**Iskorak ka poboljšanju pamćenja:**

**longitudinalni efekti neinvazivne neuromodulacije na asocijativnu memoriju**

Asocijativna memorija (AM) predstavlja sposobnost formiranja i pamćenja veze između nezavisnih jedinica informacije. Ona propada usled neurodegenerativnih oboljenja, ali i usled normalnog starenja, te je poboljšanje AM jedan od najvećih izazova savremene neurorehabilitacije. Prethodna istraživanja pokazala su da je AM moguće facilitirati tehnikama neinvazivne neuromodulacije, konkretno transkranijalnom stimulacijom jednosmernom strujom (tDCS). Glavni cilj aktuelne studije bilo je ispitivanje trajnosti efekata tDCS posteriornog parijetalnog korteksa na AM. Pored standardnog anodalnog (1.5mA), primenjen je i novi oscilatorni tDCS protokol (1.5 ± 0.1mA, 5Hz), koji svojim oscilacijama simulira hipokampalni teta ritam, i koji je bio eksplorativno ispitan u ovom istraživanju. Pokazano je da i anodalni i oscilatorni tDCS protokol dovode do značajnog poboljšanja AM u odnosu na kontrolnu situaciju bez stimulacije, ali dva tDCS protokola nisu bila međusobno značajno različita. Ovakav obrazac razlika održao se i na naknadnim merenjima jedan i pet dana nakon protokola. Dodatno, tDCS protokoli nisu ostvarili efekat na kontrolni zadatak koji je merio funkcije van kortiko-hipokampalne mreže, čime je potvrđena specifičnost efekata ovako lokalizovane tDCS. Dobijeni rezultati sugerišu da je moguće zabeležiti pozitivne efekte jednokratnog tretmana neinvazivnom neuromodulacijom na AM, čak i na relativno malom uzorku mladih zdravih ispitanika. Predložena dva tipa tDCS protokola facilitiraju inicijalno asocijativno kodiranje, dovodeći do boljeg neposrednog pamćenja, a razlike u neposredno upamćenom opstaju kroz vreme najmanje 5 dana. Ovakav nalaz ohrabruje buduća tDCS istraživanja kumulativnih efekata višestrukih tretmana, kao i ispitivanja uspešnosti protokola na populacijama koje pate od deficita AM. Ograničenja ovog istraživanja i same tehnike tDCS biće dodatno diskutovana.

*Ključne reči:* asocijativna memorija, poboljšanje pamćenja, neinvazivna neuromodulacija, transkranijalna stimulacija jednosmernom strujom (tDCS), posteriorni parijetalni korteks (PPC), teta ritam

**One step toward memory enhancement:**

**Longitudinal effects of noninvasive neuromodulation on associative memory**

Associative memory (AM) represents the ability to form and retrieve relations between independent information units. Associative deficits occur as a common consequence of neurodegenerative conditions as well as normal aging. That is why AM enhancement has become one of the main challenges of modern neurorehabilitation. Previous research had shown that AM can be facilitated by noninvasive neuromodulation techniques, transcranial direct current stimulation (tDCS) in particular. The aim of this study was to investigate longitudinal effects of tDCS over posterior parietal cortex (PPC). Beside standard anodal tDCS protocol (1.5mA), a novel theta oscillatory tDCS protocol (1.5 ± 0.1mA, 5Hz) had been applied. The results had shown that both anodal and oscillatory tDCS led to AM enhancement comparing to control situation with no stimulation applied, but the two tDCS conditions were not statistically different. The same pattern of differences in AM was registered one and five days after the protocol. Additionally, both tDCS protocols had no effect on control task that assessed functions outside the cortico-hippocampal network, confirming that obtained tDCS effects were localization-specific. These findings suggest that it is possible to obtain positive effects of single tDCS treatment, even on a relatively small sample of young and healthy participants. Both variations of tDCS protocol facilitated initial encoding which led to initial AM enhancement, and those differences in AM lasted at least 5 days after the protocol. This finding provides foundation for future research of cumulative effects of multiple treatments, as well as tDCS research in populations that suffer from associative deficits. Limitations of this study and the tDCS technique will be further discussed.

 *Keywords:* associative memory, noninvasive neuromodulation, transcranial direct current stimulation (tDCS), posterior parietal cortex (PPC), theta rythm