**Supplementary file 1.**

**Reasons for excluded studies**

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| N | Author, Year | Reason for exclusion |
| 1 | St George et al, 2014 [1] | No neuropsychological outcomes. |
| 2 | Odekerken et al. 2013 [2]  | No neuropsychological outcomes. |
| 3 | Rocchi et al. 2012 [3] | No neuropsychological outcomes. |
| 4 | Dietz et al. 2013[4] | Assessing GPi-DBS only |
| 5 | Weaver et al. 2012[5] | Data overlap Rothlind et al study [6] |
| 6 | Robertson et al. 2011[7] | Irrelevant |
| 7 | Locke et al. 2011[8] | No neuropsychological outcomes |
| 8 | Follett et al. 2010[9] | Data overlap with Rothlind et al study [6] |
| 9 | Mann et al. 2009[10] | No neuropsychological outcomes |
| 10 | Weaver et al. 2009[11] | Data overlap with Rothlind et al study [6] |
| 11 | Hariz et al. 2008[12] | No neuropsychological outcomes |
| 12 | Anderson et al. 2005[13] | No neuropsychological outcomes |
| 13 | Escamilla-Sevilla et al., 2004 [14] | No neuropsychological outcomes |
| 14 | Volkmann et al. 2004[15] | Assessing GPi-DBS only. |
| 15 | Rocchi et al. 2004[16] | No neuropsychological outcomes |
| 16 | Okun et al. 2003[17] | No neuropsychological outcomes |
| 17 | Moro et al. 2002 [18] | No neuropsychological outcomes |
| 18 | Limousin et al. 1995[19] | No neuropsychological outcomes |
| 19 | Zahodne et al 2009[20] | Data overlap. |
| 20 | Vesper et al. 2012[21] | Irrelevant |
| 21 | [22] | No neuropsychological outcomes |
| 22 | Kruase et al. 2001[23] | No neuropsychological outcomes |
| 23 | Hristova et al. 2000[24] | No neuropsychological outcomes |
| 24 | Burchiel et al. 1999[25] | No neuropsychological outcomes |
| 25 | Gálvez-Jiménez et al 1998[26] | Assessing GPi-DBS only |
| 26 | Duff et al. 1997[27] | Irrelevant |
| 27 | Witt et al. 2013[28] | Assessing STN-DBS only |
| 28 | Sáez-Zea et al. 2012[29] | Assessing STN-DBS only |
| 29 | Chang et al. 2012[30] | Assessing STN-DBS only |
| 30 | Phillips et al. 2102[31] | Assessing STN-DBS only |
| 31 | St George et al. 2012[32] | No neuropsychological outcomes |
| 32 | McDonald et al. 2012[33] | Assessing STN-DBS only |
| 33 | Elena Moro et al. 2010[34] | No neuropsychological outcomes |
| 34 | Péron et al. 2010[35] | Assessing STN-DBS only |
| 35 | Mikos et al. 2010[36] | Present the data as DBS group without separating STN & GPi group |
| 36 | Volkmann et al. 2009[37] | No neuropsychological outcomes |
| 37 | York et al. 2008[38] | Assessing STN-DBS only |
| 38 | Rodriguez-Oroz et al. 2005[39] | No neuropsychological outcomes |
| 39 | Burdick et al 2011[40] | No neuropsychological outcomes |
| 40 | Zahodne et al. 2009[41] | Present the data as DBS group without separating STN & GPi group |
| 41 | Castelli et al. 2008[42] | Assessing STN-DBS only |
| 42 | Volkmann et al. 2001[43] | No neuropsychological outcomes |

REFERENCES

[1] St George RJ, Carlson-Kuhta P, Nutt JG, Hogarth P, Burchiel KJ, Horak FB. The effect of deep brain stimulation randomized by site on balance in Parkinson’s disease. Mov Disord 2014;29:949–53. doi:10.1002/mds.25831.

[2] Odekerken VJJ, van Laar T, Staal MJ, Mosch A, Hoffmann CFE, Nijssen PCG, et al. Subthalamic nucleus versus globus pallidus bilateral deep brain stimulation for advanced Parkinson’s disease (NSTAPS study): a randomised controlled trial. Lancet Neurol 2013;12:37–44. doi:10.1016/S1474-4422(12)70264-8.

[3] Rocchi L, Carlson-Kuhta P, Chiari L, Burchiel KJ, Hogarth P, Horak FB. Effects of deep brain stimulation in the subthalamic nucleus or globus pallidus internus on step initiation in Parkinson disease: laboratory investigation. J Neurosurg 2012;117:1141–9. doi:10.3171/2012.8.JNS112006.

[4] Dietz J, Noecker AM, McIntyre CC, Mikos A, Bowers D, Foote KD, et al. Stimulation region within the globus pallidus does not affect verbal fluency performance. Brain Stimul 2013;6:248–53. doi:10.1016/j.brs.2012.05.011.

[5] Weaver FM, Follett KA, Stern M, Harris CL, Rothlind J, Lai EC, et al. Randomized trial of deep brain stimulation for Parkinson disease: thirty-six-month outcomes. Neurology 2012;79:55–65. doi:10.1212/WNL.0b013e31825dcdc1.

[6] Rothlind JC, York MK, Carlson K, Luo P, Marks WJJ, Weaver FM, et al. Neuropsychological changes following deep brain stimulation surgery for Parkinson’s disease: comparisons of treatment at pallidal and subthalamic targets versus best medical therapy. J Neurol Neurosurg Psychiatry 2015;86:622–9. doi:10.1136/jnnp-2014-308119.

[7] Robertson LT, St George RJ, Carlson-Kuhta P, Hogarth P, Burchiel KJ, Horak FB. Site of deep brain stimulation and jaw velocity in Parkinson disease. J Neurosurg 2011;115:985–94. doi:10.3171/2011.7.JNS102173.

[8] Locke MC, Wu SS, Foote KD, Sassi M, Jacobson CE, Rodriguez RL, et al. Weight changes in subthalamic nucleus vs globus pallidus internus deep brain stimulation: Results from the COMPARE parkinson disease deep brain stimulation cohort. Neurosurgery 2011;68:1233–7. doi:10.1227/NEU.0b013e31820b52c5.

[9] Follett KA, Weaver FM, Stern M, Hur K, Harris CL, Luo P, et al. Pallidal versus Subthalamic Deep-Brain Stimulation for Parkinson’s Disease. N Engl J Med 2010;362:2077–91. doi:10.1056/NEJMoa0907083.

[10] Mann JM, Foote KD, Garvan CW, Fernandez HH, Jacobson CE, Rodriguez RL, et al. Brain penetration effects of microelectrodes and DBS leads in STN or GPi. J Neurol Neurosurg Psychiatry 2009;80:794–7. doi:10.1136/jnnp.2008.159558.

[11] Weaver FM, Follett K, Stern M, Hur K, Harris C, Marks WJ, et al. Bilateral deep brain stimulation vs best medical therapy for patients with advanced Parkinson disease: a randomized controlled trial. JAMA 2009;301:63–73. doi:10.1001/jama.2008.929.

[12] Hariz MI, Rehncrona S, Quinn NP, Speelman JD, Wensing C. Multicenter study on deep brain stimulation in Parkinson’s disease: an independent assessment of reported adverse events at 4 years. Mov Disord 2008;23:416–21. doi:10.1002/mds.21888.

[13] Anderson VC, Burchiel KJ, Hogarth P, Favre J, Hammerstad JP. Pallidal vs subthalamic nucleus deep brain stimulation in Parkinson disease. Arch Neurol 2005;62:554–60. doi:10.1001/archneur.62.4.554.

[14] Escamilla-Sevilla F, Minguez-Castellanos A, Katati MJ, Martin-Linares JM, Meersmans M, Ortega-Moreno A, et al. [Clinical utility of deep brain stimulation in an advanced Parkinson’s disease]. Neurologia 2004;19:719–27.

[15] Volkmann J, Allert N, Voges J, Sturm V, Schnitzler A, Freund HJ. Long-term results of bilateral pallidal stimulation in Parkinson’s disease. Ann Neurol 2004;55:871–5. doi:10.1002/ana.20091.

[16] Rocchi L, Chiari L, Cappello A, Gross A, Horak FB. Comparison between subthalamic nucleus and globus pallidus internus stimulation for postural performance in Parkinson’s disease. Gait Posture 2004;19:172–83. doi:10.1016/S0966-6362(03)00059-6.

[17] Okun MS, Green J, Saben R, Gross R, Foote KD, Vitek JL. Mood changes with deep brain stimulation of STN and GPi: results of a pilot study. J Neurol Neurosurg Psychiatry 2003;74:1584–6.

[18] Moro E, Esselink RJ a, Xie J, Hommel M, Benabid a L, Pollak P. The impact on Parkinson’s disease of electrical parameter settings in STN stimulation. Neurology 2002;59:706–13. doi:10.1212/WNL.59.5.706.

[19] Limousin P, Pollak P, Benazzouz A, Hoffmann D, Le Bas JF, Broussolle E, et al. Effect of parkinsonian signs and symptoms of bilateral subthalamic nucleus stimulation. Lancet 1995;345:91–5. doi:10.1016/S0140-6736(95)90062-4.

[20] Zahodne LB, Okun MS, Foote KD, Fernandez HH, Rodriguez RL, Wu SS, et al. Greater improvement in quality of life following unilateral deep brain stimulation surgery in the globus pallidus as compared to the subthalamic nucleus. J Neurol 2009;256:1321–9. doi:10.1007/s00415-009-5121-7.

[21] Vesper J, Chabardes S, Fraix V, Sunde N, Østergaard K. Dual channel deep brain stimulation system (Kinetra) for Parkinson’s disease and essential tremor: a prospective multicentre open label clinical study. J Neurol Neurosurg Psychiatry 2002;73:275–80. doi:10.1136/jnnp.73.3.275.

[22] Deep-Brain Stimulation of the Subthalamic Nucleus or the Pars Interna of the Globus Pallidus in Parkinson’s Disease — NEJM n.d. http://www.nejm.org/doi/full/10.1056/NEJMoa000827 (accessed June 30, 2014).

[23] Krause M. Deep brain stimulation for the treatment of Parkinson’s disease: subthalamic nucleus versus globus pallidus internus. J Neurol Neurosurg Psychiatry 2001;70:464–70. doi:10.1136/jnnp.70.4.464.

[24] A. H, K. L, A.I. T, R. P, S.B. W, W.C. K. Effect and time course of deep brain stimulation of the globus pallidus and subthalamus on motor features of Parkinson’s disease. Clin Neuropharmacol 2000;23:208–11. doi:10.1097/00002826-200007000-00007.

[25] Burchiel KJK, Anderson VCV, Favre J, Hammerstad JP. Comparison of pallidal and subthalamic nucleus deep brain stimulation for advanced Parkinson’s disease: results of a randomized, blinded pilot study. Neurosurgery 1999;45:1375–84. doi:10.1097/00006123-199912000-00024.

[26] Gálvez-Jiménez N, Lozano A, Tasker R, Duff J, Hutchison W, Lang AE. Pallidal stimulation in Parkinson’s disease patients with a prior unilateral pallidotomy. Can J Neurol Sci 1998;25:300–5.

[27] Duff J, Sime E. Surgical interventions in the treatment of Parkinson’s disease (PD) and essential tremor (ET): medial pallidotomy in PD and chronic deep brain stimulation (DBS) in PD and ET. Axone 1997;18:85–9.

[28] Witt K, Granert O, Daniels C, Volkmann J, Falk D, van Eimeren T, et al. Relation of lead trajectory and electrode position to neuropsychological outcomes of subthalamic neurostimulation in Parkinson’s disease: results from a randomized trial. Brain 2013;136:2109–19. doi:10.1093/brain/awt151.

[29] Saez-Zea C, Escamilla-Sevilla F, Katati MJ, Minguez-Castellanos A. Cognitive effects of subthalamic nucleus stimulation in Parkinson’s disease: a controlled study. Eur Neurol 2012;68:361–6. doi:10.1159/000341380.

[30] Chang C, Li N, Wu Y, Geng N, Ge S, Wang J, et al. Associations between bilateral subthalamic stimulation (STN-DBS) and anxiety in Parkinson’s disease patients: A controlled study. J Neuropsychiatry Clin Neurosci 2012;24:316–25. doi:10.1176/appi.neuropsych.11070170.

[31] Phillips L, Litcofsky KA, Pelster M, Gelfand M, Ullman MT, Charles PD. Subthalamic nucleus deep brain stimulation impacts language in early Parkinson’s disease. PLoS One 2012;7:e42829. doi:10.1371/journal.pone.0042829.

[32] St George RJ, Carlson-Kuhta P, Burchiel KJ, Hogarth P, Frank N, Horak FB. The effects of subthalamic and pallidal deep brain stimulation on postural responses in patients with Parkinson disease. J Neurosurg 2012;116:1347–56. doi:10.3171/2012.2.JNS11847.

[33] McDonald LM, Page D, Wilkinson L, Jahanshahi M. Deep brain stimulation of the subthalamic nucleus improves sense of well-being in Parkinson’s disease. Mov Disord 2012;27:372–8. doi:10.1002/mds.24035.

[34] Moro E, Lozano AM, Pollak P, Agid Y, Rehncrona S, Volkmann J, et al. Long-term results of a multicenter study on subthalamic and pallidal stimulation in Parkinson’s disease. Mov Disord 2010;25:578–86. doi:10.1002/mds.22735.

[35] Peron J, Biseul I, Leray E, Vicente S, Le Jeune F, Drapier S, et al. Subthalamic nucleus stimulation affects fear and sadness recognition in Parkinson’s disease. Neuropsychology 2010;24:1–8. doi:10.1037/a0017433.

[36] Mikos A, Zahodne L, Okun MS, Foote K, Bowers D. Cognitive declines after unilateral deep brain stimulation surgery in Parkinson’s disease: a controlled study using Reliable Change, part II. Clin Neuropsychol 2010;24:235–45. doi:10.1080/13854040903277297.

[37] Volkmann J, Albanese A, Kulisevsky J, Tornqvist A, Houeto J, Pidoux B, et al. Long-Term Effects of Pallidal or Subthalamic Deep Brain Stimulation on Quality of Life in Parkinson ’ s Disease. Mov Disord 2009;24:1154–61. doi:10.1002/mds.22496.

[38] York MK, Dulay M, Macias A, Levin HS, Grossman R, Simpson R, et al. Cognitive declines following bilateral subthalamic nucleus deep brain stimulation for the treatment of Parkinson’s disease. J Neurol Neurosurg Psychiatry 2008;79:789–95. doi:10.1136/jnnp.2007.118786.

[39] Rodriguez-Oroz MC, Obeso JA, Lang AE, Houeto J-L, Pollak P, Rehncrona S, et al. Bilateral deep brain stimulation in Parkinson’s disease: a multicentre study with 4 years follow-up. Brain 2005;128:2240–9. doi:10.1093/brain/awh571.

[40] Burdick AP, Foote KD, Wu S, Bowers D, Zeilman P, Jacobson CE, et al. Do patient’s get angrier following STN, GPi, and thalamic deep brain stimulation. Neuroimage 2011;54 Suppl 1:S227–32. doi:10.1016/j.neuroimage.2010.09.077.

[41] Zahodne LB, Okun MS, Foote KD, Fernandez HH, Rodriguez RL, Kirsch-Darrow L, et al. Cognitive declines one year after unilateral deep brain stimulation surgery in Parkinson’s disease: a controlled study using reliable change. Clin Neuropsychol 2009;23:385–405. doi:10.1080/13854040802360582.

[42] Castelli L, Zibetti M, Rizzi L, Caglio M, Lanotte M, Lopiano L. Neuropsychiatric symptoms three years after subthalamic DBS in PD patients: a case-control study. J Neurol 2008;255:1515–20. doi:10.1007/s00415-008-0955-y.

[43] Volkmann J, Allert N, Voges J, Weiss PH, Freund HJ, Sturm V. Safety and efficacy of pallidal or subthalamic nucleus stimulation in advanced PD. Neurology 2001;56:548–51. doi:10.1212/WNL.56.4.548.