Helen, aged 5, wore a low hypermetropic correction and had a history of left convergent squint and amblyopia. After constant right occlusion to equal visual acuity, part time occlusion was continued until she was able to control the deviation for distance at times. But owing to marked left convergent squint for near, suppression recurred whenever occlusion was stopped. As the deviation was extremely variable and the binocular function unstable, surgery although probably inevitable had been delayed. Clear half-lens occlusion was commenced with explanation to parents and child, and continued until miotics were started. With these treatments, suppression has been prevented and the binocular function stabilised, Helen maintaining control over a moderate esophoria.

Michael, an intelligent and helpful child aged 4, was esophoric for distance when wearing glasses, but after left occlusion which brought the right vision up from 6/12 to 6/6 there was still a right convergent squint with troublesome diplopia for near. With half patch brown paper occlusion, suppression was overcome, the manifest deviation for near became an esophoria, and there was no more double vision. This standard was maintained after all occlusion was abandoned.

From my experience, having used half patch occlusion in most cases where part-time occlusion might be considered, the former really only has value in the treatment of intermittent convergent squints, as here described. More than anyone else, I can appreciate the limitations of such a method, but am convinced it definitely has merits for certain patients. Perhaps the greatest advantage is as a continuous form of management.

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OBJECTIVE ORTHOPTIC TREATMENT

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Introduction

This paper is about a search for more effective methods of orthoptic treatment than are offered in text books. Where guidance from neurology leaves gaps, these have been tentatively filled in the light of orthoptic experience. "Those that go down to the sea in ships ... these see the works of the Lord and his wonders in the deep." The orthoptist deeply involved in the troubles of her patient across the synoptophore, perhaps gains glimpses of the workings of visuo-motor mechanisms that are hidden from others.

The dual control of ocular movements

In 1938 Gordon Holmes described the functions of the two cerebral oculo-motor centres in man, as deduced from study of the eye disabilities occurring when the projection tracts from either centre to the brain stem were injured or diseased. When the frontal projection fibres were affected, the patient's eye moved freely, but not by his intention. They would follow people moving in the room, or an object slowly moved towards or away from him, but by no effort of will could he turn them from one thing to another. When the ocipital cortico-tectal pathways were bilaterally interrupted, voluntary movement was free, but ability to watch moving objects or to maintain clear single vision of near or distant objects was lost.

From the sum of his observations, Holmes concluded that "the frontal oculomotor centre is concerned in those movements and reactions of the eyes which we may call voluntary. Through it we can by an effort of will look or turn our eyes in any direction

and converge them on a near object." .."In normal conditions there is an accurately adjusted co-operation between all parts of the cortex concerned in ocular movements. Through the occipital centres some visual reflexes excite movements which turn our eyes towards objects in the field of vision; other reflexes determine by fusion and accommodation the accurate preception and the unification of binocular images; others keep the eyes fixed on any point which claims attention or which excites interest. The frontal centres make possible the turning of gaze in any desired direction and the exploration of space,but they also keep under control, or inhibit, reflexes that are not appropriate to our conduct or our reactions to the world around us."

Dual control applied to convergence deficiency

Mann (1940) called attention to the significance of Holmes' paper in explaining the successful management of convergence deficiency (insufficiency). She suggested that the signs and symptoms were due to lack of frontal oculo-motor involvement, and that by teaching voluntary convergence one activated frontal convergence to facilitate the reflex occipital function.

Inhibition and facilitation

For the meaning of facilitation one must turn to Sherrington (1906). From study of the interacting spinal reflexes of dogs, Sherrington recognised that when different reflex arcs share the same muscle or muscles as effector organ, they also share a final common path in the motor nerve supplying that organ; the motor nerve nucleus, the point at which the various reflex arcs and output paths from higher centres impinge on each other, has a special role. A spinal nerve nucleus is a co-ordinating mechanism arranged to fire in response to incoming signals in such a way that a useful response is produced. An algebraic summing of incoming impulses is not to be expected. If the separate trains of impulses are antagonistic, some tending to inhibit and some to excite the action of the effector muscle(s), the resultant action is not a compromise; at any time, one set of impulses dominates the final common path.

Allied impulses from different sources, whether all excitatory, reinforce each other. The main effect of reinforcement is that the action is more certain to occur and better maintained. It may or may not make the action more vigorous or more extensive; there is wide variation in this respect, related to the importance of various actions for the individual's well-being.

Facilitation in action

Ida Mann's application of this concept was light in darkness to orthoptists of that era. The development of strong "fusion" by synoptophore training was accepted as the orthoptist's essential task. It was often a disappointing one. The value of voluntary convergence training in certain cases was recognised. The news that a different cerebral centre was involved in this gave a good physiological reason for its greater success, and justified its more whole-hearted use.

There can be no doubt that in treating convergence defects, results are quicker and surer if one aims first at obtaining convergence awareness and control away from the synoptophore. The most potent stimulus to convergence as well as accommodation is to arouse curiosity about detail in an approaching object. Once control is established, the synoptophore is useful in allowing the patient to feel the interaction of the two mechanisms in maintaining or rejoining fusion over the required range. One can, so to speak, watch the process of facilitation at work.

The improved results in convergence training naturally led to a trial of similar methods in the treatment of esophoria and accommodative squint. Of course it was found again that results are better if attention is primarily concentrated on exercises which de-

velop conscious control over convergence, rather than on fusion training. (The question of suppression will be discussed later). But if a new approach is to be accepted wholeheartedly, particularly if it is to be presented to students, a satisfactory explanation is desirable. It was doubtful whether the reinforcement explanation was applicable here. Another journal article led to the answer.

Ittelson & Ames : 3-card Trick and Card-shrinking

A very interesting series of experiments were carried out by Ittelson and Ames (1950) to whom Holmes' findings were apparently unknown. In what one might call their Three Card Trick, subjects were shown in turn each of three playing cards, visible monocularly at a distance of 32 inches in an otherwise completely darkened room. The cards were of normal, double and half sizes. Having looked at a card, the subjects turned to direct the experimenter in adjusting the distance of a post seen binocularly in normal lighting until it appeared to be the same distance from him as the card.

Four men observers, aged 30 to 45 years showed good judgment in choosing distances which would account for the size differences if all the cards had actually been of normal size. A 15-year-old boy was influenced by the card sizes, but to a lesser extent.

Each card was in fact seen through a half-silvered mirror, and a similar mirror with a shield beyond it confonted the other eye. Each mirror reflected a star point to the corresponding eye. Therefore the observer saw two star points, superimposed on the playing card in front of him. Suitable adjustment of lenses and of the mirror angle, until a single and clearly defined star appeared on the card, provided measurements of the accommodation and convergence exerted by the viewer. (Incidentally this method might also allow time for the subjects first response to the size of the target to subside somewhat.)

Measurements of the boy's accommodation varied only slightly, and in the wrong direction; his convergence hardly varied at all. In the adult subjects, convergence and accommodation were always greatest for the large card, and least for the small one. Although the changes were less than would be fully appropriate for the apparent changes in distance , one might say there was evidence, not only of a near response, but of a far response also.

In a further experiment which might be dubbed the Card-Shrinking Trick, the image of a playing card was projected on a screen at 16 inches. While each observer watched it, the size was changed continuously from that of a normal card, to one-third of that size. This gave the effect of movement to 4 feet away.

This time the measured changes in convergence and accommodation were greater. Most subjects, moreover, reported that as the card grew smaller, it blurred. One of them accused the experimenter of mismanaging his projector. But when the image was held at the small size, most of the observers reported that it "slowly, and completely beyond their control, cleared up."

Finally, three observers watched the image binocularly, while the size was rapidly and continuously changed. Accommodation decreased. There was no change in convergence. The observers all reported that the card moved further away, and blurred as it reached the far point. In addition, all reported a feeling of strain about the eye with discomfort which lasted for about an hour afterwards. Ittelson and Ames comment that this may account for complaints of eye strain after prolonged close television viewing.

The Near/far response and voluntary convergence

The card-shrinking trick gives evidence of three separate but interacting involuntary functions, namely

1) one providing accommodation and convergence changes in response to apparent changes in distance of a familiar object, which one might call the near/far response,

2) the accommodation reflex, action of which is seen in the unexpected clearing of the target at the distal point,

3) the fusional vergence reflex which in the binocular part of the experiment, kept the eyes accurately converging on the target in spite of the size change.

Significantly, symptoms occurred when fusion(3) acted in opposition to (1).

The fact that responses to the size changes were made quite unconsciously and without intention forces one to reconsider the meaning of "effort of will" and "voluntary convergence" as used by Holmes and Mann. In fact, just such responses are likely to be typical of frontal oculo-motor activity as it affects disjugate movement. Holmes wrote "Through it we can by an effort of will...converge (our eyes) on a near object." But the truth is that none of us under ordinary circumstance do converge our eyes intentionally on a near object. Even when by training we become aware of convergence as a positive action and of our power to control it, we do not make any sort of decision to converge or diverge as we look from far to near, or consider vergence as an act of choice as we sometimes do of conjugate changes of gaze.

Vergence movements in fact fit Sherrington's (1955) description of habits: "they are reactions to a mental situation rather than to any simple stimulus...These trains of reaction have become automatic, though at first attended by acute and critical awareness," Changes in fixation must be among the earliest intentional acts to be mastered, and perhaps for that reason we are often unaware of making them. When we are aware, we do not subjectively distinguish vergence components from the conjugate components of the change.

One can feel sure, for instance, that Holmes' patients could be aware of, and could complain of, their inability to bring their eyes quickly to focus on a near object, without ever having been aware of this necessary ability while they still had it.

Thus we believe there is justification for accepting the near/far responses demonstrated by Ittelson and Ames as being typical of normal frontal vergence activity. It is probably acquired in the first year of life, conditioned by experience to reinforce the vergence and accommodation reflexes during slow changes of fixation distance, and to initiate immediate greater changes when required.

The etiology of convergence insufficiency

Mann suggested that voluntary convergence, the power to converge the eyes without a near fixation object, is usually acquired early in life, and that those who fail or are slow to acquire are liable to difficulties over near work. For reasons to be recounted, some of us now believe that there is actual unconscious inhibition of convergence in most cases of convergence insufficiency.

We have found that many patients under treatment make no progress until the subject of physiological diplopia is raised. Some bring it up themselves; others welcome the orthoptists' mention of it, others deny any concern. But most of them recall

childhood incidents when they were scolded for attempting the dangerous game of going cross-eyed. Once the matter is explained, and reassurance given, progress is normal.

Is it too much to accept that we can unconsciously inhibit actions that are unconsciously performed? The writer of this paper, well experienced in converging and in training those who could not, used to take pride in flower arrangement, but became concerned about the common after-effect, a blurring of vision which persisted 30 minutes or more. She wondered if some allergic reaction might be involved. Then a psychology professor consulted her about his problem, a blurring of vision which occurred repeatedly when, in his work as journal editor, he selected papers for publication. He did not, he emphasised, have to read them in detail - a general impression of topic and setting-out was sufficient. The orthoptist already knew her psychology, primed by his own lectures. She pointed out that the psychologist must be, in effect, instructing himself not to look closely - i.e. not to accommodate. He had only, on such occasions, briefly to examine his own finger tip, and he would recover. At this moment, she realised she had the answer to her own problem. She had deliberately ignored detail, looking for broad effect, in her flower arrangement. Now and again similar cases crop up.

In short, we came to the conclusion that convergence insufficiency as we know it is probably due to habitual inhibition of convergence and accommodation, by a mental rejection of the near response and due in some way to the thoughts, intentions and experiences of the sufferers. This explains the familiar signs and symptoms. We (skilled in orthoptic tricks) can if we wish interrupt fusion so that a book in our hands appears blurred and double; so we know that if inhibitory innervation is relatively strong, there must be manifest deviation for near. If it is less intense, there must be exophoria and discomfort without deviation, just as in Ittelson & Ames diminishing card trick.

Clearly there is here a departure from Sherrington's one-or-the-other rule for competing innervations. But he was dealing with spinal co-ordinating centres, we with midbrain ones. (Discomfort as a result of unresolved cerebral conflicts is all too common!)

The dual involuntary vergence systems: a hypothesis

The considerations outlined in the last two sections led us to believe that two involuntary systems regulate convergence and accommodation, working in parallel. On one hand are the occipital, essentially unconditioned, accommodation and fusion reflexes, on the other the habits or conditioned responses mediated by frontal oculo-motor centres, and typically seen as the near response and its antithesis, the far response, in normal binocular vision.

What is called proximal convergence is one aspect of the near response. For those interested in accommodation - convergence relationships this is worth noting. Burian, following Morgan, denied the existence of proximal accommodation because experimentally, the total accommodative change is the same, whether measured on a distant fixation target with and without added –3.00 dioptre sphers, or with normal correction only at 6 metres and at 1/3 metre. Their reasoning assumes that innervation from 2 sources necessarily stimulates a greater reaction than from one acting alone; this is an unjustifiable assumption according to Sherrington. Proximal accommodation was demonstrated by Ittelson and Ames, and is known to us when we experience blur as well as diplopia during voluntary convergence.

Next to the inhibition of convergence which gives rise to convergence insufficiency the most common abnormal habit is excessive use of the near response for the sake of clear vision in hypermetropia, evident as accomodative squint. Similar habits of more obscure origin produce what we call convergence spasm. In fact variability in concomitant deviations, may usually be attributed to acquired responses of one sort or another.

Clearly much of this is supposition. Those who accept the concept of convergence habit, do so because it is a useful guide, which makes treatment shorter and which patients accept and work at because they can see its purpose.

Treatment

The methods of treatment are fairly traditional but the emphasis is different,as described earlier. They are surprisingly effective in cases of convergence spasm and esophoria.

Once attention was concentrated on motor responses it became clear that fusional vergence is a complex process. If one eye has been favoured over a period of time a conditioned inhibition of fixation develops, affecting the deviating eye. Even when by voluntary effort it is brought into position for binocular fixation, this eye fails to fixate into position. We judge the need for occlusion now, on fixation behaviour rather than on subjective evidence of suppression...finding that this ensures sufficient treatment and avoids what is unnecessary.

Acknowledgement

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Summary

Gordon Holmes' distinction between the role of the occipital oculo-motor centre, concerned with fixational, fusional and accommodation reflexes, and that of frontal centres which are concerned with voluntary eye movements, was quoted by Mann to explain the cure of convergence deficiency through instruction in voluntary convergence. Convergence and accommodation are not ordinarily conscious actions, but the frontal oculo-motor centre is seen by the writer as responsible for changes in both functions in response to perceived changes in fixation distance, as demonstrated by Ittelson and Ames, and also for certain mal-adaptive convergence habits. Such habits, it is claimed, underly any binocular disorder which is susceptible to improvement by orthoptic treatment. They may be cured by making the patient aware of vergence movements and of his power to control them. Fusional vergence is regarded as innate reflex, but a complex one, involving active fixation of each eye. Its function in the control of ocular deviations can be improved not be direct training, but by frontal facilitation and by suitable occlusion of the preferred eye.

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SUPERIOR OBLIQUE SURGERY

Jeanette Yap

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The logical treatment of a paralytic deviation is to strengthen the affected muscle and/or to weaken its direct antagonist. Other methods of attack are unsound, in our experience. We have frequently seen disastrous results from the surgical treatment often recommended for superior oblique palsy, namely weakening of the contralateral inferior rectus or of the ipsilateral inferior oblique. The following case history illustrates this point.