

2.1 Sanomechanical Approach to Exercises

The systems of perfecting body and mind through systematic exercises usually try to unite the physical aspects of the routine with a philosophical background. Sanomechanics as a system does the same. What distinguishes sanomechanics from other systems is its foundation in the floating skeleton concept. Relying on this new, biomechanically justified concept, sanomechanics consists of the corresponding technique, autosuggestion and criterion of correctness of performance. The structure of the sanomechanical approach to exercise is schematically depicted in Fig. 2.1 (where the “biomechanical concept” was presented and discussed in Chap. 1). The conceptual autosuggestion, technique, and criterion of correctness of performance, their biomechanical justification will be discussed below.

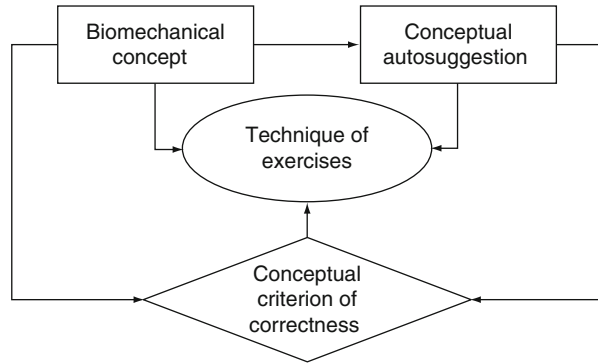
2.2 Conceptual Autosuggestion

2.2.1 Biomechanics of Visualization and Anticipation

Visualization is a way of seeing beyond what the eyes see. An image either appears when we consciously suggest it to our mind, or uncontrollably, as in dreams. Visualization is the bridge between our conscious and subconscious, and a tool for their interaction. Just as any tool, it can be useful if used properly, or useless and harmful otherwise. The spectrum of focused applications of visualization is very wide, ranging from athletes who hope to improve their performance to autogenic training and religious mysticism.

People have harnessed the power of visualization through meditation for thousands of years. Only in the past decades have neurological advances permitted us to begin to understand the link between mental visualization and the attendant physiological responses. Visualization, when applied to biomechanics, would require a person to select an image from a mental “library” of images, and guided by it, to coordinate his or her body segment’s movements.

Fig. 2.1 Structure of the method of sanomechanics



The physiological mechanism called *anticipation* is a generalization of visualization. It is the brain's ability to predict movements and prepare the body for its tasks. Unlike visualization, anticipation does not require a definite image. It is a preplan for a goal-oriented movement in response to a visual or verbal stimulus, or for a movement generated by reflex. An example is the goal of maintaining balance while walking. The goal is achieved with a preplan for how to respond to external disturbances, like a patch of ice on the sidewalk, or your name yelled out across the street. With anticipation, the body is aware of the imminent task, and reacts faster than when the task comes abruptly. Naturally, the body's reaction is safer when it is prepared (Houck et al. 2006).

The human skeleton has more than 200 movable joints. The joints have one, two or three degrees of freedom, and almost each degree of freedom can be operated independently. Controlling body movements with both speed and precision in order to reach purposeful outcomes is therefore a great challenge. The breakthrough explanation of how the body meets this challenge was proposed by Nikolai Bernstein (Бернштейн 1927, 1947; Bernstein 1967), who suggested that certain degrees of freedom can be controlled together by one parameter synergistically.¹ According to the theory, goal-oriented actions of the body are organized through hierarchical top-down control, where the bottom levels are devoted to automatic and instinctual movements, freeing the higher levels to respond to new and unexpected tasks.

When a person is standing and is told to raise his hand, his conditions of balance change, and without compensatory action, the innocent arm raise will jeopardize his balance and safety. The system of posture control prevents him from falling. The posture control directs synchronous movements of body segments, adjusting to the movement of the arm automatically. An analysis detected a delay (latent period) of 130–140 ms ($1 \text{ ms} = 10^{-3} \text{ sec}$) between the time when a subject was given the command to raise his hand and the beginning of movements (Belen'kii et al. 1967). The latent period depends on the nature of the task that the body performs. If the task is expected, the latent period is shorter, and if the task is an unexpected perturbation, the latent period is longer. When the task is preplanned,

¹Synergy from Greek *syn-ergos* (working together)

the control system can use the more standard programs of synergistic movements in the required degrees of freedom of the body. When the task is unplanned, it takes additional time to adjust the standard programs adequately.

The latent period of muscle response is also age dependent, and increases with age (Inglin and Woollacott 1988), especially for unexpected perturbations. To maintain safety, a compensatory strategy of generalized stiffening through co-contraction may be developed, as suggested by Maki (1993). The body's stiffening in the elderly corresponds to the process of a decrease in the range of motion (flexibility) in joints (Nigg and Skleryk 1988; Bassey et al. 1989).

The complexity of controlling movements in multiple degrees of freedom can be appreciated if we, following the studies conducted by Nikolai Bernstein in 1930 (Bernstein 1930), look at how a pianist presses the piano key. We began by positioning the index finger on an A key in a “regular” fashion, as shown in Fig. 2.2. The pianist was asked to press the same key with different configurations of the arm (Fig. 2.3), without changing the position of the torso. In this setting, the distance between the shoulder joint and the piano key remained unchanged. The shoulder joint has three degrees of freedom; the elbow joint has one; the

Fig. 2.2 Positioning of the index finger on the piano key “A” with standard angulations in its phalanges, as well as in the wrist, elbow, and shoulder joints



Fig. 2.3 The same end positioning of the index finger on the “A” key (as shown at the top left), but with different angulations in the joints of the arm

wrist, three; the finger, three. So the tip of the finger is an end point of a poly-linker with ten degrees of freedom. Figure 2.3 shows ten configurations of the arm, representing a tiny fraction of the total number of possible configurations that solve the experiment's task.

Now, let us turn to the reality of playing a piece of music, when the fingers have to press many keys in a predetermined time sequence (tempo/rhythm). We immediately see a dramatic reduction of the number of possible configurations of the arm. Moreover, even if the piece is played by different musicians, their respective patterns of arm movements are remarkably similar to each other's, with minor individual differences. The phenomenon of such a stable pattern of pre-trained movements can be explained by the concept of joint synergies as well.

The development of synergies allows the motion of many segments to be organized and controlled by a single parameter. If we try to imagine how many degrees of freedom there are in internal organs, vessels, and soft tissues, we realize that control over the motion of body segments is just the tip of the iceberg. In this book, we will work towards achieving the goal of restoring and activating the hydraulic net around our skeleton. This task also requires precise control over the performance of all components of the net. To provide this control, we need to inform the body of what is anticipated in the course of exercising according to the new *floating skeleton* concept. The best way to do this is to develop a specific autosuggestion, and to use it during exercise sessions.

2.2.2

Autosuggestion

In a sense, autosuggestion is a goal-oriented anticipation of a body's reaction to a task. Autosuggestion as a healing factor was introduced by Emile Coué (Coué 1923), who has written about its closeness to meditation. He also stressed that it was only realistic outcomes – not miracles – that could be expected.

The second milestone in broadly introducing therapeutic autosuggestions to the masses was the development of *autogenic training* by Schultz in 1932 (Luthe and Schultz 1969). The method includes a special relaxation technique designed to increase the acceptance of autosuggestion by the body and mind (suggestibility). Dr. Schultz found that natural suggestibility reaches its maximal level in the morning during the transition from sleep to wakefulness.

The next step in making autogenic therapy a successful methodology was made by Sonya Lyubinskaya, who formulated a rule called the “right to autosuggestion” (Lyubinskaya 1970). A person must “earn” the right to practice autosuggestion by taking adequate preparatory measures, i.e., meeting certain preconditions. For example, if a person wishes to restore his or her energy, the autosuggestion “I feel more energetic and less tired” will work only if the person is genuinely willing to improve his lifestyle, eating habits, etc. The autosuggestion “I will earn a high score on my exam” is useful only after the person has dutifully attended lecture and read his notes.

For all sanomechanical exercises, we will invoke the image of a skeleton, with synovial liquid filling the space between the bones' surfaces and the periosteum. The image is based on the concept of the *floating skeleton* (Chap. 1) and will be used to develop

the sanomechanical autosuggestion. We must visualize this image; in combination with the *criterion of correctness of the exercise* to be discussed below, it will provide us with the right to sanomechanical auto suggestion: “My skeleton in totally immersed in synovial fluid.”

2.3

Criterion of Correctness of the Exercise

2.3.1

Level of Sensation

It is good to know, before embarking on an exercise, how we will control its duration, associated loads, and ranges of motion. We need a criterion or criteria of correctness for our exercises, which can minimize the risks and maximize the positive effects of the exercises.

In sanomechanical exercises, I suggest that a *hedonic² criterion*, based on the pleasurable signal coming from the involved zones of the body, be used to evaluate the exercise’s correctness. The hedonic criterion loosely finds its philosophical grandfather in the *pleasure principle* proposed by Sigmund Freud with his hierarchy of the psyche: *id-ego-super ego*.

In the *pleasure principle*, Freud ascribed the motivating and rewarding signals of pleasure to a person’s *id* lying at the bottom of the psyche’s hierarchy. In Freud’s theory, the person’s *ego* and *super ego* have to suppress the *id*’s desire of perpetually remaining in the pleasure zone, in order to set up and solve the tasks of higher importance. The requests for pleasure from the *id* are constrained by Freud’s *reality principle*, which separates the “good” requests from the “bad” according to standards meaningful for the person.

For the purpose of *sanomechanical* theory, let us borrow Freud’s terminology, and speak of the physical body’s or skeleton’s unconscious requests as those coming from the *id*. These requests may be for pleasure, or for the avoidance of pain. These signals can also be suppressed by reality. For example, a surgeon will continue a procedure until its completion, even if his feet feel pain for having stood for a long time. Or, one might not stretch in the boardroom, no matter how pleasurable the stretch, because it would contradict the code of social conduct.

When we reach a point of unhappiness with our health, we may realize by looking back that in the past we did not follow and did not respect some legitimate requests from the body. So, to stop or at least to slow down our health’s decline let us elevate the meaning of the pleasure signal from the skeleton by accepting its importance through the *super ego*. It will give us a hedonic criterion of correctness of our actions during exercising. From now on, according to the criterion, let us nourish the pleasure signal from the skeleton, rather than suppress it. Compared to many of the *id*’s other pleasure requests like those associated with hunger or sexuality, the requests from our skeleton, if met, do not have potential negative side effects. As to the positive consequences, they were presented and discussed in Chap. 1 and will be made more evident in Chap. 5.

²The term *hedonic* means “related to pleasure” from the Greek *hēdonē*, pleasure

Each relative position of body segments produces one of three basic types of signals to the brain: zero/neutral, pleasure, and pain. When you read a book – for example, when you read this page – your head's position is determined by what is convenient for your eyes. At the same time, this position is probably comfortable enough for your neck. If it is comfortable indeed, you may say that the neck generates a zero/neutral signal. If the position generates pain then you, like everyone else, will (or should) alter it in an attempt to eliminate or minimize the pain. That unconscious change in neck position will be an action generated by your *id*. If your *ego* or *super ego* insists on the critical importance of continuing the reading uninterrupted, you will comply, leaving the pain signal unaddressed at least for a while. If suppressing or ignoring the pain signal becomes a pattern, it may cause *osteochondritis*,³ and the first and most straightforward recommendation from your doctor would be to avoid the painful position of the neck during reading. To use Freud's terminology, the recommendation is to teach your *super ego* not to suppress the pain signal from the *id*.

A fundamental fact is that between the neutral and painful zones there is an interval that gives a sense of pleasure. We need to examine the nature of the pleasure signal from our joints in order to understand the purpose and the aim of such encouragement.

The signals entering the brain and informing it about the situation at the periphery are called *afferent* signals, whereas the brain sends *efferent* signals as commands back to the periphery. Usually, routine locomotion and familiar movements are organized in such a way as to reduce the inflow of signals, and this tendency is called the *principle of minimization of afferent information*. Those movements which are new and require learning, like new professional or athletic techniques, generate an influx of afferent information, which is diminished once the movements become more automatic.

Let us ask ourselves: why, in the course of an automatic routine's development, does the body not try to increase the inflow of pleasure signals, but organizes the motions to generate a lesser and lesser volume of afferent signals? To find the answer we need to go beyond biomechanics and to enter the philosophy of a human life's purpose. In a broad sense, the purpose is to modify the environment. The purpose is ambitious indeed and requires guidance from the *super ego*, not the *id*. Cyclic routines have to use a small part of the brain's controlling capacity, leaving its major power for solving extraordinary tasks in the quickly changing and dangerous world surrounding us.

Generally, pleasure is the signal of a useful stimulus, and pain is a signal of danger. Usefulness or danger in maintaining homeostasis and in achieving higher human aims is judged by the peripheral and central nervous system. A hedonic hierarchy is thereby established, with positive and negative values of stimuli, where the higher levels have supremacy over the lower levels, and where physiological stimuli are mixed and bound with the psychological. Positive values relate to pleasure (Cabanac 1979) and negative values relate to displeasure (Hoffman et al. 2008). Over a lifetime, the stimuli may change their position in the hierarchy, thereby directly or indirectly affecting our motivations and behavior. They may change their position several times within a day, like the desire to eat (appetite), which goes up in the hierarchy when we are hungry and goes down as we consume enough

³Inflammation of bone and cartilage

food. An abrupt jump to the highest priority of a stimulus may occur any time if related to protecting the body's integrity, such as when we are burned. The changes in priorities are described by Sigmund Freud as the constant conflict of the *reality principle* and the *pleasure principle* (Freud 1929). We may say that a person establishes for himself/herself and chooses to follow the *hedonic criterion* as result of a victory of Freud's *pleasure principle* over the *reality principle*. It is a victory driven by the person's *id*, but proclaimed and confirmed by the person's *ego* and *super ego*.

We already spoke about positioning the head while reading. Once we feel that the reading is important, either for giving us intellectual pleasure or meeting professional needs, we may and we almost certainly do automatically suppress the demand from the neck to find a position in which the sensation of pleasure would be maximized. We prefer reading with an indifferent afferent signal from the neck. It is convenient indeed, since it allows us to concentrate on the contents of the reading material in front of us, instead of sharing our attention with analyzing the neck's well-being. The reality principle assigns higher priority to reading and lower priority to the neck's pleasure. The reward comes or is anticipated to come from the sphere of psychology rather than the body's physiology.

The situation may change if a negative hedonic signal (pain) tells us that our neck is in trouble. If the signal is tolerable, we may choose not to react and continue what we were doing before. However, if the pain persists, its priority in the hedonic hierarchy goes up, until it exceeds that of reading. At this point, we have to address the pain somehow. For instance, we may change the neck's position or massage it. We may simply stop reading. In worse scenarios, we opt for treatment. However, the best way to address the situation would be to do a couple of exercises, to be described soon.

2.3.2

Pleasure Signal from Joints and from Muscles

Pain and pleasure – these are the two most informative “words” in the language through which the body and the mind communicate. These two “words” come from various locations in the body, and with different levels of intensity and duration. Sometimes, the message is clear, but most of the time, it has to be decoded in order to better understand it and to respond. Such decoding may require collecting and analyzing data from medical tests. All organs and systems in the body use this language directly or indirectly. The sense of pleasure encourages us toward certain actions and rewards us for doing certain things, while pain serves as a discouraging warning or punishment for something.

Below is a portrait of muscular pleasure presented by Dr. Thomas Brown in his *Lectures on the Philosophy of the Mind* (Brown 1822).

Muscular pleasure of alacrity and action forms so great a part of the delight of the young of every species of living beings and is felt, though in a less degree, at every period of life that doubles to every one the delight of exercise by sweetening the repose to which it leads, and thus making it indirectly, as well as directly, a source of enjoyment.

In response to muscle exercises, the body produces dopamine, which contributes to the pleasure sensation (Arakawa 2002; Foley and Fleshner 2008). Activation of muscles attached to the bones periodically pulls the periosteum away from the bone surfaces and in

this way improves the hydraulic connectivity of the joints. Therefore, the chemical mechanism of encouragement of the muscle workout and development indirectly rewards the restoration of the skeleton's hydraulic net. That chemical mechanism may mask a direct signal of pleasure from the articulation in a particular joint. We therefore need to learn how to listen to that voice with our full attention, and respectfully follow its humble requests, giving them higher priority.

Based on the floating skeleton concept, we assume that the pleasure signal from the joints is an encouragement for creating and maintaining conditions for the restoration of the hydraulic net of all synovial joints. At the same time, it may coincide with the encouragement for activity in muscles, and for a regenerative effect in the joint cartilages as the mobility in joints increases (Salter 1994).

2.3.3

Duration of Keeping a Position

Understanding and addressing the body's pleasure signal is easy and enjoyable. When I bend my torso forward, trying to touch the floor with my fingers, I hold my position as soon as the encouragement zone is reached, and stay in this position until the pleasure subsides. I don't try anymore, like I did in my younger years, to cross the pleasure threshold and enter the pain zone, in attempts to increase my range of motion.

2.4

Technique of Exercising

The technique of exercising is at the core of sanomechanics. It includes informational and instructional parts for the mind and for the body. We will observe the technique now, since we have already become familiar with conceptual autosuggestion, and with criterion of correctness of performance.

The sanomechanical autosuggestion:

“My skeleton is totally immersed in the synovial fluid” will work to maximize the effectiveness of your exercises because you can now visualize the concept and activate a mechanism of anticipation for optimal selection of synergies.

You are already familiar with the hedonic criterion of correctness of performance and you understand the nature of the feedback that the body generates in response to the current angle in a joint. You know that the sensation of pleasure we find at a certain angle in the joint encourages us to keep that angle and to hold that position until the signal disappears. We know the purpose of this holding in space and time: the joint becomes hydraulically connected to the entire skeletal net.

As any joint sends feedback signals to the nervous system about its well-being, the signal may be neutral, encouraging, or discouraging. A neutral signal conveys that in this zone of the joint's anatomical range of motion, mobility is not restricted. An encouraging/pleasurable signal comes when the amplitude of articulation is extended outside of the

neutral zone and it tells us that by holding this angle, we benefit our body. Once articulation continues, the encouraging feedback signal transforms into a discouraging one and very soon becomes a signal of pain.

The structure of mobility zones of a typical joint at the beginning of the sanomechanical series (position 1) is depicted in Fig. 2.4 (replica of Fig. 1.12). It shows zone A_1 where mobility is unrestricted and the sensation feedback is neutral; zones B_{1-} and B_{1+} , where the feedback signal becomes encouraging; and zones C_{1-} and C_{1+} with the pain signal. The ranges for zones A, B, and C are very individual and are different not only for the different joints, but for the different degrees of freedom in each of them.

The level of the feedback signal, as a function of the angle in a joint, is schematically depicted in Fig. 2.5, where the joint angle zones correspond to the diagram in Fig. 2.4. In addition to the ranges of zones A, B, and C, the amplitudes of the signals are strictly individual, and may not be symmetrical as shown.

Attributing any position of the joint to a specific zone also depends on how long the joint remains in that zone. For example, if one keeps the head in a neutral position without any pleasant or unpleasant sensation for a long time, a sensation of tiredness and even pain may appear. The sanomechanical technique recognizes that the encouragement/pleasure sensation also diminishes with time.

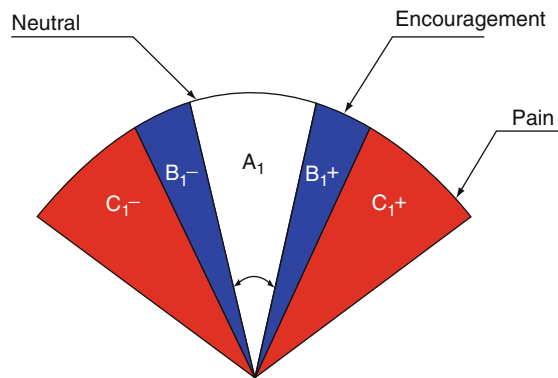


Fig. 2.4 Zones of mobility of a joint in position 1. A_1 , unrestricted neutral zone; B_{1-} and B_{1+} , encouragement zones; C_{1-} and C_{1+} , pain zones

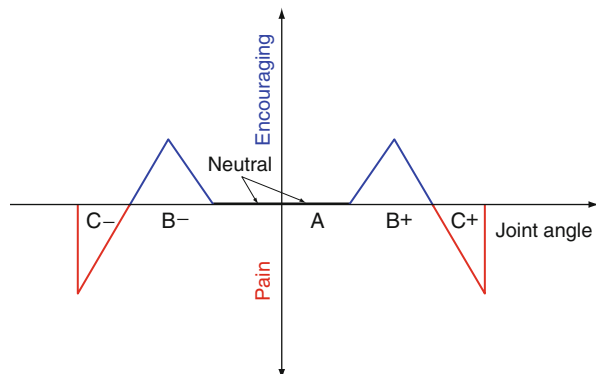


Fig. 2.5 A chart of the feedback sensation the body gets in response to a changing angle in a typical joint. Blue – encouraging/pleasure signal; red – discouraging/pain signal. The joint angle zones correspond to the diagram in Fig. 2.4

2.4.1

Cycles of Changing the Joint Angle

- We begin any sanomechanical exercise in the middle of zone A_1 , as the initial position 1 (Fig. 2.4) where the sensation is neutral (Fig. 2.5).
- Next, we move within zone A_1 , to its border with the zone B_1+ , where the sensation is encouraging.
- When we enter zone B_1+ we hold the position, for as long as the encouragement/pleasure feedback is sensed.
- We may carefully move within B_1+ , but not enter the zone of pain C_1+ .
- Once the encouragement/pleasure signal disappears, we may continue articulation, looking for the next encouragement zone B_2+ in position 2 (Fig. 2.6).
- We stay in zone B_2+ until the encouragement/pleasure signal disappears. That will complete the first cycle of the exercise: transfer from position 1 to position 2.
- We will see that the combined range of motion of zones A_2 and B_2+ in position 2 will be greater than the combined range of motion of zones A_1 and B_1+ in position 1.
- Then, we may go to the next cycles of transfer: from position 2 to position 3, and finally from position 3 to position 4, with position 3 and 4 defined the same way as positions 1 and 2.
- We complete the exercise by returning to position 1, and may repeat it, moving in the other direction.

2.4.2

Example of a Sanomechanical Exercise

Here is a typical sanomechanical exercise. Figure 2.7 (R) depicts three cycles of bending from the neutral position (1) to the right (2,3,4). Figure 2.7 (L) shows the neck bending from the neutral position (1) to the left (2,3,4). All cycles have to be performed very slowly, without any tension.

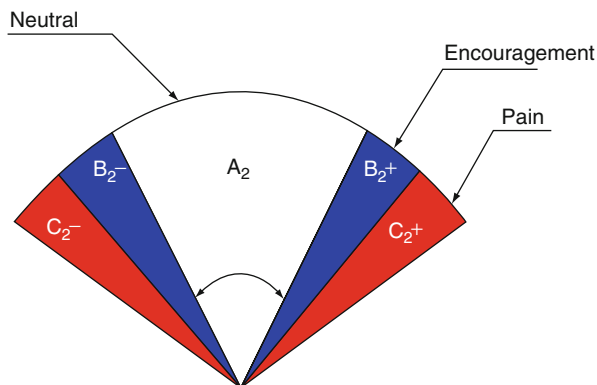


Fig. 2.6 Zones of mobility of a joint in position 2. A_2 , new unrestricted neutral zone (compare with Fig. 2.4); B_2- and B_2+ , encouragement zones; C_2- and C_2+ , pain zones

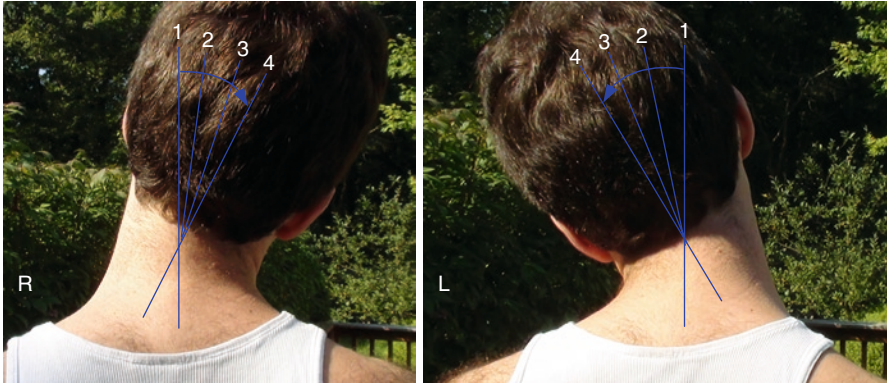


Fig. 2.7 R, bending the neck from the neutral position (1) to the right (2,3,4); L, bending the neck from the neutral position (1) to the left (2,3,4)

- Step 1. Confirm to yourself that the current position (Fig. 2.7 (R,1)) of your neck generates neither a signal of pleasure, nor of displeasure.
- Step 2. Tell yourself:
 - “I am going to lean my head to the right so slowly that a casual observer might not notice it.”
 - “I will stop bending and will slowly return back if a sensation of displeasure or pain arises.”
 - “I will stop bending when a sensation of pleasure arises, and will stay in that position until the sensation of pleasure disappears. I will then continue to position 2 (Fig. 2.7 (R,2)) or return to the neutral position.”
- Step 3. Begin bending your neck as slowly as you instructed yourself and with the end points described in Step 2.
- Step 4. You may do all positions 1,2,3,4, or return back to neutral position 1 based on your feeling.
- Step 5. Repeat Steps 1–4 for bending to the left (Fig. 2.7 (L)).

I hope that the experiments will go well and you will feel some relief in the neck.

2.5 Conclusion

You might feel shy about doing sanomechanical exercises as often as you feel is needed, since other people around might see you, and you are not comfortable with it. You understand that the people around are not comfortable either, watching you in strange postures.

To deal with this feeling you may first recall whether you have ever seen someone running in the street, or stretching, or doing tai chi or yoga in the park or somewhere else? What was your reaction, what did you think about these people, if you thought about them at all?

Most likely you have seen people who were exercising without being self-conscious. Most likely you told yourself: “I would do it also, if I had enough time, appropriate apparel, a place for changing and taking a shower, or if I were younger and slimmer.”

Then imagine that someone who is less fit, older, and heavier is watching you exercising and thinks about you as a model to follow. Would not you be willing to help someone who needs your example?

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