PERSPECTIVES
ON OPTOMETRIC VISUAL TRAINING

Graham T. Peachey, B. Optom.

ABSTRACT

The enhancement of visual information acquisition and processing abilities is the essential purpose for a patient's involvement in an optometric visual training regimen. A rationale for a holistic approach is considered. The successful completion of any visual training case is dependent on appropriate optometric management and a motivated and compliant patient. Patients must develop their own visual efficiency. The optometrist can assist by arranging conditions for success. The role the optometrist plays during implementation of visual training is reviewed. The need to plan an appropriate sequence of 'procedures' into an individualized curriculum is emphasised.[1]

KEY WORDS

procedures, schemes, lenses, educational principles, curriculum, instructional set, internalise, process

Gathering information from the environment beyond arms reach is primarily dependent on vision and audition. Vision is generally agreed to be the predominant sense providing the largest sensory input from the environment. Consequently, deficiencies in visual function may affect not only our general interactions with our environment, but may specifically affect education and learning, particularly when involving reading and writing tasks.

Efficient visual function depends on a complex interaction of innate factors and learned skills, so that minimal conscious involvement is needed during information acquisition and processing. To facilitate description, the innate factors have been arbitrarily divided into four groupings by Forrest.[2]

1. Genetic Guidelines: Within this aspect would be included those physical and behavioural traits that are involved with being human. Our basic anatomical and physiological traits are obviously innate. The general behavioural responses relating to aggression, territorial imperative, mating and sleeping would also seem to be innate.
2. Imprinting: Evidence from animal studies has shown that early social experiences that occur at key times during development can have a marked impact on adult behaviour. It has been speculated that the smile response in human infants is an example of this effect.[3]
3. Critical Stages: Included in this aspect are those built-in stages that emerge at different periods of a person's life. Developmental sequences have been described by Gesell, Piaget, Bruner, Kagen and White, among others. The fact that performance capabilities can be even approximately categorised by age grouping is an indication that the 'program' is built-in. Puberty and presbyopia are excellent examples of this type of innate programming.
4. Reflexes: This refers to those automatic 'wired-in' responses that seem part of the human species. Some appear and then disappear, while others stay throughout life. Even though many are used for survival purposes, many more are utilised in infancy to initiate sensory-motor interactions. In one case, the eye is directed toward the hand. In another, sound is integrated with eye blinking. In still another, sound is integrated with eye movement. It is from these interactions and their later inhibition that more sophisticated sensory activity is developed.

This group of innate factors provides the essential ingredients for action, but the learned components are also important. It is becoming increasingly more obvious that the refinement of action, the integrative efficiency of all the sensory-motor systems during visually directed behaviour and the ability to gain ever increasing meaning and comprehension from visual function involve learned skills and developed 'schemes.'

Learning is the gaining of knowledge and/or skill; of specific interest to us is the appreciation or comprehension of a situation at a higher level than previously achieved. This usually builds on the level achieved from previous experience and involves the use of previously developed pre-programmed perceptual, cognitive and motor strategies.

Development can be considered as the use of these conscious higher level learning processes to organise and program successfully more sophisticated automatic percepetual, cognitive and motor strategies for subsequent use as the basis of new and more meaningful learning and problem solving experiences. The term 'scheme' is used to describe a unit of behaviour that has been developed by practice and then generalised to become relatively automatic. It is in this context that we develop and learn to use efficient visual function.

The psychological literature has referred to these pre-programmed strategies as 'schemes', (see Gibson[4] for a review of the work of Head, Bartlett, Vernon, Piaget and others). Piaget[5] distinguishes development from learning and conceptualises development to be a spontaneous self-directed process, whereby mind/body behaviour patterns are organised into these pre-programmed schemes.

Efficient solving of a problem requires that all the necessary prerequisite schemes are in place and can be operated with minimum conscious thought. This frees our higher thinking ability so that it can be applied to the appreciation or solving of the new intellectual challenge. The new solution, if appropriately reinforced, may be incorporated into a new, more highly developed scheme which is then available to assist with solving a subsequent problem.

The ability to solve a problem also depends upon being able to 'think' with the minimum of distraction from other tasks. Attention divided between a number of tasks is generally recognised to result in a reduced ability for each of the tasks.[6] This concept can be extended to include the proportioning of attention between the demands of operating the appropriate schemes and the attention available for conceptualisation. The absence, or failure, of a necessary scheme will require the re-directing of some conscious attention in an effort to compensate for the scheme. This re-directed attention will reduce attention for learning.

The ability to get information from visual function is degraded when conscious mental effort is required to manage the processes involved during information acquisition. Ludlam and Ludlam[7] have reported that prismatic disturbance to binocular coordination has a direct effect on reading comprehension. The 'loss of meaning point' phenomenon within the fusional vergence ranges is easy to demonstrate on most binocular patients by having them read through prisms. The prism power (base-out or base-in) can be adjusted until the patient experiences inability to read for meaning, while still maintaining single, clear and comfortable binocular vision.

Using a Piagetian perspective, Wachs and Furth[8] have expressed the opinion that children who fail to cope with classroom academic demands are usually not troubled by problems in memory, attention or information. However they often are troubled by their lag in developing/constructing an adequate mental framework and sensory motor behaviours from classroom experiences, and the resulting associated learning does not result in generalisations.

A patient's ability to perform visually directed tasks with maximum efficiency depends on factors including the ability to simultaneously synchronise the higher level perceptual processes with ocular physiology. These two operations must occur while the conscious mind is free to conceptualise on the meaning and relevance of the information acquired. Optical and physiological problems, as well as pathological conditions, can be considered as further complications of this complex *holistic* relationship.

The above are the basic factors and assumptions that underpin the behavioural approach to optometric vision care and visual training .

When a person is learning to master a new task, such as riding a bicycle, there is experimentation with movement patterns and organisations that are appropriate to the task. During the learning task the conscious mind is significantly involved in planning and directing body movements. At an early stage, just gaining balance is a significant achievement. When success at the task has been achieved and practiced the conscious mind is freed for attention to other tasks. The ability to ride a bicycle is now organised and generalised at a subconscious level, so that a person can use other bicycles as a means of transport. Likewise when a child practices playing the piano and rehearses a set musical score, the goal is to make music—and not to exercise fingers. The child achieves the status of a musician when hand and finger activity become relatively automatic and the conscious mind can assess the quality of the music.

These simple examples illustrate aspects of human development. Vision development, likewise, is considered to be a complex interaction of growth, experience, learning and practice, with the ultimate goal being efficient visual function controlled at an automatic or sub-conscious level. It is in this context that we develop and learn to use efficient visual function.

When a person with no eye or general health problem lacks the ability, even with the best refractive aid, to efficiently acquire and comprehend visual information and/or to sustain visually directed behaviour, a comprehensive evaluation of visual function is indicated. Recommendations for visual training could be expected to be a likely result.

The goal of this paper is to assist the general practice optometrist to understand the complexity of the regimen utilised during optometric visual training. Working from the behavioural perspective, the role of visual training procedures and lenses as 'tools' for the job of developing visual abilities can be described.

WHAT IS OPTOMETRIC VISUAL TRAINING?

Optometric visual training has been defined as the art and science of developing visual abilities to achieve optimal visual performance and comfort. Government recognition of this aspect of optometry has occurred; for example, in Australia the Medicare Participating Optometrists Handbook includes within the scope of Medicare-supported optometry 'the use of visual training regimen to preserve or restore maximum visual efficiency.'

Aspects of visual function that are addressed during visual training include:

1. Eye movement skills (schemes involving ocular motility). Can the patient follow moving objects smoothly, accurately, effortlessly and with minimal demand on conscious attention? Can the patient quickly and accurately look from object to object, converge, diverge, and can the patient sustain such activity without undue fatigue or discomfort?[9,10,11]
2. Eye focus skills (schemes involving accommodation). Is it easy for the patient to quickly change focus from

near to far and from far to near, and get clear detail with each change? Can the patient sustain focus at near tasks without fatigue, blur or discomfort?[12,13,14]

3. Eye teaming skills (schemes involving binocular co-ordination). How well do the two eyes work together on far seeing tasks; and on near seeing tasks? Can they sustain their teaming so that accurate single and clear information can be obtained and comprehended without undue effort, fatigue or discomfort?[15,16,17,18,19,20]
4. Eye-hand co-ordination. The ability to team eye and hand as 'learning tools' is obviously important to the patient in the classroom. What is the patient's ability to visually plan and perform a task in a defined spatial area? Can accurate visual judgements of sizes, shapes, contours, weights, textures, temperatures and solidities be made 'as if' the hand was also being used?[15,21,22]
5. Visual perceptual skills. The patient develops an understanding of himself as a point of reference for developing spatial concepts and making judgements of direction. From an understanding of 'where I am', the position of objects and their sequences, the 'where it is' takes on meaning. What is the patient's ability at making judgements of size, shape, position and distance? Can he remember what is seen, and can he visualise objects in different spatial relations?[8,21,23]

WHAT DOES OPTOMETRIC VISUAL TRAINING DO?

Visual training provides the patient with an opportunity for both development and learning experiences. Development, in the Piagetian sense, occurs when new behaviours (schemes) are created or synthesised by the patient; they are usually associated with the 'ah ha' phenomenon. Learning is the acquisition of knowledge and occurs when visual experiences provide raw data on which future activities can be better based.

Optometric visual training utilises arranged conditions which create conflict between existing behaviour (existing schemes) and the behaviour which is required to complete the task successfully. Thus in the process of resolving these conflicts the patient is ablè to develop new behaviours and/or awareness (new schemes). Said another way, optometric visual training involves the utilisation of structured and appropriately sequenced sensory-motor experiences while wearing appropriate lenses. Lenses are used to change the mind/body organisation necessary for self-directed behaviour. Schemes involving one or more of the following can be specifically selected for elaboration: ocular motility, accommodation, binocular co-ordination, eye-hand co- ordination, visual perception. Through the combined use of lenses and sensory-motor experiences, the optometrist contrives to have the visual training patient respond to the 'feedback' that accompanies such activity.

Optometric visual training improves visual abilities. The efficacy of visual training is well documented. Flax and Duckman,[19] Press,[20] Suchoff and Petito[24] and Cohen et al.[25] have considered aspects of visual function which can be modified by visual training. Visual training is meeting a need: it has been estimated that of the patients presenting for optometric care, approximately 21% of these would significantly benefit from visual training.[26] Hence it is likely that this area is under-serviced within the Australian community.

It is perhaps important to state also that visual training is not something that we can do to patients; it is not eye muscle exercise; it is not the random use of many 'fun and games' procedures and it is also not teaching reading. There are no visual training procedures that work, only procedures that can be made to work within the context of a specific visual training curriculum.

THE SCOPE OF OPTOMETRIC VISUAL TRAINING

Visual training is an extension of the practice of traditional orthoptics. While it includes all that is encompassed by orthoptics, the scope of optometric visual training is much broader.

Four major areas can be identified:

1. Developmental visual training is used for the guidance and development of visual abilities in young children.[21,22,23]
2. Preventive visual training is used to help the development of children with potential visual disorders that are preventable by visual training. An example of this would be amblyopia, secondary to strabismus or asymmetric refractive conditions.[16,20,27]
3. Rehabilitative visual training refers to visual training to remediate specific diagnosed visual disorders. Examples here could be convergence insufficiency or accommodative insufficiency.[15,17,20]
4. Enhancement visual training is visual fitness training and aims to enhance the efficiency and stamina of visual abilities, so that the patient can more efficiently and comfortably apply such function to desired areas. These areas may include sports involvement,[28,29,30] work demands or academic areas.[10,23]

ESSENTIAL INGREDIENTS FOR VISUAL TRAINING SUCCESS

Three interacting factors are suggested as being the essential ingredients of visual training success. The effectiveness of visual training will be compromised when one or more of these components is less than adequate.

1. An informed optometrist. The role of the optometrist is the subject of this paper.
2. A motivated and compliant patient/parent if we are dealing with a child, or patient if we are dealing with a patient old enough to take responsibility for his or her own training program. Active participation of the patient is essential.
3. Appropriate office management and office facilities.

ROLE OF THE OPTOMETRIST

Prescribes Visual Training Lenses

One of the most essential ingredients within optometric visual training is lens usage. The optometrist needs to prescribe the appropriate lens support for use during visual training activities and all other lifestyle activities so that visual training can be supported during all waking time. The behavioural perspective considers the therapeutic use of lenses (as distinct from the compensatory use of lenses) to be a powerful tool for modifying *perception*[4,21,31] and visual function.[15,16,32,33,34,35] A review of these references will show that the prescribing of visual training lenses is complex and depends on factors such as a complete case analysis, the planned curriculum and specific procedure to be conducted while wearing the lenses.

Because the visual system is the 'master co-ordinator' during visually directed activity, the use of visual training lenses can force many adjustments to posture, co-ordination and thinking schemes. Lenses can be used to make objects appear smaller and closer (minus spheres, base-out prism OU) or larger and further away (plus spheres, base-in prism OU).

During bi-ocular training, lenses can be used to create diplopia so that the patient can make a direct comparison of the functional efficiency of each eye. They can be used to help develop the ability to selectively control visual attention through right eye or left eye under various demands. Visual training lenses can be used to create many changed relationships. Care must be taken to use lenses of powers within the patient's ability to perform.

To help the patient develop and/or elaborate schemes which enable skilled performance to be sustained with visual training lenses, it is important to consider the fundamental role of the procedure as a way of increasing the awareness of the motor- sensory feedback loop, for as Held[36] has said, "... the sensory feedback accompanying movement—reafference—plays a vital role in perceptual adaptation."

Rock and Harris[37] have shown that when a person is faced with a conflict between what they see and what the touch sense conveys, the visual function determines the perception. This phenomenon is referred to as 'visual capture' and shows the dominance of visual input over other sensory inputs during visually directed activities.

Monocular prism lenses and yoked prisms up, down, right and left, alter the spatial relationship of the perceived object relative to the observer. They also alter the perceived spatial orientation of self. The way people can learn to adjust to the lens-induced distortions (which are best exemplified by yoked prisms) and quickly gain stability and organised spatial orientation has been considered by Gibson[4] as "a true case of perceptual learning." The informed optometrist thus can use lenses and prisms as 'tools.' They can help lead the development of controlled, self-selected visual attention, to help develop schemes of visual inspection, prediction and analysis and schemes of visually directed dynamic action and manipulation, as well as developing accommodation and convergence ranges and degrees of freedom between the synkinetic accommodative/convergence coupling.[38]

Uses Sound Educational Principles

The optometrist needs to arrange conditions for visual training success by utilising sound educational principles.[39]

Some important educational principles that should be applied during the conducting of a visual training program include:

1. The optometrist should secure the patient's involvement and active participation. This is sometimes easier said than done, but active management steps should be taken in this direction. The success or failure of visual training depends on an actively involved patient.
2. The optometrist should provide visual training demands at the patient's level. We should remember to work from the patient's strengths to get to the patient's weaknesses. Start with things that the patient can do and gradually elaborate as the patient's abilities expand.
3. Take small steps; this is a basic tenet of any programmed instruction, and ensures that a correct response is virtually guaranteed. In this connection, the optometrist should help the patient to set realistic goals. Unless the patient perceives a small step as one that is significant, he may not gain satisfaction and a sense of achievement.
4. Reinforce success, even when successful performance is apparent and obvious from the visual training feedback. Reinforcement can be either tangible (jelly beans, points or stars) or intangible (a smile, a nod or positive comment). This lets the patient know that not only was he aware of that performance, but someone else has noticed as well.
5. Keep visual training tasks and materials meaningful. Endeavour to explain to the patient what a visual training task requires, and how that task relates to his visual problem and abilities to gain improved function in areas important to him.
6. Facilitate remembering: the most frequent method used during visual training to achieve this end is 'over learning,' the use of repetitive practice (drill). The unique features of each new instrument or procedure should be discussed and the demands related to past success; for example, after the patient has gained success with Brock string procedures and vectograms, the aperture rule could be introduced. The patient could be told about the aperture rule instrument and asked to recall how he had to control his eyes to gain success with the Brock string and vectogram procedures.
7. Encourage the patient to discover relationships and generalisations for himself. When patients are able to discover relationships and similarities of visual function demands between various procedures, their transfer of any enhanced visual function to new situations and new tasks is improved. Perceived spatial relationships may be altered with base-in or base-out prism: smaller in, larger out (SILO) inducing activities often provide excellent opportunities for the patient to discover spatial relationships.
8. Provide for regular practice: it is common to request a half hour of daily involvement with visual training activities to reinforce what has been done within the office. This will do much to ensure the development of speed, skill and automatic performance as well as the long term retention of such performance.
9. Build a backlog of success: it is my view that success during visual training occurs when the patient is able to 'internalise' something about the control of his visual function. Make the patient aware that the phenomena observed during visual training tasks such as blurring, clearing, diplopia and suppression of the training task are only reflections of how well he is

controlling his own visual process. Children who are having problems 'learning to learn' often expect to fail because of all their previous bad experiences. Such children demonstrate poor motivation or willingness to sustain effort to solve problems. A backlog of success experiences often helps to turn these children from "I can't do it—it's too hard" attitudes into "OK, I will give it a go!"

10. Seek support from the family. Parents frequently feel defensive about a child in need of visual training. Their help is necessary but they can exert excessive pressure on the patient to 'work harder' if they are not given suitable guidance and advice. Communicate to parents about the steps that will be taken during the visual training program. Then either you or the patient should report to the parents about each gain made on the way to the long term goal.

Provides Planned Curriculum

It is the role of the optometrist to provide an individualised curriculum or programmed sequence of visual training activities appropriate to meet the patient's abilities, needs and goals. Such a visual training curriculum can be considered as a 'construction plan' or guide, to direct the process of the visual training program.

The uniqueness of optometric visual training [40] in this area is that it is initially directed at improving visual efficiency skills before addressing visual perceptual-motor skills development. The ability to integrate sub-conscious control of visual function into information acquisition and processing schemes becomes the ultimate goal.

The general principles of an optometric visual training curriculum, when dealing with most visual function disorders, would be to first establish equal monocular skills, then to gain efficiency and equality under biocular conditions at far and near and finally to integrate efficient binocular function into tasks demanding dynamic performance while engaged in visual information acquisition and processing.

Models of visual function and of vision development become important when preparing a curriculum and also when monitoring the progress of visual training.[41,42,43,44] They enable strategies of lens usage, procedures and sequential instructions to be conceptualised which could not have occurred using the limited perspectives of traditional orthoptics. The informed optometrist will realise the limitations of the 'models' used and also the ways alternative strategies can be applied.

It is also important to communicate that for many visual training cases there are often a number of alternative ways of sequencing procedures and also a multitude of procedures that can be used more or less interchangeably. As with a carpenter building a house, many tools can be used and each of these tools used in various ways—but the 'plans' and knowledge of dependent relationships guide the overall involvement. For optometric visual training, procedures and lenses are the tools—the curriculum is the plan.

Constructs Appropriate Instructional Set

The optometrist must work to construct, within the patient, the appropriate mental set from which the patient can then approach and interact with the visual training procedure. This is an extension of the orthoptic concept of mental effort.

An important key to the optimal utilisation of a visual training procedure is the effective use of instructional set.[45] Strategies are used to encourage the patient to 'internalise' his control over the process and to become aware of how he can 'push the right buttons' to visually inspect and analyse details quickly and efficiently. With appropriate verbal cuing and task presentation the optometrist can work to achieve:

1. Awareness of the process
2. Control of the process
3. Skill and stamina with the process
4. Sub-conscious control of the process

A mental set that I have found helpful when dealing with children requiring readiness skills development is to apply the six D's of perceptual development, derived from the work of Getman. These are:

1. Detection. At the start ensure the child understands the visual training task requirements.
2. Discrimination. Appropriate inspections and discriminations are encouraged by instructing the child to 'have a careful look' and to 'take time and think about what has to be done.'
3. Decision. Now the child is led to a decision and to motor-plan the performing of the task.
4. Directed action. The task is now done.
5. Discussion. Dialogue about how well the task was done and what could be done to improve the next performance.
6. Do again. Repetition of the task provides the child with opportunities to experiment. The aim is to lead the child into developing new ways of organising behaviour (new schemes), or to refine existing abilities (elaborate existing schemes).

By working the patient through each step in sequence, we can help the impulsive child who acts without thinking or appropriate inspection. This strategy can ensure a thoughtful self-directed response and also heighten the introspection on the 'feedback' from the performance.

CONCLUSION

Visual training is hard work, but also an exciting and challenging area. The optometrist must do all that can be done to ensure that visual training is a meaningful and positive contribution to the patient; but the patient has responsibilities too. The optometrist must closely monitor involvement and discontinue training for those who cannot or do not comply. Passive and non-compliant patients will gain little from visual training. Our professional reputation and community attitudes to optometric visual training are dependent on providing patient benefits.

A number of alternative management approaches can be utilised to deliver visual training. The approach that seems to best meet most patient's optometric needs is weekly in-office visual training , under supervision of the optometrist, supported by daily home practice. Other management approaches are considered a compromise.

During visual training the optometrist frequently has to deal with children who have both visual dysfunction and educational difficulties. The educational problems are not the prime concern of the optometrist—but ensuring that visual function can be applied to educational