

Breathing In The Gravity Field

Part I

By Aline Newton

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This is the first of a three-part series.
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P R E F A C E

Breathing is a familiar phenomenon to us all. Each one of us has a unique experience of breathing; in fact, we don't have any experience of life without breath. Nonetheless, if I were to ask you "what is the function of breathing?" chances are you would answer something like "CO₂-O₂ exchange." You would answer something learned, and not from your actual experience at all.

The group of thinkers that called themselves phenomenologists tried to take experience as the starting point for their investigations of human issues. Starting from experience implies at least two fundamental changes in the way we usually pursue knowledge. For one, experience implies an experienter. From this point of view, to divide experience into subject and object is exactly what we don't want. The role of actual experience and perception is considered the key to understanding any phenomenon.

Another aspect that changes is that experience always and only takes place in a context. It is never independent of the situation. From this point of view, there is no way to study an object independent of its environment. The context is always part of

the experience.

Today, the phenomenological point of view, while less popular in the academic circles of philosophy and psychology, has been followed up by scientists looking at issues of development and rehabilitation¹. It is not surprising that it would be in seeking to *apply* the insights of physiology and biomechanics that the influence of the context and the experience of the subject would take on more importance.

This paper seeks to apply the knowledge of physiology and biomechanics to working with the breath. It is an attempt to look at breath keeping the phenomenological considerations in mind. To really make sense of breathing we need to look at the physiology and mechanics of breath in the context in which they take place. For human beings, the most ubiquitous context is the field of gravity. This is the force, the environment, that is always with us. We also need to consider the role perception plays in the dynamics of breathing. In fact, what this paper reveals is that the physiology and mechanics only really make sense when these factors are given their primary place.

The first part of the paper will take a look at the basic physiology of

breathing, and see how it can be applied to working with breath. In the second part will expand our understanding of the anatomy and biomechanics that underlie the breath, which will lead to Part 3, an indepth look at the interactions between the body's way of organizing itself in gravity and the organization of the breath. We will find that perception plays a fundamental and inevitable role in the organization of the human breath and being.

I N T R O D U C T I O N

Breath is the basic movement of life. Gravity is the most basic force. No matter what else we are doing, we are also breathing and with each breath our body subtly adjusts to keep us upright in relation to gravity's field. These two primary functions are intimately connected.

A careful study of basic respiratory physiology, and the anatomy and mechanics that underlie the breath, reveals that breathing is an involuntary, automatic process. The ease and adaptability of the movement of breathing depends on the body/ muscles being free to respond to the nerve signals coming from the lower brain centers. A natural breath also depends on the ability of the muscles of inspiration to operate freely and minimal interference from unnecessary muscles.

An individual's particular posture inevitably comes into play here. Posture depends on the gravity system: the brain, nerve, muscle connections whose continuous resistance to stretch, what is known as tonic activity, forms the basis of our ability to adjust our uprightness to constantly changing circumstances. When this system is not operating properly, muscles will be inappropriately coopted to maintain upright stance, which will interfere with the normal ease of breathing.

Furthermore, appropriate tonic postural activity depends on sensation and perception. Every single breath we take involves the coordination of all these aspects; breakdown in any one of them will immediately affect the breath. They will be important considerations in assessing the function of respiration (because what looks like a breathing problem may originate elsewhere), and in strategizing interventions with integrative results.

1 -Theien, Esther and Smith, Linda, A Dynamic Approach to the Development of Cognition and Action, MIT Press, Cambridge, MA 1995

-Reed, Edward. An Outline of a Theory of Action Systems

BREATHING BASICS

"TAKE A DEEP BREATH"

How often have you heard this suggestion? Usually it is meant as a way to calm yourself, to pull yourself together. Have you ever heard or

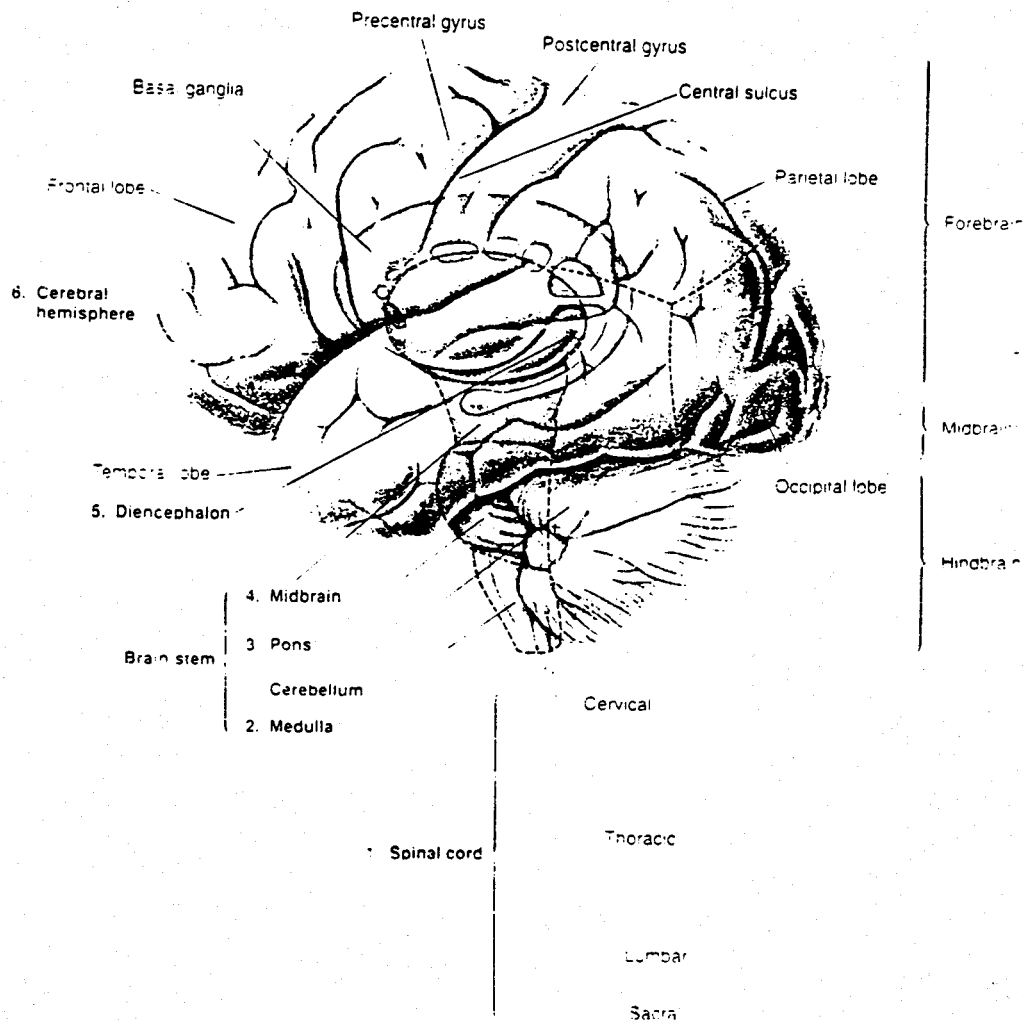


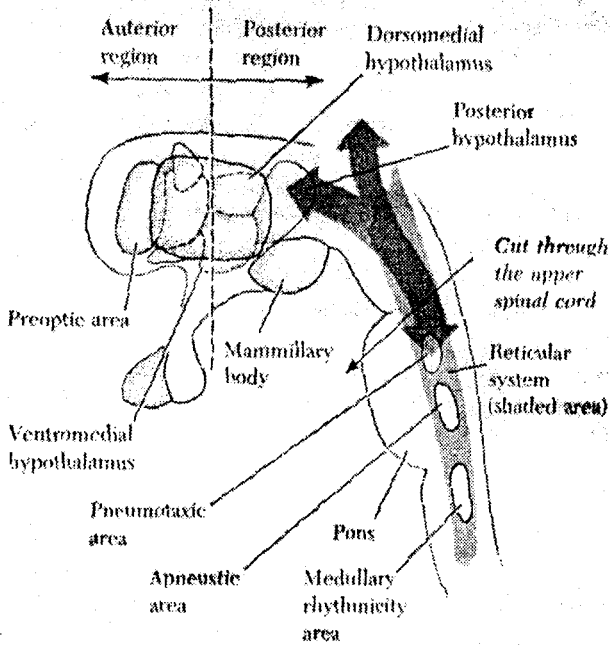
Figure 1: Divisions of the central nervous system²

said, "I know I don't breathe right; I catch myself holding my breath," or "I'm not breathing?"

Of course, this could not be true exactly—since our lives depend upon our breath, so long as we are alive, we must be breathing—but it does illustrate a unique aspect of breathing: it is a function that is mostly involuntary, out of our control, like our heart beat and the electric impulses of our nervous system; but at the same time, unlike our heartbeat (except for rare instances) we can voluntarily affect our breathing rate and rhythms; there is the possibility of conscious override.

This may lead us to the unconscious assumption that breathing is a voluntary activity which requires our conscious attention, but a careful look at the physiology underlying breathing makes it abundantly clear that this is not the case. Breathing happens, but you do not have to do it, any more than you have to beat your heart or remember to trigger the release of enzymes in your stomach after you have eaten. The real work of breathing is an automatic mechanism that simply does not need our voluntary attention or interference. Not only that, but even the involuntary muscular work necessary is minimal: in quiet respiration¹, both

UPPER SPINAL CORD



Medulla: contains the medullary rhythmicity area; contains the inspiratory and expiratory neurons responsible for the basic rhythmicity of respiration.

Pons: contains the apneustic area and the pneumotaxic area; provides an inspiratory drive to respiration (when stimulated, inspiration is stronger and more prolonged), whereas the pneumotaxic area accelerates breathing and provides an expiratory drive.

HYPOTHALAMUS

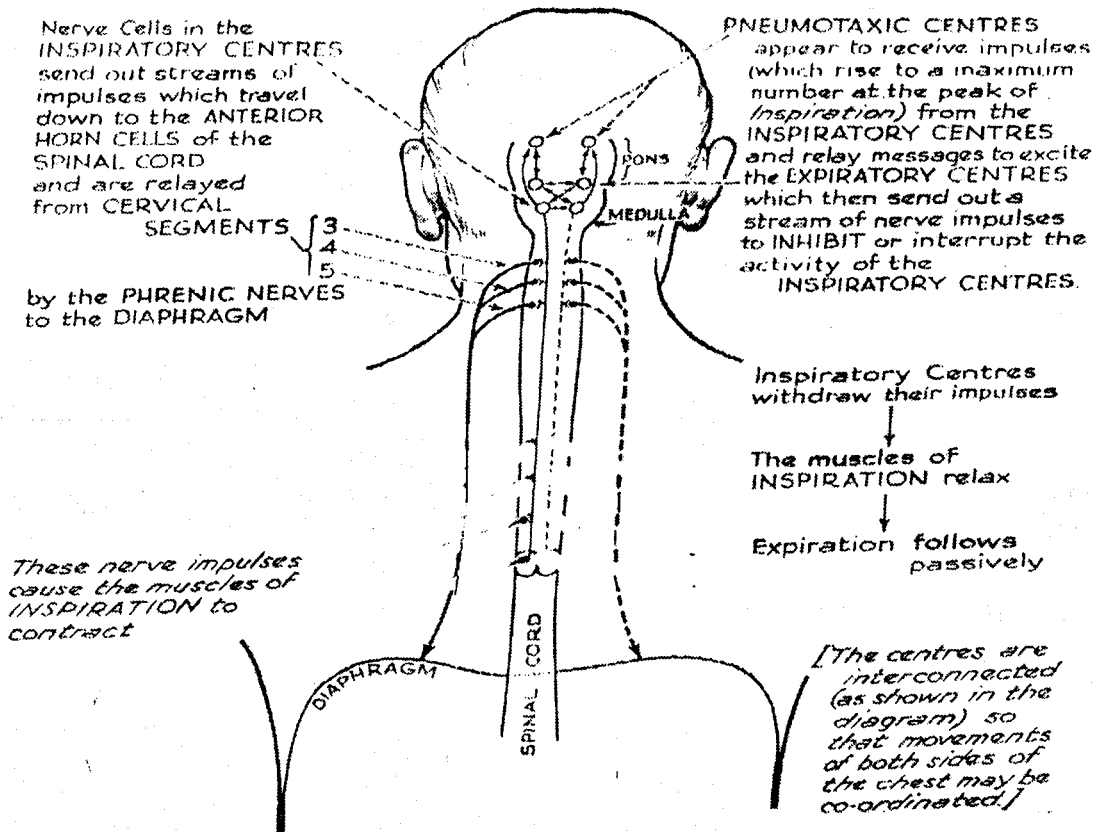
Preoptic area: involved in temperature regulation. When body temperature rises, cells in this area increase the rate of respiration (panting).

Posterior region: includes the posterior hypothalamus, mammillary body, dorsomedial hypothalamus, and ventromedial hypothalamus; when stimulated, increases the rate of breathing. The posterior region is involved in many arousal mechanisms.

Figure 2: Many areas of the brainstem have specific functions in respiration. (Bloch p. 64)

Figure 3

The following chart outlines the neurological events that control inhalation and exhalation.*



* Adapted from McNaught, A. and Callendar, R. Illustrated Physiology. Churchill Livingstone, London. 1975. p.130

inhalation and exhalation happen as a result of pressure differences inside and outside the ribcage. Natural breathing is almost effortless.

There are many opinions about what is the natural breath, and what the best way is to work with it. Different schools describe different rhythms, (whether there is a pause, whether it comes before or after exhalation), and different movements (breathing into the belly, chest or pelvis) that underlie what each considers the best breath. Some favor special breathing techniques, a "right way" to breathe. Whatever point of view we hold, the breath itself depends on basic physiological mechanisms.

In this chapter we will take a careful look at the neural, chemical and mechanical processes that underlie a natural breath.

I. NEURAL CONTROL OF RESPIRATION

Normal breathing occurs without conscious control through complex neurological and chemical feedback systems.

1. NEURAL CONTROL AT THE REPTILIAN BRAIN LEVEL

Deep within the old, reptilian part of the brain, the brainstem, lie special nerve cells, the respiratory centers, that are in control of the rhythm of breath at the most basic level. Activity in these neurons triggers a signal which travels through the spinal cord to the muscles of inhalation, causing them to contract, expanding the ribcage and thus initiating the process of inhaling. The normal movements of respiration are involuntary: They are carried out automatically through the rhythmic discharge of these nerve impulses. Neural mechanisms within the brain stem and reflex signals from stretch receptors in the lungs themselves

influence the switch-off point of the respiratory neurons. When the respiratory centers stop discharging, the muscles relax and inspiration ceases. Exhalation follows from the elastic recoil of the lungs and ribcage: muscle contraction is not necessary³.

2. NEURAL CONTROL AT THE VOLUNTARY-CORTICAL LEVEL

Breathing can certainly be affected by intention. We can override the reptilian system: Using descending nerve pathways from the cerebral cortex to the motor neurons of the respiratory muscles, we can voluntarily regulate the rhythm of the breath, and we do, for example, whenever we talk or sing. However, this voluntary control cannot be maintained when involuntary stimuli, such as high levels of carbon dioxide, become intense. Ultimately, the autonomic system is stronger. For example, if you tried to hold your breath underwater, even though an intake of breath would mean drowning, eventually you would breathe in. The will would not be able to prevent the body's breathing, even though it means death. In a demanding action, a sudden or effortful movement such as jumping or dancing, it will not be possible to control the breath. The attempt to control, or the habit, may even interfere with the spontaneous adjustment of the breath to the situation, and impede the movement we are making.

IN PRACTICE

A breath can be taken, using a voluntary action that employs the cortical pathways, or it can be allowed, ie, the lower brain processes can be left to breathe free from inhibition. The specific

words we choose when working with someone's breath pattern will influence which pathway is triggered: For example, directing a client to "Take a deep breath," or commanding a client, "Breathe!," will evoke different neural responses than suggesting, "Allow the air to fill your lungs." The practitioner always has the choice to use either direct intervention approaches (such as controlled breathing, or pranayama), which may trigger a cortical, voluntary action in the client, or indirect approaches (working with sensory perception, exploring without changing), which may lead to more lower brain influence.

II. CHEMICAL CONTROL OF RESPIRATION

The rate of breathing is closely tied to the levels of oxygen and carbon dioxide in our blood, as well as body pH. Sensitive chemoreceptors in the respiratory centers themselves register the level of CO₂ in the blood that supplies them. Peripheral chemoreceptors located in the neck and thorax are also involved. An increase in the amount of CO₂ serves as a trigger that causes the respiratory neurons—both inspiratory and

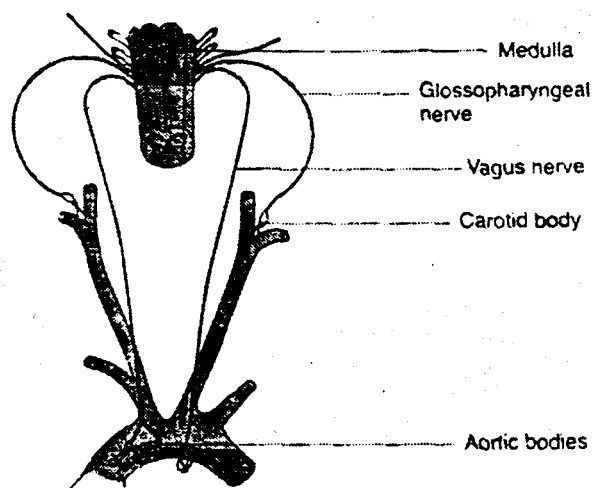


Figure 4: The carotid and aortic bodies located in the neck and thorax are important peripheral chemoreceptors⁵.

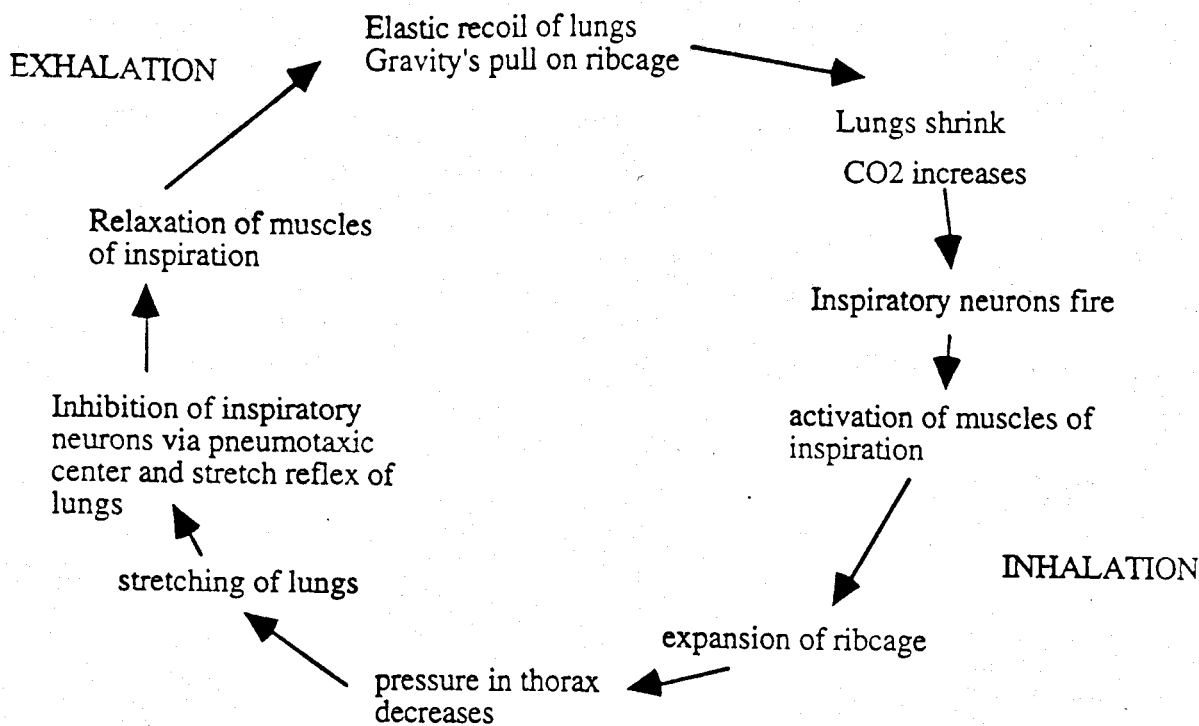


Figure 5

expiratory—to increase their activity.

IN PRACTICE

Understanding the chemical regulation of breathing may provide an explanation of one point of view: that the natural rhythm of breathing is inhalation, exhalation, followed by a pause. After exhalation, there is still oxygen in the alveoli. The pause after the exhalation allows the time for the CO₂ level to mount in the alveoli.

When the appropriate level is reached, the various receptors trigger a signal to the respiratory centers in the brainstem, which automatically trigger a new inhalation. Like the breath of a newborn, there is no sense of effort in the breath. The autonomic response allows the breath to be bigger and easier. If you inhale again immediately after exhaling, the natural rhythm cannot occur. You will have to involve a cortical pathway, a voluntary override to the natural rhythm of breath.

OTHER CHEMICAL INFLUENCES ON THE RATE OF BREATHING

The respiratory neurons will also be activated by a fall in blood oxygen levels or a decrease in body pH (reflected by an increase in H⁺ ions). Thus, at each moment, the neurological regulation of the breath is directly tied in with the chemical makeup of the blood.

IN PRACTICE

The mechanisms that control breathing are complex and highly organized. None of them depend on voluntary behavior or conscious experience, but all can be affected in a critical way by conscious behaviors. Breathing exercises requiring conscious direction could run the risk of interfering with the automatic mechanisms⁶. For example, rapid breathing elevates body pH, reducing the amount of free ionized calcium in the blood. This makes nerve and muscle much more excitable, increasing their level of tension.

III. THE MECHANISM OF BREATHING

The neural and chemical processes lead to inspiration by stimulating muscles that act on the ribcage to expand its volume. This in turn changes the volume of the lungs, which then determines the intake of air. From a mechanical point of view, normal exhalation is entirely passive; no muscular action is required at all. In both normal or forceful breathing, the muscles only work indirectly on the breath, to change the shape of the container. That is what changes the flow of air. Our muscles don't pull air into the lungs nor push it out, in spite of how we may model (or perceive) it.

INHALATION

In inspiration, action potentials from the reptilian brain's respiratory centers trigger the muscles of inhalation (primarily diaphragm and scalenes in normal inhalation). The muscles contract, increasing the diameter of the ribcage, and thereby

Normal, Quiet Breathing

INSPIRATION:

SCALENES muscles actively contract.

-upper ribs move upward
-sternum moves upwards and forwards

DIAPHRAGM contracts

-descends
-depth of chest increases

Capacity of thorax is increased

Pressure between pleural surfaces (already negative) is reduced from -2 to -6mmHg (i.e. an increased suction pull is exerted on lung tissue)

Elastic tissue of lungs is stretched

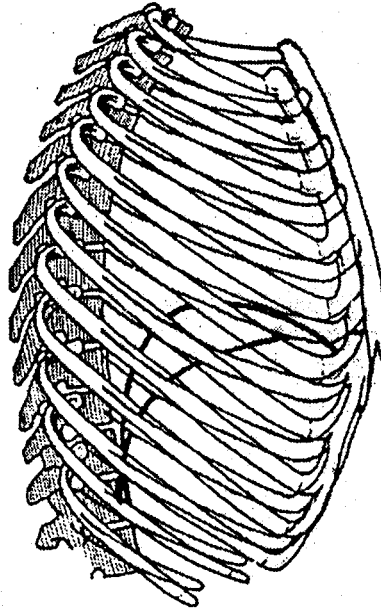
Lungs expand to fill thoracic cavity

Air pressure within alveoli is now less than atmospheric pressure
Air is sucked into alveoli from atmosphere

Forced Breathing

Muscles of Nostrils and around glottis may contract to aid entrance of air to lungs

external intercostals may contract
-extensors of vertebral column may aid inspirations



EXPIRATION:

SCALENES relax

-ribs move downwards

DIAPHRAGM relaxes

-ascends
-depth of chest diminishes

Capacity of thorax is decreased

Pressure between Pleural surfaces is increased from -6 to -2mm Hg (i.e. less pull is exerted on Lung Tissue)

Elastic Tissue of Lungs Recoils

Air pressure within alveoli is now greater than atmospheric pressure
Air is forced out of alveoli to atmosphere

Figure 6

Adapted from McNaught and Callendar

decreasing the pressure in the thoracic cavity and lungs. Air flows into the lungs until the pressures inside and outside equalize. The muscular effort is not to pull air into the body: The work performed by the muscles acts on the ribcage to increase its volume, but the flow of air into the lungs is the result of the pressure gradient—an entirely passive process.

EXHALATION

Normal exhalation is simply what happens when the inspiratory centers cease firing: The inhalation muscles then cease contracting, the effect of gravity on the ribcage in turn lessens its dimensions, lessening the pull on the lung tissue itself. The elastic recoil of the lungs then promotes exhalation without the need of any muscular contraction. From a muscular point of view, exhalation is a passive process. The weight of the ribcage responding to gravity lengthens the muscles of inspiration; muscles considered muscles of exhalation, primarily the abdominals, are only necessary for forced exhalation.

IN PRACTICE

When working with the breath, to get a free and easy exhalation, are the muscles of inspiration free to release? Rather than imposing voluntary, cortical control on the breath, we can work from the point of view of the container—working with the freedom of the ribcage to expand and the freedom of the muscles of inhalation to release.

CONCLUSION

Physiology, chemistry and mechanics all underline the same point: breathing at a basic level is involuntary. You don't have to work to breathe. Normal breathing is triggered automatically by the brainstem. The physical properties of the lungs and the atmosphere, and gravity take care of the rest. Breathing is not designed to involve intention nor much muscular effort, voluntary or involuntary. Breath can respond to direct approaches through the cortical pathways. Breath also responds to indirect work, with the freedom of the ribcage, with the sensations of the skin⁷, with increased sensory, immediate experience. The work is not to bring about the breath, but to act in such a way that does not prevent it.

FOOTNOTES

1. The mechanisms for forced or high amplitude inhalation or exhalation will often involve muscle contraction. In this paper we are primarily considering quiet, normal breathing.
2. Kandel, E., Schwartz, J., *Principles of Neural Science*. Appleton&Lange, CT, 1991. p. 8
3. Again, we are considering normal breath. In forced exhalation, abdominal muscles will be called into play.
4. Adapted from McNaught, A. and Callendar, R. *Illustrated Physiology*. Churchill Livingstone, London. 1975. p. 130
5. Guyton, A., *Human Physiology and Mechanisms of Disease*. Harcourt, Brace, Janovich, Philadelphia. 1992. p. 309
6. Bloch, George, *Body and Self*. William Kaufmann, Inc. Los Altos, CA, 1985. p. 70
7. Bloch, George, *Body and Self*. William Kaufmann, Inc. Los Altos, CA. 1985. p. 59

The simplicity and efficiency of the process upon which breath depends relies on the freedom and coordination of the muscles involved. The muscles of inhalation (primarily diaphragm and scalenes) must be free to contract to change the volume of the ribcage so that the air can flow into the lungs—that means no unnecessary antagonist activity. Normal exhalation is primarily a passive process, that should not require muscular action. For this, it is important that the muscles of inhalation be free to release so that muscles that can contribute to exhalation not be called upon unnecessarily. Given this, we can begin to anticipate the role posture will play in the dynamics of breathing. We will explore this at length in the next sections. □

New Conceptions of Breathing Anatomy and Biomechanics

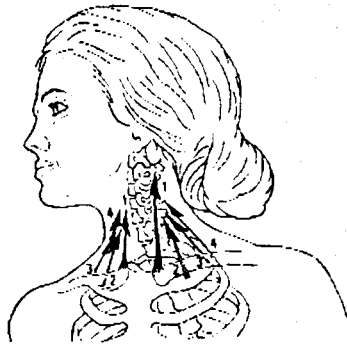
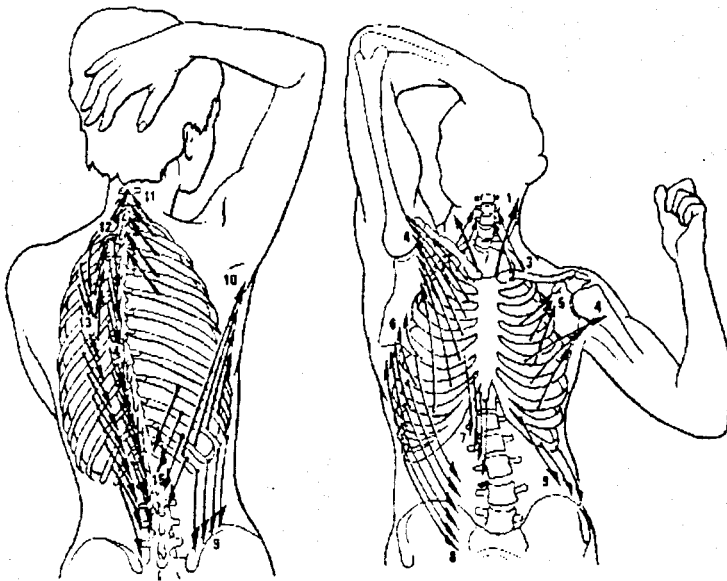
Part Two

By Aline Newton

This paper is an attempt to synthesize in written form the perspective of breathing, perception and biomechanics I have heard Hubert Godard articulate on many occasions. I am grateful for his patience and assistance and also for his many references.

To understand the role of posture in the breath, we are going to start by looking at the biomechanics of the breath itself. Again, we will be primarily concerned with normal, quiet breathing and focusing therefore on the muscles involved in inhalation.

All the muscles in Table One are said to be involved in inspiration in some way. Obviously though, some must be more important than others. Which muscles should be considered primary? Among anatomists, this is not a simple matter. There is continued debate about which muscles are involved in which aspects of breathing. The diaphragm is the one muscle everyone agrees is primary in breathing—but here the opportunity for argument is provided by the complexity of the biomechanics. In this section we will consider some of the differing views and their impact on our understanding of the relationship



COSTAL
intercostals
diaphragm

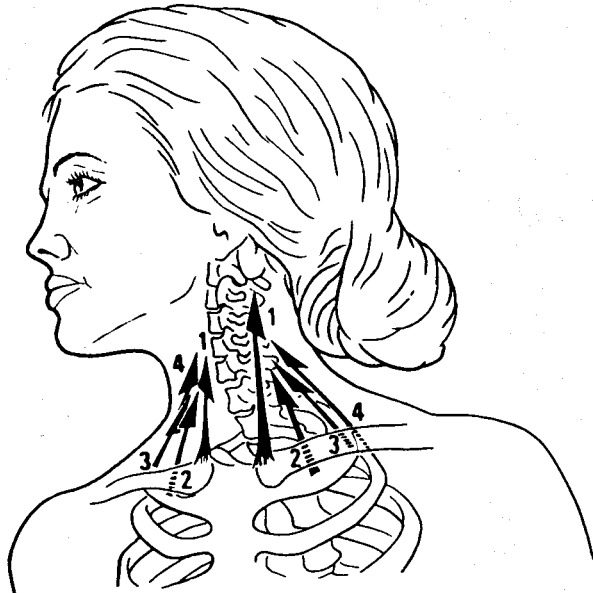
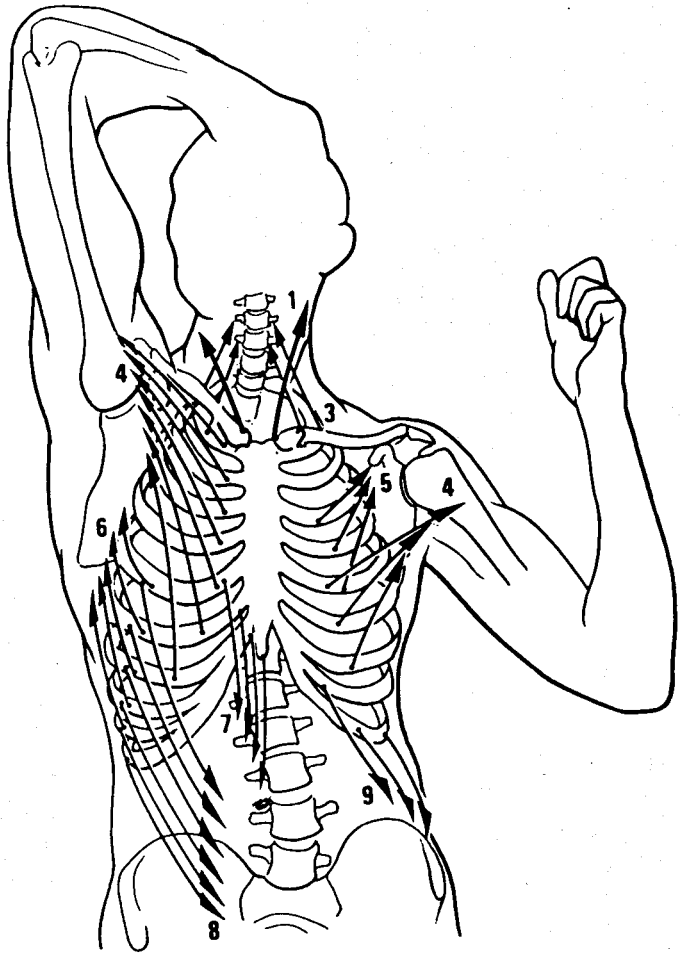
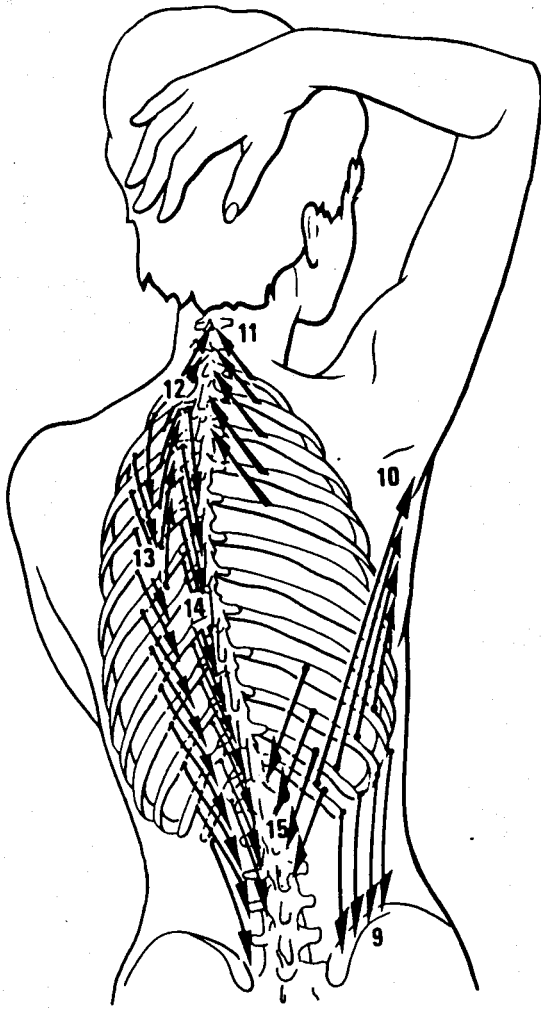
NUCHAL
sternocleidomastoid-1
scalenes 2-3-4
superior trapezius
subclavius

SCAPULAR
pectoralis minor-5
pectoralis major-4
Medial trapezius
levator scapula
rhomboids
serratus anterior
latissimus-10

SPINAL
longissimus-14
iliocostalis
lumborum-12
spinalis

TABLE ONE/FIGURE 1: INSPIRATORY MUSCLES

Figure 1
Inspiratory Muscles
From Kapandji



between posture and breathing. Increasing clarity in our images of anatomy and biomechanics may lead to a different understanding of function and to new ideas for working with the breath in practice.

As we begin to consider the biomechanics of the breath, the notion of "fixed point" becomes an important theme: Anatomists often talk of muscle attachments in terms of origins and insertions. From a functional point of view this can be misleading: it implies that the muscle's pull is always in the same direction; that the insertion moves towards the origin. In reality, the result of the pull of a muscle depends on which end is fixed. The term "fixed point" is a little misleading: it would be more descriptive if it could include the sense that the point is dynamic, active but stabilizing, in contrast to the other end, which is active and moving. Which end of a muscle acts as the fixed point is the consequence of a combination of the demands of the moment, the individual's postural habits, neurological organization and relationship with the surrounding space², and the coordinated action of many muscles that act as stabilizers. The variability of the location of the fixed point will be an important aspect of the dynamics of breathing.

I. THE DIAPHRAGM

One thing all the authoritative anatomy texts agree on: the diaphragm is the most important muscle for respiration. But even this is not so simple. In an article published in *Science* in 1981, research showed that the diaphragm consists of two muscles that act differently on the ribcage—at least in the dogs that were the subjects of the study.³

Traditionally, the diaphragm is composed of three main parts: the

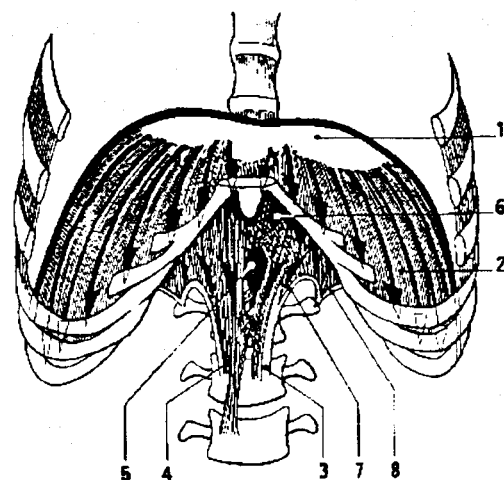
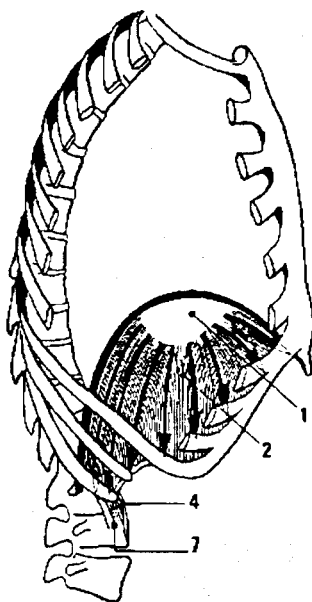


FIGURE 2: 'DIAPHRAGM AND CRURA CAN BE CONSIDERED AS SEPARATE MUSCLES

costal diaphragm (2) which attaches to the border of the ribs and to the central tendon (1); the crural diaphragm (3-4) going from the vertebral column to the central tendon; and the central tendon itself. When the costal diaphragm's fibers contract, they pull on the central tendon. The resulting change in volume causes a fall in the pressure inside the thorax which leads to inflation of the lungs. Stimulation of the crural fibers will also result in a change in pressure inside the thorax but without displacing the ribcage at all. Other experiments show that the embryological development and the segmental spinal innervation of the two parts are also different. The costal diaphragm and the crura have different anatomic origins, different embryological development, different segmental innervation and different actions. They can thus be considered two separate muscles.⁵

IN PRACTICE:

The central tendon, the ribs and the spinal attachment of the crura can each act as a fixed point, leading to a different movement of breathing. The

underlying biomechanics will be developed further in following sections.

a- The lower ribs can be stabilized by posture and by the abdominal muscles, in which case the diaphragm muscles will pull on the central tendon. Although the sensation of inhaling in this case can feel very big, the actual excursion of the central tendon of the diaphragm is only one or two centimeters. We don't feel the diaphragm's movement directly, but only the consequences of it on the ribs and viscera.

b- With proper abdominal tone, as the central tendon descends, the mass of the viscera will provide a supporting point so that the central tendon can act as a fixed point. The contraction of the diaphragm's fibers will then lead to elevation of the lower ribs. In this case, the abdominal muscles, normally considered muscles of forced exhalation, actually become accessory to inspiration.

c- If the lumbar act as the fixed point, contraction of the crura will pull down on the back of the dia-

phragm. The fact that the crura may be considered a separate muscle may help to explain certain respiratory patterns which result in a breath in spite of minimal diaphragm involvement or movement of the ribcage.

BIOMECHANICS OF THE "BELLY BREATH"

The movement of diaphragm and crura may seem to have a piston-like effect on the abdominal contents. Were this so, the force of the diaphragm would press the viscera down into the pelvis with each breath. Some approaches to working with the breath do encourage this downward movement. Other sources point out the vulnerability of the pelvic viscera, emphasizing the detrimental effect repeated pressure would have.

In his book, *Les chaines musculaires*, Leopold Busquet[®] describes what he considers the body's ingenious solution to this problem: The viscera are contained in two different pouches. The organs contained within the peritoneum benefit from the variation of pressure caused by the movement of the diaphragm and lumbar spine, whereas the organs in the other pouch, the rectum, uterus, prostate and bladder, need to be protected from the same pressure. The biomechanics allow just this difference: When the diaphragm contracts, the sum of the force of contraction pushes forward and downward just below the navel, an area which is reinforced by the transversus abdominis muscle. The pressure does not go directly down into the pelvis. The iliac bones, by their very shape, orient the downward force of the diaphragm's pressure in a forward direction, above the pubes. The organs in the pelvis are thus protected from the changing pressure caused by the



SUM OF DIAPHRAGM'S PRESSURE



FIGURE 3

THE PELVIC ORGANS ARE PROTECTED FROM THE ABDOMINAL PRESSURES

diaphragm's action. (Figure 3) The obturator membrane is yet another mechanism which serves the same purpose: to protect the pelvic organs by regulating the pressure in the pelvic basin. The natural lordotic curve of the lumbar spine also helps direct the pressure towards the sub-umbilical area. Good tonus in this area is essential to sustain the forces that come to bear here. If the lumbar lordosis is lost or the pelvis is held too posteriorly, the protection of the pelvic organs will be compromised.

IN PRACTICE

- a- Exercises that encourage breathing into the pelvic floor can be very useful from a proprioceptive point of view: The movement of the breath can stimulate sensory awareness of the pelvic floor. It is important, however, to differentiate a movement for proprioceptive education from movements of normal respiration.
- b- Belly breathing. The movement of

the ribcage in response to the breath we will call upper respiration and the movement of the breath down toward the subumbilical area we will call lower respiration. The chain of sympathetic nerve ganglia, that relates to the fight or flight response, runs along side the spine the length of the ribcage. Upper respiration stimulates sympathetic capacity: it increases overall tone and energizes. Lower respiration stimulates the parasympathetic part of the autonomic nervous system, bringing rest and relaxation. Breathing with the belly alone can thus be a positive exercise. But misapplied, it can also depress sympathetic capacity. In the case of someone who is depressed or lacks energy, a focus on belly breathing may actually reinforce the presenting problem. For someone with a collapsed ribcage, or for a person with depression, encouraging movement of the ribcage and chest during breathing can be constructive.

SUSPENSORY SYSTEM OF THE DIAPHRAGM

In the book, *Fascias et Pompages*⁷, Marcel Bienfait describes a fascial chain that he says could be named the "chain of the 3 diaphragms." It begins at the base of the skull and continues in the neck as the prevertebral fascia and in the thorax as the fascial sheaths around the heart to the diaphragm. Below the diaphragm, the fascial sheet continues via the crura and the psoas fascia, thus connecting to the lumbar spine, and divides into two fascial chains for the lower limbs.⁸ As a whole, this long span of fascia is known appropriately as the deep cervico-thoraco-abdomino-pelvic fascial chain.

The diaphragm is in some sense suspended by a sling of connective tissue from the base of the cranium. The mass of aponeuroses, fascia and ligaments that form the upper part of the chain creates a fascial webbing

that acts as a suspensory system for the diaphragm. Bienfait calls it the anterior mediastinal ligament, (also known as the phreno-pericardiac ligament). Souchard describes it as a virtual tendon, which looks as if designed for repeated big effort.

(Figure 5¹⁰)

Instead of the usual image of the diaphragm as a central tendon with muscles all around, Bienfait describes the diaphragm as a musculo-tendinous complex made up of 8 digastric muscles. The central tendon adapts to the movements of the trunk and ribcage and at the same time serves as the fixed point for the movement of the ribs in breathing. Suspended from above by the anterior mediastinal ligament and pulled from below by the crura, the movement of the central tendon is extremely limited.

(Figure 6¹¹) Both the abdominal viscera and the tendon of the diaphragm act as brakes on the diaphragm's move-

ment.¹² Thus, as we mentioned earlier, if the abdominal muscles are properly toned, when the muscular fibers of the diaphragm contract, they pull on the ribs below which lift and allow lateral expansion of the ribcage.

THE SCALENES

In most anatomy texts, the scalenes are considered only as accessory muscles of inhalation, while the external intercostals are thought to do the primary work of changing the shape of the ribcage during inhalation (Kendall, Kapandji). But according to Platzer, (1986 p. 82) electromyographical studies by Fick show that the intercostals are active only in forced inhalation. Platzer states that the scalenes are the most important muscles for quiet inspiration. By lifting the top ribs and the upper part of the thorax, they are

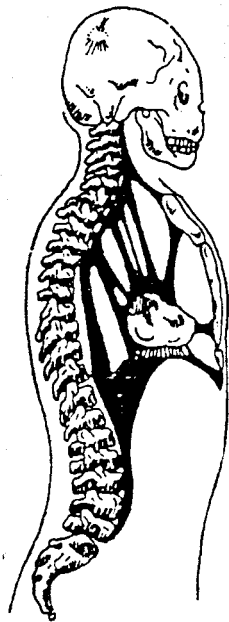


FIGURE 4: THE WEB OF CONNECTIVE TISSUE THAT SUSPENDS THE DIAPHRAGM WRAPS AROUND THE HEART, CONNECTS TO THE LUMBAR SPINE.⁹



Anterior mediastinal ligament

FIGURE 5

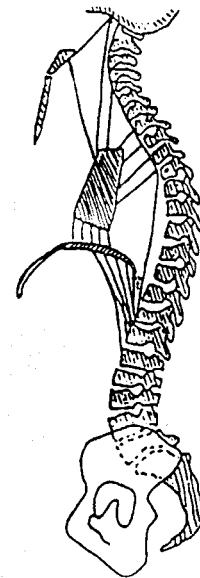


FIGURE 6

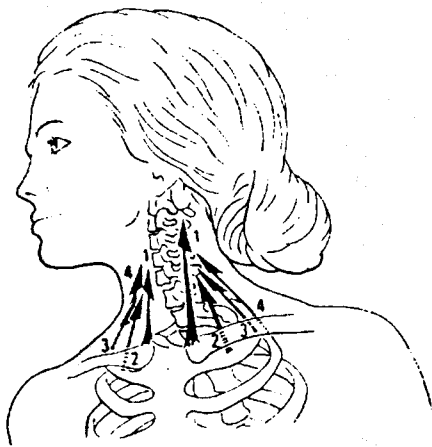


FIGURE 7: THE SCALENES¹³

crucial to the expansion of the ribcage which allows the mechanics of inspiration to operate with minimum effort. Perhaps the role of the scalenes is so controversial because it depends on many factors, including overall posture and what is acting as the fixed point.

Souchard calls the scalenes "static suspensory muscles of the upper thorax." They attach to the vertebrae very far laterally and parallel to the spinal column. If the head and neck are correctly placed, when the scalenes contract symmetrically they will be able to lift the first and second rib without causing rotation or forward bending of the cervical vertebrae.

Kapandji points out that the scalenes' action will only be effective when they act on a cervical column stabilized by other muscles, in other words, when the neck or head act as a fixed point. If there was no upper fixed point, the action of the scalenes would pull on the cervicals, compromising the head's stability in gravity. Contraction of the scalenes would pull the head down and forward. The upper fixed point will be important for both inhalation and exhalation: when the scalenes' contraction ceases

after inhalation, the upper point of support will ensure their ability to release as the weight of the ribs exerts its pull.

PRIMARY RESPIRATORY MECHANISM

If the diaphragm/crura and the scalenes alone are considered the primary muscles of inspiration, we arrive at an odd situation: Without stabilization of the lumbar spine, the action of the crura pulls the lumbar forward; without stabilization of the cervical spine, the action of the scalenes pulls the neck forward and down. What is required is something to create a fixed point that will stabilize the lumbar, neck and head. From a functional point of view, spinal stabilizers are exactly suited for this role. They should therefore also be considered essential players in the basic biomechanics of breathing.¹⁴

THE SPINAL MUSCLES

The spinal stabilizers are a complex of muscle groups that blanket the back from the sacrum to the occiput. The individual muscles do not extend directly from lumbar to occiput: there is an interweaving of muscle fibers. The multifidus continues to the occiput in the form of semi-spinalis capitis, and longissimus as longus capitis. Spinalis stops at T1 and iliocostalis lumborum at C3.

The two most important spinal muscles for respiration are longissimus and iliocostalis lumborum. Both these muscles have attachments on the ribcage itself. These muscles influence respiration in several ways:

a) On the spine itself: When the muscles on both sides of the spine contract simultaneously, with the lumbar as the fixed point, the spinal column will extend (backbending),

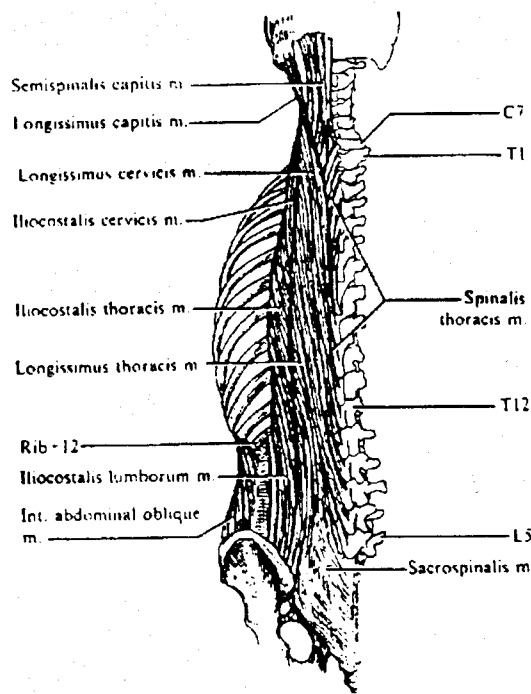


FIGURE 8: SPINAL MUSCLES¹⁵

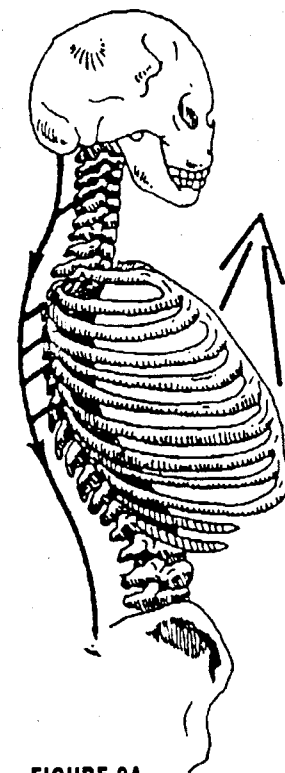


FIGURE 9A

which elevates and opens the ribcage. (Figure 9a, from Soucard, p.57)

b) On the ribs: Longissimus and iliocostalis lumborum can also act from below, pulling down on the small arm of the rib (inside the costal angle). The 90 degree angle of the long arm relative to the short one transforms the rotation into elevation of the long arm of the rib. From one fixed costal point to the next, longissimus and iliocostalis lumborum pull on the ribs like the cord of a venetian blind. With inspiration, each rib rotates just like the slats of the blind. (Figure 9b')

c) As a stabilizer: The attachments via the upper insertion of iliocostalis lumborum and via semi-spinalis can act to stabilize the neck and head, providing the support necessary for effective scalenes action. This also allows the cervical muscles that are accessory to inspiration to be active. The influence of the spinal muscles can reach as far up as the first rib and the first thoracic vertebra, stabilizing

the thoracic spine which allows the accessory muscles of inspiration attached to the scapulae to come into play.¹⁷

The basic mechanism of inspiration includes the diaphragm, the erector spinae, and the scalenes muscles. The diaphragm remains the basic element, but added to its contraction is the action of the spinal muscles which give the lumbar and cervical spine the necessary support to bring the muscles into play. This stabilization also enables the action of the scapular, cervical and thoracic accessory muscles of inspiration.

IN PRACTICE: PATTERNS OF COMPENSATION

The dual role of the spinal muscles is one important element in the inter-connection between posture and respiration. Through them, breathing patterns influence posture, and posture influences the breath. In both cases, the patterns can end up interfering with the basic physiology of

breath (—that it's an automatic movement, that you don't have to do it, but just not prevent it—) described in Part 1.

When the primary respiratory mechanism is not working—if the spinal extensors don't come in to play, if the head is not stabilized, if somewhere the extension is not available—the movement of the breath will be concentric: With each breath the action of the scalenes will pull the head down and voluntary muscles will become involved and increasingly contracted.

BREATH INFLUENCES POSTURE

There are many factors influencing the movement of the diaphragm. Muscular restrictions, blood chemistry, as well as the impact of the autonomic nervous system can all affect the basic respiratory pattern. When the diaphragm's movement is blocked, you have to use the other muscles to make room for the air. One such compensation involves the

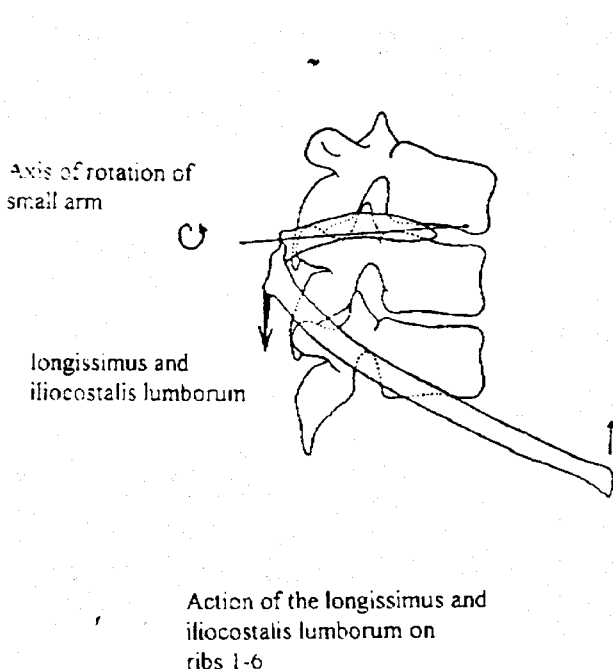


FIGURE 9B

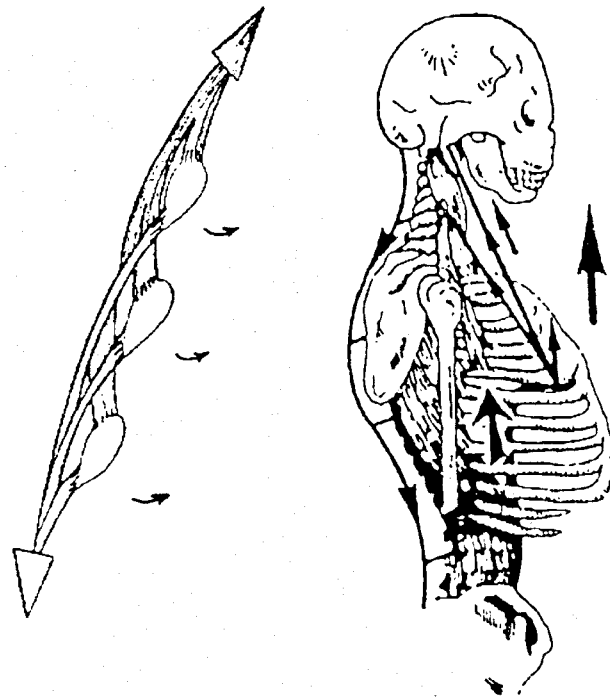


FIGURE 10:
PRIMARY RESPIRATORY MECHANISM

crura and scalenes acting together. It results in a breath but also in chronic contraction of the spinal extensors. If these muscles become contracted because of involvement in the breath, then when the person tries to move the muscles are not free to release. When the spinal muscles act in their role as antagonists to another group of muscles, they will no longer easily or properly lengthen. The agonists will have to work much harder, requiring more energy, more contraction, and ultimately leading to a loss of length and freedom of movement in the body as a whole.

BREATH AND POSTURE INFLUENCE EACH OTHER

In the deep fascial chain that runs from the cervicals to the diaphragm, Bienfait distinguishes the mediastinal ligament and the prevertebral fascia.(Figure 11a¹⁸). Posteriorly, the

spine and its long muscles and anteriorly, the mediastinal ligament, prevertebral fascia and diaphragm affect each other.

The mediastinal ligament and spinal muscles are like a bow and its string. The spinal muscles control the tension of the bow in the back, and the mediastinal ligament and crura control the tension of the string in the front. (Figure 11b¹⁹) If the spinal muscles are hypertoned, this can lead to shortening of the ligament in front. Conversely, shortening of the ligament in front will lead to hypertonicity of the spinal muscles. In turn, shortness in the prevertebral fascia is implicated in spinal problems such as scoliosis and Scheuermann's disease. (Bienfait, 1995, p.79)

IN PRACTICE

One way to work with this deep fascia is to ask for an inhalation, and

a paradoxal exhalation, ie exhaling while pushing out the belly wall. As the client exhales, traction of the cervicals will have the effect of stretching the fascial chain in two directions.

LORDOSIS AND BREATH

- We can distinguish two kinds of hyperlordosis: one could be called "diaphragmatic," and affects the spine at T11,12, and L1,2.²⁰ It is the result of restricted or overused crura. The other hyperlordosis occurs primarily as a result of psoas contraction and affects the 3rd, 4th and 5th lumbar.

- Normally, the lumbar lordosis has to act in two capacities in breathing: it must be able to be stabilized in order to give the crura a stable point against which to pull; but it must also be free to aid in directing the down-

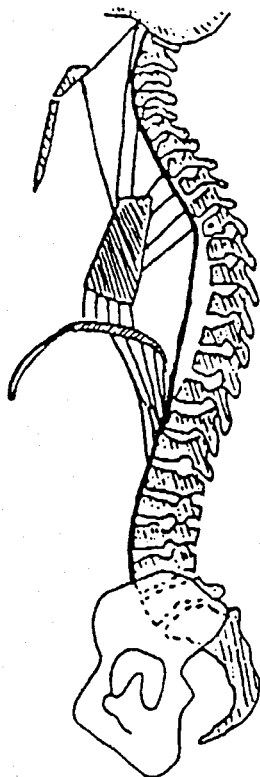


FIGURE 11A

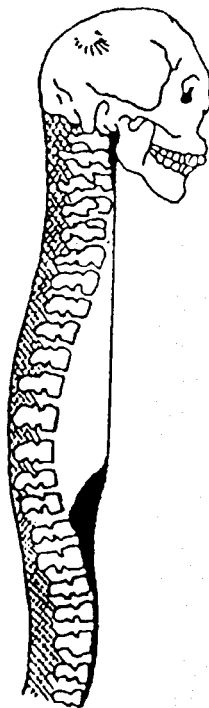


FIGURE 11B

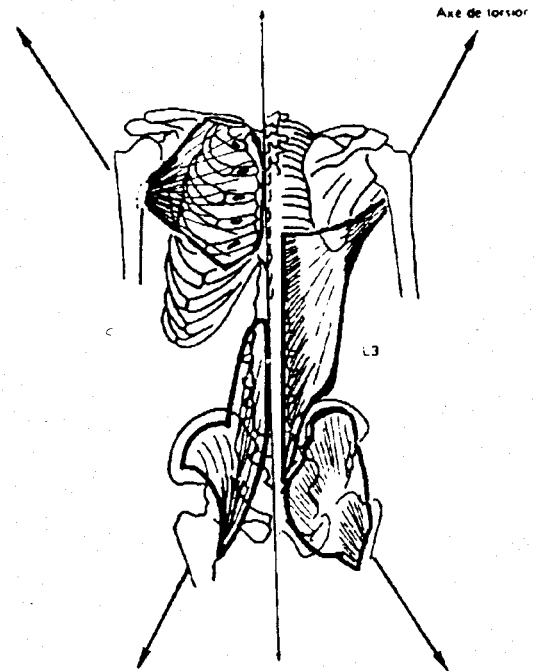


FIGURE 12

ward force of the diaphragm forward. The integrity of the lumbar lordosis—ie. the possibility of responsive movement—is one of the keys to the breath. We will consider lumbar stabilization from both a static and a dynamic point of view.

1. An increase in the proprioceptive sense of the body's weight activates the spinal muscles by activating the stretch reflex. The sense of weight will be further described in Part 3.
2. As we have seen, when the abdominal muscles, especially transversus, keep a slight tension in inhalation, they help the central tendon act as a fixed point. They also support lumbar stability.
3. From a dynamic point of view, the lumbar are given an extra means of stabilization by the opposing tensions of the latissimus and its opposite psoas. In movement, as one arm moves forward, the resulting tension in the latissimus dorsi exerts a counterbalance to the pull of the opposite psoas. The normal rotational influence of the psoas on the lumbar is thus controlled resulting in a dynamic stabilization. (Figure 12²¹)

INHALE OR EXHALE?

As we have already seen, anatomy is far from an exact science. There is an ongoing debate over which muscles are primary in respiration. Also, in several cases, there is disagreement over whether a particular muscle functions in inhalation or exhalation. In part the disagreement about function stems from a disregard of the influence of postural patterns on muscle function. Which muscles are most active in breathing will depend on the person you are looking at. For some muscles, whether they perform as a muscle of inhalation or exhalation depends on the particulars of the individual's posture and coordination. Habitual postural patterns affect the position of various muscles which

in turn changes their effect. Habits of function, such as initiating a movement with a particular contraction, also changes the function of other muscles. For example, from one person to another, serratus anterior can serve as a muscle of inhalation or of exhalation, depending on what structures act as the fixed point: Serratus inserts on the ribs and on the scapula. If the scapula acts as the fixed point, a contraction of serratus pulls up on the ribs, and thus serratus is recruited to help with inhalation. However, in the case of a person who chronically contracts rectus abdominis first, where the fixed point is anterior, serratus can become a muscle of exhalation. In people with posterior pelvises and shortened recti, a contraction of serratus will help in exhalation. Thus in order to

understand the function of a specific muscle in respiration, it behooves us to examine carefully the structural and movement patterns of each individual.

IN PRACTICE

When as practitioners we look at the breath, we can distinguish two basic patterns: one of inhalation and the other exhalation. If we look at the basic postural set, we can also distinguish two basic patterns based on the relationship of the upper center of gravity (G') and the head of the femurs: In one, G' is anterior of the line connecting the femoral heads, in the other, G' is posterior. (Figure 13) Breath and posture are intimately related: Breath is a movement between the two patterns, a shifting from one to the other, forward to

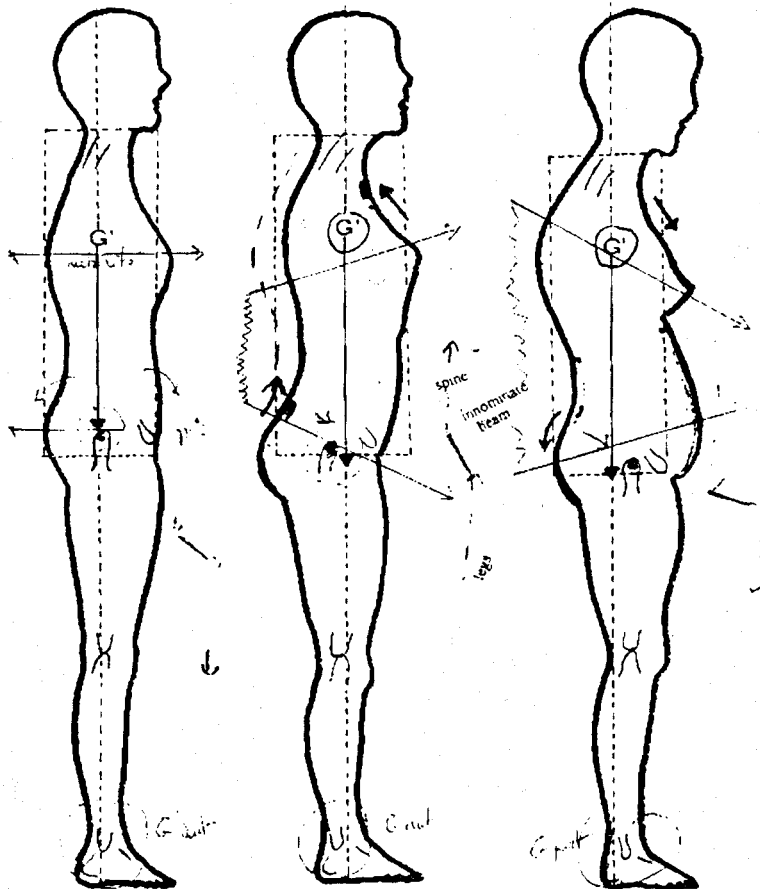
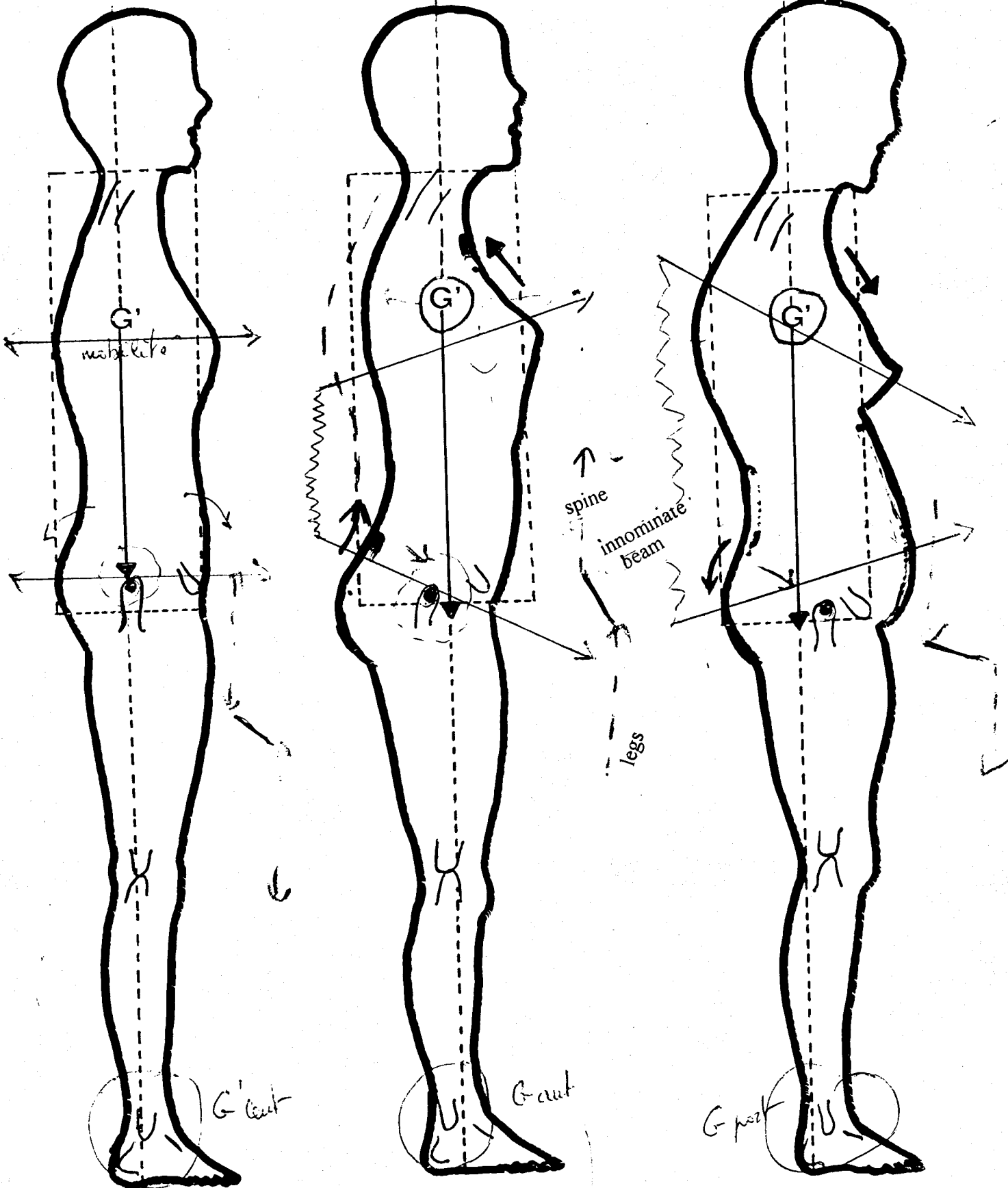


FIGURE 13

Figure 13
Basic Respiratory Patterns
From Godard

Anterior

Posterior



inhale, back to exhale. This gives us a dynamic definition of balance: the ability to move forward and back between the two gravity relationships—a different point of view from the one that equates balance with staying in the center. Any postural tension that prevents this forward and back movement will interfere with the breath. As well, a preference for inhalation or exhalation can be affected by working with the forward/back movement. To have this effect, we can start from a structural point of view by looking at the relationship of the body's masses: between the chest, head and pelvis; or from a functional view-point at the responsiveness of the spinal curves, cervical and lordotic.²² In both cases, responsiveness of the spinal muscles will be one key.²³

CONCLUSION

The biomechanics we have been exploring emphasize the inseparability of postural phenomena and breathing: The erector spinae, primary postural muscles, can also be considered primary breath muscles. The connective tissue sling that suspends the diaphragm can have a major effect on posture. Posture will also affect the work of specific muscles and the direction of the breath overall. Compensatory patterns provoke changes in breath and vice versa. For all these reasons, to understand an individual's breathing pattern it seems unavoidable to consider the postural patterns that interweave with it. But posture is not merely biomechanics. A person lives in constant relationship with an environment. Perception is a fundamental element in shaping that relationship. In the next section, we will look into this further. □

ENDNOTES

- ¹ Kapandji, I. *The Physiology of the Joints*, vol. 3. Churchill Livingstone, Edinburgh, 1974, p. 149.
- ² The relationship of an individual's movement patterns and his/her perception of the surrounding space will be developed in Part 3.
- ³ DeTroyer, A. Sampson, Michael, Sigrist, S., Macklem, P., *The Diaphragm: Two Muscles*, *Science*, Vol. 213, 10 July 1981.
- ⁴ Kapandji, 1974, p. 147.
- ⁵ Garlick, D. and Korner, P. (editors), *The actions of the two muscles of the diaphragm*, *Frontiers in Physiological Research*, Australian Academy of Science, p. 220-227.
- ⁶ Busquet, Leopold, *Les chaines musculaires*, Tome II, Editions. Maloine, Paris, 1992 p 26.
- ⁷ Bienfait, Marcel, *Fascias et Pompages*, SPEK, Paris 1995.
- ⁸ Ibid.
- ⁹ Souchart, Ph.E., *La respiration*, S.E.D. "Le Pousoæ" Saint-Mont, France.
- ¹⁰ Ibid.
- ¹¹ Bienfait, 1995, p.79.
- ¹² Souchart, p.25.
- ¹³ Kapandji, p.150.
- ¹⁴ Souchart, Ph.E. Ibid.
- ¹⁵ Pansky, B., *Review of Gross Anatomy*, Macmillan Publishing Co., NY 1979.
- ¹⁶ Souchart, p.56: "The respiratory contraction of the erector spinae can reach as far as T1 and rib 1 via longissimus which goes to T1 and by iliocostalis lumborum whose two inferior heads (from the common mass to the last 6 ribs and from the last six to the first ten) can contract independently of the superior head. This inspiratory fixation of the thoracic vertebral column allows the scapular inspiratory muscles to come into play." [translation mine]
- ¹⁷ Souchart, Ibid.
- ¹⁸ Bienfait, p. 79.
- ¹⁹ Souchart p.111.
- ²⁰ Souchart p.62.
- ²¹ Busquet, L., p.73.
- ²² The freedom of the knees, a virtual curve, will also be involved here.
- ²³ This is very much apparent in the traditional approach to the first session in Rolwing® structural integration. The goal is to affect the breath. The goal is accomplished by affecting the chest and pelvis relationship: by allowing them the freedom to move in relation to a changing gravity center.

Posture and Gravity¹

Part III

by Aline Newton

As bodies, we live in the field of gravity. Whatever other activity we are engaged in, be it sitting and reading this paper, walking, or playing, we also have to keep ourselves from falling over—we have to address the problem of the pull of gravity on our body. How we come to terms with this problem relates directly to what we commonly think of as posture. Moment by moment, below the level of consciousness, sensors are informing our brain of the location of each limb while the brain anticipates minute changes in our center of gravity as we move. At many levels data is collected and coordinated. The brain and nervous system orchestrate the perfect response to maintain our integrity, our uprightness, for the most part without our even noticing. This complex coordinative system could be called the postural or tonic system. It includes parts of the cortex, cerebellum, reticular formation, and brainstem, as well as nerve pathways, proprioceptors and exteroceptors, muscles spindles, golgi tendon organs, and special muscle fibers distributed throughout the body.² The oculomotor system and the inner ear play an important part, as do vestibular and neck reflexes. All parts are constantly occupied with keeping us upright in relation to the gravitational field, oriented, whatever task we may be performing. The basic action of breathing is intimately linked with this tonic, postural

activity in several ways which are outlined below.

MUSCLES OF RESPIRATION ARE ALSO POSTURAL MUSCLES

The natural breath is dependent on the complex coordination of mechanical and chemical actions in the body. Staying upright depends on intricate

In breathing, the muscles of inhalation are tonic, postural muscles, while the muscles that can help exhalation are more phasic.

patterns of interaction between nerves and muscles. Many muscles involved in natural breathing also participate in the activity of keeping us upright. Most of the muscles in the upper chest (pectoralis: minor and major: scalenes: sternocleidomastoid), for example, can be muscles of inhalation since their contraction can expand the ribcage. But we can also use them to hold ourselves up.

When this happens, the system becomes vulnerable: A small mis-

alignment that has become habitual can lead to an excess of contraction in these tonic, postural muscles. This then prevents their release, their response to the weight of ribcage, as the mechanism of exhalation unfolds. Remember that normal exhalation is a passive process, one that does not require muscular effort. The extra postural contraction throws a wrench in the works: when the muscles of inhalation do not release, muscles of forced expiration will be called into play to pull the ribcage down. The next breath then requires extra force of contraction for the inhalation muscles, and so on. The needs of the gravity system can disturb the delicate balance of muscular coordination upon which an easy breath depends. The result: a vicious circle, a spiraling increase in tension.

IN PRACTICE

Postural muscles have more tonic muscle fibers. They are designed for endurance. In contrast, phasic muscle fibers, designed for bursts of action, work at high intensity for a short time. In breathing, the muscles of inhalation are tonic, postural muscles, while the muscles that can help exhalation are more phasic. In a contest between a mostly tonic and a mostly phasic muscle, the tonic muscle wins out, since it is designed for endurance. When the muscles involved in inhalation, such as the scalenes or pectorals, don't release,

the muscles of forced expiration have to contract against them to allow exhalation. In the end, however, the tonic muscles of inhalation are stronger. In practice, this means that it is more effective to work towards the release of the tonic muscles, the scalenes, for example, than towards strengthening phasic muscles of forced exhalation, like the abdominals. As we have seen repeatedly, strengthening the antagonists (the abdominals, in this case) will just lead to an overall increase in tension. Are the muscles of inhalation free to release? Check for restrictions in the mouth, the jaw, the palate, or any one of the cervical vertebrae.

The postural system as a whole adjusts to the movement of the breath. Another way in which posture and breathing interact can be seen in the movement the breath induces in the body as a whole. With each breath, there is a small, continuous oscillation of the body's center of gravity. Breathing in, or breathing out, the body is always moving; the postural system is constantly adapting to this subtle shift. If for any reason, the body holds against the shift, the muscular contraction will interfere with the breath. Neither inhalation nor exhalation will be complete. And since inhaling depends on complete exhalation and vice versa, as we saw earlier in the mechanism of breathing, when the postural system is unable to adapt, the restriction will be reflected in the breath. Gurfinkel found that what looked like restrictions in the breath could actually be attributed to problems in the gravity system.³

Clearly there is a close connection between the tonic activity of the body in relation to gravity, what we tend to call posture, and the responsiveness of breathing. Although apparent once described, like the gravity function itself, it is an aspect of breathing that is often ignored.

BREATH, TONIC POSTURAL ACTIVITY AND TWO DIRECTIONS

For the easiest breath, the body has to be comfortable adjusting to shifts in relation to the gravitational field. Posture has to be adaptable to changing demands so as not to interfere with the breath.

As Hubert Godard points out, when we speak of "relationship with gravity," posture, or tonic activity — the body's constant adjustment to changing circumstances — we are referring to a sensory experience. We experience gravity through information coming through our senses, from within and from without.

E. Reed describes posture as the orientation of the individual vis-a-vis the environment.⁴ Thus it contains some information that is internal (proprioception) and some that is external (exteroception). Internal information is the sensation of one's own self: the sensations of proprioception and of the weight of the body. External information comes through the senses with which we orient; it is exteroception, the sense of the space around us, our environment.

According to Godard, these two kinds of perceptual information provide the basis for an inherent polarity of two directions, that can be expressed as up and down, or as inside and outside. As we will see, the way a person perceives the sensations related to these two directions, the way the information is received, will directly affect both the postural set and the mechanics of the breath. Ultimately it is the appropriate balance between the two directions that allows an effective relationship with gravity and easy and adaptive breathing.

SENSE OF WEIGHT

As we described in the preceding section, each breath induces a move-

ment in the whole body. The oscillation of the breath brings about a weight shift which is registered by plantar baroreceptors as the pressure in the feet changes. The receptors' signal brings about a readjustment of the postural system via the spinal curves to preserve upright stance. Tension in the feet and back, the quality of the relationship with the ground, will all also influence the flow of the breath.

The ability to exhale depends upon a comfortable relationship with the feeling of the body's weight. Without appropriate support through the back and feet into the ground, exhaling, feeling the body's weight, can feel like falling, an instability. This may create an unconscious holding pattern ("holding up") which interferes with an easy flow of breath. Resistance to the sensation of the weight in any segment of the body will cause a holding of the breath in inhalation, an inability to exhale completely.

SENSE OF ORIENTATION

Breathing can be facilitated or inhibited depending on the state of the mechanisms involved in orientation. The degree of tonic contraction needed to maintain our upright stance in the field of gravity depends in part on the orientation system. The inner ear, the tension level of the cervical vertebrae and the position of the head all influence the level of tone of the body as a whole and will thereby influence the freedom of the breath.

The work of Matthias Alexander provides a good illustration: In scientific studies, Alexander's technique, which works to increase proprioceptive awareness, with a focus on movements of the neck, results in a distinct improvement in respiration—without ever directing attention to the breath itself.⁵

The quality of perception of the orientation system also has an impact on the mechanics of breath: Electromyographical research shows that the scalenes are primary in inspiration because they pull up on the upper ribs, thus increasing the diameter of the ribcage. However, as we noted above, Kapandji points out that these muscles can only help in inspiration when they can act on a cervical vertebral column that is stabilized.⁶ Without this support, the scalenes would simply pull down on the cervical vertebrae, increasing the cervical lordosis.

Based on empirical evidence from training dancers over many years and borne out by his own electromyographical research, Godard has shown that the orienting senses, when properly activated, stimulate a relationship with the surrounding space that allows it to offer support for movement just like the ground. The perceptual receptivity to the space provides a direction that changes the pattern of muscle contraction in the spinal muscles, allowing them to stabilize the cervical vertebrae without excessive compression, putting the scalenes in a mechanically efficient position to lift the ribs for inhalation.

The movement of inhaling depends on the sensations of orientation; it is a movement upward and outward; exhaling is coming home, coming back into ourselves, feeling our weight. The movements and the breath are influenced by the perception of the sensations of the two directions.

TONIC POSTURAL ACTIVITY DEPENDS ON PERCEPTION, ON SENSATION

Godard emphasizes the distinction between sensation and perception:

"The space of sensation is to the space of perception as the terrain is to geography. The space of perception is a geographic space. The structure of geographic space is in no way identical to the physical space (the terrain itself, the state of the body).⁷ Perception is an interpretation of information coming through the senses. Through descending pathways, the nervous system is always undergoing a selection process in relation to incoming information. Receptors from skin, muscles, joints, and all our senses are bringing signals towards the brain. The descending pathways are the control mechanism that chooses which sensations reach the brain. These pathways are influenced by our physical and emotional history (via the limbic system) and our state in the present.

As Godard points out in the two examples that follow, the perception of body sensations can be modified or even suppressed by the will or by a mistake in cognitive interpretation brought about through the other senses. In one study, subjects walking forward were exposed to films projected on the walls of the room that gave them the optical impression of moving backward. When asked, the subjects reported that they were moving backwards despite the actual forward movement of their legs.⁸

In another case, a workman who was accidentally locked in a freezer was discovered in the morning frozen to death with all the clinical signs of that condition. However, due to an electrical failure the previous evening, the freezer had not been on. He believed, and so it was.⁹

Many veils can obscure sensory information from the body and thus falsify its perception. These examples illustrate that perception and sensation are not a simple straightforward

phenomenon. Perception is an action: an activity in which choices are being made. In part, these choices are a function of each individual's personal history. We have already seen that breath depends on the quality of tonic postural activity which itself depends on the perception of sensory information coming from inside and outside. Thus, a person's breath is a physiological event and a perceptual one. Habits of perception are strongly influenced by personal history and environment, assumptions and cultural customs. Meaning shapes perception. The breath will be a result of symbolism and psychology as much as it is of anatomy and biomechanics.

As Godard has described it, our experience of gravity has two directions, an inside (weight) and an outside (orientation). In breathing we also create a relationship between the inside and the outside. From this point of view, the experience of breath (like the experience of gravity) expresses the relationship between the person and the environment. It is an interaction. It raises issues of territoriality and control. Breath relates us to our world.¹⁰ Each breath has a particular shape: the deep, calm breath of a sleeping child, the short "breathlessness" of anxiety, the resignation of a sigh. Through its ease, its depth, its rhythm, breath expresses the quality of that relationship at each moment.

In inhaling, we open a connection to the outside. Breath brings to us the smells of the world outside. Some draw us out while others repel us. We can welcome the air, trusting its flow, or we can struggle with it, pulling it to us—two very different breaths, two different expressions in muscle use and physiological effect. To have an easy inhalation, there needs to be a real sense of the space outside, a link to another. Exhaled, breath is voice. It

carries us beyond our own body, extending our frontier. It returns to us, as we hear the sound of our own voice. With the voice we reach out, and meet response or indifference, experiencing our power or our weakness.

Exhaling forcibly requires the same muscles as the action of pushing, what we need to be able to do to establish a space of our own. The symbolic significance of pushing, issues of autonomy and relationship, may lead to muscular holding¹¹—holding back which restricts the movement of the ribcage either in inhaling or exhaling. This then impedes the freedom of the parts and interferes with a free and easy breath.

The quality of each breath reflects the complexity of our relation with the world. The physiological breath is a vehicle for the expression of being human.

IN PRACTICE

a. What does our breath do when we touch? It will be an expression of our relationship with our client.

b. The surface, the skin, the interface between the inside and outside of our body boundary, has as important a role to play as the center. Sensory stimulation, via tactile and temperature receptors in the skin, has a direct effect on the rate of breathing. The skin breathes; expanding and contracting like a third lung. Experience and physiology inform us that work with the skin, with the sense of touch, has a direct effect on the breath.

c. Understanding the interaction of the gravity system and the breath, suggests an indirect way to work with the breath: by working with a person's sense of his/her own weight, the proprioceptive sense or sense of inside, and with the sense of exteroception, of the space outside

and around them. The work will be to balance the quality and quantity of sensory information coming from the two types of receptors, the two directions.

Even as simple a cue as to direct the eyes/the gaze slightly upward when inhaling, and towards the knees, or downward upon exhaling may change the quality of the breath. Our analysis above also reminds us that in context, to work with breath or with the perception of gravity, we will always have to take into consideration what the breath expresses for a given individual in a given relationship—be it with another individual or a group or the world as a whole. To affect the breath, beyond a superficial moment of voluntary control, is to work with the meaning of the movement.

CONCLUSION

Breathing is a fundamental expression of life. As such it is deeply related to other fundamental functions like posture and emotional expression. The study of breathing traces a circle in which physiology, mechanics and expression follow each other like the inhalation and exhalation of the breath itself.

The meaning dimension directly affects perception, sensation, and therefore posture and the mechanics of breathing, and through this path, directly impacts the physiology of the breath.

A person exists only in relation to their environment and not as an independent "objective" entity. Physiology does not describe the working of a machine: It is an expression of our being in the world. Breathing is a fundamental movement through which the whole human being-in-situation is expressed. Working in rehabilitation or to change patterns of breathing

necessitates maintaining the broad view of a human being in the world with which we began this inquiry. It requires remembering to include ourselves, the practitioner, in the encounter. To consider a living being from the point of view of mechanics and biochemical functioning prevents any true meeting. To work with breathing requires as deep an understanding of psychodynamics as of science, and a willingness to begin always again with experience. This synthesis underlies effective, original work with the breath. □

1 This section is based on an untranslated paper by Hubert Godard, "Le souffle-le lien."

2 Azemar, G., *Neurobiologie des comportements moteurs*, Publication of INSEP, Paris.

3 Gurfinkel, V.S., et al, *Models of the structural-functional organization of certain biological systems*, Cambridge, MIT, 1971.

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11. Conversely, a weakness in one of the senses of gravitational direction may lead to an inability to make comfortably the fundamental movement of pushing, which may be reflected in the experience of autonomy issues on a behavioural level.