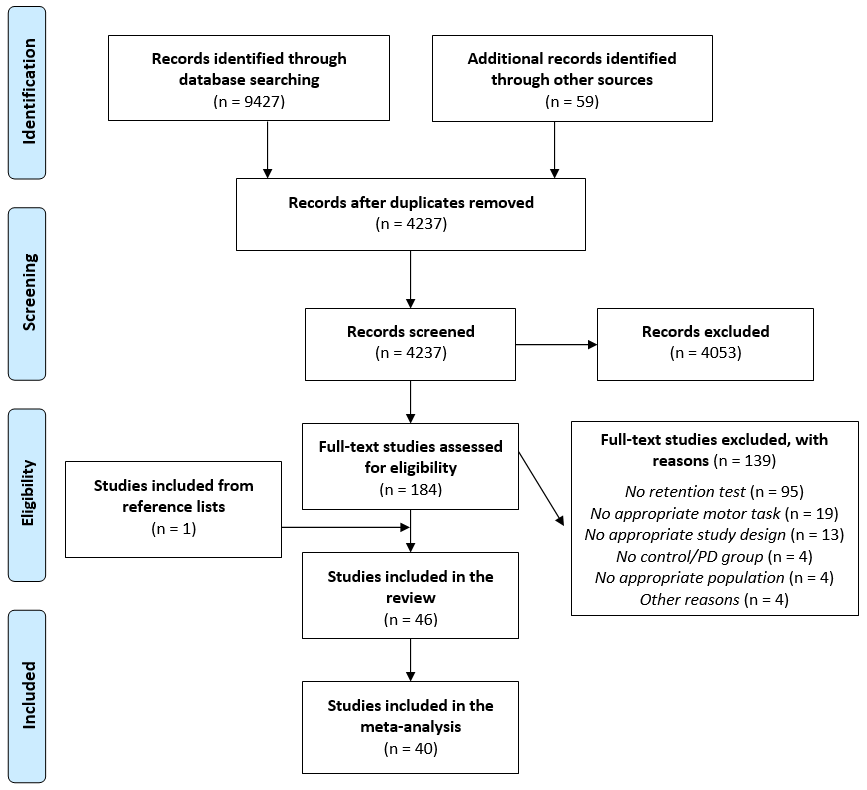
**Supplementary Material 7. Flow diagram showing the flow of information through the different stages of the systematic review with meta-analysis.**



**Retention test**: Ninety-five studies were excluded because they did not have a retention test, or the latter was assessed less than one hour after the end of practice (eligibility criteria) [1-95].

**No appropriate motor task**: Nineteen studies were excluded because they did not use an appropriate motor task/method to assess motor learning [96-114].

**No appropriate study design**: Thirteen studies used a study design that did not meet the inclusion criteria [115-127].

**No appropriate population**: Two studies used deep brain stimulation [128, 129], one study included a control group with neurological conditions [130], and another study had a control group with an age that differed significantly from the PD group [131].

**No control/PD group**: Four studies were excluded due to the lack of control/PD group [132-135].

**Other reasons**: Four studies were excluded for other reasons [136-139] (e.g., duplicated data).

**REFERENCES**

[1] Abdel-Malek A, Markham CH, Marmarelis PZ, Marmarelis VZ (1988) Quantifying deficiencies associated with Parkinson's disease by use of time-series analysis. *Electroencephalogr Clin Neurophysiol* **69**, 24-33.

[2] Agostino R, Bagnato S, Dinapoli L, Modugno N, Berardelli A (2005) Neither simple nor sequential arm movements are bradykinetic in parkinsonian patients with peak-dose dyskinesias. *Clin Neurophysiol* **116**, 2077-2082.

[3] Agostino R, Berardelli A, Formica A, Accornero N, Manfredi M (1992) Sequential arm movements in patients with Parkinson’s disease, Huntington’s disease and dystonia. *Brain* **115**, 1481-1495.

[4] Agostino R, Sanes JN, Hallett M (1996) Motor skill learning in Parkinson's disease. *J Neurol Sci* **139**, 218-226.

[5] Alberts JL, Saling M, Adler CH, Stelmach GE (2000) Disruptions in the reach-to-grasp actions of Parkinson's patients. *Exp Brain Res* **134**, 353-362.

[6] Alberts JL, Tresilian JR, Stelmach GE (1998) The co-ordination and phasing of a bilateral prehension task. The influence of Parkinson's disease. *Brain* **121**, 725-742.

[7] Ashoori A, McKeown MJ, Oishi MMK (2011) Switched manual pursuit tracking to measure motor performance in Parkinson's disease. *IET Control Theory Appl* **5**, 1970-1977.

[8] Barzgari A, Sojkova J, Dowling NM, Pozorski V, Okonkwo OC, Starks EJ, Oh J, Thiesen F, Wey A, Nicholas CR, Johnson S, Gallagher CL (2019) Arterial spin labeling reveals relationships between resting cerebral perfusion and motor learning in Parkinson's disease. *Brain Imaging Behav* **13**, 577-587.

[9] Bédard P, Sanes JN (2009) On a basal ganglia role in learning and rehearsing visual-motor associations. *Neuroimage* **47**, 1701-1710.

[10] Beigi M, Wilkinson L, Gobet F, Parton A, Jahanshahi M (2016) Levodopa medication improves incidental sequence learning in Parkinson's disease. *Neuropsychologia* **93**, 53-60.

[11] Bondi MW, Kaszniak AW (1991) Implicit and explicit memory in Alzheimer's disease and Parkinson's disease. *J Clin Exp Neuropsychol* **13**, 339-358.

[12] Boonsinsukh R, Saengsirisuwan V, Carlson-Kuhta P, Horak FB (2012) A cane improves postural recovery from an unpracticed slip during walking in people with Parkinson disease. *Phys Ther* **92**, 1117-1129.

[13] Broeder S, Heremans E, Pinto Pereira M, Nackaerts E, Meesen R, Verheyden G, Nieuwboer A (2019) Does transcranial direct current stimulation during writing alleviate upper limb freezing in people with Parkinson's disease? A pilot study. *Hum Mov Sci* **65**, 142-153.

[14] Caligiuri MP, Heindel WC, Lohr JB (1992) Sensorimotor disinhibition in Parkinson's disease: Effects of levodopa. *Ann Neurol* **31**, 53-58.

[15] Carbon M, Eidelberg D (2006) Functional imaging of sequence learning in Parkinson's disease. *J Neurol Sci* **248**, 72-77.

[16] Carbon M, Felice Ghilardi M, Dhawan V, Eidelberg D (2007) Correlates of movement initiation and velocity in Parkinson's disease: A longitudinal PET study. *Neuroimage* **34**, 361-370.

[17] Carbon M, Ghilardi MF, Feigin A, Fukuda M, Silvestri G, Mentis MJ, Ghez C, Moeller JR, Eidelberg D (2003) Learning networks in health and Parkinson's disease: Reproducibility and treatment effects. *Hum Brain Mapp* **19**, 197-211.

[18] Carbon M, Ma Y, Barnes A, Dhawan V, Chaly T, Ghilardi MF, Eidelberg D (2004) Caudate nucleus: influence of dopaminergic input on sequence learning and brain activation in Parkinsonism. *Neuroimage* **21**, 1497-1507.

[19] Carbon M, Reetz K, Ghilardi MF, Dhawan V, Eidelberg D (2010) Early Parkinson's disease: Longitudinal changes in brain activity during sequence learning. *Neurobiol Dis* **37**, 455-460.

[20] Carey JR, Deskin KA, Josephson KT, Wichmann RL (2002) Sex differences in tracking performance in patients with Parkinson's disease. *Arch Phys Med Rehabil* **83**, 972-977.

[21] Catala MM, Woitalla D, Arampatzis A (2016) Reactive but not predictive locomotor adaptability is impaired in young Parkinson's disease patients. *Gait Posture* **48**, 177-182.

[22] Chen J, Ho SL, Lee TM, Chang RS, Pang SY, Li L (2016) Visuomotor control in patients with Parkinson's disease. *Neuropsychologia* **80**, 102-114.

[23] Contreras-Vidal JL, Buch ER (2003) Effects of Parkinson's disease on visuomotor adaptation. *Exp Brain Res* **150**, 25-32.

[24] Cressman EK, Salomonczyk D, Constantin A, Miyasaki J, Moro E, Chen R, Strafella A, Fox S, Lang AE, Poizner H, Henriques DYP (2021) Proprioceptive recalibration following implicit visuomotor adaptation is preserved in Parkinson's disease. *Exp Brain Res* **239**, 1551-1565.

[25] Cunnington R, Iansek R, Bradshaw JL (1999) Movement-related potentials in Parkinson's disease: External cues and attentional strategies. *Mov Disord* **14**, 63-68.

[26] Deroost N, Kerckhofs E, Coene M, Wijnants G, Soetens E (2006) Learning sequence movements in a homogenous sample of patients with Parkinson's disease. *Neuropsychologia* **44**, 1653-1662.

[27] Dominey P, Decety J, Broussolle E, Chazot G, Jeannerod M (1995) Motor imagery of a lateralized sequential task is asymmetrically slowed in hemi-Parkinson’s patients. *Neuropsychologia* **33**, 727-741.

[28] Dominey PF, VentreDominey J, Broussolle E, Jeannerod M (1997) Analogical transfer is effective in a serial reaction time task in Parkinson's disease: Evidence for a dissociable form of sequence learning. *Neuropsychologia* **35**, 1-9.

[29] Doyon J, Gaudreau D, Laforce Jr RL, Castonguay M, Bédard PJ, Bédard F, Bouchard JP (1997) Role of the striatum, cerebellum, and frontal lobes in the learning of a visuomotor sequence. *Brain Cogn* **34**, 218-245.

[30] Fattapposta F, Pierelli F, Traversa G, My F, Mostarda M, D'Alessio C, Soldati G, Osborn J, Amabile G (2000) Preprogramming and control activity of bimanual self-paced motor task in Parkinson's disease. *Clin Neurophysiol Pract* **111**, 873-883.

[31] Fernandez-Ruiz J, Diaz R, Hall-Haro C, Vergara P, Mischner J, Nunez L, Drucker-Colin R, Ochoa A, Alonso ME (2003) Normal prism adaptation but reduced after-effect in basal ganglia disorders using a throwing task. *Eur J Neurosci* **18**, 689-694.

[32] Frith CD, Bloxham CA, Carpenter KN (1986) Impairments in the learning and performance of a new manual skill in patients with Parkinson's disease. *J Neurol Neurosurg Psychiatry* **49**, 661-668.

[33] Gamble KR, Cummings TJ, Jr., Lo SE, Ghosh PT, Howard JH, Jr., Howard DV (2014) Implicit sequence learning in people with Parkinson's disease. *Front Hum Neurosci* **8**, 563.

[34] Geffe S, Schindlbeck KA, Mehl A, Jende J, Klostermann F, Marzinzik F (2016) The single intake of levodopa modulates implicit learning in drug naïve, de novo patients with idiopathic Parkinson's disease. *J Neural Transm (Vienna)* **123**, 601-610.

[35] Ghilardi MF, Eidelberg D, Silvestri G, Ghez C (2003) The differential effect of PD and normal aging on early explicit sequence learning. *Neurology* **60**, 1313-1319.

[36] Ghilardi MF, Feigin AS, Battaglia F, Silvestri G, Mattis P, Eidelberg D, Di Rocco A (2007) L-Dopa infusion does not improve explicit sequence learning in Parkinson's disease. *Parkinsonism Relat Disord* **13**, 146-151.

[37] Gobel EW, Blomeke K, Zadikoff C, Simuni T, Weintraub S, Reber PJ (2013) Implicit perceptual-motor skill learning in mild cognitive impairment and Parkinson's disease. *Neuropsychol* **27**, 314-321.

[38] Guadagnoli MA, Leis B, Van Gemmert AWA, Stelmach GE (2002) The relationship between knowledge of results and motor learning in Parkinsonian patients. *Parkinsonism Relat Disord* **9**, 89-95.

[39] Heindel W, Salmon D, Shults C, Walicke P, Butters N (1989) Neuropsychological evidence for multiple implicit memory systems: A comparison of Alzheimer's, Huntington's, and Parkinson's disease patients. *J Neurosci* **9**, 582-587.

[40] Jackson GM, Jackson SR, Harrison J, Henderson L, Kennard C (1995) Serial reaction time learning and Parkinson's disease: evidence for a procedural learning deficit. *Neuropsychologia* **33**, 577-593.

[41] Jackson SR, Jackson GM, Harrison J, Henderson L, Kennard C (1995) The internal control of action and Parkinson's disease: a kinematic analysis of visually-guided and memory-guided prehension movements. *Exp Brain Res* **105**, 147-162.

[42] Jordan N, Sagar HJ (1994) The role of the striatum in motor learning: Dissociations between isometric motor control processes in Parkinson's disease. *Int J Neurosci* **77**, 153-165.

[43] Kelly SW, Jahanshahi M, Dirnberger G (2004) Learning of ambiguous versus hybrid sequences by patients with Parkinson's disease. *Neuropsychologia* **42**, 1350-1357.

[44] Kemeny F, Demeter G, Racsmany M, Valalik I, Lukacs A (2019) Impaired sequential and partially compensated probabilistic skill learning in Parkinson's disease. *J Neuropsychol* **13**, 509-528.

[45] Kitahara E, Shimo Y, Mori H, Nagaoka M (2018) Preservation of explicit learning of visuomotor sequences during Parkinson's disease progression. *Sci Rep* **8**, 10337.

[46] Krebs HI, Hogan N, Hening W, Adamovich SV, Poizner H (2001) Procedural motor learning in Parkinson's disease. *Exp Brain Res* **141**, 425-437.

[47] Kwak Y, Muller M, Bohnen NI, Dayalu P, Seidler RD (2010) Effect of dopaminergic medications on the time course of explicit motor sequence learning in Parkinson's disease. *J Neurophysiol* **103**, 942-949.

[48] Kwak Y, Muller M, Bohnen NI, Dayalu P, Seidler RD (2012) L-DOPA changes ventral striatum recruitment during motor sequence learning in Parkinson's disease. *Behav Brain Res* **230**, 116-124.

[49] Linden A, Bracke-Tolkmitt R, Lutzenberger W, Canavan AGM, Scholz E, Diener HC, Birbaumer N (1990) Slow cortical potentials in Parkinsonian patients during the course of an associative learning task. *J Psychophysiol* **4**, 145-162.

[50] Lukos JR, Lee D, Poizner H, Santello M (2010) Anticipatory modulation of digit placement for grasp control is affected by Parkinson's disease. *PLoS One* **5**, e9184.

[51] MacAskill MR, Anderson TJ, Jones RD (2002) Adaptive modification of saccade amplitude in Parkinson's disease. *Brain* **125**, 1570-1582.

[52] Marinelli L, Perfetti B, Moisello C, Di Rocco A, Eidelberg D, Abbruzzese G, Ghilardi MF (2010) Increased reaction time predicts visual learning deficits in Parkinson's disease. *Mov Disord* **25**, 1498-1501.

[53] Meissner SN, Krause V, Sudmeyer M, Hartmann CJ, Pollok B (2018) The significance of brain oscillations in motor sequence learning: Insights from Parkinson's disease. *Neuroimage Clin* **20**, 448-457.

[54] Meissner SN, Krause V, Sudmeyer M, Hartmann CJ, Pollok B (2019) Pre-stimulus beta power modulation during motor sequence learning is reduced in 'Parkinson's disease. *Neuroimage Clin* **24**, 102057.

[55] Meissner SN, Sudmeyer M, Keitel A, Pollok B, Bellebaum C (2016) Facilitating effects of deep brain stimulation on feedback learning in Parkinson's disease. *Behav Brain Res* **313**, 88-96.

[56] Mentis MJ, Dhawan V, Feigin A, Delalot D, Zgaljardic D, Edwards C, Eidelberg D (2003) Early stage Parkinson's disease patients and normal volunteers: comparative mechanisms of sequence learning. *Hum Brain Mapp* **20**, 246-258.

[57] Mentis MJ, Dhawan V, Nakamura T, Ghilardi M, Feigin A, Edwards C, Ghez C, Eidelberg D (2003) Enhancement of brain activation during trial-and-error sequence learning in early PD. *Neurology* **60**, 612-619.

[58] Merritt KE, Seergobin KN, Mendonca DA, Jenkins ME, Goodale MA, MacDonald PA (2017) Automatic online motor control is intact in Parkinson's disease with and without perceptual awareness. *Eneuro* **4**, ENEURO.0215-17.2017.

[59] Messier J, Adamovich S, Jack D, Hening W, Sage J, Poizner H (2007) Visuomotor learning in immersive 3D virtual reality in Parkinson's disease and in aging. *Exp Brain Res* **179**, 457-474.

[60] Mollion H, Dominey PF, Broussolle E, Ventre-Dominey J (2011) Subthalamic nucleus stimulation selectively improves motor and visual memory performance in Parkinson's disease. *Mov Disord* **26**, 2019-2025.

[61] Mongeon D, Blanchet P, Messier J (2013) Impact of Parkinson's disease and dopaminergic medication on adaptation to explicit and implicit visuomotor perturbations. *Brain Cogn* **81**, 271-282.

[62] Moreno Catalá M, Woitalla D, Arampatzis A (2016) Reactive but not predictive locomotor adaptability is impaired in young Parkinson's disease patients. *Gait Posture* **48**, 177-182.

[63] Nakamura T, Ghilardi MF, Mentis M, Dhawan V, Fukuda M, Hacking A, Moeller JR, Ghez C, Eidelberg D (2001) Functional networks in motor sequence learning: abnormal topographies in Parkinson's disease. *Hum Brain Mapp* **12**, 42-60.

[64] Nemanich ST, Earhart G (2015) Prism adaptation in Parkinson disease: comparing reaching to walking and freezers to non-freezers. *Exp Brain Res* **233**, 2301-2310.

[65] Oates AR, Van Ooteghem K, Frank JS, Patla AE, Horak FB (2013) Adaptation of gait termination on a slippery surface in Parkinson's disease. *Gait Posture* **37**, 516-520.

[66] Osman M, Wilkinson L, Beigi M, Castaneda CS, Jahanshahi M (2008) Patients with Parkinson's disease learn to control complex systems via procedural as well as non-procedural learning. *Neuropsychologia* **46**, 2355-2363.

[67] Paquet F, Bedard MA, Levesque M, Tremblay PL, Lemay M, Blanchet PJ, Scherzer P, Chouinard S, Filion J (2008) Sensorimotor adaptation in Parkinson's disease: evidence for a dopamine dependent remapping disturbance. *Exp Brain Res* **185**, 227-236.

[68] Pascual-Leone A, Grafman J, Clark K, Stewart M, Massaquoi S, Lou JS, Hallett M (1993) Procedural learning in Parkinson's disease and cerebellar degeneration. *Ann Neurol* **34**, 594-602.

[69] Price A, Shin JC (2009) The impact of Parkinson's disease on sequence learning: Perceptual pattern learning and executive function. *Brain Cogn* **69**, 252-261.

[70] Rafal RD, Inhoff AW, Friedman JH, Bernstein E (1987) Programming and execution of sequential movements in Parkinson's disease. *J Neurol Neurosurg Psychiatry* **50**, 1267-1273.

[71] Robertson C, Flowers KA (1990) Motor set in Parkinson's disease. *J Neurol Neurosurg Psychiatry* **53**, 583-592.

[72] Sarazin M, Deweer B, Merkl A, Von Poser N, Pillon B, Dubois B (2002) Procedural learning and striatofrontal dysfunction in Parkinson's disease. *Mov Disord* **17**, 265-273.

[73] Schendan HE, Tinaz S, Maher SM, Stern CE (2013) Frontostriatal and mediotemporal lobe contributions to implicit higher-order spatial sequence learning declines in aging and Parkinson's disease. *Behav Neurosci* **127**, 204-221.

[74] Smith J, Siegert RJ, McDowall J (2001) Preserved implicit learning on both the serial reaction time task and artificial grammar in patients with Parkinson's disease. *Brain Cogn* **45**, 378-391.

[75] Smith JG, McDowall J (2006) The implicit sequence learning deficit in patients with Parkinson's disease: A matter of impaired sequence integration? *Neuropsychologia* **44**, 275-288.

[76] Soliveri P, Brown RG, Jahanshahi M, Marsden CD (1992) Effect of practice on performance of a skilled motor task in patients with Parkinson's disease. *J Neurol Neurosurg Psychiatry* **55**, 454-460.

[77] Sprengelmeyer R, Canavan AG, Lange HW, Hömberg V (1995) Associative learning in degenerative neostriatal disorders: contrasts in explicit and implicit remembering between Parkinson's and Huntington's diseases. *Mov Disord* **10**, 51-65.

[78] Stefanova ED, Kostic VS, Ziropadja L, Markovic M, Ocic GG (2000) Visuomotor skill learning on serial reaction time task in patients with early Parkinson's disease. *Mov Disord* **15**, 1095-1103.

[79] Stephan MA, Meier B, Zaugg SW, Kaelin-Lang A (2011) Motor sequence learning performance in Parkinson's disease patients depends on the stage of disease. *Brain Cogn* **75**, 135-140.

[80] Thomas V, Reymann J-M, Lieury A, Allain H (1996) Assessment of procedural memory in Parkinson's disease. *Prog Neuropsychopharmacol Biol Psychiatry* **20**, 641-650.

[81] Tremblay PL, Bedard MA, Langlois D, Blanchet PJ, Lemay M, Parent M (2010) Movement chunking during sequence learning is a dopamine-dependant process: a study conducted in Parkinson's disease. *Exp Brain Res* **205**, 375-385.

[82] Tzvi E, Bey R, Nitschke M, Brüggemann N, Classen J, Münte TF, Krämer UM, Rumpf JJ (2021) Motor sequence learning deficits in idiopathic Parkinson's disease are associated with increased substantia nigra activity. *Front Aging Neurosci* **13**, 685168.

[83] van Tilborg I, Hulstijn W (2010) Implicit motor learning in patients with Parkinson's and Alzheimer's disease: differences in learning abilities? *Mot Control* **14**, 344-361.

[84] Vandenbossche J, Deroost N, Soetens E, Coomans D, Spildooren J, Vercruysse S, Nieuwboer A, Kerckhofs E (2013) Impaired implicit sequence learning in Parkinson's disease patients with freezing of gait. *Neuropsychology* **27**, 28-36.

[85] Venkatakrishnan A, Banquet JP, Burnod Y, Contreras-vidal JL (2011) Parkinson's disease differentially affects adaptation to gradual as compared to sudden visuomotor distortions. *Hum Mov Sci* **30**, 760-769.

[86] Verschueren SM, Swinnen SP, Dom R, De Weerdt W (1997) Interlimb coordination in patients with Parkinson's disease: motor learning deficits and the importance of augmented information feedback. *Exp Brain Res* **113**, 497-508.

[87] Weiner MJ, Hallett M, Funkenstein HH (1983) Adaptation to lateral displacement of vision in patients with lesions of the central nervous system. *Neurology* **33**, 766.

[88] Werheid K, Ziessler M, Nattkemper D, von Cramon DY (2003) Sequence learning in Parkinson's disease: The effect of spatial stimulus-response compatibility. *Brain Cogn* **52**, 239-249.

[89] Westwater H, McDowall J, Siegert R, Mossman S, Abernethy D (1998) Implicit learning in Parkinson's disease: Evidence from a verbal version of the serial reaction time task. *J Clin Exp Neuropsychol* **20**, 413-418.

[90] Wieczorek D, Sławek J, Białkowska M, Dziadkiewicz A, Sitek EJ (2011) Sequence learning and multi-step activity impairment in Parkinson’s disease. *Acta Neuropsychol* **9**, 303-312.

[91] Wilkinson L, Khan Z, Jahanshahi M (2009) The role of the basal ganglia and its cortical connections in sequence learning: Evidence from implicit and explicit sequence learning in Parkinson's disease. *Neuropsychologia* **47**, 2564-2573.

[92] Wu T, Hallett M (2005) A functional MRI study of automatic movements in patients with Parkinson's disease. *Brain* **128**, 2250-2259.

[93] Wu T, Hallett M (2008) Neural correlates of dual task performance in patients with Parkinson's disease. *J Neurol Neurosurg Psychiatry* **79**, 760-766.

[94] Wu T, Liu J, Zhang H, Hallett M, Zheng Z, Chan P (2015) Attention to automatic movements in Parkinson's disease: modified automatic mode in the striatum. *Cereb Cortex* **25**, 3330-3342.

[95] Wu T, Wang L, Hallett M, Li K, Chan P (2010) Neural correlates of bimanual anti-phase and in-phase movements in Parkinson's disease. *Brain* **133**, 2394-2409.

[96] Adam JJ, van Houdt H, Scholtissen B, Visser-Vandewalle V, Winogrodzka A, Duits A (2011) Executive control in Parkinson's disease: Effects of dopaminergic medication and deep brain stimulation on anti-cue keypress performance. *Neurosci Lett* **500**, 113-117.

[97] Arroyo-Anll EM, Ingrand P, Neau J-P, Gil R (2015) Procedural learning of semantic categorization in Parkinson's disease. *J Alzheimers Dis* **45**, 205-216.

[98] Arroyo-Anllo EM, Ingrand P, Neau JP, Aireault A, Gil R (2004) Pictorial and lexical priming: Patterns of implicit memory in Alzheimer's and Parkinson's disease patients. *EJPE* **16**, 535-553.

[99] Beatty WW, Monson N (1990) Picture and motor sequencing in Parkinson's disease. *J Geriatr Psychiatry Neurol* **3**, 192-197.

[100] Bellebaum C, Kobza S, Ferrea S, Schnitzler A, Pollok B, Südmeyer M (2016) Strategies in probabilistic feedback learning in Parkinson patients OFF medication. *Neurosci* **320**, 8-18.

[101] Chong RK, Horak FB, Woollacott MH (2000) Parkinson's disease impairs the ability to change set quickly. *J Neurol Sci* **175**, 57-70.

[102] De Boer C, Van Der Steen J, Mattace-Raso F, Boon AJW, Pel JJM (2016) The effect of neurodegeneration on visuomotor behavior in Alzheimer's disease and Parkinson's disease. *Mot Control* **20**, 1-20.

[103] DiFrancisco-Donoghue J, Jung MK, Geisel P, Werner WG (2015) Learning effects of the sensory organization test as a measure of postural control and balance in Parkinson's disease. *Parkinsonism Relat Disord* **21**, 858-861.

[104] Djamshidian A, Jha A, O'Sullivan SS, Silveira-Moriyama L, Jacobson C, Brown P, Lees A, Averbeck BB (2010) Risk and learning in impulsive and nonimpulsive patients with Parkinson's disease. *Mov Disord* **25**, 2203-2210.

[105] Filoteo JV, Salmon DP, Maddox WT, Song DD (2005) Information-integration category learning in patients with striatal dysfunction. *Neuropsychol* **19**, 212-222.

[106] Grogan JP, Tsivos D, Smith L, Knight BE, Bogacz R, Whone A, Coulthard EJ (2017) Effects of dopamine on reinforcement learning and consolidation in Parkinson's disease. *Elife* **6**, e26801.

[107] Hodgson TL, Sumner P, Molyva D, Sheridan R, Kennard C (2013) Learning and switching between stimulus-saccade associations in Parkinson's disease. *Neuropsychologia* **51**, 1350-1360.

[108] Huang P, Tan YY, Liu DQ, Herzallah MM, Lapidow E, Wang Y, Zang YF, Gluck MA, Chen SD (2017) Motor-symptom laterality affects acquisition in Parkinson's disease: A cognitive and functional magnetic resonance imaging study. *Mov Disord* **32**, 1047-1055.

[109] Myers CE, Shohamy D, Gluck MA, Grossman S, Kluger A, Ferris S, Golomb J, Schnirman G, Schwartz R (2003) Dissociating hippocampal versus basal ganglia contributions to learning and transfer. *J Cogn Neurosci* **15**, 185-193.

[110] Oishi MM, TalebiFard P, McKeown MJ (2011) Assessing manual pursuit tracking in Parkinson's disease via linear dynamical systems. *Ann Biomed Eng* **39**, 2263-2273.

[111] Oishi MMK, Ashoori A, McKeown MJ, Ieee (2010) Mode detection in switched pursuit tracking tasks: hybrid estimation to measure performance in Parkinson's disease. In *49th IEEE CDC*, pp. 2124-2130.

[112] Roncacci S, Troisi E, Carlesimo GA, Nocentini U, Caltagirone C (1996) Implicit memory in Parkinsonian patients: Evidence for deficient skill learning. *Eur Neurol* **36**, 154-159.

[113] Vakil E, Herishanu-Naaman S (1998) Declarative and procedural learning in Parkinson's disease patients having tremor or bradykinesia as the predominant symptom. *Cortex* **34**, 611-620.

[114] Zokaei N, Sillence A, Kienast A, Drew D, Plant O, Slavkova E, Manohar SG, Husain M (2020) Different patterns of short-term memory deficit in Alzheimer's disease, Parkinson's disease and subjective cognitive impairment. *Cortex* **132**, 41-50.

[115] Bello O, Sanchez JA, Fernandez-del-Olmo M (2008) Treadmill walking in Parkinson's disease patients: adaptation and generalization effect. *Mov Disord* **23**, 1243-1249.

[116] Broeder S, Nackaerts E, Cuypers K, Meesen R, Verheyden G, Nieuwboer A (2019) tDCS-enhanced consolidation of writing skills and its associations with cortical excitability in Parkinson disease: a pilot study. *Neurorehabil Neural Repair* **33**, 1050-1060.

[117] Camacho PB, Carbonari R, Shen S, Zadikoff C, Kramer AF, López-Ortiz C (2019) Voluntary saccade training protocol in persons with Parkinson's disease and healthy adults. *Front Aging Neurosci* **11**, 77.

[118] Chuma T, Faruque Reza M, Ikoma K, Mano Y (2006) Motor learning of hands with auditory cue in patients with Parkinson's disease. *J Neural Transm (Vienna)* **113**, 175-185.

[119] Daum I, Schugens MM, Breitenstein C, Topka H, Spieker S (1996) Classical eyeblink conditioning in Parkinson's disease. *Mov Disord* **11**, 639-646.

[120] dos Santos Mendes FA, Pompeu JE, Modenesi Lobo A, Guedes da Silva K, Oliveira Tde P, Peterson Zomignani A, Pimentel Piemonte ME (2012) Motor learning, retention and transfer after virtual-reality-based training in Parkinson's disease--effect of motor and cognitive demands of games: a longitudinal, controlled clinical study. *Physiotherapy* **98**, 217-223.

[121] Elangovan N, Tuite PJ, Konczak J (2018) Somatosensory training improves proprioception and untrained motor function in Parkinson's disease. *Front Neurol* **9**, 1053.

[122] Esculier JF, Vaudrin J, Bériault P, Gagnon K, Tremblay LE (2012) Home-based balance training programme using Wii Fit with balance board for Parkinsons's disease: a pilot study. *J Rehabil Med* **44**, 144-150.

[123] Flowers KA (1976) Visual "closed-loop" and "open-loop" characteristics of voluntary movement in patients with Parkinsonism and intention tremor. *Brain* **99**, 269-310.

[124] Horiba M, Ueki Y, Nojima I, Shimizu Y, Sahashi K, Itamoto S, Suzuki A, Yamada G, Matsukawa N, Wada I (2019) Impaired motor skill acquisition using mirror visual feedback improved by transcranial direct current stimulation (tDCS) in patients with Parkinson's disease. *Front Neurosci* **13**, 602.

[125] Lester ME, Cavanaugh JT, Foreman KB, Shaffer SW, Marcus R, Dibble LE (2017) Adaptation of postural recovery responses to a vestibular sensory illusion in individuals with Parkinson disease and healthy controls. *Clin Biomech (Bristol, Avon)* **48**, 73-79.

[126] Moisello C, Blanco D, Fontanesi C, Lin J, Biagioni M, Kumar P, Brys M, Loggini A, Marinelli L, Abbruzzese G, Quartarone A, Tononi G, Di Rocco A, Ghilardi MF (2015) TMS enhances retention of a motor skill in Parkinson's disease. *Brain Stimul* **8**, 224-230.

[127] Normand R, Kerr R, Grimes JD (1993) Complex motor performance and Parkinson's disease. *Can J Aging* **12**, 89-101.

[128] Bédard P, Sanes JN (2011) Basal ganglia-dependent processes in recalling learned visual-motor adaptations. *Exp Brain Res* **209**, 385-393.

[129] Marcelino D.A. AL, Horn A, Krause P, Kuhn AA, Neumann W-J (2019) Subthalamic neuromodulation improves short-term motor learning in Parkinson's disease. *Brain* **142**, 2198-2206.

[130] Goldenberg G, Wimmer A, Auff E, Schnaberth G (1986) Impairment of motor planning in patients with Parkinson's disease: evidence from ideomotor apraxia testing. *J Neurol Neurosurg Psychiatry* **49**, 1266-1272.

[131] Ioffe ME, Ustinova KI, Chernikova LA, Kulikov MA (2006) Supervised learning of postural tasks in patients with poststroke hemiparesis, Parkinson's disease or cerebellar ataxia. *Exp Brain Res* **168**, 384-394.

[132] Adams SG, Page AD, Jog M (2002) Summary feedback schedules and speech motor learning in Parkinson's disease. *Int J Speech-Lang Pathol* **10**, 215-220.

[133] Chiviacowsky S, Wulf G, Lewthwaite R, Campos T (2012) Motor learning benefits of self-controlled practice in persons with Parkinson's disease. *Gait Posture* **35**, 601-605.

[134] Chung YC, Lewthwaite R, Winstein CJ, Monterosso JR, Fisher BE (2020) Expectancy and affective response to challenging balance practice conditions in individuals with Parkinson's disease. *Eur J Neurosci* **52**, 3652-3662.

[135] Wu T, Kansaku K, Hallett M (2004) How self-initiated memorized movements become automatic: a functional MRI study. *J Neurophysiol* **91**, 1690-1698.

[136] Bowen FP, Brady E, Yahr MD (1973) Sensorimotor coordination in parkinson’s disease before and after levodopa therapy. *Neurology* **23**, 1101-1106.

[137] Manuel AL, Nicastro N, Schnider A, Guggisberg AG (2018) Resting-state connectivity after visuo-motor skill learning is inversely associated with offline consolidation in Parkinson's disease and healthy controls. *Cortex* **106**, 237-247.

[138] Sternad D (2015) From theoretical analysis to clinical assessment and intervention: Three interactive motor skills in a virtual environment. In *2015 ICVR*, pp. 265-272.

[139] Worringham CJ, Stelmach GE (1990) Practice effects on the preprogramming of discrete movements in Parkinson's disease. *J Neurol Neurosurg Psychiatry* **53**, 702-704.