Monofixation or Bifixation: Physiological and Clinical Considerations

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Can bifoveal fusion result from treatment of patients with congenital esotropia?

Jampolsky\textsuperscript{1,2} says yes. Jampolsky contends that a stable motor bifoveal fusion lock can result from surgical correction of patients with congenital esotropia.

Parks\textsuperscript{3,4} says no. Parks contends that none of the therapeutic regimes offered to the infant with congenital esotropia has produced bifixation due to an inherent inability of these patients to fuse similar images on each macula. Bifixation, he states, signifies simultaneous bilateral functioning macular areas. Thus, he claims, the best result is the monofixational syndrome. Parks specifically asserts that stereacuity is a reliable indication of monofixation, with the majority of these patients having between 60 and 3000 seconds of arc, as compared to bifixators, who have stereacuity between 14 and 40 seconds of arc.

The purpose of this paper is to analyze Parks' assertion that stereacuity is a reliable indication of monofixation. Parks has drawn two conclusions that need re-evaluation: The first, that physiologically, the absence of a high level of stereacuity is a valid

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determinant of foveal suppression; and the second, that clinically, the absence of a high level of stereoaucity is a valid determinant of lack of bifoveal fusion.

**Stereoaucity and Foveal Suppression**

In order to evaluate whether or not the absence of a high level of stereoaucity is a valid determinant of foveal suppression, a discussion of retinal correspondence must be considered. Both Burian and Walls describe corresponding retinal elements as those elements of the two retinas which give rise, in binocular vision, to the localization of sensations in one and the same subjective visual direction. The horoptor is defined as that part of external space on which lie all the points imaged upon corresponding retinal elements. Around the horoptor exists a region called Panum's Fusional Area beyond which binocular single vision becomes impossible. Within Panum's Fusional Area, stereoaucity has been documented up to 600 seconds of arc by Ogle and up to 120 minutes of arc by Fender and Julesz, depending on the complexity of the binocular stimuli. These measurements specify the physiological limits within which stereoaucity indicates bifixation; they also suggest that Parks' limitation of bifixation to 40 seconds of arc of stereoaucity may be physiologically too restricting.

The critical question, however, is whether or not motor fusion can indicate bifixation, independent of stereoaucity findings. Both Adler and Alpern maintain that it is easy enough to produce a fusional movement without any conscious diplopia merely by introducing a weak prism in front of one eye while binocularly fixating a given object in the visual field. The eyes automatically move in response to the prism, even though the subject is unaware of any diplopia. Disparities of less than five minutes of arc can evoke fusional movements, which is well inside Panum's Fusional Area (15 minutes of arc), the foveola (radius=0.60° or 36 minutes of arc), and the fovea (radius=2.5° or 150 minutes of arc). The presence of motor fusion within Panum's Fusional Area thus proves that foveal impressions are not suppressed, regardless of the degree of stereoaucity. This agrees with Burian's findings that a negative result on stereoscopic tests does not necessarily mean that foveal impressions are completely suppressed. Therefore, physiologically, the absence of a high level of stereoaucity by itself would not seem a valid determinant of foveal suppression.

**Stereoaucity and Bifoveal Fusion**

Clinically, Parks has defined bifixation as simultaneous bilateral functioning macular areas determined by the presence of stereoaucity between 14 and 40 seconds of arc, emphasizing subjective testing. Conversely, Jampolsky has defined bifixation as bifoveal alignment with motor fusion, determined by the use of the cover test, with the observation of the patient's eye movements, emphasizing objective testing. The trained observer, Jampolsky notes, will easily be able to detect one prism diptter of eye movement. (One prism diptter=35 minutes of arc or about 0.5°.) This effectively places the clinical determination of binocular alignment by Jampolsky to within the foveola (radius=0.6° or 36 minutes of arc). In addition, the observation of a fusional vergence movement verifies that motor fusion is present. A high level of visual acuity must, of course, be present in each eye.

Clinical evidence has confirmed the separate qualities of motor fusion and stereopsis as distinct indicators of binocular vision. Patients have been reported by Worth, Burian, Ogle, and Costenbader with motor fusion but limited or no stereopsis, while a patient has been reported by Fisher and Jampolsky with stereopsis but no motor fusion. Worth, 80 years ago had the insight to appreciate the separate qualities of stereopsis and motor fusion as distinct indicators of binocular vision.

Repeated studies by both Fisher and Foster have reported patients with congenital esotropia meeting the clinical criteria of bifixation as defined by Jampolsky. The determination of binocular alignment within the foveola and the fovea, with the presence of motor fusion, and a high level of visual acuity, suggests that bifoveal fusion can indeed result in these patients with congenital esotropia regardless of the degree of stereoaucity. Therefore, clinically, the absence of a high level of stereoaucity by itself would not be a valid determinant of lack of bifoveal fusion.

**Conclusion**

The presence of stereoaucity up to 600 seconds of arc, or up to 120 minutes of arc, depending on the complexity of the binocular stimuli, is an indication of bifixation. Therefore, Parks' limitation of bifixation to 40 seconds of arc may be physiologically too restricting.

The absence of a high level of stereoaucity by itself does not seem a valid determinant of foveal suppression. Therefore, Parks' assertion that stereoaucity is a reliable indication of monofixation is probably not physiologically valid.

The absence of a high level of stereoaucity by itself does not appear to be a valid determinant of lack of bifoveal fusion. Therefore, Park's assertion that none of the therapeutic regimes offered to the infant with congenital esotropia has produced bifixation, based on the absence of a high level of stereoaucity, would not be clinically valid.

Jampolsky's contention that a stable motor bifoveal fusion lock can result from surgical correction of patients with congenital esotropia appears valid.
References