EXERCISES FOR THE AUTONOMIC NERVOUS SYSTEM

You Need Them!

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This unique book presents a training program for exercising all important autonomic nervous system components. It also provides guidelines for evaluating which exercises and activities are most appropriate for meeting individual needs.

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optimal situation for the previously mentioned behavioral activities and for others not listed. So far in this chapter little has been said about quantities. Only timing and schedules have been discussed. The amount of sleep and the amount of food intake that are needed for healthy existence is quite a different topic from the timing of these activities. People with low metabolic efficiency need more food than others. Similarly, some people need more sleep than others.

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Chapter 11

THE GRAVITATIONAL FIELD AND INVERTED BODY POSTURES

WHAT IN THE WORLD does gravitation have to do with the autonomic nervous system? Quite a lot! The vestibular system provides primary information about the orientation of the head in the gravitational field. This information is integrated into the ANS and is involved in maintaining a number of important body functions. These functions are mediated through the brain stem and the autonomic nervous system.

Most obvious is the maintenance of adequate muscle tone in those muscles needed to maintain posture. While standing or sitting the body is constantly correcting its position within the gravitational field in order to retain the most efficient position. That position is usually the one of maximal comfort and occurs when the center of body mass is so situated that only the smallest amount of musculature energy is needed to maintain the posture.

Most people are constantly moving about, changing position, occasionally losing their balance, correcting it etc., so that those parts of their neural circuits receive plenty of exercise. Concerning the people, though, who start to lose muscle tone in some of their muscles, their bodies start to compensate for the weaknesses by slightly altering the position of other parts of the body in the gravitational field. If this persists long enough, the condition known as bad posture develops. People with bad posture often tire out sooner and have lost adaptability to do certain types of activities. They can no longer do large amounts of strenuous physical work.

Adequate muscle tone is extremely important to overall well-being. Poor muscle tone results in flaccid muscles unable to perform their proper function. The most common obvious example is soft stomach muscles with resulting protruding abdomen. Inversely, what might be termed "too much muscle tone" results in tensed muscles. Often, emotional stress causes people to have muscles that are too tense. This is an unnecessary strain on the muscles, causing them to be more active than is needed in the gravitational field.

The right amount of skeletal muscle tone is the result of a continuous slow discharge of the nerve fibers innervating each muscle. The amount of muscle tone is increased when the nerve cell firing rate increases and is decreased by a reduction in the rate of nerve cell discharge. A thorough understanding of skeletal muscle function is *much* more complex, though, than is stated in these brief paragraphs. Moreover, within the autonomic nervous system itself there also exists what is termed sympathetic tone and parasympathetic tone. These functions of the ANS are also continuously active with basal rates of activity. The activity of many organs and tissues can be increased or decreased by modulating the basal rate in either division of the ANS. One of the effects of neural exercises is to alter sympathetic and parasympathetic tone (basal rates) of the ANS in appropriate directions.

It should be apparent then that the way of retaining proper muscle tone lies not totally in the muscles themselves but more in the appropriate discharge rate of the nerve cells that innervate the muscles. Thus, exercises for the nervous system that cause nerve cells to discharge at the correct basal rate are needed.

So, our orientation in the gravitational field is related in ways to some aspects of muscle tone and to some aspects of ANS basal discharge rate. How can a category of neural exercises be designed that involves the gravitational field and takes us out of the maximal comfort zone? Almost none of us will be able to orbit in outer space in zero gravity! Nevertheless, there are other *simple* neural exercises that are helpful. Before proceeding into this, consider some other important effects that gravitation has on us.

Posture and muscle tone have been discussed. Blood pressure is another important physiological variable that gravity affects. For an astronaut in free fall in outerspace there is no perceivable gravitational field. As a consequence of this, blood pressure in the

astronaut's body is approximately equal in all portions of the body, i.e. blood pressure in arterioles in the brain will be equal to analogous arterioles in the feet. For a person standing on earth, however, blood pressure is never the same in all portions of the body. The hydrostatic pressure difference caused by gravity in a person who is six feet tall (or for that matter someone only four feet tall) is significant. The pressure differences between the head and the feet due to gravity are considerable in the veins and in the arteries. A standing person who has an arterial pressure of 100 mm Hg at the level of the heart will have an arterial pressure of around 190 mm Hg at the level of his feet. In the noncollapsible vein in the head (in the dural sinuses) *negative* pressure can even exist in some conditions.

The blood pressure measurements quoted by physicians are measured at the accepted hydrostatic standard in the body, i.e. at the level of the heart. However, it is the ANS that has the task of maintaining the appropriate blood pressures everywhere in the body, and the pressures vary at different hydrostatic levels. Moreover, during every twenty-four-hour period an average person stands, sits, stoops over, and lies down. With each change of body position in the gravitational field, the ANS makes compensatory blood pressure adjustments for all portions of the body. For most people a gradation in amount of comfort exists that is directly related to gravity. The prone position is most comfortable, followed by sitting, standing, and stooping over, which is least comfortable. However, the stooping over position is only the simplest exercise in this category of neural exercises for the ANS.

The arterial system has pressure receptors (baroreceptors) located at different hydrostatic levels as shown in Figure 9 at positions A and B. When the body moves to a different orientation or configuration in the gravitational field, the firing rate of the baroreceptors changes. The ANS somehow compares the firing rate of the baroreceptors at the different hydrostatic levels and computes what modifications are needed to maintain suitable blood pressure throughout the body as the body changes configuration in the gravitational field. When either standing or sitting, the baroreceptors at A and B in Figure 9 are at different elevations. However, when a person lies down to sleep these

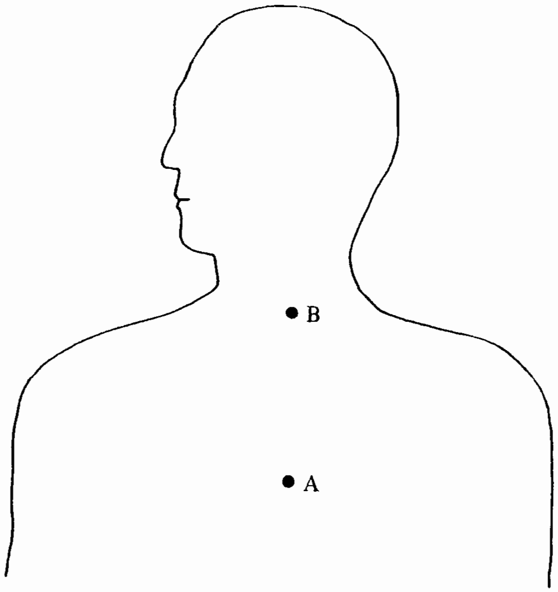

Figure 9. The locations of the two major groups of baroreceptors (pressure sensors) are shown by points labelled A and B. Both are in the artery walls, and they monitor blood pressure at two different elevations in the body. When a person lies down or stoops over, the relative elevations change (thus the pressures also), and the baroreceptors send appropriate neural signals to alter blood pressure at different body regions.

A maximal neural exercise for this part of the ANS is when A and B completely reverse positions, i.e. a headstand.

baroreceptors are at the same elevation. The ANS integrates all baroreceptor output from these positions and interim body positions as well.

So, concerning the importance of gravity on the ANS, posture, muscle tone, and blood pressure have been mentioned. Still another fluid dynamic system in the body that is less well known is the cerebrospinal fluid (CSF). The CSF is in the ventricles of the brain and also down the spinal column. It too has different hydrostatic pressures at different anatomy points due to orientation in the gravitational field. Although less well known than blood pressure, proper CSF pressure is also quite important in the health of everyone. The mechanisms of CSF pressure regulation are not well understood, and whatever compensatory

pressure changes that might occur as the body reorients itself in the gravitational field are not known. The mechanisms probably exist, though.

What are some of the neural exercises that can be done that temporarily tax to a near maximum those neural circuits, muscles, and organs that are involved with or affected by gravity? First, consider hydrostatic pressure differences in CSF and blood pressure. A maximum gravitational stress situation that the baroreceptors can easily be subjected to is to put the body in an inverted posture. When the body is upside down in the gravitational field, the baroreceptors at A in Figure 9 will be at a lower pressure than the baroreceptors at B. Many children and many athletes experience this situation often. The general population almost never experiences inverted body postures, however, because they are "too uncomfortable."

A healthy person should be able to easily adapt to inverted orientations for relatively short periods of time. If not, then a training program can improve this capacity providing that no disease exists. In any training program that includes inverted postures, additional neural circuits of the autonomic nervous system are exercised that otherwise are neglected. In particular, blood pressure regulatory systems are pushed to tolerable limits or near limits. When these neural exercises are done at appropriate intensities and suitable durations—extending over months, the ANS develops (actually *re*attains) a broader range of adaptability.

It would seem that research studies on topics as "simple" as those previously mentioned ideas, specifically the relationships of training by inverted body positions to blood pressure regulation, would have been carried out long ago. However, this research has not been done, especially not over the time durations (two or more months) for training to have occurred in the ANS.

So, inverted postures tax (stress) some components of the body toward the direction of one of the extremes regarding gravitational effects. Another extreme is the approximation of zero gravity. Floating in water, especially salt water, approximates this for other aspects of the body. Hydrostatic differences due to different depths in the water can be minimized by floating horizontally. When the ANS encounters this situation, it is indeed a form of an extreme, even though in this situation the perceived discomfort is small. In the ANS, as integration of this unusual near zero gravity information takes place, relaxation occurs (if the water temperature is warm enough).

Regarding muscle tone and posture, there are two basic but *very different* types of inverted postures, each of which subjects the ANS to quite different stresses. In one, gravity tends to compress or shorten the body along the axis defined by the backbone; in the other, gravity tends to stretch out or elongate the body along the axis defined by the backbone. Regarding blood pressure regulatory mechanisms, though, that part of the ANS cannot differentiate between these two types of inverted postures, even though the muscles, joints, and ligaments very well "know" the difference.

Headstands are an example of the inverted body posture type that is compressional along the length of the body. (This is, of course, similar to the effect that gravity has on people in the noninverted regular standing posture.) An example of the inverted body posture type neural exercise that is elongational (or extensional) is hanging upside down in the air from the knees (which are bent over a bar). In this position, the vertebrae tend to be pulled away from each other by gravity acting on the weight of the body. In this situation, the muscles and ligaments involved with posture and body attitudes are subjected to an unusual but not abnormal physical stress that should be well within the adaptation range in healthy people. It is the author's opinion from his experience that *advancing age is not* the real reason some people are no longer able to do these exercises. Detraining is responsible; that is to say, many people begin a sedentary lifestyle at age twenty-three or so, never do strenuous exercises again, and eventually lose the capacity to do the exercises as the onset of disease occurs. Detraining can happen when a person is in his/her 20s or 60s, etc., i.e. whenever sedentary living occurs.

One interesting scientific study investigated the effect of a training program of simulated hypogravity (water emersion) and simulated hypergravity (acceleration) on adult males (Shulzhenko et al., 1979). The hypogravity environment caused physiological deconditioning (detraining) that included decreases in skeletal muscle tone and several other effects. The hypergravity environment caused training in increased venous compliance, increased

ability to tolerate an acceleration field of +3g, and also other effects.

Inverted body postures probably have a variety of other less obvious effects throughout the body also; however, there exists no evidence that any of these effects are detrimental *except* perhaps in people who are so extremely detrained in this activity that irreversible damage has already occurred. The ANS *needs* these relatively extreme forms of neural exercise to maintain a broad adaptability range, and some people may need the inverted posture neural exercises simply in order to maintain good health. For relatively healthy people just beginning a training program, the milder forms of inverted body postures (*see* Chapter 14) are the exercises to start on.

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