BODY ALARM REACTION and SPORTS VISION

■ **EDWARD C. GODNIG, O.D.**

Abstract

The moment in sports competition when one's body is suddenly assaulted results in the body alarm reaction (BAR). Visual changes occur by direct end organ (ciliary muscle) sympathetic nervous system activation, which are not immediately related to the systemic release of noradrenaline. This reaction is in response to an unexpected and sudden change of events in one's environment. The dual nature response of sympathetic nervous system activation is necessary to fully explain visual changes during the body alarm reaction found in moments of intense sports conflict. Visual attention during the immediate stages of the body alarm reaction is drawn towards infinity.

Key Words

body alarm reaction, accommodation, autonomic nervous system, sports performance, stress, visual behavior, sports visual training, ciliary muscle.

Many superior athletes have reported a visual ability of maintaining an awareness of a central target while simultaneously being aware a vast amount of the peripheral visual field. This delicate balance and interplay between central and peripheral awareness is crucial to high level performance in many athletic skills. Maintaining this neurologically controlled behavior becomes of paramount importance when sports competition intensifies and an athlete potentially enters into the body alarm reaction. The body alarm reaction (BAR) is the body's response to an unexpected and sudden change in the environment. It is a type of stress caused by the body's response to stronger than normal stimuli or stressor agents.

An example of an athlete who may experience the BAR is a wide receiver who perceives that he is about to be 'hit' as soon as he catches a pass. If this individual enters into the BAR, an inevitable series of neural and biochemical reactions cascade into action. From a visual perspective, the accommodation system loses it ability to maintain clear focus on close targets. Practically speaking, the athlete's visual attention is drawn to release focus on objects within a few feet on his eyes, and focus towards infinity. This accommodative movement from near to far focus is a direct result of the change from parasympathetic nervous system control to sympathetic nervous system control. This neurological shift can be correlated to a behavioral shift from central (detailed) visual attention to peripheral (global) visual attention. It is possible that during the transition phase the athlete may lose the ability to separate figure from ground, and become confused about his spatial position on the football field.

Autonomic Nervous System Involvements

The autonomic nervous system has two major branches; the parasympathetic and sympathetic. Generally speaking, the sympathetic nervous system prepares the body for direct action and confrontation by increasing heart pulse rate and bringing increased blood supply to large muscle groups. Also, ocular pupil diameter increases, and the ciliary muscle relaxes, forcing a person to focus the eyes at far distance, perhaps to be behaviorally better prepared for a perceived on-coming threat. Looking towards infinity has the tendency of allowing the observer to process a relatively greater volume of peripheral space.

The parasympathetic nervous system allows one to maintain a more relaxed, balanced state of readiness by slowing an accelerated heart rate, decreasing pupil size, and allowing the eye's accommodative system to focus at closer distances. The parasympathetic nervous system aims to bring neural physiology back to a state of balance or relative homeostasis.

When the BAR is activated, along with the neural changes, there are hormonal and other biochemical channels activated concurrently by the hypothalamus. These chemical mediators are useful in helping to maintain the influence of the autonomic nervous system response, either by encouraging the body to stay in 'high alert' or by reversing this high intensity response to strong stimuli and resume a more normal relaxed controlled state of neural balance. However, during the early stages of the BAR, adrenaline is released in the body to further enhance the excitatory component of the BAR.

It is important to remember that the sympathetic nervous system can exert its neural messengers in two ways. This can be accomplished in a focal manner through secretion of noradrenaline or norepinephrine at local end organs (as is the case with negative accommodation induced directly at the ciliary muscle). The second manner is by releasing noradrenaline or norepinephrine systemically into the bloodstream to prepare the body for combat.

The visual changes resulting from sympathetic dominance are not immediately related to the systemic flow of noradrenaline into the bloodstream, but are directly related to the specific end organ (ciliary muscle) activation of muscle fibers that actively relax accommodation causing vision to focus toward infinity.[1,2] This rapid loss of near focus control lasts for a few seconds. This is precisely the reason why artificially inducing the BAR by injecting epinephrine into the bloodstream does not have an immediate influence on accommodation. Therefore, from a perspective of visual attention, it is misleading to equate the BAR only with the widely accepted physiologic changes such as an increased heart rate, faster breathing, cooling of the hands and feet, etc., all of which are geared to prepare the body to respond to a perceived threat. The dual mechanism resulting in sympathetic nervous system dominance must be taken into account for appreciating the visual component of the relative loss of accommodation.[3,4]

The autonomic nervous system's sympathetic response is the most immediate mechanism by which an athlete responds to a stressful stimulus such as a wide receiver about to be tackled by a defensive back. Adrenaline aids in maintaining high levels of sympathetic activity, but it is slower acting because of its need to use systemic circulation to transport the hormone. Research has shown that adrenaline causes little change in the permeability of the eye's blood aqueous zone during the first hour of administration, and that it does cause an increase in permeability subsequent to this. Therefore, injecting epinephrine into the bloodstream will require about an hour before effecting an influence on accommodation.[5]

These neural and biochemical reactions were first made popular by Cannon in 1922. He proposed the famous term 'fight or flight' autonomic nervous system duality. In 1974, the prolific researcher, Hans Seyle, further clarified and defined components of the BAR while classifying how humans respond to 'stressors' of various degrees and intensities. The first state of Seyle's stress theory, called the General Adaptation Syndrome, characterizes the initial response to the stressor and this description closely parallels what is now called the BAR.[6]

The BAR Visual Consequences

Back to our wide receiver athlete about to be hammered by an opposing defensive back while simultaneously trying to maintain accurate eye focus on a fast approaching football he is attempting to catch. Seyle's first stage of adaptation describes how our bodies react to stress and prepare ourselves to deal with adversity. The sympathetic dominance at this point explains why our visual focus is drawn away from the incoming football and toward infinity.

From a behavioral optometric perspective, as early as the 1940's A.M. Skeffington theorized that during stress, the human ability to center (converge), identify (accommodate), and maintain meaningful awareness on a specific visual target or task is severely hampered.[7] The BAR type of stress causes a decline in a human's ability to derive meaning and maintain attention on immediate visual information, as well as to derive meaning from one's visual memory because of a perceptual narrowing that accompanies the breakdown of optimal human performance. Thus, Skeffington had applied the pertinent physiological knowledge and research at that time specifically to vision.

Another example of a sports challenge that is sensitive to the effects of the BAR is whether a marksman can maintain focusing clarity on the front sight of a pistol while engaged in the BAR. Police firearms trainers often question whether it is possible to maintain accurate visual focus on the front target of a pistol (approximately arms length from the eyes) while suddenly forced to deal with a surprise and threatening attack. A question often arises at this point as to whether or the marksman actually sees the front sight at all. The human visual system is capable of responding to objects located within the total visual field (which for each eye is approximately 50 degrees up, 60 degrees toward the nose, 70 degrees down, and 90 degrees towards the temple measured from a central point of fixation).[8] Now if one is able to maintain mental attention on the front sight, she will always 'see' the front sight although it will not be in clear focus. Remember that with the appropriate degree of attention, skill and practice, an athlete can visually 'see' images within the limits of his peripheral visual awareness while simultaneously viewing a clear, central straight-ahead visual image.

The depth of field allows a certain area of visual space in front of and behind a specific point of fixation from one's eyes to remain in relative clarity of focus and is controlled by the size of the pupil. As pupil size decreases, as in bright sunlight, the depth of field increases, and as pupil size increases, the depth of field decreases. This is one of the reasons it is normally easier to maintain accommodative accuracy during bright sunlight and high contrast viewing situations as opposed to a dark or dimly lit environment.

Let's now address the question that if a marksman cannot clearly focus on the front sight, can he mentally still register the sight's location and use it for target indexing? Some marksmen can maintain visual awareness of the front sight even though the eye's focusing system is drawn toward infinity during the BAR. Try this experiment on yourself. Assume a shooting posture, visually focus monocularly on where an imaginary front sight would be located (or focus on one fingernail at arm's length straight in front of your line of sight). Then change your fixation and focus to an object more than twenty feet away. Your mind may be aware that your fingernail is located at a distance approximating the end of your arm even though your sight picture is clearly focused on the distant target. The concurrent awareness of the front sight in this example is possible because of a learned eye-hand-mind coordination relationship. The coordination of the eye, hand, and mind to organize where you are in visual space in relation to other objects develops more strongly as one learns to fine tune these sensory-motor coordinating systems. Experiences in moving through the three dimensional world causes a feedback loop between where your eyes are focusing, where your mind is attending, and where your hand is pointing or touching. Athletes who can maintain this visual spatial and motor synchrony during the BAR become less visually confused. Athletes with poorly developed eye-hand-mind coordination easily become confused as to where objects (e.g., the football) are located in space during states of high arousal. This is also the case when a second baseman or shortstop "takes his eye off the ball" just before being hit by a sliding base runner.

Visual Training

Is there a way to control or instantly recover from the loss of near point accommodative control during the BAR, other than training one not to enter the BAR at all? Current physiological eye research seems to indicate that once sympathetic nervous system dominance is activated during the BAR, there is not a way to control or instantly recover from the loss of near point (positive accommodation) focusing ability. [9] It takes time to return to a more controlled state of equilibrium, yet some athletes are still able to consistently perform many athletic skills with great accuracy during the BAR. Why are some athletes able to maintain visual-motor accuracy despite high arousal leading to lower visual focusing control?

There are various models to help explain this seemingly paradoxical relationship of visually monitored athletic body and mind control during the BAR. The one consistent thread that is part of most explanations is professional, comprehensive sports training. This includes knowing when and how to implement this training with confidence as a key ingredient to successful sports accuracy during the BAR. Current neurobiological biofeedback research has clearly demonstrated that humans can be trained to control certain autonomic nervous system functions.[10-12] This implies that with proper training, a well established image of proper visual spatial alignment can be maintained as a consistent visual-motor attentional image during the BAR, despite the fact that an athlete's accommodative system is drawn toward infinity. It is possible that athletes, who can maintain sufficient and efficient eye-body-mind coordination control and targeted visual attention during the BAR, will be capable of accurate sports performance during the BAR. One can learn to "visualize" an object even without having direct ocular focus on the object of regard. The ability to visualize and develop improved eye-body-mind skills can be trained using a variety of visual training techniques.

An example is tachistoscopic training, or commonly referred to as 'flash recognition training.' This technique is designed to improve an athlete's ability to perceive and retain visual information in increasingly shorter periods of time. One behavioral outcome of this type of perceptual training may be increased visual attention to increasingly complex visual stimuli. Learning to retain and repeat seven digits after exposure of 0.01 seconds is an example of training one's mind to recall visual images that are fleeting.

Another example of visual training to improve autonomic nervous system visual control is biofeedback training. Using an instrument that allows feedback as to the relative stimulation or relaxation of the ciliary muscle can exert a carry over effect during intense sports competition. With appropriate training using an instrument such as the Accommotrac Vision Trainer,[a] an athlete can learn to voluntarily stimulate or relax accommodation while viewing targets at various distances. If properly learned, appropriate acccom- modative controls can be activated while under the influence of the BAR.

One more visual training activity to assert control on the autonomic nervous system via the accommodation is the use of plus and minus lenses. While viewing a distant target, an athlete is asked to keep the object of regard blurred while looking through a minus lens power that is well within the athlete's accommodative amplitude; or requiring an athlete to blur a nearpoint target at sixteen inches while monocularly looking through a +2.50 lens. This can be done first monocularly and then binocularly, and is aimed at eventually enhancing the athlete's ability to stimulate positive accommodation (parasympathetic response) during the BAR to counter the reflexive negative accommodation response.

The ultimate goal of visual training is to bring visual skills and abilities to the point of automaticity. Automaticity training results in the ability of the patient to invoke a learned visual skill without any conscious awareness and effort. Once automaticity of the visual skills listed above has been attained, there is a reasonably good chance they will be appropriately maintained during the BAR.

An important consideration to clarify is whether two athletes facing identical fearful stress encounters react the same way neurologically and behaviorally. The answer is most likely not. The reason is that people perceive and react to adverse conditions and noxious surprises in a unique and individual manner. What is considered fearful to one person may be seen as a more neutral set of stimuli or circumstances to another. But, once an event is perceived as a threat, and the BAR is activated, a series of neural and hormonal reactions outlined earlier will occur and will be maintained until the perceived threat is resolved or a state of exhaustion is reached.

There are other methods that can be learned and trained to help individuals minimize the duration of the BAR. For example, learning to recognize one's physiological body response to the BAR and begin measures such as controlled, deep breathing to activate the calming parasympathetic nervous system response, is one strategy to minimize the duration of the BAR. Another method to help retard the BAR includes training under visually stressful conditions, e.g., cold temperatures, loud noises. This can result in a reduction of an athlete's anxiety, leading to decreased heart rate, and an increased confidence in a specific sports skill. Further, appropriate training for each sport leading to the ability to reverse the negative performance changes that accompany the BAR, is enhanced by proper nutrition and physical condition.

In closing, it is worthwhile to emphasize an important training concept that will aid athletes in minimizing some of the loss of visual attention following the entrance in the BAR. It is imperative that first, athletes are properly trained in developing accuracy in all the motor and sensory aspects involved in controlling all the movement strategies necessary for the particular sport. Once this is accomplished, it is imperative that training procedes into automaticity. Training to the point of automaticity implies that the speed of processing and performing a set of skills is fast, there is a relative lack of effort to perform a skill, and the skill is autonomous such that it may be initiated and run without an active voluntary conscious thought process. The automaticity realization of athletic skills is useful in avoiding visual perceptual overload resulting in confusion in target recognition and spatial awareness.

(Dr. Godnig has no financial or other business interest in the Accommotrac Vision Trainer or in Biofeedtrac, Inc.)

Sources

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Corresponding author:
Edward C. Godnig, O.D., FCOVD
Director, Low Vision Services
N. H. Association for the Blind
25 Walker Street
Concord, NH 03301

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