27. On the Origin of the Relationship of Accommodation and Convergence

I come to a question which is of highest importance, especially for pathology, aside from its physiological interest. The issue is whether the association between the innervations of the medial muscles and certain lateral muscles of the double eye are inborn or are established by long habit. The importance of the differentiation, as one will remember, throws light on the fact that myopia and hypermetropia are already apparent in the first years of childhood. The hypermetropic child must accommodate even with parallel lines of sight in order to see clearly, and with converging lines of sight he must accommodate much more strongly than is necessary for emmetropes, while the myopic child conversely need not let accommodation grow when converging with near vision in the same way as the normal person. If the association in question were not inborn, neither hypermetropes nor myopes would find difficulty in vision for objects of sight within their monocular accommodation range. Even with relatively small convergence of the lines of sight, the hypermetrope could call forth the higher degrees of accommodation tension without difficulty, while the myope in spite of strong convergence of the lines of sight would not be burdened by using his accommodation muscles very little or not at all.

The phenomena would be quite different if the association in question were inborn. The myopes as well as the hypermetropes would have to struggle against it, and even if the young organism because of its great flexibility succeeded in dissociating the association to a certain degree, it would be possible only slowly and with difficulty; during this time hypermetropes would necessarily have a great tendency toward inward squint and myopes toward outward squint. In order to see clearly the hypermetropes would always have to accommodate strongly with the innervation necessary for this, the innervation of the adductor group. A tendency to converge would set in and the temptation would arise to give up binocular vision in order to see the observed object clearly at least with one eye. The other eye would therefore deviate, and all the sooner if one of those fortunate moments were added as Donders has discussed them. The myope, on the other hand, because he can obtain sharp images only from near objects, would have to converge strongly; the innervation of the medial recti would be irrevocably linked with that of the accommodation muscles, his eye would thereby become even more shortsighted, and if the struggle against this compulsion burdened him too much he would give up the innervation of the medial recti. He would at least be able to see sharply with the fixating eye, though one eye would then indeed squint outward. He would grasp this solution even
earlier if other further advantageous circumstances occur in addition, such as the mechanical difficulty of convergence or less sharp vision in one eye.

Donders has made us aware how frequently strabismus internus occurs in hypermetropes and strabismus externus in myopes. He has sought to explain the fact that the above refraction anomalies so often lead to squinting, especially when they are inborn, partly because of the relationship between accommodation and convergence of the lines of sight. This explanation would be unnecessary as I see it if this relationship were not inborn. But it would be just as unnecessary if an inborn compulsion for always equal innervation of both eyes did not occur. For how would it be conceivable for instance to assume, along with accommodation for nearness, a simultaneous compulsion for increasing the convergence of the lines of sight, if the child were free to move one eye outward or inward independently from the other? Thus if Donders' explanation is correct, it is also a convincing proof not only that the law of the always equal innervation of both eyes given above is correct, but also that this law is grounded in inborn mechanisms.

Most opthalmologists now agree that Donders correctly grasped the association in question as a significant cause of squinting with refraction errors. Even the single fact that the beginning strabismus internus of hypermetropic children can be cured by appropriate convex glasses is an adequate proof. Other facts are indeed available to support the assumption of an inborn relationship between the focusing innervation and the innervation of the adductors.

Donders and MacGillavry have determined the binocular accommodation range of various myopes and hypermetropes. It is quite generally true that the absolute near point of the hypermetropes is nearer to the eye than their binocular near point, that is, although it would be necessary for clear vision, they never use their full accommodation capabilities with binocular vision. They could do this only if they also gave the eyes a convergence that was too large in comparison to the position of the fixation point, as they in fact do in monocular vision. They are therefore not capable of fully dissociating the relationship between accommodation and convergence. To give an especially striking example, it is said that Donders (5, p. 202) described a relative hypermetropia in which the patient, a 17-year-old girl, could never accommodate for the distance of the fixated object if she saw binocularly, although the near point of her two eyes singly was only ten inches from her face. If she could make accommodation independent of convergence she would have been able to see everything sharply up to about one foot.