Parkinson's disease and Memory

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8/2/06
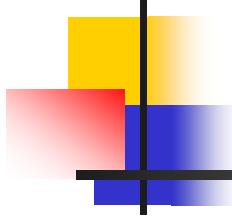
PD and Memory

- PD without dementia impairs declarative memory processes
- Recall
- Recognition (Recollection and Familiarity)
- Prospective memory
- Metamemory
- Moderators: task difficulty, disease severity, depression
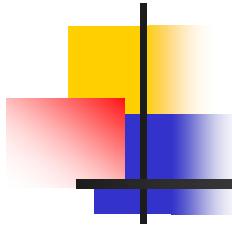
Recall in nondemented PD

- PD impairs both verbal and nonverbal recall (Bowen et al., 1976; Halgin, 1977; Cooper et al., 1993)

- Especially when information is not semantically organized (Tweedy et al., 1982; Villardita et al., 1982; Weingartner et al., 1984)
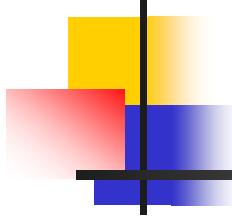
Recall deficit in PD

- Recall deficit is present in early-onset PD and is not worse in the late-onset form of the disease

- Deficit also observed in early, untreated PD

- Dopaminergic and cholinergic neuronal systems influence acquisition and retrieval of information in PD, but not storage of information (challenged view!)
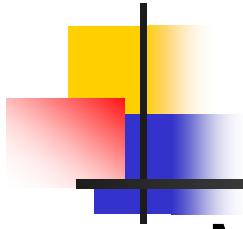
Recognition in PD

Mixed results:

- Some found no deficit in recognition (e.g., Flowers et al.,1984; Taylor et al., 1986)

- Others found decline (e.g., Tweedy et al., 1982; Hay et al., 2002; Davidson et al., 2006)
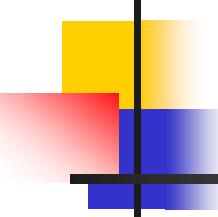
Why mixed results?

- Floor or ceiling effects?

- Statistical power (Whittington et al., 2000)

- 48 studies, mean power to detect small effects was 20% ($\Uparrow$ Type II error)

- Meta-analysis showed small deficits in recognition in nondemented PD patients
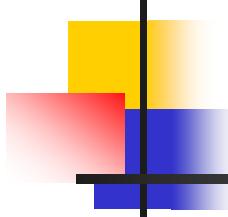
Dual-process models

- Recognition based on two processes:

- 1) Recollection -- vivid, clear memory of an item and context around it

- 2) Familiarity -- intuitive feeling of encountering the item without awareness of context
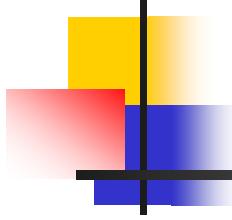
Brain regions implicated

- Recollection -- both frontal and hippocampus proper

- Familiarity -- parahippocampal and perirhinal cortex

- PD: Mesocortical pathway deficits, dysfunction of connections between the basal ganglia and temporal lobes, and reduced MTL volume leads to prediction of recollection and familiarity decline
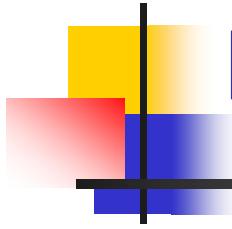
Recollection and Familiarity in PD

- Hay et al. (2002) used Process Dissociation Task (PDP) to estimate recollection and familiarity in PD and amnesia (MTL lesion)

- Moderate PD patients showed impairment in recollection (frontal) and familairity (striatal dysfunction) compared to controls and mild PD patients

- Amnesics showed impairment in recollection and intact familairity
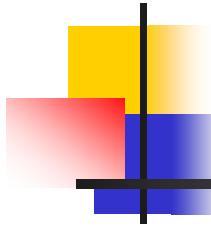
Prospective Memory in PD

- Remembering to execute an action

- Time-based / event-based tasks (Einstein & McDaniel, 1990)

- Very few studies despite prevalence in everyday life

- Likely involves frontal and executive functions (planning) which are impaired in PD
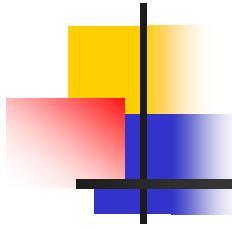
Previous findings

- Katai (1999) -- impaired prospective memory in PD (Rivermead Behavioral Memory Test)

- Katai et al. (2003) -- PD impaired event-based but not time-based tasks

- Whittington et al. (2006) replicated and expanded Katai et al.'s (2003) results
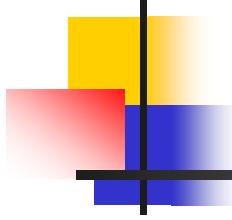
Task Difficulty

- Recall vs. recognition

- Recognition requires less effort, less self-initiated activity, or less processing resources than recall tests

- Whittington et al. (2006) -- within-task difficulty manipulation
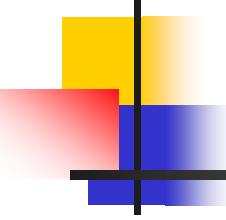
Disease Severity

- Advanced stage of PD -- greater deficits in recognition memory than those in early stages

- For example, pattern recognition (Sahakian et al. (1998)

- Whittington et al. (2000) meta-analysis -- medicated PD (more advanced stages) showed more deficit in recognition memory than non-medicated PD

- Whittington et al. (2006) confirmed and expanded this hypothesis to recall and prospective memory
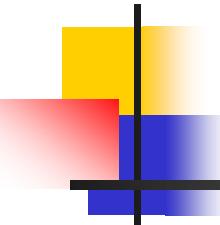
Participants

Variable	Early-stage PD (N=21)		Advanced-stage PD (N=20)		Control (N=41)	
	M	SD	M	SD	M	SD
Age (years)	68.24	6.19	70.80	5.82	69.80	5.31
Premorbid IQ	108.69	8.13	110.20	12.58	110.88	8.94
OMCT	3.52	3.68	4.35	2.96	2.39	2.38
L-Dopa[a]	436.11	202.91	407.89	239.98	–	–

Note:
Premorbid IQ = Premorbid full-scale IQ (WAIS-R) estimated from National Adult Reading Test;
OMCT = Orientation-Memory-Concentration Test;
L-Dopa = mean daily levodopa dose in milligrams.
[a]N = 18 (early-stage PD), 19 (advanced-stage PD)

Characteristics of the early-stage Parkinson's disease (early-stage PD) group, the advanced-stage Parkinson's disease (advanced-stage PD) group, and the control group.

Figure by MIT OCW.

Whittington et al. (2006)
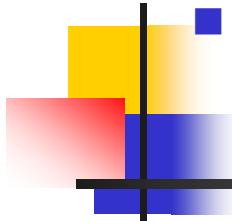
- Nonverbal Recognition Memory Task (NRMT) -- 2 levels of difficulty

- Verbal Recognition Memory Task (VRMT)

- Kendrick Object Learning Task (KOLT) -- recall memory

- Prospective Memory Tasks: 2 event-based (Huppert & Beardsall, 1993)

  1) Prospective Memory for a Question Task (PMQT)

  2) Prospective Memory for an Object Task (PMOT)

Disease severity and task difficulty are moderators in PD memory performance

Variable	Early-stage PD (N=21)		Advanced-stage PD (N=20)		Control (N=41)	
	M	SD	M	SD	M	SD
NRMT Easy (PC[a])	72.62	6.85	65.62	11.51	72.73	8.32
NRMT Hard (PC)	63.90	7.87	60.15	11.32	66.79	8.84
VRMT (PC)	81.57	7.73	79.21	7.23	85.02	7.73
KOLTQ	95.79	15.99	91.80	8.00	104.50	9.73
PMQT	2.84	0.80	2.00	1.23	3.09	0.88
PMOT	3.43	0.66	3.18	0.69	3.42	0.66

Note:
NRMT = Nonverbal Recognition Memory Task
VRMT = Verbal Recognition Memory Task
KOLTQ = Kendrick Object Learning Task - age-scaled quotients
PMQT = Prospective Memory Question Task
PMOT = Prospective Memory Object Task
[a]PC   = Percentage correct

Mean scores on the recognition, recall, and prospective memory tasks for the early-stage Parkinson's disease (early-stage PD) Group, the advanced-stage Parkinson's disease (advanced-stage PD) group, and the control group.

Figure by MIT OCW.

Whittington et al. (2006)

Disease severity affects memory performance in PD

Variable	H & Y Stage	
	r	95%CI[2]
NRMT[b]	-.30*	-.62 – -.02
VRMT	-.22	-.50 – .06
KOLTQ	-.05	-.33 – .24
PMQT	-.34*	-.60 – -.08
PMOT	-.35*	-.61 – -.09

Note:
NRMT = Nonverbal Recognition Memory Task
VRMT = Verbal Recognition Memory Task
KOLTQ = Kendrick Object Learning Task - age-scaled quotients
PMQT = Prospective Memory Question Task
PMOT = Prospective Memory Object Task
[a]95% confidence interval of r(N = 41).
[b]Averaged across difficulty level. *$p < .05$.

Zero-order correlations between the Hoehm and Yahr (H & Y) stage and scores on the recognition, recall, and prospective memory tasks.

Figure by MIT OCW.

Whittington et al. (2006)
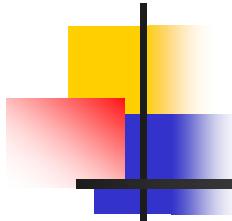
Depression

- Some found depression to significantly impact cognitive function in PD (Norman et al., 2002; Starkstein et al., 1989)

- Especially effortful tasks (e.g., free recall; Hartlage et al., 1993)

- Recent studies suggest otherwise (Higginson et al., 2005; Whittington & Podd, 1999)

Depression impairs memory performance

Variable	NC	D	PDD	PDN	F
Age, years	64.11 ± 4.51	59.11 ± 9.14	62.14 ± 7.16	61.74 ± 7.50	1.51
Education, years	14.79 ± 2.72	12.53 ± 3.12	14.07 ± 2.27	11.89 ± 2.26	4.75[b]
Age at disease onset, years	—	—	55.57 ± 10.68	54.37 ± 7.95	0.14
Disease duration, years	—	—	6.50 ± 4.72	6.79 ± 6.53	0.02
UPDRS motor score	—	—	22.93 ± 6.96	19.68 ± 5.01	2.43
BDI score (out of 63)	3.84 ± 2.22	22.05 ± 9.44	17.93 ± 8.05	5.89 ± 2.47	36.02[c]
DRS scores					
Total (out of 144)	138.84 ± 3.20	134.16 ± 7.51	128.50 ± 12.43	131.21 ± 7.88	4.88[b]
Attention (out of 37)	35.79 ± 1.08	36.21 ± 0.86	35.21 ± 1.85	33.95 ± 3.76	3.13[a]
Conceptualization (out of 37)	36.68 ± 2.36	35.42 ± 3.82	34.43 ± 4.03	33.84 ± 2.99	1.56
Construction (out of 6)	6.00 ± 0.0	5.89 ± 0.32	5.50 ± 0.94	5.58 ± 0.77	2.53
Initiation/Perseveration (out of 39)	36.16 ± 1.98	34.21 ± 3.63	32.36 ± 5.84	34.11 ± 3.83	2.37
Memory (out of 25)	24.21 ± 1.18	22.42 ± 3.29	21.00 ± 3.14	23.74 ± 1.19	7.63[c]

Note:

NC = Normal control subjects

D = Depression alone

PDD = Parkinson's disease with depression

PDN = Parkinson's disease without depression

UPDRS = Unified Parkinson's disease rating scale

BDI = Beck depression inventory

[a]$p < 0.05$,

[b]$p < 0.01$,

[c]$p < 0.001$,

All significance tests were two-tailed.

Demographics, disease characteristics, and mean Dementia Rating Scale (DRS) scores of the four subject groups (mean ± SD)

Figure by MIT OCW.

Norman et al. (2002)
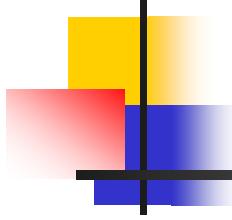
Dementia

- Non-demented PD patients have AD pathology largely restricted to the limbic system

- Parkinson-dementia cases often have severe neuritic AD lesion

- Dementia in PD develops when the disease broadens from nigral neurons to cortex leading to a cholinergic dysfunction

  (Hilker et al., 2005)
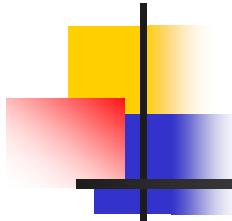
Emotion & face recognition in PD

- Basal ganglia important in recognizing emotion

- PD impairs emotional regulation, esp., recognition of facial expressions (Blonder et al., 1989; Jacobs et al., 1995)

- PD showed deficits in recognizing fear (amygdala) and digust (striatum or insula) in facial expressions, but not in prosodic or written verbal stimuli (Kan et al., 2002)

# PD impairs recognition of fear and digust facial expressions

			EMOTION					
			Happiness	Sadness	Anger	Fear	Surprise	Disgust
Facial Videotape	PD	Mean	1.00	1.00	0.95	0.55[b]	0.94	0.84[a]
		SD	0.00	0.00	0.09	0.30	0.12	0.18
	NC	Mean	1.00	1.00	0.98	0.83	0.96	0.94
		SD	0.00	0.00	0.05	0.20	0.08	0.12
Prosodic Stimuli	PD	Mean	0.69	0.74	0.72	0.57	0.77	0.62
		SD	0.17	0.12	0.12	0.22	0.23	0.26
	NC	Mean	0.77	0.84	0.70	0.62	0.78	0.61
		SD	0.25	0.13	0.17	0.20	0.15	0.25
Written Verbal Stimuli	PD	Mean	0.93	0.88	0.86	0.83	0.79	0.80
		SD	0.14	0.14	0.20	0.17	0.15	0.19
	NC	Mean	0.90	0.87	0.95	0.88	0.81	0.89
		SD	0.16	0.11	0.11	0.14	0.18	0.16

[b] $p < 0.01$; [a] $p < 0.05$.
Mean scores (rates of correct answers) are shown with the standard deviation (SD).

Performance in Each Test by Parkinson's Disease Patients (PD) and Controls (NC)

Kan et al. (2002)

Figure by MIT OCW.

PD patients recognize moving negative facial expresions better than static ones
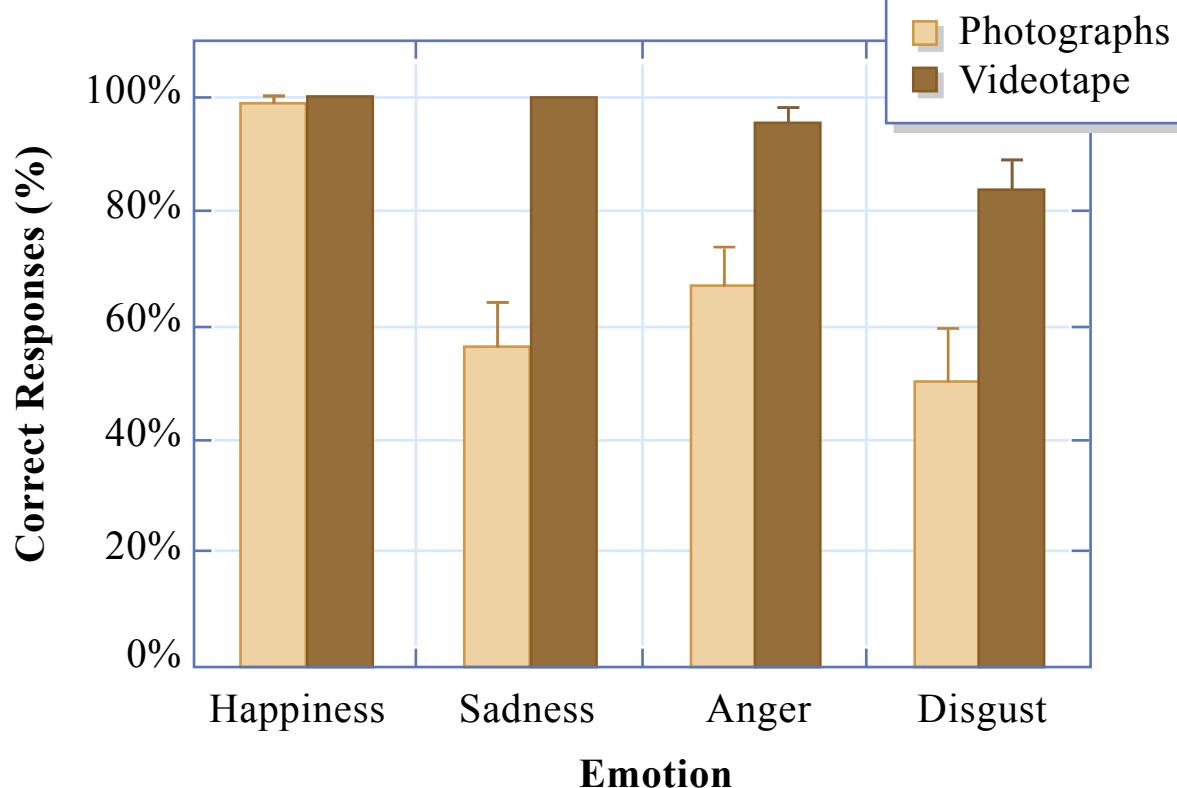
Comparison of the average performance of PD patients in recognizing moving and static facial expressions. The error bars show the standard error. PD patients performed better with video recordings than with photographs when asked to recognize sadness, anger, and disgust ($p < 0.01$ for all).

Figure by MIT OCW.
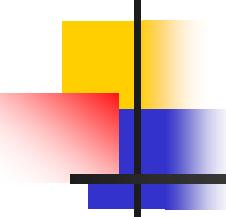
Kan et al. (2002)

Paper presentations!

- Paymon -- Recall (Ivory et al.,1999)

- Julien -- Recognition memory (Higginson et al., 2005)

- David -- Recognition memory (ERPs; Minamoto et al., 2001)

- Christie -- Recollection & familiarity (Davidson et al., 2006)

- Meredith -- Metamemory (Souchay et al., 2006)

- Sue -- Emotional processing (Glozman et al., 2003)

- Heather -- Face recognition (Sprengelmeyer et al., 2003)