Acta Salus Vitae, Vol 7, No 1 (2019)
ISSN 1805-8787 actasalus@palestra.cz

THE USE OF MOTOR LEARNING PRINCIPLES IN YOGA

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Abstrakt
The article introduces the basic principles of motor learning and presents their possible application in learning of yoga postures. The first part brings the definitions of the basic terms of motor control and motor learning. The second part presents the particular types of motor learning with examples, how they can be applied in yoga practice. The third part introduces the Schema theory of motor learning and its implication in yoga; the next part provides a look at the traditional text of Yoga Sutra from the perspective of this motor learning theory. In the end several clinical studies that explore yoga in psychomotor performance are presented.

Keywords
Yoga, yoga postures, motor control, motor learning.

INTRODUCTION

Yoga is generally considered as a method for improving health. According to the great survey about yoga in USA from 2016, the main motivation for practicing yoga is improving flexibility, physical fitness, strength and overall health including mental health and stress reduction (Ipsos Public Affairs, 2016). Especially performing yoga postures (asanas) is believed to improve flexibility, strength and endurance as well as motor control, balance, stability and body awareness.

The aim of this article is to introduce the basic principles of motor learning and present their possible application in learning of yoga posture (asana). It could be helpful for yoga teachers for teaching and explaining basic principles of yoga postures and yoga movement; it could be useful for yoga practitioners as well for better understanding how to perform yoga postures; if we consider using yoga in health care the theoretical framework of yoga and motor learning would be necessary too, especially for conditions where the motor control is impaired, e.g. for patients with chronic back or neck pain, multiple sclerosis, Parkinson disease or after cerebral stroke or injury.

In current yoga literature we have found only one comprehensive scientific article about the potential neurophysiological mechanism of yoga where, among others, the motor learning in yoga asanas is discussed (Schmalzl, Powers, & Henje Blom, 2015). The authors state that a fundamental aspect of yoga-based practices is paying attention to interoceptive (from inner organs) and proprioceptive (from musculoskeletal system) signals as well as to kinesthetic and spatial sensations. That information are then used to adjust and fine-tune one´s movements. The terms of procedural learning and working memory are further discussed: procedural learning includes planning and learning of motor sequences as well as decision making according to neuromuscular feedback in the context of postural adjustments; working memory is important for the ability to hold in mind instructions and consequently select very specific sequential motor actions.

In our article we will take a more detailed look at the aspects of motor learning in yoga. The main source of the definitions and descriptions of the basic principles of motor learning is the

authoritative publication Motor Control – Translating Research into Clinical Practice (Shumway-Cook & Woollacott, 2007).

DEFINITIONS

Motor control can be defined as the ability to regulate or direct the mechanisms essential to movement. It addresses three questions:

1) how does the central nervous system organize muscles and joints into coordinated functional movements?
2) how is sensory information from the environment and the body used to select and control movement?
3) how do our perceptions of ourselves, the task we perform and the environment influence our movement behavior?

Movement emerges from interactions between the individual, the task and the environment. Within the individual are important three factors which determine resulting movement: *the cognitive processes* such a motivation, emotion and attention are essential; from these emerges the action, that should be perform; and for right action is necessary perception, which includes peripheral sensory mechanisms and its higher level processing (Shumway-Cook & Woollacott, 2007).

Postural control is essential for any action and like motor control emerges from an interaction of the individual, the task with its inherent postural demands, and the environmental constraints on postural actions. Postural control involves postural stability – the ability to control the center of mass in relationship to the base of support, and postural orientation – the ability to maintain an appropriate relationship between the body segments and between the body and the environment (Shumway-Cook & Woollacott, 2007).

Motor learning is the process of the acquisition or modification of movement that produces relatively permanent changes in the capability for producing skilled action. Similarly to long-term memory we can distinguish the two major types of motor learning: non-declarative (implicit) and declarative (explicit). Non-declarative forms of learning can be further divided into non-associative forms of learning, that are habituation and sensitization, and associative forms of learning, that are classical conditioning and operant conditioning. The last type of non-declarative form of learning is procedural learning (Shumway-Cook & Woollacott, 2007).

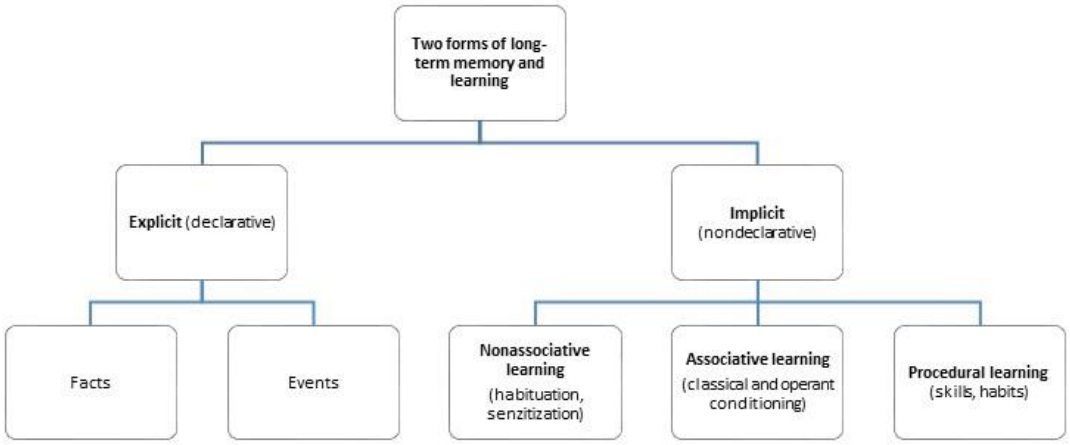

Fig. 1 Different forms of learning (adapted from Shumway-Cook & Woollacott, 2007. Motor Control: Translating research into Clinical practice, p.55)

AIMS

The aim of the presented study is to define the different types of motor learning and give an example how they can manifest or can be applied in yoga teaching and especially in teaching of yoga asanas.

METHODS

The following methods were used in the methodological framework of the presented study: methods of content analysis, analysis and synthesis, induction and deduction were selected from the point of view of the phenomena research methodology and applied in the form of causal and operative thinking.

ANALYZES, RESULTS, DISCUSSION

Different forms of motor learning

Habituation is a decrease in responsiveness that occurs as a result of repeated exposure to a non-painful stimulus (Kandel, Schwartz, & Jessell, 2000). Using habituation in common yoga lessons is probably impracticable. In yoga therapy it may be used in people with some kind of the skin hypersensitivity, when they are repeatedly exposed to gradually increasing levels of skin pressure while gently performing some asanas. But it is disputable and should be performed under control of the experienced therapist.

Sensitization is an increased responsiveness following a threatening or noxius stimulus (Kandel et al., 2000). That means, when a person receive a painful stimulus and then a light touch on the skin, then he will react more strongly to this light touch than he normally do. Using the sensitization is very limited in yoga as well. One example for usefulness of increasing sensitivity to a threatening stimulus could be a training of the balance poses: increasing a person awareness of stimuli indicating likelihood for impending falls could be useful.

Classical conditioning is learning to pair two stimuli. The typical example is when the unconditioned stimulus (food) always produces an unconditioned response (salivation). This unconditioned stimulus is then associated with the conditioned stimulus (bell) and after repeated pairing of these two stimulus, only one (conditioned stimulus - bell) is able to produce a conditioned response (salivation). The subject is learning here

to predict relationship between two stimuli or events and to respond accordingly (Shumway-Cook & Woollacott, 2007). An example in yoga could be, if a teacher give students a verbal cue in conjunction with physical assistance when making a movement and they are finally able to make the movement with only the verbal cue or even unassisted. But it is not common practice in yoga as well, like the previous two types of motor learning – habituation and sensitization.

The following two types of non-declarative learning have probably more applications in yoga.

Operant conditioning learns to associate a certain response with a consequence. The principle is that the behaviors that are rewarded tend to be repeated and by contrast behaviors followed by aversive stimuli tend to be left. Thy typical example is an experiment with animals that were given food whenever they randomly pressed a lever inside their cage. They soon learned to associate the lever press with the presentation of food (Shumway-Cook & Woollacott, 2007). Operant conditioning could be use during teaching yoga asanas, when verbal praise by a teacher could serves as a heartening for some students. Another example of operant conditioning could be setting up the yoga lesson so that a particular movement is rewarded by the successful accomplishment of the final poses in the asana.

Procedural learning is the last type of non-declarative learning, which refers to learning tasks that can be performed automatically without attention or conscious thought. Typically it is developed slowly through repetition of the task and with improved performance. It is important, that after the motor skill acquisition, it does not require awareness, attention or other higher cognitive processes (Shumway-Cook & Woollacott, 2007). It is typical for training of most sports or learning of working skills. And it is also the main difference between practicing classical yoga and other exercises. But this form of motor learning could be partly applied in some types of yoga, which are focused on sequencing of asanas in flow and relatively fast order. In these types of yoga could be important to learn the sequence of asanas relatively automatically through many repetition to be able pay more attention and awareness to better performance of the single asanas and their connection with breathing or maybe a spiritual meaning. Another example of using the procedural learning in yoga could be a process, when the student practice an optimal movement strategy to move to difficult poses like head stand and its variations. Finding and practicing the optimal movement scheme finally enable the students to practice these position with more awareness to the body but without much effort. Additionally, this new skill can be then applied in other poses or in daily life.

Declarative learning results in knowledge that can be consciously recalled and thus requires processes such as awareness, attention and reflection (Kandel et al., 2000). It can be expressed in declarative sentences in which we can described for example the performance of every yoga asanas. And moreover, teaching movement skills declaratively allows students to rehearse their movement mentally and thus contribute to better physical performance of the movement (or asana). At this place we should distinguish between “learning” and “performance”. Learning is defined as a relatively permanent change and should be evaluated during specific retention or transfer test. Performance is a temporary change in motor behavior which is seen during practice sessions and can reflect not only changes in learning, but changes in other variables like fatigue, motivation, anxiety and others.

In yoga most of the motor learning is realized as the declarative learning. On

the other hand, constant repetition can transform declarative knowledge of the performance to non-declarative procedural knowledge and becomes automatic motor activity that does not require conscious attention and monitoring. And that is not the aim of yoga. Together with Indian authors (Govindaraj, Karmani, Varambally, & Gangadhar, 2016) we can say "…even exercise, if done mindfully, can also become a spiritual practice comparable to the asana component of yoga, and yogasana if done mechanically can be a mere physical activity as well."

The theories of motor learning and yoga

There are several theories of motor learning about the nature and control of the acquisition or modification of movement. The *Schema theory* by R. A. Schmidt seems to be the most convenient for demonstration of motor learning in yoga. Schmidt assumed the existence of generalized motor program that represent a schema of the generalized rules for a specific class of movements. When an individual learns a new motor program, he or she is learning a generalized set of rules that can be applied to a variety of contexts. During motor learning four things must be stored in short-term memory: 1/ the initial movement conditions such as the position of the body and the characteristics of the manipulated object or the environment; 2/ the parameters used in the generalized motor program; 3/ the outcome of the movement in terms of knowledge of results; 4/ the sensory consequences of the movement – that is how it is felt and looked (Schmidt & Lee, 2005). While teaching yoga asana we can move in a process analogous with this theory; it means: 1/ to be aware about the initial stable position before moving to asana; 2/ to move consciously to the asana that is projected in our mind; 3/ to take up a steady and comfortable position with full knowledge of results; 4/ to observe sensory consequences, feelings in the body and the mind in both the movement as well as the final position (asana).

After completing the movement and storage the information in short-term memory, Schmidt propose the abstraction of the information into two schemas, the recall schema (motor) and recognition schema (sensory). In the recall schema each new movement adds a new data to their internal system to refine the rule. The refined rule is then used for a next movement and its better outcome. In the recognition schema the sensory consequences of previous movements are coupled with the current initial conditions to create a representation of the expected sensory consequences. This is then compared to the sensory information from the ongoing movement in order to evaluate the efficiency of the response. Thus the motor learning consists of the ongoing process of updating the recognition and recall schemas with each movement that is made. Finally Schmidt hypothesized, that 1/ with increased variability of practice the generalized motor program rules were made stronger, 2/ particular movement may be produced accurately even if it has never been made before, if it is based on a rule that has previously been created as part of an earlier movement practice (Schmidt & Lee, 2005). Practical assertion of these processes in learning yoga asanas could be: 1/ when yoga asanas are practiced regularly and repetitively we create the refined rules for each movement and poses, 2/ variability of yoga asanas can improve not only learning of new asanas but can be transferred to motor learning in everyday life.

Ancient definition of asana as could be seen by motor learning theory

Yoga Sutra by Patanjali is considered the oldest and traditional text about yoga. Only three short aphorisms are saying here about asanas, their principles and goals

and how they are attained. Knowledgeable interpretation of this aphorism are presented in the book Yogic therapy (Kuvalayananda & Vinekar, 1963). According the authors, the first aphorism "sthira-sukhamásanam" defines the asana as a steady and comfortable position. But the stability here is not only steadiness of position, but it is a stability of body and mind as a whole, and this functional stability brings a good feeling. The second aphorism learns that the right way to attain asana is to perform it by the relaxation of effort and by absorption in the infinite, "prayatna-shaithilya ananta samapattibhyam". As a hint for it is recommended to tune up oneself to infinity or to visualize oneself floating easily on a great body of water. Other recommendation is focusing one´s mind to the flow of breath, that enables deepening the relaxed state in the asana. When the asana is attained by this right way, then the conflicts between the opposites are vanished, "dvandvaanbhi-ghaatah". Kuvalayanda and Vinekar explain it on the physiological level as an equilibrium between the agonist and antagonist muscles and on the higher level as a harmony between mind and body.

How can we interpret these instructions in the perspective of motor learning theory? According to the Schmidt´s Schema theory we can say here: 1/ for attaining the "steady and comfortable position" we have to consider initial position of the body and the characteristics of the environment; 2/ then, during imagination of the final position, a schema from generalized motor program is chosen and the movement is performed with constant awareness about its parameters and in the same time with tuning them to minimal effort; 3/ after taking the posture we have to evaluate it in terms of knowledge of results that in yoga means again the steady position with minimum effort; 4/ and for it the sensory consequences of the position is important – that is how it is felt and looked. And if we can simultaneously breathe slowly and easily in the position, we probably can accomplish the state of harmony between mind and body.

Clinical studies exploring yoga in psychomotor performance

Several clinical studies evaluating motor performance after yoga intervention were conducted: one trial assessed the performance in a mirror star tracing task in adults between 18 and 45 years. The study suggest that one month of practicing yoga improved reversal ability, eye-hand coordination, speed and accuracy which are necessary for mirror star tracing (Telles, Praghuraj, Ghosh, & Nagendra, 2006). Other study assessed the effect of yoga-based intervention on psychomotor performance and self-efficacy in school children with ages from 11 to 16 years using trial making tasks. Results suggest that, beside other things, yoga practice enhances processing speed with fine motor coordination, visual-motor integration, visual perception and planning ability (Das, Deepeshwar, Subramanya, & Manjunath, 2016). Another study assessed the impact of Kindergarten-based yoga practice in 5-year-old children using Visual Attention and Visuomotor Precision subtest of Neuropsychological Evaluation Battery and ADHD Rating Scale-IV. The results indicate that yoga in these children improves selected visual attention and visual-motor precision parameters and decrease behavior of inattention and hyperactivity (Jarraya, Wagner, Jarraya, & Engel, 2019).

CONCLUSION

The yogic movements are mostly performed in a slow and controlled manner and require balance, coordination and constant tracking of the body´s position. Postural alignment, fluidity and

fine-tuning of the movement are emphasized. The final position should be hold with balanced muscle tone that allows to feel stable and well rooted, yet light and effortless (Schmalzl et al., 2015). It is not easy to fulfill all these conditions and feel comfortable at the same time, especially if one starts his or her yoga practice. Therefore it could be useful to know the basic scientific principles of motor learning alongside the traditional recommendation for performing yoga asanas as they are presented in traditional texts. Our article tries to describe these two branches together to show how they could be interconnected and thus contribute to better understanding to the yogic movement and give some hints to both the yoga teachers and the yoga practitioners. It could be helpful for using yoga to promote health and well-being too.

A good example of possible employment of the traditional yoga teachings in modern medicine is the recent American guideline for treatment low back pain (Qaseem, Wilt, McLean, & Forciea, 2017): yoga is recommended here as one of the treatment modalities. And as one of the possible mechanisms of yoga effects in treatment of chronic low back pain is suggested improvement of the motor control.

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