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Sex, quality of life and brain function in complex regional pain syndrome

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LIST OF PUBLICATIONS

van Velzen GAJ, Perez RSGM, van Gestel MA, et al. Health-related quality of life in 975 patients with complex regional pain syndrome type 1. *Pain*. 2014;155(3):629-634. doi:10.1016/j.pain.2013.12.017

van Velzen GA, Marinus J, van Dijk JG, van Zwet EW, Schipper IB, van Hilten JJ. Motor cortical activity during motor tasks is normal in patients with complex regional pain syndrome. *J Pain*. 2015;16(1):87-94. doi:10.1016/j.jpain.2014.10.010

van Velzen GA, Rombouts SA, van Buchem MA, Marinus J, van Hilten JJ. Is the brain of complex regional pain syndrome patients truly different?. *Eur J Pain*. 2016;20(10):1622-1633. doi:10.1002/ejp.882

van Velzen GAJ, Huygen FJPM, van Kleef M, van Eijs FV, Marinus J, van Hilten JJ. Sex matters in complex regional pain syndrome. *Eur J Pain*. 2019;23(6):1108-1116. doi:10.1002/ejp.1375

van Velzen GA, Rombouts SA, van Buchem MA, Marinus J, van Hilten JJ. Noxious heat elicits opposite responses in brain regions that mediate salience and affection in complex regional pain syndrome *Submitted*



REWARDS

European Pain Federation – Fondazione IBSA publication award 2016 voor “Is the brain of complex regional pain syndrome patients truly different?”

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CURRICULUM VITAE

Gijsbrecht Abraham Johan van Velzen was born on the 24th of May, 1984. After graduating high school (Stedelijk Gymnasium Leiden) in 2002, he studied Political Science at the University of Leiden for one year. In 2003 he was accepted at the medical school (University Leiden) which he completed in 2010. In his last year of medical school he attended a scientific internship in Bath, United Kingdom, under the supervision of Candy McCabe. In May 2010 he started his PhD research at the department of neurology in the Leiden University Medical Center, under the supervision of prof. J.J. van Hilten and dr. J. Marinus. This was followed up by one year of residency neurology-not-in-training (ANIOS) in the Reinier de Graaf Gasthuis. In July 2015 he started his residency neurology at the Leiden University Medical Center which he completed in October 2021. After two months as chef de clinique in Franciscus Gasthuis en Vlietland, he started as a neurologist in the Noord West Ziekenhuisgroep from the first of January 2022.

Gijsbrecht has a beautiful fiancé Janneke Schilder and three children (Klaas, Emma and Tijn).

REFERENCES

1. Marinus J, Moseley GL, Birklein F, et al. Clinical features and pathophysiology of complex regional pain syndrome. *Lancet Neurol*. 2011;10(7):637-648. doi:10.1016/S1474-4422(11)70106-5
2. Harden R, Bruehl S. Proposed new diagnostic criteria for complex regional pain syndrome. *Pain*. 2007;8(4):326-331.
3. Novak CB, Anastakis DJ, Beaton DE, Mackinnon SE, Katz J. Relationships among pain disability, pain intensity, illness intrusiveness, and upper extremity disability in patients with traumatic peripheral nerve injury. *J Hand Surg Am*. 2010;35(10):1633-1639. doi:10.1016/j.jhsa.2010.07.018
4. De Mos M, de Bruijn AG, Huygen FJ, Dieleman JP, Stricker BH, Sturkenboom MC. The incidence of complex regional pain syndrome: a population-based study. *Pain*. 2007;129(1-2):12-20.
5. Bean DJ, Johnson MH, Heiss-Dunlop W, Kydd RR. Extent of recovery in the first 12 months of complex regional pain syndrome type-1: A prospective study. *Eur J Pain (United Kingdom)*. 2016;20(6):884-894. doi:10.1002/ejp.813
6. Beerthuizen A, Stronks DL, Van 't Spijker A, et al. Demographic and medical parameters in the development of complex regional pain syndrome type 1 (CRPS1): Prospective study on 596 patients with a fracture. *Pain*. 2012;153(6):1187-1192. doi:10.1016/j.pain.2012.01.026
7. Merskey H, N B. Classification of chronic pain: descriptions of chronic pain syndromes and definitions of pain terms. In: *Task Force on Taxonomy of the International Association for the Study of Pain*. 2nd ed. IASP Press; 1994:39-43.
8. De Mos M, Van Der Hoeven-Borgman M, Dieleman JP, Stricker BH, Sturkenboom MC, Huygen FJ. Outcome of the complex regional pain syndrome. *Clin J Pain*. 2009;25(7):590-597. doi:10.1097/AJP.0b013e3181a11623
9. Taylor VR, Weis K. *Measuring Healthy Days: Population Assessment of Health-Related Quality of Life*; 2000.
10. Duman I, Dincer U, Taskaynatan M. Reflex sympathetic dystrophy: a retrospective epidemiological study of 168 patients. *Clin Rheumatol*. 2007;26(9):1433-1437. doi:10.1007/s10067-006-0515-8
11. Galer B, Henderson J. Course of symptoms and quality of life measurement in complex regional pain syndrome: a pilot survey. *J Pain Symptom Manage*. 2000;20(4):286-292.
12. Kemler M, Vet H de. Health-related quality of life in chronic refractory reflex sympathetic dystrophy (complex regional pain syndrome type I). *J Pain Symptom Manage*. 2000;20(1):68-76.
13. Savaş S, Baloğlu HH, Ay G, Cerçi SS. The effect of sequel symptoms and signs of Complex Regional Pain Syndrome type 1 on upper extremity disability and quality of life. *Rheumatol Int*. 2009;29(5):545-550. doi:10.1007/s00296-008-0748-8
14. Tan ECTH, van de Sandt-Renkema N, Krabbe PFM, Aronson DC, Severijnen RSVM. Quality of life in adults with childhood-onset of Complex Regional Pain Syndrome type I. *Injury*. 2009;40(8):901-904. doi:10.1016/j.injury.2009.01.134
15. Reedijk W, Rijn M van, Roelofs K. Psychological features of patients with complex regional pain syndrome type I related dystonia. *Mov Disord*. 2008;23(11):1551-1559.
16. Pieretti S, Di Giannuario A, Di Giovannandrea R, et al. Gender differences in pain and its relief. In: *Annali Dell'Istituto Superiore Di Sanita*. Vol 52. ; 2016:184-189. doi:10.4415/ANN_16_02_09
17. Berkley KJ. Sex differences in pain. *Behav Brain Sci*. 1997;20(3):371-380; discussion 435-513.
18. Racine M, Tousignant-Laflamme Y, Kloda LA, Dion D, Dupuis G, Choinire M. A systematic literature review of 10 years of research on sex/gender and pain perception - Part 2: Do biopsychosocial factors alter pain sensitivity differently in women and men? *Pain*. 2012;153(3):619-635. doi:10.1016/j.pain.2011.11.026

19. Racine M, Tousignant-Laflamme Y, Kloda LA, Dion D, Dupuis G, Choinière M. A systematic literature review of 10 years of research on sex/gender and experimental pain perception – Part 1: Are there really differences between women and men? *Pain*. 2012;153(3):602–618. doi:10.1016/j.pain.2011.11.025
20. Bharwani KD, Dirckx M, Stronks DL, Dik WA, Schreurs MWJ, Huygen FJPM. Elevated Plasma Levels of sIL-2R in Complex Regional Pain Syndrome: A Pathogenic Role for T-Lymphocytes? *Mediators Inflamm*. 2017;2017. doi:10.1155/2017/2764261
21. Huygen FJPM, Ramdhani N, Van Toorenenbergen A, Klein J, Zijlstra FJ. Mast cells are involved in inflammatory reactions during Complex Regional Pain Syndrome type 1. *Immunol Lett*. Published online 2004. doi:10.1016/j.imlet.2003.11.013
22. Huygen FJPM, Bruijn AGJ De. Evidence for local inflammation in complex regional pain syndrome type 1. *Mediators Inflamm*. 2002;51:47–51.
23. Schinkel C, Gaertner A, Zaspel J, Zedler S, Faist E, Schuermann M. Inflammatory mediators are altered in the acute phase of posttraumatic complex regional pain syndrome. *Clin J Pain*. 2006;22(3):235–239. doi:10.1097/01.aip.0000169669.70523.f0
24. Bharwani KD, Dik WA, Dirckx M, Huygen FJPM. Highlighting the Role of Biomarkers of Inflammation in the Diagnosis and Management of Complex Regional Pain Syndrome. *Mol Diagnosis Ther*. 2019;23(5):615–626. doi:10.1007/s40291-019-00417-x
25. Bruehl S. An update on the pathophysiology of complex regional pain syndrome. *Anesthesiology*. 2010;113(3):713–725. doi:10.1097/ALN.0b013e3181e3db38
26. Groeneweg JG, Huygen FJPM, Heijmans-Antonissen C, Niehof S, Zijlstra FJ. Increased endothelin-1 and diminished nitric oxide levels in blister fluids of patients with intermediate cold type complex regional pain syndrome type 1. *BMC Musculoskelet Disord*. Published online 2006. doi:10.1186/1471-2474-7-91
27. Schattschneider J, Hartung K, Stengel M, et al. Endothelial dysfunction in cold type complex regional pain syndrome. *Neurology*. Published online 2006. doi:10.1212/01.wnl.0000229931.40631.31
28. Wasner G. Vasomotor disturbances in complex regional pain syndrome—A review. *Pain Med (United States)*. Published online 2010. doi:10.1111/j.1526-4637.2010.00914.x
29. Koban M, Leis S, Schultze-Mosgau S, Birklein F. Tissue hypoxia in complex regional pain syndrome. *Pain*. Published online 2003. doi:10.1016/S0304-3959(02)00484-0
30. Cheng JK, Ji RR. Intracellular signaling in primary sensory neurons and persistent pain. *Neurochem Res*. Published online 2008. doi:10.1007/s11064-008-9711-z
31. Couture R, Harrisson M, Vianna RM, Cloutier F. Kinin receptors in pain and inflammation. *Eur J Pharmacol*. Published online 2001. doi:10.1016/S0014-2999(01)01318-8
32. Tsuda M, Inoue K, Salter MW. Neuropathic pain and spinal microglia: A big problem from molecules in “small” glia. *Trends Neurosci*. 2005;28(2):101–107. doi:10.1016/j.tins.2004.12.002
33. Del Valle L, Schwartzman RJ, Alexander G. Spinal cord histopathological alterations in a patient with longstanding complex regional pain syndrome. *Brain Behav Immun*. 2009;23(1):85–91. doi:10.1016/j.bbi.2008.08.004
34. Ji RR, Nackley A, Huh Y, Terrando N, Maixner W. Neuroinflammation and central sensitization in chronic and widespread pain. *Anesthesiology*. 2018;129(2):343–366. doi:10.1097/ALN.0000000000002130
35. Latremoliere A, Woolf CJ. Central sensitization: a generator of pain hypersensitivity by central neural plasticity. *J Pain*. 2009;10(9):895–926. doi:10.1016/j.jpain.2009.06.012
36. Woolf CJ, Mannion RJ. Neuropathic pain: aetiology, symptoms, mechanisms, and management. *Lancet*. 1999;353(9168):1959–1964. doi:10.1016/S0140-6736(99)01307-0
37. Seifert F, Kiefer G, Decol R, Schmeltz M, Maihöfner C. Differential endogenous pain modulation in complex-regional pain syndrome. *Brain*. 2009;132(3):788–800. doi:10.1093/brain/awn346

38. Pleger B, Ragert P, Schwenkreis P, et al. Patterns of cortical reorganization parallel impaired tactile discrimination and pain intensity in complex regional pain syndrome. *Neuroimage*. 2006;32(2):503–510.
39. Maihöfner C, Handwerker HO, Neundörfer B, Birklein F. Patterns of cortical reorganization in complex regional pain syndrome. *Neurology*. 2003;61(12):1707–1715.
40. Maihöfner C, Baron R, Decol R, et al. The motor system shows adaptive changes in complex regional pain syndrome. *Brain*. 2007;130(Pt 10):2671–2687. doi:10.1093/brain/awm131
41. Geha PY, Baliki MN, Harden RN, Bauer WR, Parrish TB, Apkarian AV. The Brain in Chronic CRPS Pain: Abnormal Gray-White Matter Interactions in Emotional and Autonomic Regions. *Neuron*. 2008;60(4):570–581. doi:10.1016/j.neuron.2008.08.022
42. Barad MJ, Ueno T, Younger J, Chatterjee N, Mackey S. Complex regional pain syndrome is associated with structural abnormalities in pain-related regions of the human brain. *J Pain*. 2014;15(2):197–203. doi:10.1016/j.jpain.2013.10.011
43. Pleger B, Draganski B, Schwenkreis P, et al. Complex regional pain syndrome type I affects brain structure in prefrontal and motor cortex. *PLoS One*. 2014;9(1):e85372. doi:10.1371/journal.pone.0085372
44. Baliki MN, Schnitzer TJ, Bauer WR, Apkarian a.V. Brain Morphological Signatures for Chronic Pain. Luque RM, ed. *PLoS One*. 2011;6(10):e26010. doi:10.1371/journal.pone.0026010
45. Bolwerk A, Seifert F, Maihöfner C. Altered Resting-State Functional Connectivity in Complex Regional Pain Syndrome. *J Pain*. 2013;14(10):1–17. doi:10.1016/j.jpain.2013.04.007
46. Schwenkreis P, Janssen F, Rommel O, et al. Bilateral motor cortex disinhibition in complex regional pain syndrome (CRPS) type I of the hand. *Neurology*. 2003;61(4):515–519.
47. Eisenberg E, Chistyakov A V, Yudashkin M, Kaplan B, Hafner H, Feinsod M. Evidence for cortical hyperexcitability of the affected limb representation area in CRPS: a psychophysical and transcranial magnetic stimulation study. *Pain*. 2005;113(1–2):99–105. doi:10.1016/j.pain.2004.09.030
48. McCabe CS, Haigh RC, Halligan PW, Blake DR. Referred sensations in patients with complex regional pain syndrome type 1. *Rheumatology (Oxford)*. 2003;42(9):1067–1073.
49. Rommel O, Malin JP, Zenz M, Jänig W. Quantitative sensory testing, neurophysiological and psychological examination in patients with complex regional pain syndrome and hemisensory deficits. *Pain*. 2001;93(3):279–293.
50. Gierthmühlen J, Maier C, Baron R, et al. Sensory signs in complex regional pain syndrome and peripheral nerve injury. *Pain*. 2012;153:765–774.
51. Wasner G, Schattschneider J, Heckmann K, Maier C, Baron R. Vascular abnormalities in reflex sympathetic dystrophy (CRPS I): mechanisms and diagnostic value. *Brain*. 2001;124(Pt 3):587–599.
52. Schilder JCM, Schouten a C, Perez RSGM, et al. Motor control in complex regional pain syndrome: A kinematic analysis. *Pain*. 2012;153(4):805–812. doi:10.1016/j.pain.2011.12.018
53. Galer BS, Butler S, Jensen MP. Case reports and hypothesis: a neglect-like syndrome may be responsible for the motor disturbance in reflex sympathetic dystrophy (Complex Regional Pain Syndrome-1). *J Pain Symptom Manage*. 1995;10(5):385–391.
54. Ribbers GM, Mulder T, Geurts AC, den Otter R a. Reflex sympathetic dystrophy of the left hand and motor impairments of the unaffected right hand: Impaired central motor processing? *Arch Phys Med Rehabil*. 2002;83(1):81–85. doi:10.1053/apmr.2002.27331
55. Bank PJM, Peper C (Lieke) E, Marinus J, Beek PJ, van Hilten JJ. Motor dysfunction of complex regional pain syndrome is related to impaired central processing of proprioceptive information. *J Pain*. 2013;14(11):1460–1474. doi:10.1016/j.jpain.2013.07.009
56. Acerra NE, Moseley GL. Dysynchiria: watching the mirror image of the unaffected limb elicits pain on the affected side. *Neurology*. 2005;65(5):751–753.

57. Moseley G, Parsons T, Spence C. Visual distortion of a limb modulates the pain and swelling evoked by movement. *Curr Biol*. 2008;18(22):R1047-R1048.
58. Schrag A, Trimble M, Quinn N, Bhatia K. The syndrome of fixed dystonia: An evaluation of 103 patients. *Brain*. 2004;127(10):2360-2372. doi:10.1093/brain/awh262
59. Gupta A, Lang AE. Psychogenic movement disorders. *Curr Opin Neurol*. 2009;22(4):430-436. doi:10.1097/WCO.0b013e32832dc169
60. Hallett M. Functional movement disorders: Is the crisis resolved? *Mov Disord*. 2019;34(7):971-974. doi:10.1002/mds.27713
61. Lang AE. Dystonia in complex regional pain syndrome type 1. *Neurology*. 2009;67(3):412-414. doi:10.1002/ana.21964
62. Verdugo RJ, Ochoa JL. Abnormal movements in complex regional pain syndrome: assessment of their nature. *Muscle Nerve*. 2000;23(2):198-205.
63. Schwingenschuh P, Katschnig P, Edwards MJ, et al. The blink reflex recovery cycle differs between essential and presumed psychogenic blepharospasm. *Neurology*. 2011;76(7):610-614. doi:10.1212/WNL.0b013e32831820c3074
64. Liepert J, Hassa T, Tüscher O, Schmidt R. Electrophysiological correlates of motor conversion disorder. *Mov Disord*. 2008;23(15):2171-2176.
65. Liepert J, Hassa T, Tüscher O, Schmidt R. Abnormal motor excitability in patients with psychogenic paresis. A TMS study. *J Neurol*. 2009;256(1):121-126.
66. Liepert J, Hassa T, Tüscher O, Schmidt R. Motor excitability during movement imagination and movement observation in psychogenic lower limb paresis. *J Psychosom Res*. 2011;70(1):59-65. doi:10.1016/j.jpsychores.2010.06.004
67. Geertzen J, Dijkstra P. Reflex sympathetic dystrophy of the upper extremity--a 5.5-year follow-up. Part II. Social life events, general health and changes in occupation. *Acta Orthop Scand*. 1998;279:19-23.
68. Geertzen JH, Dijkstra PUU, van Sonderen EL, et al. Relationship between impairments, disability and handicap in reflex sympathetic dystrophy patients: a long-term follow-up study. *Clin Rehabil*. 1998;12(5):402-412. doi:10.1191/026921598676761735
69. Maleki J, LeBel A, Bennett G, Schwartzman R. Patterns of spread in complex regional pain syndrome, type I (reflex sympathetic dystrophy). *Pain*. 2000;88(3):259-266.
70. van Rijn M a, Marinus J, Putter H, Bosselaar SRJ, Moseley GL, van Hilten JJ. Spreading of complex regional pain syndrome: not a random process. *J Neural Transm*. 2011;118(9):1301-1309. doi:10.1007/s00702-011-0601-1
71. Veldman PH, Goris RJ. Multiple reflex sympathetic dystrophy. Which patients are at risk for developing a recurrence of reflex sympathetic dystrophy in the same or another limb. *Pain*. 1996;64(3):463-466.
72. Sandroni P, Benrud-Larson LM, McClelland RL, Low PA. Complex regional pain syndrome type I: incidence and prevalence in Olmsted county, a population-based study. *Pain*. 2003;103(1-2):199-207.
73. Poplawski Z, Wiley A, Murray J. Post-traumatic dystrophy of the extremities. *J Bone Jt Surg Am*. 1983;(65):642-655.
74. Perez RSGM, Collins S, Marinus J, Zuurmond WW a, de Lange JJ. Diagnostic criteria for CRPS I: differences between patient profiles using three different diagnostic sets. *Eur J Pain*. 2007;11(8):895-902. doi:10.1016/j.ejpain.2007.02.006
75. Harden R, Bruehl S, Perez R. Development of a severity score for CRPS. *Pain*. 2010;151(3):870-876.
76. Ware J, Sherbourne C. The MOS 36-item short-form health survey (SF-36). *Med Care*. 1994;30(6):473-483.

77. Melzack R. The McGill Pain Questionnaire: major properties and scoring methods. *Pain*. 1975;1(3):277-299.
78. Zigmond A, Snaith R. The hospital anxiety and depression scale. *Acta Psychiatr Scand*. 1983;67(6):361-370.
79. Margreet Oerlemans H, H. C. Cup E, De Boo T, A. Goris RJ, A. B. Oostendorp R. The Radboud skills questionnaire: construction and reliability in patients with reflex sympathetic dystrophy of one upper extremity. *Disabil Rehabil*. 2000;22(5):233-245. doi:10.1080/096382800296809
80. Roorda LD, Molenaar IW, Lankhorst GJ, Bouter LM. Improvement of a questionnaire measuring activity limitations in rising and sitting down in patients with lower-extremity disorders living at home. *Arch Phys Med Rehabil*. 2005;86(11):2204-2210. doi:10.1016/j.apmr.2005.06.005
81. Roorda LD, Roebroeck ME, Van Tilburg T, Molenaar IW, Lankhorst GJ, Bouter LM. Measuring activity limitations in walking: Development of a hierarchical scale for patients with lower-extremity disorders who live at home. *Arch Phys Med Rehabil*. Published online 2005. doi:10.1016/j.apmr.2005.06.014
82. Kvien T, Kaasa S, Smedstad L. Performance of the Norwegian SF-36 Health Survey in patients with rheumatoid arthritis. II. A comparison of the SF-36 with disease-specific measures. *J Clin Epidemiol*. 1998;51(11):1077-1086.
83. Edlinger M, Hoeymans N, Tijhuis M, Feskens E. De kwaliteit van leven (RAND-36) in twee Nederlandse populaties. *Tijdschr Soc Gezondheidsz. Tijdschr Soc gezondheidszorg*. 1998;76:211-219.
84. Jong J de, Vlaeyen J, Onghena P. Reduction of pain-related fear in complex regional pain syndrome type I: the application of graded exposure in vivo. *Pain*. 2005;116(3):264-275. doi:10.1016/j.pain.2005.04.019
85. Marinus J, Perez R, Eijs F van. The Role of Pain Coping and Kinesiophobia in Patients With Complex Regional Pain Syndrome Type 1 of the Legs. *Clin J Pain*. 2013;29(7):563-569.
86. Barnhoorn K. The effectiveness and cost evaluation of pain exposure physical therapy and conventional therapy in patients with complex regional pain syndrome type 1. *BMC Musculoskelet Disord*. 2012;13:58. doi:10.1186/1471-2474-13-58
87. Alfen N van. Long-term pain, fatigue, and impairment in neuralgic amyotrophy. *Arch Phys Med Rehabil*. 2009;90(3):435-439. doi:10.1016/j.apmr.2008.08.216
88. Schans C van der, Geertzen J. Phantom pain and health-related quality of life in lower limb amputees. *J Pain Symptom Manage*. 2002;24(4):429-436.
89. Sinha R, van den Heuvel WJ a, Arokiasamy P. Factors affecting quality of life in lower limb amputees. *Prosthet Orthot Int*. 2011;35(1):90-96. doi:10.1177/0309364610397087
90. Verbunt J a, Pernot DHFM, Smeets RJEM. Disability and quality of life in patients with fibromyalgia. *Health Qual Life Outcomes*. 2008;6. doi:10.1186/1477-7525-6-8
91. Perrot S, Winkelmann a, Dukes E, et al. Characteristics of patients with fibromyalgia in France and Germany. *Int J Clin Pract*. 2010;64(8):1100-1108. doi:10.1111/j.1742-1241.2010.02418.x
92. Aaronson N, Muller M. Translation, validation, and norming of the Dutch language version of the SF-36 Health Survey in community and chronic disease populations. *J Clin Epidemiol*. 1998;51(11):1055-1068.
93. Sprangers M a, de Regt EB, Andries F, et al. Which chronic conditions are associated with better or poorer quality of life? *J Clin Epidemiol*. 2000;53(9):895-907.
94. Vinik A, Emir B, Cheung R, Whalen E. Relationship between pain relief and improvements in patient function/quality of life in patients with painful diabetic peripheral neuropathy or postherpetic neuralgia treated with pregabalin. *Clin Ther*. 2013;35(5):612-623. doi:10.1016/j.clinthera.2013.03.008
95. Hashmi JA, Davis KD. Deconstructing sex differences in pain sensitivity. *Pain*. 2014;155(1):10-13. doi:10.1016/j.pain.2013.07.039

96. Fillingim RB, King CD, Ribeiro-Dasilva MC, Rahim-Williams B, Riley JL. Sex, gender, and pain: a review of recent clinical and experimental findings. *J Pain*. 2009;10(5):447-485. doi:10.1016/j.jpain.2008.12.001
97. Fillingim RB. Sex, Gender, and Pain: Women and Men Really Are Different. *Curr Rev Pain Curr Sci Inc ISSN*. 2000;4:24-30.
98. Greenspan JD, Craft RM, LeResche L, et al. Studying sex and gender differences in pain and analgesia: A consensus report. *Pain*. Published online 2007. doi:10.1016/j.pain.2007.10.014
99. Rovner GS, Sunnerhagen KS, Björkdahl A, et al. Chronic pain and sex-differences; Women accept and move, while men feel blue. *PLoS One*. 2017;12(4). doi:10.1371/journal.pone.0175737
100. Vanderiet K, Adriaensen H, Carton H, Vertommen H. The McGill Pain Questionnaire constructed for the Dutch language (MPQ-DV). Preliminary data concerning reliability and validity. *Pain*. Published online 1987. doi:10.1016/0304-3959(87)90027-3
101. Jensen MP, Turner JA, Romano JM, Strom SE. The chronic pain coping inventory: development and preliminary validation. *Pain*. 1995;60(2):203-216. doi:10.1016/0304-3959(94)00118-X
102. Kraaiaat FW, Bakker A, Evers AWM. Pijn coping-strategieën bij chronische pijnpatiënten: De ontwikkeling van de Pijn-Coping-Inventarisatielijst (PCI). *Gedragstherapie*. Published online 1997. doi:10.1063/1.3033202
103. Oerlemans MH. Vragenlijst Vaardigheden https://meetinstrumentenzorg.blob.core.windows.net/test-documents/Instrument330/450_3_N.pdf. https://meetinstrumentenzorg.blob.core.windows.net/test-documents/Instrument330/450_3_N.pdf
104. Roorda LD. Walking and Rising questionnaire (WRQ) Dutch <https://www.leo-d-roorda.nl/en/vragenlijst-lopen-vl35/>. <https://www.leo-d-roorda.nl/geen-toegang/download-id/516/>
105. Bjelland I, Dahl AA, Haug TT, Neckelmann D. The validity of the Hospital Anxiety and Depression Scale An updated literature review.
106. Spinhoven P, Ormel J, Sloekers PPA, Kempen GJIM, Speckens AEM, Van Hemert AND A M. A validation study of the Hospital Anxiety and Depression Scale (HADS) in different groups of Dutch subjects. *Psychol Med Copyr #*. Published online 1997. doi:10.1017/S0033291796004382
107. Vlaeyen JWS, Kole-Snijders AMJ, Boeren RGB, van Eek H. Fear of movement/(re)injury in chronic low back pain and its relation to behavioral performance. *Pain*. 1995;62(3):363-372. doi:10.1016/0304-3959(94)00279-N
108. Ellis P. *The Essential Guide of Effect Sizes: Statistical Power, Meta-Analysis, and the Interpretation of Research Results*.; 2010.
109. Thissen D, Steinberg L, Kuang D. Quick and easy implementation of the Benjamini-Hochberg procedure for control ... *Education*. 2002;27(1):77-83.
110. Kraaiaat FW, Evers AWM. Pain-coping strategies in chronic pain patients: Psychometric characteristics of the pain-coping inventory (PCI) TL - 10. *Int J Behav Med*. 2003;(4):343-363. doi:10.1207/S15327558IJBM1004_5
111. McCormick ZL, Gagnon CM, Caldwell M, Patel J, Kornfeld S. Short-Term Functional , Emotional , and Pain Outcomes of Patients with Complex Regional Pain Syndrome Treated in a Comprehensive Interdisciplinary Pain Management Program. *Pain Med*. 2015;16:2357-2367.
112. Keogh E, Denford S. Sex differences in perceptions of pain coping strategy usage. *Eur J Pain*. 2009;13(6):629-634. doi:10.1016/j.ejpain.2008.07.002
113. Keogh E. Men , masculinity , and pain. 2015;156:2408-2412.
114. Munce SEP, Stewart DE. Gender Differences in Depression and Chronic Pain Conditions in a National Epidemiologic Survey. *Psychosomatics*. 2007;48(5):394-399. doi:10.1176/appi.psy.48.5.394

115. Geertzen JH, de Bruijn-Kofman AT, de Bruijn HP, van de Wiel HB, Dijkstra PU. Stressful life events and psychological dysfunction in Complex Regional Pain Syndrome type I. *Clin J Pain*. 1998;14(2):143-147.
116. Lohnberg J a, Altmair EM. A review of psychosocial factors in complex regional pain syndrome. *J Clin Psychol Med Settings*. 2013;20(2):247-254. doi:10.1007/s10880-012-9322-3
117. Feldman SI, Downey G, Schaffer-Neitz R. Pain, negative mood, and perceived support in chronic pain patients: a daily diary study of people with reflex sympathetic dystrophy syndrome. *J Consult Clin Psychol*. 1999;67(5):776-785. doi:10.1037/0022-006X.67.5.776
118. Haley WE, Turner JA, Romano JM. Depression in chronic pain patients: relation to pain, activity, and sex differences. *Pain*. 1985;23(4):337-343.
119. Bränström H, Fahlström M. Kinesiophobia in patients with chronic musculoskeletal pain: Differences between men and women. *J Rehabil Med*. 2008;40(5):375-380. doi:10.2340/16501977-0186
120. Jong J de, Vlaeyen J, Gelder J de, Patijn J. Pain-related fear, perceived harmfulness of activities, and functional limitations in complex regional pain syndrome type I. *J Pain*. 2011;12(12):1209-1218. doi:10.1016/j.jpain.2011.06.010
121. den Hollander M, Goossens M, de Jong J, et al. Expose or protect? A randomized controlled trial of exposure in vivo vs pain-contingent treatment as usual in patients with complex regional pain syndrome type 1. *Pain*. 2016;157(10):2318-2329. doi:10.1097/j.pain.0000000000000651
122. Di Pietro F, Stanton TR, Moseley GL, Lotze M, McAuley JH. Interhemispheric somatosensory differences in chronic pain reflect abnormality of the healthy side. *Hum Brain Mapp*. 2015;36(2):508-518. doi:10.1002/hbm.22643
123. Baliki MN, Mansour AR, Baria AT, Apkarian AV. Functional reorganization of the default mode network across chronic pain conditions. *PLoS One*. 2014;9(9):e106133. doi:10.1371/journal.pone.0106133
124. Pietro F Di, McAuley J, Parkitny L. Primary Motor Cortex Function in Complex Regional Pain Syndrome: A Systematic Review and Meta-Analysis. *J Pain*. 2013;14(11):1270-1288. doi:10.1016/j.jpain.2013.07.004
125. Di Pietro F, McAuley JH, Parkitny L, et al. Primary somatosensory cortex function in complex regional pain syndrome: a systematic review and meta-analysis. *J Pain*. 2013;14:1001-1018. doi:10.1016/j.jpain.2013.04.001
126. Moseley GL. Graded motor imagery for pathologic pain: a randomized controlled trial. *Neurology*. 2006;67(12):2129-2134.
127. Johnson S, Hall J, Barnett S, et al. Using graded motor imagery for complex regional pain syndrome in clinical practice: failure to improve pain. *Eur J Pain*. 2012;16(4):550-561. doi:10.1002/j.1532-2149.2011.00064.x
128. McCabe CS, Haigh RC, Ring EF, Halligan PW, Wall PD, Blake DR. A controlled pilot study of the utility of mirror visual feedback in the treatment of complex regional pain syndrome (type 1). *Rheumatology (Oxford)*. 2003;42(1):97-101.
129. Moseley GL, Zalucki NM, Wiech K. Tactile discrimination, but not tactile stimulation alone, reduces chronic limb pain. *Pain*. 2008;137(3):600-608.
130. Pleger B, Tegenthoff M, Ragert P, et al. Sensorimotor retuning [corrected] in complex regional pain syndrome parallels pain reduction. *Ann Neurol*. 2005;57(3):425-429. doi:10.1002/ana.20394
131. Oerlemans HM, Cup EH. The Radboud skills questionnaire: construction and reliability in patients with reflex sympathetic dystrophy of one upper extremity. *Disabil Rehabil*. 2000;22(5):233-245.
132. Burke RE, Fahn S, Marsden CD, Bressman SB, Moskowitz C, Friedman J. Validity and reliability of a rating scale for the primary torsion dystonias. *Neurology*. 1985;35:73-77. doi:10.1212/WNL.35.1.73

133. Jenkinson M, Beckmann CF, Behrens TE, Woolrich MW, Smith SM. FSL. *Neuroimage*. 2012;62:782–790. doi:S1053-8119(11)01060-3 [pii]\r10.1016/j.neuroimage.2011.09.015 [doi]
134. Smith SM, Jenkinson M, Woolrich MW, et al. Advances in functional and structural MR image analysis and implementation as FSL. *Neuroimage*. 2004;23 Suppl 1:S208–S219. doi:10.1016/j.neuroimage.2004.07.051
135. Woolrich MW, Jbabdi S, Patenaude B, et al. Bayesian analysis of neuroimaging data in FSL. *Neuroimage*. 2009;45:S173–S186. doi:10.1016/j.neuroimage.2008.10.055
136. Maihöfner C, Peltz E. CRPS, the parietal cortex and neurocognitive dysfunction: an emerging triad. *Pain*. 2011;152(7):1453–1454. doi:10.1016/j.pain.2011.03.018
137. Douaud G, Smith S, Jenkinson M, et al. Anatomically related grey and white matter abnormalities in adolescent-onset schizophrenia. *Brain*. 2007;130(Pt 9):2375–2386. doi:10.1093/brain/awm184
138. Ashburner J, Friston KJ. Voxel-based morphometry--the methods. *Neuroimage*. 2000;11(6 Pt 1):805–821.
139. Good CD, Johnsrude IS, Ashburner J, Henson RN, Friston KJ, Frackowiak RS. A voxel-based morphometric study of ageing in 465 normal adult human brains. *Neuroimage*. 2001;14(1 Pt 1):21–36. doi:10.1006/nimg.2001.0786
140. Smith SM. Fast robust automated brain extraction. *Hum Brain Mapp*. 2002;17(3):143–155. doi:10.1002/hbm.10062
141. Andersson JLR, Jenkinson M, Smith S. Non-linear registration aka Spatial normalisation. *FMRIB Tech Rep TRO7JA2*. Published online 2007.
142. Smith S, Nichols T. Threshold-Free Cluster Enhancement : Addressing problems of smoothing , threshold dependence and localisation in cluster inference. *Neuroimage*. 2009;1:1–20.
143. Nichols T, Holmes A. Nonparametric permutation tests for functional neuroimaging. In: Ashburner J, Friston KJ, Penny W, eds. *Human Brain Function*. second edi. ; 2003.
144. Smith S, Jenkinson M, Johansen-Berg H. Tract-based spatial statistics: voxelwise analysis of multi-subject diffusion data. *Neuroimage*. 2006;31:1487–1505. doi:S1053-8119(06)00138-8
145. Beaulieu C. The basis of anisotropic water diffusion in the nervous system – a technical review. *NMR Biomed*. 2002;15(7–8):435–455. doi:10.1002/nbm.782
146. Leemans A, Jeurissen B, Sijbers J, Jones D. ExploreDTI: a graphical toolbox for processing, analysing, and visualizing diffusion MR data. In: *17th Annual Meeting of International Society of Magnetic Resonance in Medicine*. ; 2009:3537.
147. Jenkinson M, Bannister P, Brady M, Smith S. Improved optimization for the robust and accurate linear registration and motion correction of brain images. *Neuroimage*. 2002;17:825–841. doi:S1053811902911328 [pii]
148. Jenkinson M, Smith S. A global optimisation method for robust affine registration of brain images. *Med Image Anal*. 2001;5(2):143–156.
149. Beckmann CF, Smith SM. Probabilistic independent component analysis for functional magnetic resonance imaging. *IEEE Trans Med Imaging*. 2004;23:137–152. doi:10.1109/TMI.2003.822821
150. Beckmann, Mackay, Filippini, Smith. Group comparison of resting-state fMRI data using multi-subject ICA and dual regression. *Neuroimage*. 2009;47:S148. doi:10.1073/pnas.0811879106
151. Maihöfner C, Handwerker HO. Differential coding of hyperalgesia in the human brain: a functional MRI study. *Neuroimage*. 2005;28(4):996–1006.
152. Raichle ME, MacLeod A, Snyder a Z, Powers WJ, Gusnard D a, Shulman GL. A default mode of brain function. *Proc Natl Acad Sci U S A*. 2001;98(2):676–682. doi:10.1073/pnas.98.2.676

153. Hashmi J a., Baliki MN, Huang L, et al. Shape shifting pain: chronification of back pain shifts brain representation from nociceptive to emotional circuits. *Brain*. 2013;136(9):2751–2768. doi:10.1093/brain/awt211
154. Bennett CM, Wolford GL, Miller MB. The principled control of false positives in neuroimaging. *Soc Cogn Affect Neurosci*. 2009;4(4):417–422. doi:10.1093/scan/nsp053
155. Bennett C, Baird A. Neural Correlates of Interspecies Perspective Taking in the Post-Mortem Atlantic Salmon: An Argument For Proper Multiple Comparisons Correction. *J Serendipitous unexpected results*. 2011;1(1):1–5.
156. Moseley GL, Gallace A, Spence C. Space-based, but not arm-based, shift in tactile processing in complex regional pain syndrome and its relationship to cooling of the affected limb. *Brain*. 2009;132(11):3142–3151. doi:10.1093/brain/awp224
157. Birklein F, Dimova V. Complex regional pain syndrome—up-to-date. *Pain Reports*. Published online 2017. doi:10.1097/PR9.0000000000000624
158. Freund W, Wunderlich AP, Stuber G, et al. The role of periaqueductal gray and cingulate cortex during suppression of pain in complex regional pain syndrome. *Clin J Pain*. 2011;27(9):796–804. doi:10.1097/AJP.0b013e31821d9063
159. Loggia ML, Berna C, Kim J, et al. The Lateral Prefrontal Cortex Mediates the Hyperalgesic Effects of Negative Cognitions in Chronic Pain Patients. *J Pain*. 2015;16(8):692–699. doi:10.1016/j.jpain.2015.04.003
160. van Velzen GAJAJ, Rombouts SARBARB, van Buchem MAA, Marinus J, van Hilten JJJ. Is the brain of complex regional pain syndrome patients truly different? *Eur J Pain*. 2016;20(10):1–12. doi:10.1002/ejp.882
161. Maihöfner C, Handwerker HO, Birklein F. Functional imaging of allodynia in complex regional pain syndrome. *Neurology*. 2006;66(5):711–717. doi:10.1212/01.wnl.0000200961.49114.39
162. Maihöfner C, Forster C, Birklein F, Neundörfer B. Brain processing during mechanical hyperalgesia in complex regional pain syndrome: a functional MRI study. *Pain*. 2005;114(1–2):93–103.
163. Freund W, Wunderlich AP, Stuber G, et al. Different activation of opercular and posterior cingulate cortex (PCC) in patients with complex regional pain syndrome (CRPS I) compared with healthy controls during perception of electrically induced pain: a functional MRI study. *Clin J Pain*. 2010;26(4):339–347. doi:10.1097/AJP.0b013e3181cb4055
164. Staud R, Bovee CE, Robinson ME, Price DD. Cutaneous C-fiber pain abnormalities of fibromyalgia patients are specifically related to temporal summation. *Pain*. 2009;139(2):315–323. doi:10.1016/j.pain.2008.04.024
165. Staud R, Craggs JG, Perlstein WM, Robinson ME, Price DD. Brain activity associated with slow temporal summation of C-fiber evoked pain in fibromyalgia patients and healthy controls. *Eur J Pain*. 2008;12(8):1078–1089. doi:10.1016/j.ejpain.2008.02.002
166. Aguiar P, Sousa M, Lima D. NMDA channels together with L-type calcium currents and calcium-activated nonspecific cationic currents are sufficient to generate windup in WDR neurons. *J Neurophysiol*. 2010;104(2):1155–1166. doi:10.1152/jn.00834.2009
167. Sigtermans MJ, van Hilten JJ, Bauer MC, et al. Ketamine produces effective and long-term pain relief in patients with Complex Regional Pain Syndrome Type 1. *Pain*. 2009;145(3):304–311.
168. Harden R, Bruehl S, Perez R. Validation of proposed diagnostic criteria (the “Budapest Criteria”) for complex regional pain syndrome. *Pain*. 2010;150(2):268–274. doi:10.1016/j.pain.2010.04.030
169. Herrero JF, Laird JM, López-García J a. Wind-up of spinal cord neurones and pain sensation: much ado about something? *Prog Neurobiol*. 2000;61(2):169–203.

170. Kelly RE, Alexopoulos GS, Wang Z, et al. Visual inspection of independent components: defining a procedure for artifact removal from fMRI data. *J Neurosci Methods*. 2010;189(2):233–245. doi:10.1016/j.jneumeth.2010.03.028
171. Woolrich MW, Ripley BD, Brady M, Smith SM. Temporal autocorrelation in univariate linear modeling of FMRI data. *Neuroimage*. Published online 2001. doi:10.1006/nimg.2001.0931
172. Woolrich MW, Behrens TEJ, Beckmann CF, Jenkinson M, Smith SM. Multilevel linear modelling for FMRI group analysis using Bayesian inference. *Neuroimage*. Published online 2004. doi:10.1016/j.neuroimage.2003.12.023
173. Friston KJ, Buechel C, Fink GR, Morris J, Rolls E, Dolan RJ. Psychophysiological and modulatory interactions in neuroimaging. *Neuroimage*. Published online 1997. doi:10.1006/nimg.1997.0291
174. O'Reilly JX, Woolrich MW, Behrens TEJ, Smith SM, Johansen-Berg H. Tools of the trade: Psychophysiological interactions and functional connectivity. *Soc Cogn Affect Neurosci*. 2012;7(5):604–609. doi:10.1093/scan/nss055
175. Rolke R, Baron R, Maier C, et al. Quantitative sensory testing in the German Research Network on Neuropathic Pain (DFNS): standardized protocol and reference values. *Pain*. 2006;123(3):231–243. doi:10.1016/j.pain.2006.01.041
176. Drummond PD. Sensory disturbances in complex regional pain syndrome: Clinical observations, autonomic interactions, and possible mechanisms. *Pain Med (United States)*. Published online 2010. doi:10.1111/j.1526-4637.2010.00912.x
177. Grothusen JR, Alexander G, Erwin K, Schwartzman R. Thermal pain in complex regional pain syndrome type I. *Pain Physician*. 2014;17(1):71–79.
178. Roberts K, Papadaki A, Gonçalves C, et al. Contact heat evoked potentials using simultaneous EEG and fMRI and their correlation with evoked pain. *BMC Anesthesiol*. 2008;8:8. doi:10.1186/1471-2253-8-8
179. Jensen KB, Regenbogen C, Ohse MC, Frasnelli J, Freiherr J, Lundström JN. Brain activations during pain: A neuroimaging meta-analysis of patients with pain and healthy controls. *Pain*. 2016;157(6):1279–1286. doi:10.1097/j.pain.0000000000000517
180. Duerden EG, Albanese M-C. Localization of pain-related brain activation: a meta-analysis of neuroimaging data. *Hum Brain Mapp*. 2013;34(1):109–149. doi:10.1002/hbm.21416
181. Legrain V, Iannetti GD, Plaghki L, Mouraux A. The pain matrix reloaded: A salience detection system for the body. *Prog Neurobiol*. 2011;93(1):111–124. doi:10.1016/j.pneurobio.2010.10.005
182. Treede RD, Kenshalo DR, Gracely RH, Jones AKP. The cortical representation of pain. *Pain*. Published online 1999. doi:10.1016/S0304-3959(98)00184-5
183. Downar J, Crawley AP, Mikulis DJ, Davis KD. A multimodal cortical network for the detection of changes in the sensory environment. *Nat Neurosci*. 2000;3(3):277–283. doi:10.1038/72991
184. Kucyi A, Hodaie M, Davis KD. Lateralization in intrinsic functional connectivity of the temporoparietal junction with salience- and attention-related brain networks. *J Neurophysiol*. 2012;108(12):3382–3392. doi:10.1152/jn.00674.2012
185. Mouraux A, Diukova A, Lee M, Wise R, Iannetti G. A multisensory investigation of the functional significance of the “pain matrix.” *Neuroimage*. 2011;54(3):2237–2249. doi:10.1016/j.neuroimage.2010.09.084
186. Orenius TI, Raji TT, Nuortimo A, Näätänen P, Lipsanen J, Karlsson H. The interaction of emotion and pain in the insula and secondary somatosensory cortex. *Neuroscience*. 2017;349:185–194. doi:10.1016/j.neuroscience.2017.02.047
187. Raichle ME. The Brain's Default Mode Network. *Annu Rev Neurosci*. 2015;38(1):433–447. doi:10.1146/annurev-neuro-071013-014030

188. Vogt BA, Laureys S. Posterior cingulate, precuneal and retrosplenial cortices: Cytology and components of the neural network correlates of consciousness. *Prog Brain Res.* 2005;150:205–217. doi:10.1016/S0079-6123(05)50015-3
189. Zhang Z, Gadotti VM, Chen L, Souza IA, Stemkowski PL, Zamponi GW. Role of Prelimbic GABAergic Circuits in Sensory and Emotional Aspects of Neuropathic Pain. *Cell Rep.* 2015;12(5):752–759. doi:10.1016/j.celrep.2015.07.001
190. Seifert F, Bschorer K, De Col R, et al. Medial prefrontal cortex activity is predictive for hyperalgesia and pharmacological antihyperalgesia. *J Neurosci.* 2009;29(19):6167–6175. doi:10.1523/JNEUROSCI.4654-08.2009
191. Hänsel A, von Känel R. The ventro-medial prefrontal cortex: A major link between the autonomic nervous system, regulation of emotion, and stress reactivity? *Biopsychosoc Med.* 2008;2:1–5. doi:10.1186/1751-0759-2-21
192. Lee M, Manders TR, Eberle SE, et al. Activation of corticostriatal circuitry relieves chronic neuropathic pain. *J Neurosci.* 2015;35(13):5247–5259. doi:10.1523/JNEUROSCI.3494-14.2015
193. Jensen KB, Kosek E, Wicksell R, et al. Cognitive Behavioral Therapy increases pain-evoked activation of the prefrontal cortex in patients with fibromyalgia. *Pain.* 2012;153(7):1495–1503. doi:10.1016/j.pain.2012.04.010
194. Bruehl S, Chung OY. Psychological and behavioral aspects of complex regional pain syndrome management. *Clin J Pain.* 2006;22(5):430–437.
195. Kim J, Kang I, Chung YA, et al. Altered attentional control over the salience network in complex regional pain syndrome. *Sci Rep.* 2018;8(1). doi:10.1038/s41598-018-25757-2
196. Hashmi JA, Baliki MN, Huang L, et al. Shape shifting pain: Chronification of back pain shifts brain representation from nociceptive to emotional circuits. *Brain.* 2013;136(9):2751–2768. doi:10.1093/brain/awt211
197. van Hilten JJ. Movement disorders in complex regional pain syndrome. *Pain Med.* 2010;11(8):1274–1277. doi:10.1111/j.1526-4637.2010.00916.x
198. de Abreu LPF, Teodoro T, Edwards MJ. *Neuroimaging Applications in Functional Movement Disorders*. Vol 143. 1st ed. Elsevier Inc.; 2018. doi:10.1016/bs.irn.2018.10.001
199. Strick PL, Dum RP, Fiez JA. Cerebellum and Nonmotor Function. *Annu Rev Neurosci.* 2009;32(1):413–434. doi:10.1146/annurev.neuro.31.060407.125606
200. Adamaszek M, D'Agata F, Ferrucci R, et al. Consensus Paper: Cerebellum and Emotion. *Cerebellum.* 2017;16(2):552–576. doi:10.1007/s12311-016-0815-8
201. Schwartzman RJ, Kerrigan J. The movement disorder of reflex sympathetic dystrophy. *Neurology.* 1990;40(1):57–61.
202. Verdugo RJ, Bell L a, Campero M, et al. Spectrum of cutaneous hyperalgesias/allodynia in neuropathic pain patients. *Acta Neurol Scand.* 2004;110(6):368–376. doi:10.1111/j.1600-0404.2004.00341.x
203. Williams DT, Ford B, Fahn S. Phenomenology and psychopathology related to psychogenic movement disorders. *Adv Neurol.* 1995;65:231–257.
204. Schwingenschuh P, Katschnig P, Seiler S, et al. Moving toward “laboratory-supported” criteria for psychogenic tremor. *Mov Disord.* 2011;26(14):2509–2515. doi:10.1002/mds.23922
205. Hanakawa T, Immisch I, Toma K, Dimyan MA, Van Gelderen P, Hallett M. Functional properties of brain areas associated with motor execution and imagery. *J Neurophysiol.* 2003;89(2):989–1002.
206. Jeannerod M. *Motor Cognition: What Actions Tell the Self*. Oxford University Press; 2006.
207. Patuzzo S, Fiaschi A, Manganotti P. Modulation of motor cortex excitability in the left hemisphere during action observation: a single- and paired-pulse transcranial magnetic stimulation study of self- and non-self-action observation. *Neuropsychologia.* 2003;41(9):1272–1278.

208. de Lange FP, Roelofs K, Toni I. Motor imagery: a window into the mechanisms and alterations of the motor system. *Cortex*. 2008;44(5):494-506.
209. Alaerts K, Senot P, Swinnen SP, Craighero L, Wenderoth N, Fadiga L. Force requirements of observed object lifting are encoded by the observer's motor system: a TMS study. *Eur J Neurosci*. 2010;31(6):1144-1153. doi:10.1111/j.1460-9568.2010.07124.x
210. Sandbrink F. The MEP in clinical neurodiagnosis. In: Wassermann EM, Epstein CM, Ziemann U, Walsh V, Paus T, Lisanby SH, eds. *The Oxford Handbook of Transcranial Magnetic Stimulation*. Oxford University Press; 2011:244-246.
211. Ziemann U. TMS and drugs. *Clin Neurophysiol*. 2004;115(8):1717-1729. doi:10.1016/j.clinph.2004.03.006
212. Ridding MC, Rothwell J. Stimulus/response curves as a method of measuring motor cortical excitability in man. *Electroencephalogr Clin Neurophysiol Mot Control*. 1997;105(5):340-344.
213. Rosenkranz K, Williamon A, Rothwell JC. Motorcortical excitability and synaptic plasticity is enhanced in professional musicians. *J Neurosci*. 2007;27(19):5200-5206. doi:10.1523/JNEUROSCI.0836-07.2007
214. Zanette G, Manganotti P, Fiaschi A, Tamburin S. Modulation of motor cortex excitability after upper limb immobilization. *Clin Neurophysiol*. 2004;115(6):1264-1275. doi:10.1016/j.clinph.2003.12.033
215. Roberts R, Callow N, Hardy L, Markland D, Bringer J. Movement imagery ability: development and assessment of a revised version of the vividness of movement imagery questionnaire. *J Sport Exerc Psychol*. 2008;30(2):200-221.
216. van Rooijen DE, Marinus J, van Hilten JJ. Muscle hyperalgesia is widespread in patients with complex regional pain syndrome. *Pain*. Published online August 11, 2013;0-4. doi:10.1016/j.pain.2013.08.004
217. Yahagi S, Kasai T. Motor evoked potentials induced by motor imagery reveal a functional asymmetry of cortical motor control in left- and right-handed human subjects. *Neurosci Lett*. 1999;276(3):185-188.
218. Gieteling EW, van Rijn MA, de Jong BM, et al. Cerebral activation during motor imagery in complex regional pain syndrome type 1 with dystonia. *Pain*. 2008;134(3):302-309.
219. Marshall JC, Halligan PW, Fink GR, Wade DT, Frackowiak RS. The functional anatomy of a hysterical paralysis. *Cognition*. 1997;64(1):B1-8.
220. Tiihonen J, Kuikka J, Viinamäki H. Altered cerebral blood flow during hysterical paresthesia. *Biol Psychiatry*. Published online 1995:16-17.
221. Vuilleumier P. Functional neuroanatomical correlates of hysterical sensorimotor loss. *Brain*. 2001;124(6):1077-1090. doi:10.1093/brain/124.6.1077
222. Voon V, Brezing C, Gallea C, Hallett M. Aberrant supplementary motor complex and limbic activity during motor preparation in motor conversion disorder. *Mov Disord*. 2011;000(000):1-8. doi:10.1002/mds.23890
223. Hodges PW, Tucker K. Moving differently in pain: a new theory to explain the adaptation to pain. *Pain*. 2011;152(3 Suppl):S90-8. doi:10.1016/j.pain.2010.10.020
224. Malouin F, Richards CL, Durand A, et al. Effects of practice, visual loss, limb amputation, and disuse on motor imagery vividness. *Neurorehabil Neural Repair*. 2009;23(5):449-463. doi:10.1177/1545968308328733
225. Kaneko F, Murakami T, Onari K, Kurumadani H, Kawaguchi K. Decreased cortical excitability during motor imagery after disuse of an upper limb in humans. *Clin Neurophysiol*. 2003;114(12):2397-2403.
226. Toussaint L, Meugnot A. Short-term limb immobilization affects cognitive motor processes. *J Exp Psychol Learn Mem Cogn*. 2013;39(2):623-632. doi:10.1037/a0028942

227. Bassolino M, Campanella M, Bove M, Pozzo T, Fadiga L. Training the Motor Cortex by Observing the Actions of Others During Immobilization. *Cereb Cortex*. Published online July 29, 2013;1-9. doi:10.1093/cercor/bht190
228. Navarro X, Vivo M, Valero-Cabré A. Neural plasticity after peripheral nerve injury and regeneration. *Prog Neurobiol*. 2007;82(4):163-201.
229. Vartiainen NV, Kirveskari E, Forss N. Central processing of tactile and nociceptive stimuli in complex regional pain syndrome. *Clin Neurophysiol*. 2008;119(10):2380-2388.
230. Ramachandran VS. Touching the phantom limb. *Nature*. 1995;377:489-490.
231. Ramachandran VS, Altschuler EL. The use of visual feedback, in particular mirror visual feedback, in restoring brain function. *Brain*. 2009;132(Pt 7):1693-1710. doi:10.1093/brain/awp135
232. Flor H, Elbert T, Knecht S, et al. Phantom-limb pain as a perceptual correlate of cortical reorganization following arm amputation. *Nature*. 1995;375(6531):482-484.
233. Mancini F, Wang AP, Schira MM, et al. Fine-Grained Mapping of Cortical Somatotopies in Chronic Complex Regional Pain Syndrome. *J Neurosci*. 2019;39(46):9185-9196. doi:10.1523/JNEUROSCI.2005-18.2019
234. Pietro F Di, Stanton TR, Moseley GL, Lotze M, McAuley JH. An exploration into the cortical reorganisation of the healthy hand in upper-limb complex regional pain syndrome. *Scand J Pain*. 2017;13(1):18-24. doi:10.1016/j.sjpain.2016.06.004
235. Méndez-Rebolledo G, Gatica-Rojas V, Torres-Cueco R, Albornoz-Verdugo M, Guzmán-Muñoz E. Update on the effects of graded motor imagery and mirror therapy on complex regional pain syndrome type 1: A systematic review. *J Back Musculoskeletal Rehabil*. 2017;30(3):441-449. doi:10.3233/BMR-150500
236. Khosla M, Jamison K, Ngo GH, Kuceyeski A, Sabuncu MR. Machine learning in resting-state fMRI analysis. *Magn Reson Imaging*. 2019;64(May):101-121. doi:10.1016/j.mri.2019.05.031
237. Knotkova H, Hamani C, Sivanesan E, et al. Neuromodulation for chronic pain. *Lancet*. 2021;397(10289):2111-2124. doi:10.1016/S0140-6736(21)00794-7
238. Cohen SP, Vase L, Hooten WM. Chronic pain: an update on burden, best practices, and new advances. *Lancet*. 2021;397(10289):2082-2097. doi:10.1016/S0140-6736(21)00393-7
239. Becerra L, Sava S, Simons LE, et al. Intrinsic brain networks normalize with treatment in pediatric complex regional pain syndrome. *NeuroImage Clin*. 2014;6:347-369. doi:10.1016/j.nicl.2014.07.012
240. Lebel A, Becerra L, Wallin D, et al. fMRI reveals distinct CNS processing during symptomatic and recovered complex regional pain syndrome in children. *Brain*. 2008;131(Pt 7):1854-1879.
241. Kemler MA, Raphael JH, Bentley A, Taylor RS. The cost-effectiveness of spinal cord stimulation for complex regional pain syndrome. *Value Heal*. 2010;13(6):735-742. doi:10.1111/j.1524-4733.2010.00744.x
242. Geurts JW, Smits H, Kemler MA, Brunner F, Kessels AGH, Van Kleef M. Spinal cord stimulation for complex regional pain syndrome type I: A prospective cohort study with long-term follow-up. *Neuromodulation*. 2013;16(6):523-529. doi:10.1111/ner.12024
243. Kemler MA, Barendse GAM, van Kleef M, et al. Spinal Cord Stimulation in Patients with Chronic Reflex Sympathetic Dystrophy. *N Engl J Med*. 2000;343(9):618-624. doi:10.1056/nejm200008313430904
244. Deer TR, Levy RM, Kramer J, et al. Dorsal root ganglion stimulation yielded higher treatment success rate for complex regional pain syndrome and causalgia at 3 and 12 months: A randomized comparative trial. *Pain*. 2017;158(4):669-681. doi:10.1097/j.pain.0000000000000814
245. Uçeyler N, Eberle T, Rolke R, Birklein F, Sommer C. Differential expression patterns of cytokines in complex regional pain syndrome. *Pain*. 2007;132(1-2):195-205. doi:10.1016/j.pain.2007.07.031

246. Wesseldijk F, Huygen FJ, Heijmans-Antonissen C, Niehof SP, Zijlstra FJ. Tumor necrosis factor- α and interleukin-6 are not correlated with the characteristics of Complex Regional Pain Syndrome type 1 in 66 patients. *Eur J Pain*. 2008;12(6):716–721. doi:10.1016/j.ejpain.2007.10.010
247. Russo MA, Georgius P, Pires AS, et al. Novel immune biomarkers in complex regional pain syndrome. *J Neuroimmunol*. 2020;347(July):577330. doi:10.1016/j.jneuroim.2020.577330
248. Tang C, Li J, Tai WL, et al. Sex differences in complex regional pain syndrome type I (CRPS-I) in mice. *J Pain Res*. 2017;10:1811–1819. doi:10.2147/JPR.S139365
249. Sorge RE, Mapplebeck JCS, Rosen S, et al. Different immune cells mediate mechanical pain hypersensitivity in male and female mice. *Nat Neurosci*. 2015;18(June):1–5. doi:10.1038/nn.4053
250. Sorge RE, Totsch SK. Sex Differences in Pain. *J Neurosci Res*. 2016;1281(June 2016):1271–1281. doi:10.1002/jnr.23841