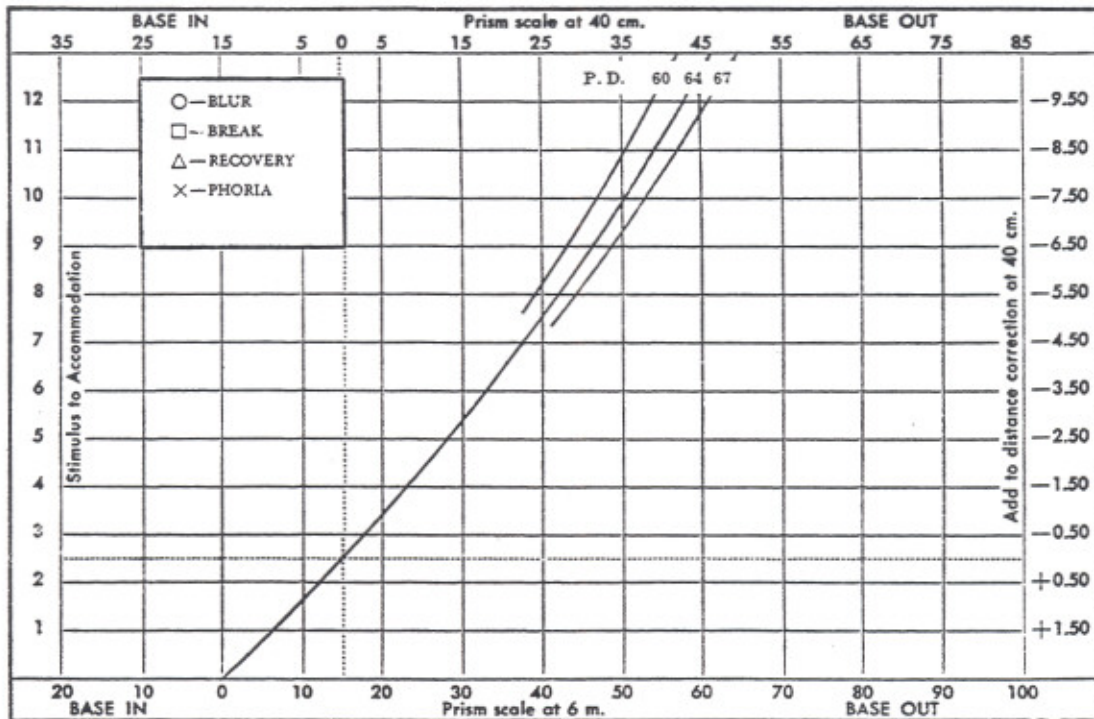


The Accommodation and Convergence Graph and the Zone of Clear Single Binocular Vision



Dist/Lens	Phoria	Base-in	Base-out	NRA	PRA

Above is a blank graph form for plotting clinical accommodation and convergence test data. Convergence stimulus in prism diopters is plotted on the x-axis, and accommodative stimulus in diopters is plotted on the y-axis. Tests that can be plotted include accommodation and convergence amplitudes, dissociated phorias, fusional vergence ranges, and relative accommodation. As can be seen by the legend in the upper left part of the form, dissociated phorias are plotted with X symbols, blur findings with a circle, break findings with a square, and recovery findings with a triangle. The blank table below the graph form can be used to record test findings.

The plotted data can be used to evaluate the consistency of test results, and to identify whether the pattern of test results is indicative of a particular vergence disorder case type. The area on the graph enclosed by blur findings is known as the zone of clear single binocular vision. When the test results are internally consistent, the zone of clear single binocular vision is approximately a parallelogram. Deviation from the parallelogram configuration can indicate inconsistency of test results or can provide clues to diagnosis. If the dissociated phorias are connected to form a phoria line, the zone of clear single binocular vision becomes double parallelogram.

The zone of clear single binocular vision tilts to the right due to accommodative convergence. The tilt to the right will be greater in high AC/A ratio cases, and less in low AC/A ratio cases. The diagonal line extending from the (0,0) point up and to the right is the demand line representing the accommodative stimulus and convergence stimulus for various distances when an individual is viewing through the subjective refraction lenses. The phoria line is parallel to the demand line when the AC/A ratio is 6 prism diopters per diopter. The placement of the zone of clear single binocular vision relative to the demand line represents the characteristics of the patient relative to the visual demands of the environment.

Accommodative stimulus is calculated by finding the reciprocal of the test distance from the spectacle plane in meters, and then adding any minus lens addition over the subjective refraction to best visual acuity (BVA) lenses or subtracting any plus lens addition over the subjective refraction lenses.

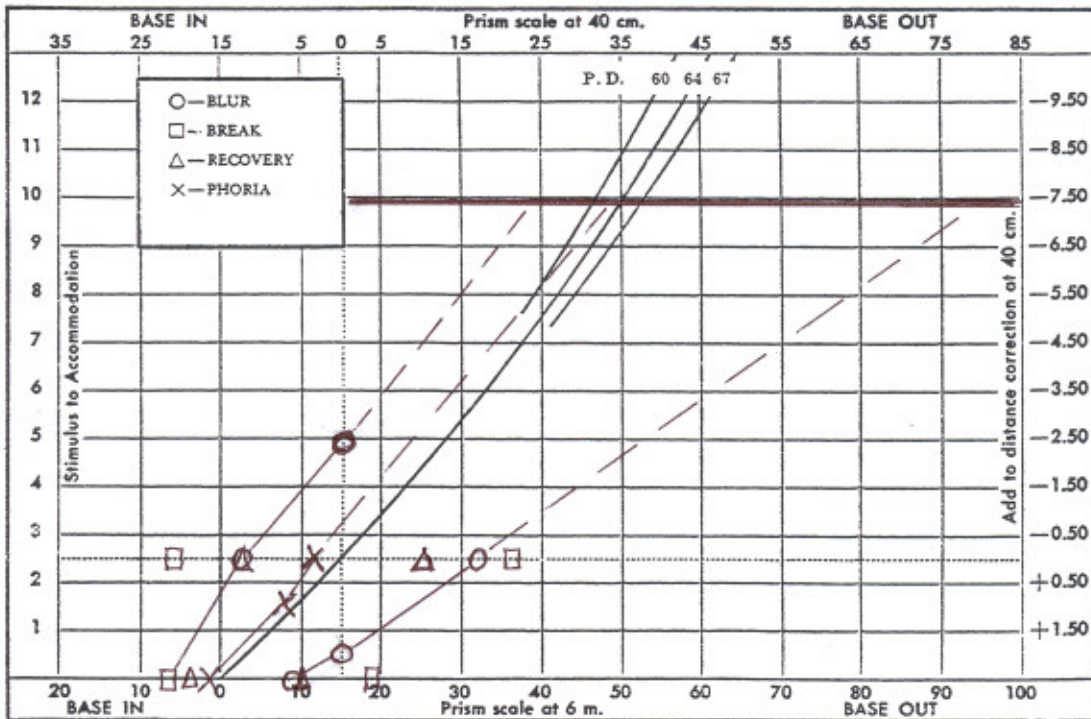
Convergence stimulus is calculated by dividing the interpupillary distance (PD) in centimeters by the test distance from the centers of rotation in meters. An assumption is made that the distance from the spectacle plane to the centers of rotation is .027 meters. So, for example, the convergence stimulus for a test distance of 40 cm from the spectacle plane for a person with a 64 mm PD would be: $6.4 \text{ cm} / 0.427 \text{ m} = 15$ prism diopters. Convergence stimulus is also affected by prism, with base-in prism decreasing the convergence stimulus and base-out prism increasing the convergence stimulus.

For more information on the accommodation and convergence graph and its interpretation, see:

Goss DA. Ocular Accommodation, Convergence, and Fixation Disparity: Clinical Testing, Theory, and Analysis, 3rd ed. Santa Ana, CA: Optometric Extension Program, 2009: 1-63, 107-127.

Hofstetter HW. Graphical analysis. In: Schor CM, Ciuffreda KJ, eds. Vergence Eye Movements: Basic & Clinical Aspects. Boston: Butterworths, 1983: 439-464.

As an example of a completed accommodation and convergence graph, the next page shows a plot of the mean values from Morgan's norms.



Dist/Lens	Phoria	Base-in	Base-out	NRA	PRA
6m/BVA	1 ^Δ exo	X/7/4	9/19/10		
40cm/BVA	3 ^Δ exo	13/21/13	17/21/11	+2.00	-2.37
40cm/BVA+1.00	7 ^Δ exo				

Morgan's norms are commonly used normative values for non-presbyopes. For the plot above, the expected amplitude of accommodation for a 24 year old was used. For information on Morgan's norms, see pages 61 to 63 in the third edition of Ocular Accommodation, Convergence, and Fixation Disparity: Clinical Testing, Theory, and Analysis.

David A. Goss, O.D., Ph.D., Indiana University School of Optometry, Bloomington, IN 47405