5 BINOCULAR INSTABILITY

A heterophoria is compensated when the vergence system is able to overcome the heterophoria adequately. Yet there are subjects with a negligible heterophoria whose opposing fusional reserves meet the conventional criteria for compensation discussed in Chapter 4 and yet who have symptoms associated with poor binocular coordination. These patients may be best described by the term binocular instability.

Binocular instability is characterized by low fusional reserves and an unstable heterophoria. The fusional reserves are usually low in both directions (divergent and convergent) so that the fusional amplitude is lower than 20 Δ, which is more than one standard deviation below normal (Evans et al 1994). The unstable heterophoria can be detected with a Maddox wing test but is likely to be more significant if it is present with more naturalistic tests, such as the Mallett fixation disparity test, when it will manifest as an unsteady position of the Nonius strips. A movement of the arrow in the Maddox wing test of $\pm 1\,\Delta$ is normal but $\pm 2\,\Delta$ or more is abnormal. Binocular instability may be associated with suppression (possibly transient) with the Mallett foveal suppression test.

Historical perspective

Nearly 70 years ago, binocular instability was defined as ‘uncertainty in the collaboration of the vision of the two eyes’, ‘a kind of binocular anarchy’ (Cantonnet & Filliozat 1938). These authors said that the condition was common and was often associated with symptoms of asthenopia, blurring and reversals of letters and numbers. It could be diagnosed using an early precursor of the Maddox wing test (Cantonnet’s test of binocular vision), where there was an inability to maintain the arrowhead in a fixed position. Cantonnet stressed that a test for binocular instability should require precise focusing. He looked upon binocular instability as a different condition from the cases of heterophoria and strabismus that required treatment.

Gibson (1947) also considered binocular instability to be a separate entity from strabismus and symptomatic heterophoria. He said binocular instability often caused a maladjustment of letters and numbers that led to complaints of reversals and of the eyes jumping from one line to another when reading. He noted that the condition was sometimes associated with foveal suppression and with anisometropia, unequal acuities or unequal accommodation.

Gibson (1955) noted that binocular instability is often found to be associated with low fusional reserves. He advocated the Turville Infinity Balance test, which was, in this respect, a precursor of the Mallett foveal suppression test.

Giles (1960) considered that there were two types of binocular instability. The first, a 'fusion deficiency', was regarded as midway between heterophoria and strabismus. The second was caused by poor general health associated with neurosis, fatigue, debility or toxaemia. In the latter type symptoms may be much worse in the evening when the patient is tired.

Mallett (1964) noted that binocular instability was sometimes associated with decompensated heterophoria, when there would usually be variation in the amount of prism or sphere required to eliminate a fixation disparity. He advocated his foveal suppression test for detecting suppression in binocular instability, noting that treatment involved correction of refractive error, alleviation of gross decompensated heterophoria, and antisuppression exercises.

More recently, fixation disparity techniques have investigated binocular instability under normal binocular viewing conditions. Jaschinski-Kruza & Schubert-Alshuth (1992) found a range of variability of fixation disparity in different subjects and Cooper et al (1981) suggested that variability of fixation disparity might be a useful clinical measure. Duwaer (1983) found the stability of fixation disparity to be a useful predictor of symptoms.

Investigation

Binocular instability is a correlate of dyslexia (Evans et al 1994) and the clinician should always consider this when examining children or adults who report difficulty with reading or spelling. It should be noted, however, that nearly all dyslexic people reverse letters and words, probably owing to problems in the higher cortical processes of decoding sequential material stored in short-term memory. Optometrists should not necessarily expect to correct reading difficulties, or even reversals, by treating binocular instability. However, in some cases treatment may help by reducing symptoms and, possibly, by improving the perception of text.

In those with symptoms of asthenopia or perceptual distortions, or in reading-disabled children who may be too young to recognize these symptoms, it is advisable to carry out a fixation disparity test even if no movement has been seen on the cover test. When carrying out the fixation disparity test it is not enough to simply ask whether the strips appear to be in alignment (Karania & Evans 2006). The patient should also be asked whether one or both strips ever move (see Fig. 4.4). If the patient can discern the movement as being predominantly in one direction then the effect of prisms or spheres can be investigated in the usual way. If there is no aligning prism but there is binocular instability (a movement) on the fixation disparity test then this can be investigated further with the Maddox wing test and by measuring fusional reserves.

Diagnostic occlusion and investigative occlusion

Since the 1920s, it has been suggested that prolonged occlusion (known as 'Marlow occlusion' or diagnostic occlusion) for up to 14 days can be useful in investigating asthenopic symptoms from binocular vision anomalies. It was originally thought that the increase in the deviation that occurred after this time was meaningful but it is now known that most symptom-free patients show a large increase in horizontal and vertical heterophorias after occlusion (Duke-Elder 1973, p 551, Neikter 1994a).

An alternative use of occlusion, 'investigative occlusion', can be helpful in rare cases where there are vague signs and symptoms of binocular instability or decompensated heterophoria. In a few cases it can be unclear whether the patient would benefit from treatment of the ocular motor problems, especially when the symptoms have another potential cause, such as Meares–Irlen syndrome (p 63) or general fatigue. The patient can be asked to occlude one eye for the tasks when the symptoms occur and to report whether this helps the symptoms. If it does help then treatment of the binocular instability is warranted; if not then another cause for the symptoms is likely.

Caution is necessary, because it is conceivable that investigative occlusion could cause a decompensated heterophoria to break down into a heterotropia. This is unlikely, however, and some studies suggest that even prolonged full-time occlusion does not adversely affect ocular motor function (Holmes & Kaz 1994, Neikter 1994b). Indeed, it has even been suggested that occlusion can be used to treat sensory and motor factors in intermittent exotropia, reducing the frequency of strabismus (Freeman & Isenberg 1989, Jin & Son 1991), possibly because of improving amblyopia (Santiago et al 1999). However, there have been no randomized controlled trials of this and it seems prudent to only prescribe investigative occlusion as a last resort, for brief periods, to monitor the patients very closely, and to instruct patients and parents to stop the occlusion and return if there is any worsening of signs or symptoms.

Evaluation

Is binocular instability different from decompensated heterophoria?

Decompensated heterophoria and binocular instability are contrasted in Table 5.1. Binocular instability can be present in an orthophoric patient who, by definition, cannot have a decompensated heterophoria. If patients are

Table 5.1 Differential diagnosis of binocular instability and decompensated heterophoria

Sign	*Binocular instability*	*Decompensated heterophoria*
Heterophoria	May be present, or may be orthophoric	Heterophoria must be present
Stability of heterophoria	Unstable: movement of arrow in Maddox wing test usually $\pm 2\,\Delta$ or more	Stable: movement of arrow in Maddox wing test usually less than $\pm 2\,\Delta$
Cover test	Recovery may or may not be normal	Recovery usually slow and hesitant
Fusional reserves	Usually both convergent and divergent reserves are low, so fusional amplitude $< 20\,\Delta$. Result may worsen markedly as patient tires	Fusional reserve opposing the heterophoria is usually low
Fixation disparity/aligning prism	One or both Nonius strips move. There may be an aligning prism, or the movement may be similar in both directions	Nonius strips are misaligned but are not necessarily moving
Foveal suppression	Often present, likely to be transient, may be alternating	May be present, likely to be constant during binocular viewing, usually unilateral
Correlation with specific reading difficulties (dyslexia; Evans et al 1994)	Statistically significant association	Not significantly correlated

orthophoric then they only need negligible fusional reserves to satisfy Sheard's criterion. To take an extreme example, an orthophoric patient with convergent and divergent reserves (to blur and break) of $3\,\Delta$ and $2\,\Delta$ respectively will meet both Sheard's and Percival's criteria. A cover test will not detect any abnormality and the subject may not have any aligning prism. In such a case, binocular instability may be detected as a movement of the Nonius strips during the fixation disparity test. The strips may move equally, often in either direction, so that there is an unstable fixation disparity without there being any aligning prism. Similarly, during the Maddox wing test the arrow may move over a large area, with the mean position still being orthophoria. Measurement of the fusional reserves would reveal them to be low, thus confirming the diagnosis of binocular instability.

Similarly, a patient with a low heterophoria might meet all, or most, of the criteria for their heterophoria being compensated yet still have binocular instability. Most cases of binocular instability with a large heterophoria also manifest one or more of the signs of decompensated heterophoria. Indeed, most patients with a significant aligning prism report some instability of the Nonius strip(s). As the magnitude of the heterophoria increases, the distinction between binocular instability and decompensated heterophoria becomes less clear.

There are both sensory and motor factors that might contribute to difficulties with fusion and lead to binocular instability. Sensory factors include uncorrected refractive errors, anisometropia, aniseikonia and possibly Meares–Irlen syndrome. Aniseikonia will occur even in bilateral emmetropes, for example when reading, because text at one end of a line will be nearer to one eye than the other and vice versa at the other end of the line.

It is easy to speculate why motor factors might cause a negligible heterophoria to be associated with symptoms from binocular instability. Julesz (1971) showed that, even when inspecting small targets, vergence errors in excess of 20′ of arc occur during saccadic eye movements. For very large saccades (such as those during reading when the eyes return to the beginning of the next line) the vergence error is likely to be greater and will be exacerbated by minute incomitancies that may exist in everyone as a result of anatomical limitations. Vergence errors of up to 2° also occur during natural vergence eye movements (Cornell et al 2003). So, even for an orthophoric patient, significant fusional reserves may be required (both divergent and convergent). Hence, motor demands may result in a significant need for 'vergence in reserve' for patients who are orthophoric or have a low heterophoria.

The distinction between binocular instability and decompensated heterophoria may be an artificial one resulting from the historical way in which we view heterophoria and fusional reserves. The two main methods of assessing fusional reserves (p 69) are intersubject, comparing values with norms, and intrasubject, comparing the opposing fusional reserve with the heterophoria. The usual intrasubject method (Sheard's criterion) requires that the appropriate fusional reserve is a multiple (2×) of the phoria. If P is the phoria, V is the opposing fusional reserve and N is the norm for the fusional reserves, then the intersubject method can be summarized as

$$V > N$$

and Sheard's criterion as

$$V > 2P$$

In view of the above argument that orthophoric and low heterophoric patients may need significant fusional reserves, a better arithmetic approach may be

$$V > MP + C$$

where C is a constant minimum amount of vergence that needs to be held in reserve and M is some factor that needs to be multiplied by the heterophoria. The above formula would be applied to the opposing fusional reserve; the non–opposing fusional reserve would simply need to exceed *C*. Hence, for an orthophore, the convergent and divergent reserves would have to exceed *C*. I am unaware of any research investigating the above hypothesis, which must, therefore, remain conjecture at present.

If the above hypothesis is correct then, where it coexists with a significant heterophoria, binocular instability may be considered as one aspect of the decompensated heterophoria. In cases where the binocular instability occurs in the absence of a significant heterophoria, it may be appropriate to consider the binocular instability as a 'decompensating orthophoria'.

Management

If there are sensory factors interfering with fusion then these are likely to be contributing to binocular instability and should be treated. These sensory factors are described in Chapter 6 and may also include Meares–Irlen syndrome. Meares–Irlen syndrome (p 63) can cause visual perceptual distortions and this unstable perception may impair sensory fusion, which in turn could be a causal factor in binocular instability.

Orthoptically, binocular instability can be treated by training the fusional reserves (Chs 6–8, 10) to exceed the values given in Appendix 10. If binocular

Table 5.2 Algorithm to assist in deciding when to treat horizontal heterophoria and binocular instability

Sign or symptom	*Score*
One or more of the symptoms of decompensated heterophoria (Ch. 4)	+3
Cover test: heterophoria detected	+1
Cover test: absence of rapid and smooth recovery (+1 if quality of recovery 'borderline')	+2
Aligning prism (Mallett): $\geq 1\,\Delta$ for under 40 years or $\geq 2\,\Delta$ for over 40 years	+2
Aligning prism (Mallett): $< 1\,\Delta$ but unstable	+1
Foveal suppression of one line or more on the Mallett foveal suppression test	+2
If score: ≤3 diagnose normal, ≥6 treat, 4–5 continue down table adding to score so far	
Sheard's criterion: failed	+2
Percival's criterion: failed	+1
Dissociated heterophoria unstable so that result is over a range $\geq 4\,\Delta$ (i.e. $\geq$ phoria $\pm 2\,\Delta$)	+1
Fusional amplitude (divergent break point + convergent break point) $< 20\,\Delta$	+1
If total score: ≤5 diagnose normal, otherwise treat	

A patient accumulates a 'score' based on the figures in the right column according to the signs and symptoms listed. The same procedure should be followed for each working distance.

instability is caused by temporary poor health then it can be treated by using prisms or, if there is adequate accommodation, spheres to correct any aligning prism (Ch. 6).

Summary of the diagnosis of decompensated heterophoria and binocular instability

Based on the contents of this and the previous chapter, the algorithm in Table 5.2 is suggested as one approach to the diagnosis of decompensated horizontal heterophoria and binocular instability. This is reproduced in more detail, as a clinical worksheet, in Appendix 3.

Clinical Key Points

- Binocular instability is characterized by an unstable heterophoria and low fusional reserves: the heterophoria may be minimal
- Binocular instability can cause similar symptoms to decompensated heterophoria: asthenopia and visual perceptual distortions
- Binocular instability is a correlate of dyslexia
- Diagnosis, as with decompensated heterophoria, should be made on the basis of a complete clinical picture (Table 5.2)
- Treatment is by fusional reserve exercises and, occasionally, treatment of any foveal suppression and significant refractive errors