, "Binocular and Accommodative Characteristics in a Normal Population," Strabismus, 25(1), 5-11 (2017).

[3] H. Momeni-Moghaddam, C. McAlinden, A. Azimi *et al.*, "Comparing accommodative function between the dominant and non-dominant eye," Graefes Arch Clin Exp Ophthalmol, 252(3), 509-14 (2014).

[4] H. Momeni-Moghaddam, J. Kundart, and F. Askarizadeh, "Comparing measurement techniques of accommodative amplitudes," Indian J Ophthalmol, 62(6), 683-7 (2014).

[5] B. Sterner, M. Abrahamsson, and A. Sjostrom, "The effects of accommodative facility training on a group of children with impaired relative accommodation--a comparison between dioptric treatment and sham treatment," Ophthalmic Physiol Opt, 21(6), 470-6 (2001).

[6] J. Maxwell, J. Tong, and C. M. Schor, "Short-term adaptation of accommodation, accommodative vergence and disparity vergence facility," Vision Res, 62, 93-101 (2012).

[7] R. A. Armstrong, L. N. Davies, M. C. Dunne *et al.*, "Statistical guidelines for clinical studies of human vision," Ophthalmic Physiol Opt, 31(2), 123-36 (2011).

[8] J. M. Bland, and D. G. Altman, "Statistical methods for assessing agreement between two methods of clinical measurement," Lancet, 1(8476), 307-10 (1986).

[9] A. Carkeet, "Exact parametric confidence intervals for Bland-Altman limits of agreement," Optom Vis Sci, 92(3), e71-80 (2015).

[10] R. Brautaset, M. Wahlberg, S. Abdi *et al.*, "Accommodation insufficiency in children: are exercises better than reading glasses?," Strabismus, 16(2), 65-9 (2008).
[11] M. Scheiman, S. Cotter, M. T. Kulp *et al.*, "Treatment of accommodative dysfunction in children: results from a randomized clinical trial," Optom Vis Sci, 88(11), 1343-52 (2011).
[12] P. M. Allen, W. N. Charman, and H. Radhakrishnan, "Changes in dynamics of accommodation after accommodative facility training in myopes and emmetropes," Vision Res, 50(10), 947-55 (2010).
[13] B. Vasudevan, K. J. Ciuffreda, and D. P. Ludlam, "Accommodative training to reduce nearwork-induced transient myopia," Optom Vis Sci, 86(11), 1287-94 (2009).