



## 2. | BÖLÜM

# FUTBOLDA DAR ALAN OYUNLARI VE ZİHİNSEL YORGUNLUK <sup>1</sup>

Yusuf SOYLU<sup>2</sup>

Fikret RAMAZANOĞLU<sup>3</sup>

### GİRİŞ

Zihinsel ve fiziksel yorgunluk olarak sınıflandırılabilen yorgunluk, aşırı zihinsel veya fiziksel faaliyetler veya hastalıktan kaynaklanan zihinsel ve/veya fiziksel etkinliklerin yetenek ve verimliliğinin azalması durumu veya fenomeni olarak tanımlanır. Yorgunluğa genellikle, yorgunluk hissi olarak adlandırılan tuhaf bir rahatsızlık hissi, dinlenme arzusu ve motivasyon azalması eşlik eder. Yorgunluğa genellikle tuhaf bir rahatsızlık hissi, dinlenme arzusu ve yorgunluk hissi olarak adlandırılan motivasyon düşüşü eşlik eder (Kitani, 2011). Son zamanlarda, fonksiyonel manyetik rezonans görüntüleme (fMRI), pozitron emisyon tomografisi ve manyetoen-sefalografiyi (MEG) kullanan davranışsal, elektrofizyolojik ve nöro-görüntüleme çalışmaları, insan hastalıkları ve sendromları ile ilişkili yorgunluğun yanı sıra insan fiziksel yorgunluğunun altında yatan bazı nöral mekanizmaları açıklığa kavuşturmuştur (Tanaka ve Watanabe, 2012). Yorgunluk, fiziksel ve zihinsel aktivelerin sonucu bitkinlik, bıkkınlık veya enerji eksikliği olarak tanımlanmaktadır (Bruce vd., 2010; Chaudhuri ve Behan, 2000; Guo vd., 2015).

### YORGUNLUK

Yorgunluk araştırmalarında, klasik “kardiyovasküler-felaket” modeli, yorgunluğu esas olarak kardiyovasküler sistemin egzersiz sırasında oksijen ihtiyacını karşılayamaması, laktat birikimi ve sonuç olarak istemli bir kas kasılması oluşturmama ile

<sup>1</sup> Doktora tezinden üretilmiştir.

<sup>2</sup> Dr., Spor Bilimleri Fakültesi, Tokat Gaziosmanpaşa Üniversitesi, Tokat  
Oyusufsoylu@gmail.com

<sup>3</sup> Dr., Spor Bilimleri Fakültesi, Sakarya Uygulamalı Bilimler Üniversitesi, Sakarya  
framazanoglu@subu.edu.tr



## KAYNAKLAR

- Åhsberg, E., Garnberale, F., & Kjellberg, A. (1997). Perceived quality of fatigue during different occupational tasks Development of a questionnaire. *International Journal of Industrial Ergonomics*, 20(2), 121–135. [https://doi.org/10.1016/S0169-8141\(96\)00044-3](https://doi.org/10.1016/S0169-8141(96)00044-3)
- Badin, O. O., Smith, M. R., Conte, D., & Coutts, A. J. (2016). Mental Fatigue: Impairment of Technical Performance in Small-Sided Soccer Games. *International Journal of Sports Physiology and Performance*, 11(8), 1100–1105. <https://doi.org/10.1123/ijsspp.2015-0710>
- Bangsbo, J., Iaia, F. M., & Krstrup, P. (2007). Metabolic Response and Fatigue in Soccer. *International Journal of Sports Physiology and Performance*, 2(2), 111–127. <https://doi.org/10.1123/ijsspp.2.2.111>
- Blanchfield, A. W., Hardy, J., De Morree, H. M., Staiano, W., & Marcora, S. M. (2014). Talking Yourself Out of Exhaustion. *Medicine & Science in Sports & Exercise*, 46(5), 998–1007. <https://doi.org/10.1249/MSS.0000000000000184>
- Boksem, M. A. S., Meijman, T. F., & Lorist, M. M. (2005). Effects of mental fatigue on attention: An ERP study. *Cognitive Brain Research*, 25(1), 107–116. <https://doi.org/10.1016/j.cogbrainres.2005.04.011>
- Borghini, G., Astolfi, L., Vecchiato, G., Mattia, D., & Babiloni, F. (2014). Measuring neurophysiological signals in aircraft pilots and car drivers for the assessment of mental workload, fatigue and drowsiness. *Neuroscience & Biobehavioral Reviews*, 44, 58–75. <https://doi.org/10.1016/j.neubiorev.2012.10.003>
- Brown, D. M. Y., & Bray, S. R. (2017a). Graded increases in cognitive control exertion reveal a threshold effect on subsequent physical performance. *Sport, Exercise, and Performance Psychology*, 6(4), 355–369. <https://doi.org/10.1037/spy0000091>
- Brown, D. M. Y., & Bray, S. R. (2017b). Effects of Mental Fatigue on Physical Endurance Performance and Muscle Activation Are Attenuated by Monetary Incentives. *Journal of Sport and Exercise Psychology*, 39(6), 385–396. <https://doi.org/10.1123/jsep.2017-0187>
- Brownsberger, J., Edwards, A., Crowther, R., & Cottrell, D. (2013). Impact of Mental Fatigue on Self-paced Exercise. *International Journal of Sports Medicine*, 34(12), 1029–1036. <https://doi.org/10.1055/s-0033-1343402>
- Bruce, J. M., Bruce, A. S., & Arnett, P. A. (2010). Response variability is associated with self-reported cognitive fatigue in multiple sclerosis. *Neuropsychology*, 24(1), 77–83. <https://doi.org/10.1037/a0015046>
- Bush, G., Whalen, P. J., Rosen, B. R., Jenike, M. A., McInerney, S. C., & Rauch, S. L. (1998). The counting Stroop: An interference task specialized for functional neuroimaging-validation study with functional MRI. *Human Brain Mapping*, 6(4), 270–282. [https://doi.org/10.1002/\(SICI\)1097-0193\(1998\)6:4<270::AID-HBM6>3.0.CO;2-0](https://doi.org/10.1002/(SICI)1097-0193(1998)6:4<270::AID-HBM6>3.0.CO;2-0)
- Carling, C., Lacombe, M., McCall, A., Dupont, G., Le Gall, F., Simpson, B., & Buchheit, M. (2018). Monitoring of Post-match Fatigue in Professional Soccer: Welcome to the Real World. *Sports Medicine*, 48(12), 2695–2702. <https://doi.org/10.1007/s40279-018-0935-z>
- Carter, C. S., Braver, T. S., Barch, D. M., Botvinick, M. M., Noll, D., & Cohen, J. D. (1998). Anterior Cingulate Cortex, Error Detection, and the Online Monitoring of Performance. *Science*, 280(5364), 747–749. <https://doi.org/10.1126/science.280.5364.747>
- Carter, E. C., & McCullough, M. E. (2013). Is ego depletion too incredible? Evidence for the overestimation of the depletion effect. *Behavioral and Brain Sciences*, 36(6), 683–684. <https://doi.org/10.1017/S0140525X13000952>
- Chalder, T., Berelowitz, G., Pawlikowska, T., Watts, L., Wessely, S., Wright, D., & Wallace, E. P. (1993). Development of a fatigue scale. *Journal of Psychosomatic Research*, 37(2), 147–153. [https://doi.org/10.1016/0022-3999\(93\)90081-p](https://doi.org/10.1016/0022-3999(93)90081-p)
- Chaudhuri, A., & Behan, P. O. (2000). Fatigue and basal ganglia. *Journal of the Neurological Sciences*, 179(S 1-2), 34–42. [https://doi.org/10.1016/S0022-510X\(00\)00411-1](https://doi.org/10.1016/S0022-510X(00)00411-1)
- Coutinho, D., Gonçalves, B., Travassos, B., Wong, D. P., Coutts, A. J., & Sampaio, J. E. (2017). Men-



- tal Fatigue and Spatial References Impair Soccer Players' Physical and Tactical Performances. *Frontiers in Psychology*, 8(SEP). <https://doi.org/10.3389/fpsyg.2017.01645>
- Coutinho, D., Gonçalves, B., Wong, D. P., Travassos, B., Coutts, A. J., & Sampaio, J. (2018). Exploring the effects of mental and muscular fatigue in soccer players' performance. *Human Movement Science*, 58(March), 287–296. <https://doi.org/10.1016/j.humov.2018.03.004>
- Coutts, A. J. (2016a). Fatigue in football: it's not a brainless task! *Journal of Sports Sciences*, 34(14), 1296–1296. <https://doi.org/10.1080/02640414.2016.1170475>
- Coutts, A. J. (2016b). Fatigue in football: it's not a brainless task! *Journal of Sports Sciences*, 34(14), 1296–1296. <https://doi.org/10.1080/02640414.2016.1170475>
- Demirakca, T., Cardinale, V., Dehn, S., Ruf, M., & Ende, G. (2016). The exercising brain: Changes in functional connectivity induced by an integrated multimodal cognitive and whole-body coordination training. *Neural Plasticity*, 2016. <https://doi.org/10.1155/2016/8240894>
- Faber, L. G., Maurits, N. M., & Lorist, M. M. (2012). Mental Fatigue Affects Visual Selective Attention. *PLoS ONE*, 7(10), e48073. <https://doi.org/10.1371/journal.pone.0048073>
- Fink, A., Bay, J. U., Koschutnig, K., Prettenhaler, K., Rominger, C., Benedek, M., Papousek, I., Weiss, E. M., Seidel, A., & Memmert, D. (2019). Brain and soccer: Functional patterns of brain activity during the generation of creative moves in real soccer decision making situations. *Human Brain Mapping*, 40(3), 755–764. <https://doi.org/10.1002/hbm.24408>
- Guo, W., Ren, J., Wang, B., & Zhu, Q. (2015). Effects of Relaxing Music on Mental Fatigue Induced by a Continuous Performance Task: Behavioral and ERPs Evidence. *PLOS ONE*, 10(8), e0136446. <https://doi.org/10.1371/journal.pone.0136446>
- Hagger, M. S., Wood, C., Stiff, C., & Chatzisarantis, N. L. D. (2010). Ego depletion and the strength model of self-control: A meta-analysis. *Psychological Bulletin*, 136(4), 495–525. <https://doi.org/10.1037/a0019486>
- Hill, A. V., Long, C. N. F., & Lupton, H. (1924). Muscular exercise, lactic acid and the supply and utilisation of oxygen.— Parts VII–VIII. *Proceedings of the Royal Society of London. Series B, Containing Papers of a Biological Character*, 97(682), 155–176. <https://doi.org/10.1098/rspb.1924.0048>
- Inzlicht, M., & Berkman, E. (2015). Six Questions for the Resource Model of Control (and Some Answers). *Social and Personality Psychology Compass*, 9(10), 511–524. <https://doi.org/10.1111/spc3.12200>
- Ishii, A., Tanaka, M., & Watanabe, Y. (2014). Neural mechanisms of mental fatigue. *Reviews in the Neurosciences*, 25(4), 469–479. <https://doi.org/10.1515/revneuro-2014-0028>
- Ivnik, R. J., Malec, J. F., Smith, G. E., Tangalos, E. G., & Petersen, R. C. (1996). Neuropsychological tests' norms above age 55: COWAT, BNT, MAE token, WRAT-R reading, AM-NART, STROOP, TMT, and JLO. *The Clinical Neuropsychologist*, 10(3), 262–278. <https://doi.org/10.1080/13854049608406689>
- Kato, Y., Endo, H., & Kizuka, T. (2009). Mental fatigue and impaired response processes: Event-related brain potentials in a Go/NoGo task. *International Journal of Psychophysiology*, 72(2), 204–211. <https://doi.org/10.1016/j.ijpsycho.2008.12.008>
- Kitani, T. (2011). Term Committee of Japanese Society of Fatigue Science. *Nihon Hirougakkaishi (In Japanese)*, 6(2), 1.
- Kunrath, C. A., Cardoso, F., Nakamura, F. Y., & Teoldo, I. (2018). Mental fatigue as a conditioner of the tactical and physical response in soccer players: a pilot study. *Human Movement*, 19(3), 16–22. <https://doi.org/10.5114/hm.2018.76075>
- Lew, F. L., & Qu, X. (2014). Effects of mental fatigue on biomechanics of slips. *Ergonomics*, 57(12), 1927–1932. <https://doi.org/10.1080/00140139.2014.937771>
- Lorist, M. M., Boksem, M. A. S., & Ridderinkhof, K. R. (2005a). Impaired cognitive control and reduced cingulate activity during mental fatigue. *Cognitive Brain Research*, 24(2), 199–205. <https://doi.org/10.1016/j.cogbrainres.2005.01.018>
- Lorist, M. M., Boksem, M. A. S., & Ridderinkhof, K. R. (2005b). Impaired cognitive control and reduced cingulate activity during mental fatigue. *Cognitive Brain Research*, 24(2), 199–205. <https://doi.org/10.1016/j.cogbrainres.2005.01.018>



- Lorist, M. M., Klein, M., Nieuwenhuis, S., De Jong, R., Mulder, G., & Meijman, T. F. (2000). Mental fatigue and task control: planning and preparation. *Psychophysiology*, 37(5), 614–625. <https://doi.org/10.1017/S004857720099005X>
- MacLeod, C. M., & Dunbar, K. (1988). Training and Stroop-like interference: evidence for a continuum of automaticity. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 14(1), 126–135. <https://doi.org/10.1037//0278-7393.14.1.126>
- MacMahon, C., Schücker, L., Hagemann, N., & Strauss, B. (2014). Cognitive fatigue effects on physical performance during running. *Journal of Sport & Exercise Psychology*, 36(4), 375–381. <https://doi.org/10.1123/jsep.2013-0249>
- Marcora, S. (2009). Perception of effort during exercise is independent of afferent feedback from skeletal muscles, heart, and lungs. *Journal of Applied Physiology*, 106(6), 2060–2062. <https://doi.org/10.1152/jappphysiol.90378.2008>
- Marcora, Samuele M., Staiano, W., & Manning, V. (2009). Mental fatigue impairs physical performance in humans. *Journal of Applied Physiology*, 106(3), 857–864. <https://doi.org/10.1152/jappphysiol.91324.2008>
- Marcora, Samuele Maria. (2010). *Effort: perception of*. In: Goldstein EB, ed. *Encyclopedia of perception*. SAGE Publications.
- Marcora, Samuele Maria, & Staiano, W. (2010). The limit to exercise tolerance in humans: Mind over muscle? *European Journal of Applied Physiology*, 109(4), 763–770. <https://doi.org/10.1007/s00421-010-1418-6>
- Nédélec, M., McCall, A., Carling, C., Legall, F., Berthoin, S., & Dupont, G. (2012a). Recovery in Soccer. *Sports Medicine*, 42(12), 997–1015. <https://doi.org/10.2165/11635270-000000000-00000>
- Nédélec, M., McCall, A., Carling, C., Legall, F., Berthoin, S., & Dupont, G. (2012b). Recovery in soccer: part I - post-match fatigue and time course of recovery. *Sports Medicine (Auckland, N.Z.)*, 42(12), 997–1015. <https://doi.org/10.2165/11635270-000000000-00000>
- Noakes, T. D., & St Clair Gibson, A. (2004). Logical limitations to the “catastrophe” models of fatigue during exercise in humans. *British Journal of Sports Medicine*, 38(5), 648–649. <https://doi.org/10.1136/bjism.2003.009761>
- Pageaux, B., & Lepers, R. (2018). The effects of mental fatigue on sport-related performance. In *Progress in Brain Research* (1st ed., Vol. 240, pp. 291–315). Elsevier B.V. <https://doi.org/10.1016/bs.pbr.2018.10.004>
- Pageaux, B., Lepers, R., Dietz, K. C., & Marcora, S. M. (2014). Response inhibition impairs subsequent self-paced endurance performance. *European Journal of Applied Physiology*, 114(5), 1095–1105. <https://doi.org/10.1007/s00421-014-2838-5>
- Rampinini, E., Bosio, A., Ferraresi, I., Petruolo, A., Morelli, A., & Sassi, A. (2011). Match-Related Fatigue in Soccer Players. *Medicine & Science in Sports & Exercise*, 43(11), 2161–2170. <https://doi.org/10.1249/MSS.0b013e31821e9c5c>
- Reilly, T. (2005). An ergonomics model of the soccer training process. *Journal of Sports Sciences*, 23(6), 561–572. <https://doi.org/10.1080/02640410400021245>
- Scarpina, F., & Tagini, S. (2017). The Stroop Color and Word Test. *Frontiers in Psychology*, 8. <https://doi.org/10.3389/fpsyg.2017.00557>
- Schiphof-Godart, L., Roelands, B., & Hettinga, F. J. (2018). Drive in Sports: How Mental Fatigue Affects Endurance Performance. *Frontiers in Psychology*, 9(AUG), 1–7. <https://doi.org/10.3389/fpsyg.2018.01383>
- Shenhav, A., Musslick, S., Lieder, F., Kool, W., Griffiths, T. L., Cohen, J. D., & Botvinick, M. M. (2017). Toward a Rational and Mechanistic Account of Mental Effort. *Annual Review of Neuroscience*, 40(1), 99–124. <https://doi.org/10.1146/annurev-neuro-072116-031526>
- Smets, E. M. A., Garssen, B., Bonke, B., & De Haes, J. C. J. M. (1995). The multidimensional Fatigue Inventory (MFI) psychometric qualities of an instrument to assess fatigue. *Journal of Psychosomatic Research*, 39(3), 315–325. [https://doi.org/10.1016/0022-3999\(94\)00125-0](https://doi.org/10.1016/0022-3999(94)00125-0)
- Smith, M. R., Coutts, A. J., Merlini, M., Deprez, D., Lenoir, M., & Marcora, S. M. (2016). Mental Fatigue Impairs Soccer-Specific Physical and Technical Performance. *Medicine & Science in Sports*



✉ *Exercise*, 48(2), 267–276. <https://doi.org/10.1249/MSS.0000000000000762>

- Smith, M. R., Fransen, J., Deprez, D., Lenoir, M., & Coutts, A. J. (2017). Impact of mental fatigue on speed and accuracy components of soccer-specific skills. *Science and Medicine in Football*, 1(1), 48–52. <https://doi.org/10.1080/02640414.2016.1252850>
- Smith, M. R., Thompson, C., Marcora, S. M., Skorski, S., Meyer, T., & Coutts, A. J. (2018). Mental Fatigue and Soccer: Current Knowledge and Future Directions. *Sports Medicine*, 48(7), 1525–1532. <https://doi.org/10.1007/s40279-018-0908-2>
- Smith, M. R., Zeuwts, L., Lenoir, M., Hens, N., De Jong, L. M. S., & Coutts, A. J. (2016). Mental fatigue impairs soccer-specific decision-making skill. *Journal of Sports Sciences*, 34(14), 1297–1304. <https://doi.org/10.1080/02640414.2016.1156241>
- Stølen, T., Chamari, K., Castagna, C., & Wisløff, U. (2005). Physiology of Soccer. *Sports Medicine*, 35(6), 501–536. <https://doi.org/10.2165/00007256-200535060-00004>
- Stroop, J. R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology*, 18(6), 643–662. <https://doi.org/10.1037/h0054651>
- Tanaka, M., Ishii, A., & Watanabe, Y. (2014). Neural effects of mental fatigue caused by continuous attention load: A magnetoencephalography study. *Brain Research*, 1561, 60–66. <https://doi.org/10.1016/j.brainres.2014.03.009>
- Tanaka, M., & Watanabe, Y. (2012). Supraspinal regulation of physical fatigue. *Neuroscience & Behavioral Reviews*, 36(1), 727–734. <https://doi.org/10.1016/j.neubiorev.2011.10.004>
- Tessitore, A., Meeusen, R., Piacentini, M. F., Demarie, S., & Capranica, L. (2006). Physiological and technical aspects of “6-a-side” soccer drills. *Journal of Sports Medicine and Physical Fitness*, 46(1), 36–43. <https://doi.org/10.1007/s13398-014-0173-7.2>
- Thompson, C. J., Fransen, J., Skorski, S., Smith, M. R., Meyer, T., Barrett, S., & Coutts, A. J. (2019). Mental Fatigue in Football: Is it Time to Shift the Goalposts? An Evaluation of the Current Methodology. *Sports Medicine*, 49(2), 177–183. <https://doi.org/10.1007/s40279-018-1016-z>
- Thompson, C. J., Noon, M., Towilson, C., Perry, J., Coutts, A. J., Harper, L. D., Skorski, S., Smith, M. R., Barrett, S., & Meyer, T. (2020). Understanding the presence of mental fatigue in English academy soccer players. *Journal of Sports Sciences*, 38(13), 1524–1530. <https://doi.org/10.1080/02640414.2020.1746597>
- Travassos, B., Araújo, D., Davids, K., Vilar, L., Esteves, P., & Vanda, C. (2012). Informational constraints shape emergent functional behaviours during performance of interceptive actions in team sports. *Psychology of Sport and Exercise*, 13(2), 216–223. <https://doi.org/10.1016/j.psychsport.2011.11.009>
- Van Cutsem, J., Marcora, S., De Pauw, K., Bailey, S., Meeusen, R., & Roelands, B. (2017a). The Effects of Mental Fatigue on Physical Performance: A Systematic Review. *Sports Medicine*, 47(8), 1569–1588. <https://doi.org/10.1007/s40279-016-0672-0>
- Van Cutsem, J., Marcora, S., De Pauw, K., Bailey, S., Meeusen, R., & Roelands, B. (2017b). The Effects of Mental Fatigue on Physical Performance: A Systematic Review. *Sports Medicine*, 47(8), 1569–1588. <https://doi.org/10.1007/s40279-016-0672-0>
- van der Linden, D., Frese, M., & Meijman, T. F. (2003). Mental fatigue and the control of cognitive processes: effects on perseveration and planning. *Acta Psychologica*, 113(1), 45–65. [https://doi.org/10.1016/S0001-6918\(02\)00150-6](https://doi.org/10.1016/S0001-6918(02)00150-6)
- Walsh, V. (2014). Is sport the brain’s biggest challenge? *Current Biology*, 24(18), R859–R860. <https://doi.org/10.1016/j.cub.2014.08.003>
- Williams, A. M. (2000). Perceptual skill in soccer: Implications for talent identification and development. *Journal of Sports Sciences*, 18(9), 737–750. <https://doi.org/10.1080/02640410050120113>
- Williamson, J. W., McColl, R., Mathews, D., Mitchell, J. H., Raven, P. B., & Morgan, W. P. (2001). Hypnotic manipulation of effort sense during dynamic exercise: cardiovascular responses and brain activation. *Journal of Applied Physiology*, 90(4), 1392–1399. <https://doi.org/10.1152/jappl.2001.90.4.1392>
- Williamson, J. W., McColl, R., Mathews, D., Mitchell, J. H., Raven, P. B., & Morgan, W. P. (2002). Brain activation by central command during actual and imagined handgrip under hypnosis. *Jour-*



*nal of Applied Physiology*, 92(3), 1317–1324. <https://doi.org/10.1152/jappphysiol.00939.2001>  
Zering, J. C., Brown, D. M. Y., Graham, J. D., & Bray, S. R. (2017). Cognitive control exertion leads to reductions in peak power output and as well as increased perceived exertion on a graded exercise test to exhaustion. *Journal of Sports Sciences*, 35(18), 1799–1807. <https://doi.org/10.1080/02640414.2016.1237777>