Neuro Tennis

THE SCIENCE BEHIND NEUROTENNIS

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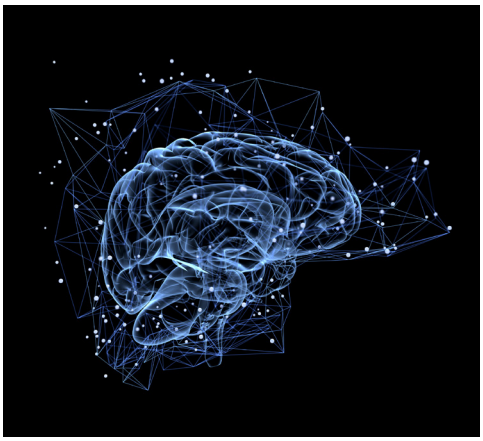
SUMMARY

NeuroTennis supports tennis development via on court feedback synchronized with real time tennis play.

Learning principles based on association, repetition, type, and frequency of feedback developed by Ivan Pavlov and B. F. Skinner, in synchrony with neuroplasticity, the brain's ability to structurally adapt and change, are leveraged to support rapid and lasting tennis skill development. Preprogrammed training sessions that allow players to link with each other's NeuroTennis devices are designed to help tennis players improve their skills and timing, as well as build and maintain motivation. Observational learning opportunities available via the NeuroTennis smart phone app and reinforced by the extensive library of NeuroTennis tips can result in the incorporation of NeuroTennis commands into players' own self-talk lexicon. The ability to customize lessons and drills allows players to focus on specific development areas. People who use NeuroTennis benefit from over a century of psychological science and brain research, providing them with the opportunity to control their own tennis learning based upon personal preferences and developmental changes over time.



INTRODUCTION

The key scientific principle underlying NeuroTennis is neuroplasticity, the brain's ability to structurally adapt and change.

As learning occurs, neural connections and related brain structures are strengthened and modified. These changes are the physical manifestation of learning embodied in the brain's biological structures.

LEARNING THEORY

More than 100 years ago in Russia, Ivan Pavlov detailed the foundational principles of classical conditioning with his research on dogs and salivation.

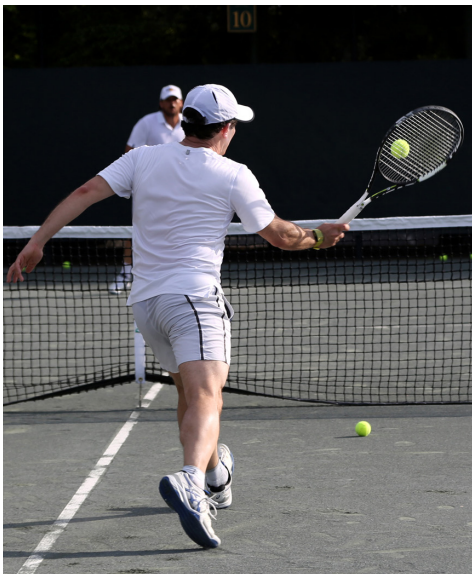
This work showed that repetition and association are fundamental components of the learning process. In the United States, B. F. Skinner's animal research demonstrated the effects of reinforcement and punishment on learning and provided the underpinnings of operant conditioning techniques that continue to influence learning research and applications such as NeuroTennis to this day.

Skinner confirmed the effectiveness of his operant conditioning techniques by teaching rats to press levers and pigeons to play ping pong. Through this and related work, Skinner verified that the length of time that elapses between behavior and reinforcement is a key factor in the learning process. When reinforcement is paired closely in time with a behavior, learning occurs more quickly than when reinforcement is delayed. NeuroTennis provides immediate reinforcement as the impact generated by striking a tennis ball activates instantaneous NeuroTennis commands in an audible format. Players who pair their NeuroTennis devices with their opponents' device also receive feedback when their opponents hit the ball.

Skinner demonstrated that the schedule of reinforcement (frequency of feedback) is also related to learning. Some behaviors, such as avoiding a food that caused or was associated with vomiting or nausea,

can be learned after just one experience. This rapid taste aversion learning has been dubbed the Garcia effect. Most behaviors require repeated association for learning to occur. Behaviors that are reinforced continuously, every time that the behavior occurs, are learned most quickly. Players who are new to the game of tennis and/or who want to accelerate learning of a particular skill can select a high frequency of NeuroTennis feedback.

Retention of knowledge and persistence of behaviors are associated with partial (intermittent) schedules of reinforcement. Learning effects are slower to appear with partial reinforcement than with continuous reinforcement, but the behaviors learned with partial reinforcement are more resistant to extinction and a return to old habits. Resistance to extinction can provide a foundation for consistency on court and contribute to what sport psychologist Richard Thelwell calls “repeatable good performance.” In a match, a repeatable good performance might involve hitting multiple shots in a rally, over the net, in the court, and to the intended location on the court. Tennis players who notice that they play better in training than in matches are often striving for repeatable good performances in match play. NeuroTennis commands provided on a variable schedule of reinforcement help players to develop consistency as they learn and regularly use key tactics and skills.



PRACTICE

Inherent in learning theory is the idea that association, repeated exposure, and practice contribute to learning.

Anders Ericsson examined the effects of practice on performance and noted that elite performers often accumulate 10,000 hours of practice before achieving their highest skill level. This amount of training can be accomplished by training 4 hours a day, 5 days a week, 50 weeks a year, for 10 years. Upon closer analysis, Ericsson and others have noted that going through the motions of training is not sufficient. Rather, deliberate practice, practice focused on specific skill development is necessary to achieve superior performance.

People who practice in a deliberate manner focus on their goals, purposefully direct their attention and efforts, gain expertise, and are

therefore better able to reach high performance levels. NeuroTennis devices come equipped with preprogrammed warmup and training tips and drills to help players of all abilities practice deliberately. Players can add and delete commands to personalize their training experiences based on their own preferences and the suggestions of tennis professionals. Players can also select new commands to help maintain interest and to accelerate their progress toward their tennis performance ideals. Over time, deliberate training increases practice session value and allows people to go beyond their previous achievement levels, moving to new and higher skill levels.

Although deliberate practice is effective in helping people reach performance goals, it is also draining both physically and mentally. Nobel Prize winner, Daniel Kahneman, has noted that System 2 cognition, the mental effort required for deliberate practice, can lead to enhanced performance, but can also use up or exhaust cognitive resources, leaving people mentally tired.

Depletion of cognitive resources is one reason that people tend to play more poorly at the end of a tennis match or training session.

When using NeuroTennis the first few times, many players notice increased focus on their play as well as cognitive depletion effects. Players often enjoy the NeuroTennis experience, but report that 30 minutes of training with NeuroTennis feels longer than “regular” training sessions. When people are mentally tired, they tend to revert to what Daniel Kanheman terms System 1 processes, which include automatic modes of thinking, feeling, and performing. That is, they revert to old habits. Taking a systematic approach to training with NeuroTennis facilitates the incorporation of new skills into players’ automatic System 1 repertoire so that they form new System 1 habits and can perform in a repeatable good way in both practice and matches without depleting cognitive resources. When used regularly, NeuroTennis can serve as a force multiplier, increasing the value of each practice session.

MOTIVATION

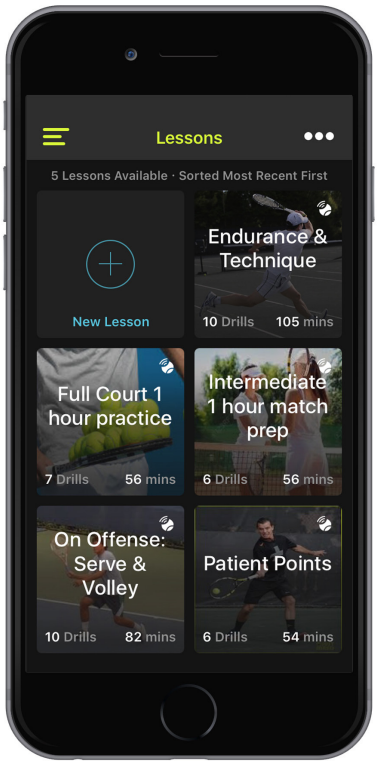
The cognitive revolution in psychological thought and research moved beyond strict behaviorism to examine

the role that individual motivation plays in learning and performance.

In tennis terms, if we compare two tennis players of equal ability and skill level, we find that the more motivated player is likely to demonstrate greater improvement, match performance, and enjoyment of the game over time.

Edward Deci and Richard Ryan have spent their careers exploring motivation in a number of research areas, including that of sport performance. The results of their research on Self-Determination Theory indicates that people who have autonomy, feel competent, and have a sense of relatedness to others are likely to be motivated, persistent, and able to perform at a high level.

Autonomy can be defined simply as the opportunity to make choices based on one's own free will. Gabriele Wulf and her colleagues have shown that people completing physical performance tasks perform better and with less effort when they choose aspects of the task they are performing, even when the choice is as small as which hand they will use first to complete a motor performance task. Based on previous research, Wulf and her colleagues hypothesize that autonomy and related cognitive-affective states serve as triggers of a dopamine response in the brain that enhances memory and facilitates consolidation and long-term retention of physical performance skills. The easy-to-modify settings built into NeuroTennis and the library of commands and drills can provide players with autonomy and support tennis motor performance and motivation.



NeuroTennis can also help players increase their feelings of competence as they follow well defined NeuroTennis lesson plans, view video clips on the NeuroTennis app demonstrating the meaning of each command, and incorporate the NeuroTennis commands into a more consistent style of play. Players who feel competent tend to enjoy what they are doing and increase their intrinsic (internal) motivation. Intrinsically motivated people tend to work hard, improve, gain confidence, and carry positive expectations into future training sessions and matches. The positive focus of most NeuroTennis commands further contributes to players' intrinsic motivation. Intrinsic motivation helps sustain interest in an activity, which can be helpful as players work through the challenges of learning new skills and approaches.

It might be surprising to consider the NeuroTennis electronic device as something that could promote relatedness. NeuroTennis, however, can support tennis players' relatedness in a number of ways. Tennis players may work with tennis professionals to select the NeuroTennis commands that they prefer to use, create and upload their own NeuroTennis lesson plans for private use and sharing, and train collaboratively with opponents in the linked mode to enhance performance of both players. NeuroTennis users may find that using and sharing NeuroTennis connects them to the game and to others.

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SELF-TALK

A large body of research in the sport psychology literature, including both a meta-analysis and a systematic review has demonstrated that motivational and instructional self-talk enhance sport performance.

Not surprisingly, self-talk is considered part of the sport psychology canon, a fundamental psychological process that contributes to sport performance outcomes.

According to the work of Daniel Kahneman and sport researchers, the repeated, deliberate, intentional use of self-talk statements, such as those provided by NeuroTennis, involves the use of attention and the cognitive resources of System 2 processing. Over time and with deliberate practice, the NeuroTennis cues that required thought and focus can be incorporated into a players' performance repertoire, as an automatic, System 1 process.

Researchers examining the self-talk of tournament tennis players have found that players regularly use self-talk during match play. Some players express frustration following lost points, some players' self-talk appears to help them maintain performance levels when performing well, and some players' self-talk appears to help with refocusing after errors. Many players use multiple forms of self-talk during matches, and their self-talk ebbs and flows depending on their personal style, individual needs, and match circumstances. No one type of self-talk is always associated with superior tennis performance.

To accommodate the range of preferences, types of tennis players, and tennis circumstances, NeuroTennis provides a diverse library of tennis commands. In line with research highlighting the value of instructional and motivational self-talk, most of the NeuroTennis commands are instructional, such as “loosen your grip” and “feet always moving.” Some of the commands provided are motivational “you can do more” and a few commands have a negative tone, “you call that an overhead?” that some players find motivating and energizing. With regular use, tennis players may find their self-talk has become infused with favorite NeuroTennis commands.

OBSERVATIONAL LEARNING

Much learning research has focused on the effects of direct experiences on the acquisition of skills or performance of tasks, but learning also occurs via observation and modeling.

In the 1960s, Albert Bandura demonstrated observational learning with children who watched aggressive behavior and then later acted aggressively themselves, showing that by observation alone, children learned, replicated, and built upon behaviors they had witnessed. More recently, researchers have identified mirror neurons and distributed networks in the brains of humans and other animals, the neural and structural foundation of observational learning.

With regard to NeuroTennis, players using the linked mode observe each other as they work on NeuroTennis skills and drills. The audio, visual, and kinesthetic modeling can enhance training, helping players to mutually improve their skills. Players may also choose to review video clips pertaining to NeuroTennis commands on the NeuroTennis app. Watching NeuroTennis videos helps clarify what the commands mean in terms of tennis movements and provides an additional opportunity for players to benefit from modeling processes.

INDIVIDUAL DIFFERENCES

"Individual differences" is the term used to describe variation or deviations among people with regard to one or more characteristics.

For example, although all people have some sort of personality, people's personalities differ along the dimensions of conscientiousness, agreeableness, neuroticism, openness, and extraversion. With regard to learning, general theories apply broadly across learning contexts. Individual variation in learning, however, also occurs. Psychologist Henry Murray and anthropologist Clyde Kluckhorn described this complexity succinctly in their 1953 classic text, noting that each individual is like all other people, like some other people, and like no other people.

Receptivity to learning by repetition and association is a shared human quality. NeuroTennis is designed to take advantage of this learning tendency and provides associative feedback and preloaded sequential learning drills that support most players in the learning process. Because each individual tennis player is also like no other players, the exact type and frequency of feedback and specific skills and drills needed to reach optimal levels of performance is adjustable. NeuroTennis allows for tailoring of commands to cater to individual strengths and weaknesses and to meet individual needs based on preferences of the moment as well as developmental changes over time.

To determine how well skills are incorporated into a player's "tennis tool kit," athletes may want to train using NeuroTennis devices and then remove the device and evaluate performance in drills or match play. Testing skills under a variety of conditions and with different opponents and partners can help consolidate gains and identify areas for further development. Research has shown distributed practice and self-testing to be some of the most effective learning strategies.

NeuroTennis has been developed based upon scientifically established principles in neuroscience, learning, and motivation. NeuroTennis allows users to link with others and grow as players as they control key aspects of their tennis skill development.

ABOUT THE AUTHOR

Judy L. Van Raalte, Ph.D. is professor of psychology at Springfield College, Certified Consultant, Association for Applied Sport Psychology, and listed in the United States Olympic Committee Sport Psychology Registry. She has presented her research at conferences in 18 countries and published over 100 sport and exercise psychology articles in peer-reviewed journals. During her five-year stint as women's tennis coach at Springfield College, Dr. Van Raalte compiled a 51-12 record. Dr. Van Raalte served as President of the American Psychological Association's Division of Exercise and Sport Psychology (Division 47) and as the Vice President of the International Society of Sport Psychology. She is a fellow of the American Psychological Association and the Association for Applied Sport Psychology.