Power Shiver Performance Training, PSPT
Shiver-Based Muscle Toning

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1. Exercise

First – an obvious contradiction. Common knowledge suggests that to tone up and strengthen your muscles one is expected to engage in vigorous exercises over long sessions. Vigorous exercising involves spending significant amount of energy and burning lots of calories… and time. However, the human body is designed in such a way that it performs physical work (and vigorous exercise) in the most economic manner: it saves energy by optimizing its use.

Thus, in our context, there is a contradiction: In order to maximize the efficiency of our exercise in achieving its objective – toning our muscles in the shortest time by spending energy – the exercise must override the body's natural energy efficiency, and do it in the most efficient way – an obvious contradiction. Shiver, the key element of the Power Shiver Performance Training (PSPT) is (1) highly "energy inefficient", (2) can be made intense, (3) short-duration, and (4) simple to accomplish. Importantly, PSPT is always available, no matter whether you are at home, office, or on travel – you do not need any equipment or gym to get in an "aerobic" state quickly, and have your exercise.

Another plus of Shiver Toning (S-toning) is its focus on the entire body engagement. A session of conventional exercises normally stops not because the entire body reaches its natural endurance limit, but because a group of muscles involved in a particular type of exercise (jumping rope, squats, regular pushups, etc.) reaches its own, “local” limit of endurance. S-toning exercise provides a more rounded-up workout for the entire body.

To check the first two claims, we ran an experiment comparing the S-toning exercise with several other types of conventional exercises. Although the ultimate objective was to compare the calorie burning rate as a function of time, in the first phase of our experiments we measured the history of the heartbeat rates as its substitute, assuming that the heartbeat rate is proportional to the rate of calories burning. Another important parameter – extent of the entire-body muscle engagement was more difficult to evaluate quantitatively. One may observe however that S-toning exercise provides a much better entire-body engagement as compared to the observations of conventional exercises.

The following high intensity conventional exercises are proposed for the experiment: jumping rope, squats, and regular pushups.

2. Why Shivering?

According to http://en.wikipedia.org/wiki/Shivering, Par. 3, in shivering caused by hypothermia, the muscle activity is utilized predominantly to generate heat, not body motion. Shivering is best for heating up the body since it is extremely “inefficient”: it produces practically no body movement in space – the body is essentially at rest – while generating a large amount of heat within the muscles that rapidly contract and relax in the shivering body.

As an example, if we look at the energy spent as a function of time for an arm waving with large amplitude of movement, we will notice that the energy spent by the arm muscles has two peaks occurring at the two moments in time, precisely when the arm reverses its direction – the moments of maximum acceleration: slowing down and then speeding up again. However, most of the time, specifically between those two peaks – let's call it the “dead zone” which is the longest part of the arm exercise cycle – the arm is actually moving mostly by inertia, with minimal acceleration, so that very little energy is required, and spent to support that movement ("dead zone" since it is "useless" in terms of the sought benefit of the exercise, or for producing heat in the muscle).

In shivering, the dead zone in the muscle contraction-relaxation cycle is significantly reduced, making the entire oscillatory process extremely efficient in power generation (and energy expenditure) – most of the time the muscles are engaged in acceleration and thus the main objective of shivering is achieved: the stored biological energy of the body is “wasted” in a most efficient way, a significant amount of heat is generated quickly and the body is rapidly heated, as intended.

3. Training in Speed of Performance – Power Shivering Technique

Turning to sports. Our main position for sports involving physical interaction (most of the one-on-one or team games) is as follows: the **speed of performance** is the dominating factor in achieving victory, with **techniques and strategy** being important but secondary contributors. The capability of faster performance elevates the athlete to an advanced, shorter-scale operation time domain and allows responding to the opponent's attacks as well as staging athlete's own attacks quicker; this capability will lead to victory since a split-second advantage in a quick game will be crucial. In other words, faster physical movement execution aided by a good game strategy and techniques, in this order, makes a winning package.

Table Tennis – Personal Experience. Most table tennis players will agree that the offensive style of play is, statistically, a winning strategy: the defensive player is already at disadvantage through being forced by his/her opponent to respond; the additional split-second advantage of the attacking player seals the victory, all other parameters equal. After just two months of PSPT exercises my table tennis partners noticed a remarkable change in my style: specifically, the game became noticeably faster, and better.

The proposed training to boost the speed of physical action/performance by the power shivering technique, aims at two complementary objectives – developing the muscles' contraction speed and muscle strengthening, both contributing to the speed of performance. The core of the PSPT is the self-induced high-frequency low-amplitude shivering of the body, optionally against an external load. For example, to improve the arms speed, the PSPT should be done while holding dumbbells; other means to impose a load on the extremities or other parts of the body are possible, including the weight of the body itself. Increasing the shiver frequency increases the efficiency of PSPT by forcing the muscles to undergo accelerations more rapidly in alternate directions against the weight of the dumbbells (and/or the body mass) strengthening the muscles and, at the same time training them to contract more rapidly. Lowering the amplitude of shiver eliminates or drastically reduces the duration of the dead zone mentioned above, contributing to the enhanced efficiency of the PSPT technique and increasing the intensity and accelerating the progress of the speed performance training. It is important that the self-induced shiver is typically imposed on a statically loaded body (anaerobic load) which increases the general body strength.

Here are some of the advantages of the PSPT technique: (a) no need for equipment except for dumbbells; thus, the training can be done even in a confined office environment, (b) practically all groups of the body muscles get engaged. This is important since most of the games or other speed-performance activities involve groups of muscles acting rapidly and in coordination, (c) the exercise is a variable-intensity aerobic-anaerobic blend controlled by the chosen training environment, and (d) PSPT exercises can be executed in a series of short bursts to reduce the duration of each training session. There is an additional advantage of the PSPT exercise: it engages the entire body – all internal organs and surrounding fat tissues pick up the vibrations of the shivering body, and that contributes to enhanced circulation and improvement of the organ performance and health, and efficiently burns the body fat. The PSPT exercises can be made as strenuous as desired so that endurance can be improved, and muscles strength and speed of response – enhanced. Importantly, estimates show that power consumption of shivering (https://openoregon.pressbooks.pub/bodyphysics/chapter/human-metabolism/) is very high: **between cycling and playing tennis**!

4. Power-to-Weight in Mechanical and Biological Systems (*In progress*)

It is interesting to explore the connection between the training in speed performance and performance of biological systems. More precisely, we are trying to make a quantitative comparative analysis of different mobile life forms (animals, birds, fish, insects, etc. – henceforth, creatures): which one is “stronger”? Obviously, to compare different creatures, we will need a parameter S, acceleration parameter for each of the species that represents its strength. The maximum acceleration that the creature can develop while moving its own body in space can be used as such a parameter; to make it dimensionless, we can express it in the units of gravitational acceleration:

$$S_{creature}=a_{max}/g. \qquad (1)$$

When applied to PS training and its results, speed of performance, the dimensionless strength of a human being can be expressed in terms of the maximum self-induced shiver frequency and its amplitude as follows:

$$S_{human}=(shiver\ amplitude)*(\ shiver\ frequency)^2/g. \qquad (2)$$

The values of $S_{creature}$ and S_{human} will have to be measured experimentally since there are no data readily available.

Using equations (1) and (2) allows comparison between the power of any creature and the power of a human and, for that matter, of any mechanical device that accelerates using power it generates, such as a car. Note that by “power” we mean the power as it is expressed in the speed of performance.

In the domain of dimensionless strength, the winner according to our definitions above is the creature that has the highest S-value. Note that a “win” is defined as an ability to catch prey or avoid being caught; no physical contact is considered.

Below is a table showing comparison of several creatures:

Creature	**a (m/s2)**	**S**	**Reference**
Human	6.25		http://hypertextbook.com/facts/2000/KatarzynaJanuszkiewicz.shtml
Elephant			
Fly			
Turtle			
Tiger			
Jaguar			
Leopard			
Wolf			
Mouse			
Cheetah	8.9		http://animals.nationalgeographic.com/animals/mammals/cheetah.html
Lion	9.5		http://press.princeton.edu/chapters/s7435.html
Gazelle	4.5		http://press.princeton.edu/chapters/s7435.html
Greyhoun			

d			
Sports car	11.1		http://en.wikipedia.org/wiki/List_of_fastest_cars_by_acceleration

It is interesting to note that a sports car and, marginally, lion have enough power per weight that would allow them to overcome the earth gravity and hypothetically, given sufficient amount of fuel and endurance, leave the earth on their own (without expensive rockets)!

5. Energy Needed for Walking and Resting: Dynamic Body

Why do we get tired when walking or running?
There are four major components (arranged in the order of contribution):

(a) Working against gravity when we lift our leg's weight, one-at-a-time every step we make (average weight of a human leg is about 10% of the total body weight),
(b) Lifting the weight of the entire body (its center of weight) at every step (excluding the leg, which is treated as a separate item per above),
(c) Accelerating and decelerating the extremities and other parts of the body at every step,
(d) Overcoming friction drag by environment (including air or water resistance).

Therefore, to reduce the energy requirements, it would be advantageous to control our walking/running techniques to minimize the effects of those components to the extent possible. Surprisingly enough, human locomotion is so efficient that our center of weight is kept practically at the same elevation relative to ground as we walk. Running is a different situation because in that case we spend some time of the cycle in the air and thus elevate the center of weight which contributes to the increase in the energy demand; this increase may by off-set somewhat by the increased length of running each stride. Note that the above discussion is based on the calculation of energy spent on covering a fixed distance. In may be interesting to note that the average elevation of a leg during normal walking (2 mph) is about 0.7 in.

So, why do we get tired while standing still or holding some weight at constant elevation, *motionlessly* – no physical work, supposedly, being done and energy – spent?

Here we come back to the issue of shivering. The seemingly "fixed" shape and position in space of our body is supported by its skeleton and muscles; that status must be "creates and recreated" at any given moment by myriads of physical micro-adjustments of multiple muscles of the body (micro-shiver) working in sync in real time while our body "seems" at rest. Holding a weight (even without a macro-movement) increases the work of the muscles performing the continuous micro-shiver adjustments and thus makes us tired eventually.

The key observation here is that a seemingly static position of your body when you we are at rest is actually a dynamic state with the body constantly struggling to preserve its shape and position in space while undergoing constant, energy-draining "micro-shiver" adjustments against the destabilizing gravity forces. Looking at the above list with four items, the energy spent on the micro-shiver must be added to that list, perhaps somewhere after the body macro-movement energy expenditure, item (b).