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# Does Cognitive Testing Predict Driving Assessment Outcome in Cognitively-Impaired Elderly?

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# Objectives

## ■ Introduction:

- ❑ Discuss driving & the elderly
- ❑ Discuss prevalence & significance of dementia
- ❑ Describe components of on- and off-road driving assessments
- ❑ Describe purpose & null hypothesis of research

## ■ Methods

- ❑ Approvals
  - ❑ Exclusion / inclusion criteria
  - ❑ Information gathered & sources
  - ❑ Discuss how various variables were categorized
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# Objectives

## ■ Results

- ❑ Descriptive statistics for demographics, referral reasons
- ❑ Compare on-road assessments to cognitive tests, gender, referral reason

## ■ Discussion

- ❑ Discuss statistically significant findings
  - ❑ Debate possible factors playing a role
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# Introduction

- MV injuries a leading cause of injury-related deaths in elderly
  - Age >75 associated with more crashes
  - Elderly tend to drive more safely, but:
    - Presence & accumulation of health-related impairments that affect driving
  - Dementia is a well-identified RF
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# Introduction (2)

## ■ Dementia

- 8% prevalence >65y, 30% >90y
  - Mandatory reporting by MDs in NL in moderate-severe cases (driving C/I)
  - In mild cases, driving ability varies greatly
    - Complicates process of establishing set point in illness when driving ability is no longer considered adequate
    - Historically, office-based exam & dx sufficient for determining medical fitness to drive
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## Introduction (3)

CMA: to test driving ability in mild dementia  
recommend: **Comprehensive on- and off-road driving test** at a specialized driving centre

- ❑ Functional, structured assessment
  - ❑ Michelle Osmond, OT – since early 1990's
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# Introduction (4)

- Off-road driving assessment includes cognitive testing
    - Validity, though, questionable
      - On-road test a better predictor
    - MMSE
    - Clock-drawing
    - Trails A & B
    - Motor-free Visual Perception Test
    - Visual processing speed
    - Maze planning
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# Introduction (5)

- Mini-Mental State Examination
    - Useful indicator of general cognitive f'n
    - Misses some relevant cognitive domains
      - Perception, motor skills, executive f'ning
    - Possible correlation w/ driving performance
      - But limited, if any, correlation w/ accidents
    - General consensus: can't be sole determinant of driving performance
      - But does contribute to a comprehensive assess.
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# Introduction (6)

- Clock-drawing & Trails tests
    - Similar debate as to predictive value
  - Above tests usually routine part of O.T. off-road assessment
    - MMSE done less over past few years
    - More focus on MVPT (visual skills incl.)
  - MDs often include MMSE in referral
    - Usefulness questionable?
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# Introduction (7)

- Referrals for driving assessments:
    - Geriatric psychiatrists (minority)
    - General adult psychiatrists
    - General practitioners
    - Neurologists
    - O.T.s, Physio (majority)
    - Self-referral
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# Introduction (8)

- Motor Vehicle Registration considers:
    - MMSE > 24 - usually competent
    - MMSE < 15 – very likely unfit to drive
    - MMSE 16-23 – grey area
  
  - Above are cutoffs for dementia severity
    - But are they meaningful predictors?
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# Introduction (9)

- No consensus in literature on:
    - Validity of tests in predicting driving
      - MVPT, Trails A & B, “useful field of view” are best
    - Which test has highest validity
  
  - Resources (O.T.) are limited
    - Beneficial to eliminate unnecessary tests?
      - Reduce wait times
      - More time spent on gold-standard (on-road)
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# Introduction (10)

- Current research aims to establish
    - Whether off-road test results correlate with on-road driving assessment outcomes
  - Null hypothesis:
    - Cognitive testing results do not significantly correlate with on-road driving assessment outcomes
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- HIC approval Dec 12/07
    - Updated Dec 11/08
  - RPAC approval May 9/08
  - Approved by O.T. Dept Oct/08
  - Chart review Oct-Dec/08
    - O.T. Dept LAMC
    - Patient list from M. Osmond's referral books
    - Geriatric Psych day hospital charts for those referred by geriatric psychiatrists
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## Inclusion criteria

Methods

- Referral for driving assessment by M. Osmond, O.T., since 1994
- Established or questioned cognitive deficit
- Over age 60

## Exclusion criteria

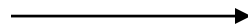
- non-cognitive complaint
  - On-road or off-road testing not completed
  - Cognitive & on-road testing over 6 mo apart
  - Missing/discarded chart
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# Exclusion

Methods

**324 referrals  
examined**



**36 were retests**  
**70 cancelled before testing**  
**14 charts discarded (pre-1995)**  
**16 charts not found**  
**9 no road test performed**  
**68 non-cognitive referrals**  
**18 under age 60**  
**5 no cognitive testing done**



**88 referrals  
for review**

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# Information collected

Methods

- Identifying data
    - Name only to correlate b/t office charts
  - Demographic
    - Gender, age
  - Referral source
  - Reason for referral
  - On-road testing
    - Date, outcome, result
-

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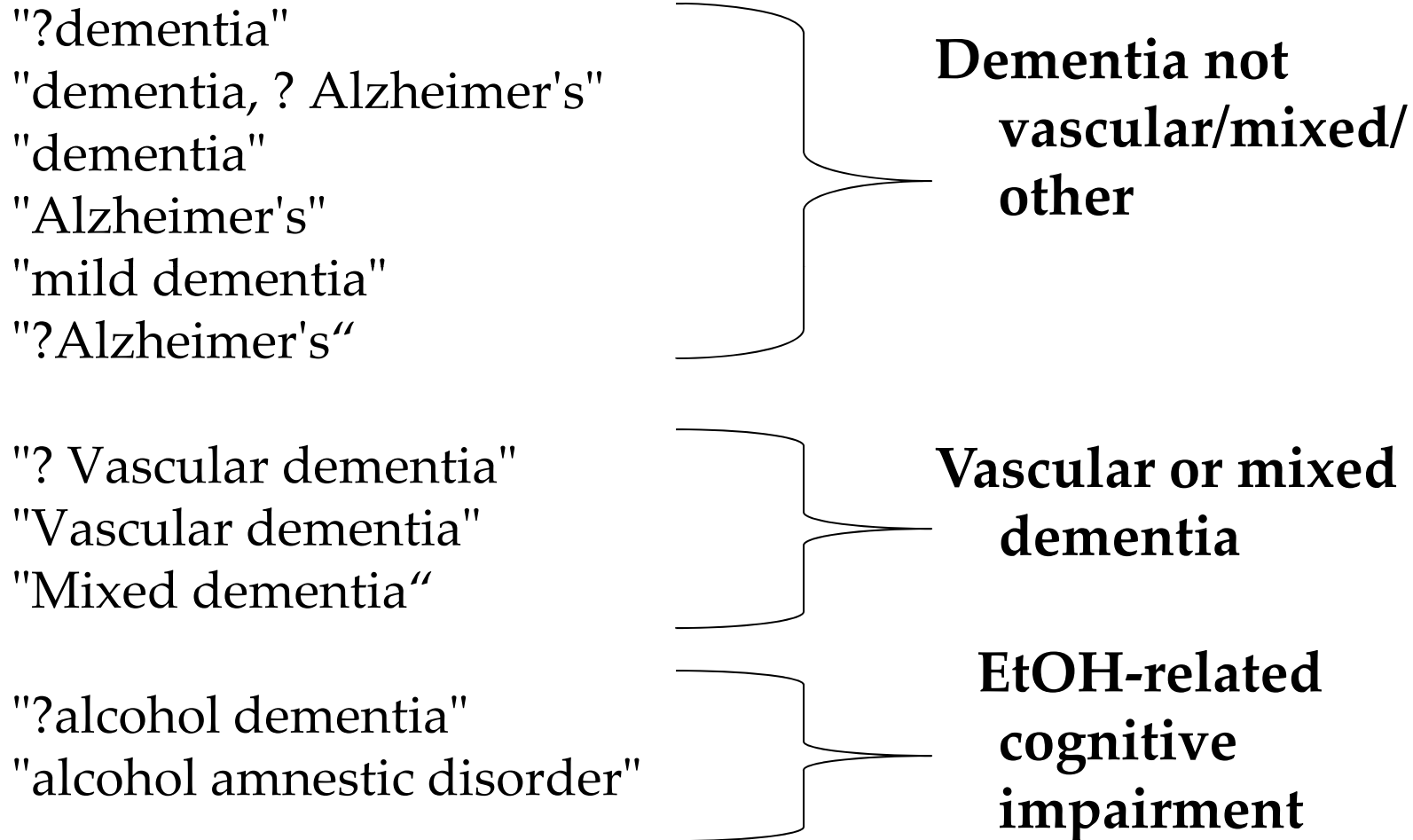
# Information collected

Methods

- Off-road testing
    - MMSE by O.T. or MD & date
    - MVPT
    - visual processing speed
    - ABCS 100
    - Trails A & B
    - Bells test
    - Maze planning
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# Referral reason summary

Methods

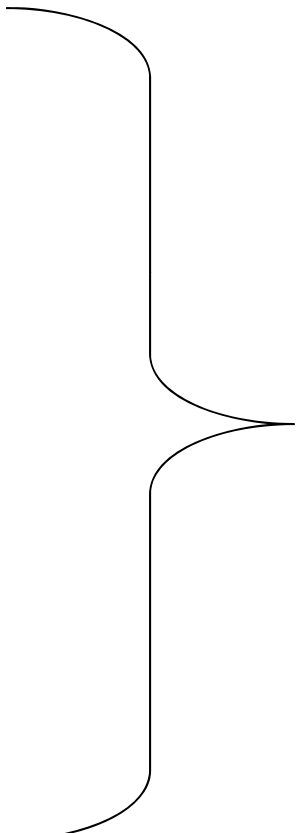


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# Referral reason summary

Methods

"MCI"  
"early dementia, ?AD"  
"age-related concerns"  
"cognitive impairment"  
"early dementia, CVA"  
"early dementia"  
"early Alzheimer's"  
"?cognitive problems"  
"? Early Alzheimer's"  
"vascular MCI"  
"CVA w/ cognitive/personality changes"



**Early dementia /  
MCI (amnestic  
& vascular)**

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# Referral reason summary

Methods

"primary progressive aphasia"

"?LBD, cognitive impairment"

"early frontotemporal dementia"

"frontotemporal dementia"

"Parkinson's disease and mild dementia"

various organic conditions w/  
cognitive changes

**Other (FTD, LBD,  
PD, PPA)**

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# On-road testing categories

Methods

- Pass
  - Pass w/ recommendations (includes re-testing)
  - Pass w/ restrictions
  - Fail
  - Borderline - retest w/ DMV
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# Data analysis

Methods

- Microsoft Excel
  - SPSS 14.0
  - Descriptive & comparison b/t outcome groups:
    - Demographics
    - Referral reasons & by gender
    - Cognitive tests
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# Demographics

## Results

- M:F ratio almost 2:1 (but dementia no more prevalent in males)
- women tend to be older but not significant

	Male		Female		Combined
Total # of patients	59	<i>% of total</i> <b>67.0%</b>	29	<i>% of total</i> <b>33.0%</b>	88
Average age	<b>75.0</b>		<b>79.6</b>		76.5
SD	7.6		6.1		7.4
Age range	60-93		61-95		60-95



# Classification of referrals

## Results

Summary Category	Included referral reasons	# of Referrals	% of Total
Dementia not vascular/mixed/other	"?dementia"	5	5.7%
	"dementia, ? Alzheimer's"	1	1.1%
	"dementia"	9	10.2%
	"Alzheimer's"	4	4.5%
	"mild dementia"	2	2.3%
	"?Alzheimer's"	5	5.7%
	<b>Total</b>	<b>26</b>	<b>29.5%</b>
Vascular or mixed dementia	"? Vascular dementia"	2	2.3%
	"Vascular dementia"	2	2.3%
	"Mixed dementia"	1	1.1%
	<b>Total</b>	<b>5</b>	<b>5.7%</b>

# Classification of referrals

## Results

Summary Category	Included referral reasons	# of Referrals	% of Total
Early dementia / MCI (amnestic & vascular)	"MCI"	4	4.5%
	"early dementia, ?AD"	3	3.4%
	"age-related concerns"	4	4.5%
	"cognitive impairment"	18	20.5%
	"early dementia, CVA"	1	1.1%
	"early dementia"	3	3.4%
	"early Alzheimer's"	3	3.4%
	"?cognitive problems"	1	1.1%
	"? Early Alzheimer's"	3	3.4%
	"vascular MCI"	1	1.1%
	"CVA w/ cognitive/personality changes"	4	4.5%
<b>Total</b>		<b>45</b>	<b>51.1%</b>

# Classification of referrals

## Results

Summary Category	Included referral reasons	# of Referrals	% of Total
EtOH-related cognitive impairment	"?alcohol dementia"	2	2.3%
	"alcohol amnestic disorder"	1	1.1%
	<b>Total</b>	<b>3</b>	<b>3.4%</b>
Other (FTD, LBD, PD, PPA)	"primary progressive aphasia"	3	3.4%
	"?LBD, cognitive impairment"	1	1.1%
	"early frontotemporal dementia"	1	1.1%
	"frontotemporal dementia"	1	1.1%
	"Parkinson's disease and mild dementia"	1	1.1%
	various organic conditions w/ cognitive changes	2	2.3%
	<b>Total</b>	<b>9</b>	<b>10.2%</b>

# Gender & referral reason

## Results

- vascular & EtOH-related impairment more common in males
- early dementia / MCI was most common referral reason, no difference b/t gender

	Male		Female		Combined	
Referral reason		<i>% of gender</i>		<i>% of gender</i>		<i>% of total</i>
Dementia not vasc/mixed/other	17	28.8%	9	31.0%	26	29.5%
Vascular or mixed dementia	5	<b>8.5%</b>	0	<b>0.0%</b>	5	5.7%
Early dementia, MCI	28	<b>47.5%</b>	17	<b>58.6%</b>	45	<b>51.1%</b>
EtOH-related	3	<b>5.1%</b>	0	<b>0.0%</b>	3	3.4%
Other	6	10.2%	3	10.3%	9	10.2%

Chi-square test,  $p > 0.05$

# Gender & driving outcome

## Results

- **males had significantly higher pass rates than females**
- more than half of all pts passed (over 40% failed)

	Male		Female		Combined	
Driving assessment outcome		<i>% of gender</i>		<i>% of gender</i>		<i>% of total</i>
Pass	9	15.3%	3	10.3%	12	13.6%
Pass w/ recommendations	8	13.6%	3	10.3%	11	12.5%
Pass w/ restrictions	21	<b>35.6%</b>	5	<b>17.2%</b>	26	29.5%
Combined passes	38	<b>64.4% *</b>	11	<b>37.9% *</b>	49	<b>55.7%</b>
Fail	19	<b>32.2%</b>	17	<b>58.6%</b>	38	43.2%
Borderline - retest w/ DMV	2	3.4%	1	3.4%	3	3.4%

\* Chi-Square Test,  $p < 0.05$

# Age & driving outcome

## Results

- males who pass tend to be younger than those who fail, but not significantly
- age not a factor for women
- **overall average age of those who pass is lower (75 cf 79), but not significantly (hence age not predictive)**

<i>Average age</i>	Passed	Failed
Males	<b>73.0 ± 7.2</b>	<b>79.9 ± 7.6</b>
Females	79.7 ± 6.6	79.0 ± 5.2
Combined	<b>74.4 ± 7.8</b>	<b>79.4 ± 5.9</b>

# Driving outcome cf referral reason

Results

Driving assessment outcome	Total	Pass		Pass w/ recomm.		Pass w/ restrict.	
		#	%	#	%	#	%
<b>Males</b>							
Dementia not vasc/ mixed/other	17	2	11.8%	1	5.9%	7	41.2%
Vascular or mixed dementia	5	0	0.0%	1	20.0%	2	40.0%
Early dementia, MCI	28	6	21.4%	3	10.7%	8	28.6%
EtOH-related	3	0	0.0%	1	33.3%	2	66.7%
Other	6	1	16.7%	2	33.3%	2	33.3%
<b>Females</b>							
Dementia not vasc/ mixed/other	9	0	0.0%	0	0.0%	2	22.2%
Vascular or mixed dementia	0	0	0.0%	0	0.0%	0	0.0%
Early dementia, MCI	17	2	11.8%	3	17.6%	1	5.9%
EtOH-related	0	0	0.0%	0	0.0%	0	0.0%
Other	3	1	33.3%	0	0.0%	2	66.7%

# Driving outcome cf referral reason

Results

Driving assessment outcome	Total	Combined passes		Fail		Borderline	
		#	%	#	%	#	%
<b>Males</b>							
Dementia not vasc/ mixed/other	17	10	58.8%	6	35.3%	1	5.9%
Vascular or mixed dementia	5	3	60.0%	1	20.0%	1	20.0%
Early dementia, MCI	28	17	60.7%*	11	39.3%*	0	0.0%
EtOH-related	3	3	100.0%	0	0.0%	0	0.0%
Other	6	5	83.3%	1	16.7%	0	0.0%
<b>Females</b>							
Dementia not vasc/ mixed/other	9	2	22.2%	7	77.8%	0	0.0%
Vascular or mixed dementia	0	0	0.0%	0	0.0%	0	0.0%
Early dementia, MCI	17	6	35.3%	10	58.8%	1	5.9%
EtOH-related	0	0	0.0%	0	0.0%	0	0.0%
Other	3	3	100.0%	0	0.0%	0	0.0%

\* Chi-Square Test,  $p < 0.05$



# Driving outcome cf referral reason

## Results

- males w/ AD-type have higher pass than fail rates, not significant
- males w/ early dementia / MCI DO have significantly higher pass rates

Driving assessment outcome	Total	Pass		Pass w/ recomm		Pass w/ restrict.	
		#	%	#	%	#	%
<b>Combined genders</b>							
Dementia not vasc/ mixed/other	<b>26</b>	2	7.7%	1	3.8%	9	34.6%
Vascular or mixed dementia	<b>5</b>	0	0.0%	1	20.0%	2	40.0%
Early dementia, MCI	<b>45</b>	8	17.8%	6	13.3%	9	20.0%
EtOH-related	<b>3</b>	0	0.0%	1	33.3%	2	66.7%
Other	<b>9</b>	2	22.2%	2	22.2%	4	44.4%

# Driving outcome cf referral reason

## Results

- pts w/ early dementia/MCI almost as likely to fail as AD-type pts
- pts w/ vascular/mixed-type may be less likely to fail cf AD (not S.S.)
- less common forms of cognitive impairment have low fail rates

Driving assessment outcome	Total	Combined passes		Fail		Borderline	
		#	%	#	%	#	%
<b>Combined genders</b>							
Dementia not vasc/ mixed/other	26	12	46.2%	13	50.0%	1	3.8%
Vascular or mixed dementia	5	3	60.0%	1	20.0%	1	20.0%
Early dementia, MCI	45	23	51.1%	21	46.7%	1	2.2%
EtOH-related	3	3	100.0%	0	0.0%	0	0.0%
Other	9	8	88.9%	1	11.1%	0	0.0%

# MMSE

## Results

- included ONLY results x/30 & if done w/in 6 mo of road test
- b/t MD & OT, full MMSE only performed in 45% of pop'n
- no significant difference b/t genders

	Male		Female		Total	
<b>Number of pts tested</b>	<i>% of sex</i>		<i>% of total</i>			
Total # of patients	24	40.7%	14	37.5%	40	45.5%
Average age	<b>73.7</b>		<b>79.4</b>		75.8	
SD	7.4		5		7.1	
Age range	61-88		68-89		61-89	
	<i>SD</i>		<i>SD</i>		<i>SD</i>	
<b>MMSE Ave score (x/30)</b>	<b>24.7</b>	3.8	<b>24.5</b>	3.5	24.6	3.6

# MMSE

## Results

- no significant difference b/t genders in outcome groups
- **MMSE in pass group not significantly better than fail group**
- MMSE of pass, no restrictions (28.3) higher than fail, but not SS

	Male		Female		Total	
<b>Driving outcome</b>	#	<i>Ave score</i>	#	<i>Ave score</i>	#	<i>Ave score</i>
Pass, no restrictions	5	28.2	1	29.0	6	28.3
Pass, recommendations only	5	24.4	1	26.0	6	24.7
Pass, w/ restrictions	6	23.8	1	28.0	7	24.4
<b>Combined Pass outcomes</b>	16	25.4	3	27.7	19	<b>25.7</b>
<b>Fail, suspend license</b>	8	24.1	10	23.9	18	<b>24.0</b>
Undecided; refer to DMV	0	n/a	1	21.0	1	21.0

# Motor free visual perception test

Results

- performed in over ¾ of all pts
- no difference in performance b/t genders

	Male		Female		Total	
<b>Number of pts tested</b>		<i>% of total</i>		<i>% of total</i>		
Total # of patients	42	62.7%	25	37.3%	67	76.1%
Average age	73.7		79.9		76	
SD	7.3		6.4		7.6	
Age range	60-92		70-95		60-95	
		<i>SD</i>		<i>SD</i>		<i>SD</i>
<b>MVPT Ave score (x/36)</b>	<b>27.8</b>	4.2	<b>27.6</b>	5.1	27.7	4.5

# Motor free visual perception test

Results

- **no significant difference in scores b/t pass & fail groups, nor sex**
- but is there bias?...

	Male		Female		Total	
Driving outcome	#	<i>Ave score</i>	#	<i>Ave score</i>	#	<i>Ave score</i>
Pass, no restrictions	9	30.8	2	33	11	31.2
Pass, recommendations only	5	29.6	2	29.5	7	29.6
Pass, w/ restrictions	16	25.2	5	26.2	21	25.4
Combined Pass outcomes	30	<b>27.6</b>	9	<b>28.4</b>	39	<b>27.8</b>
Fail, suspend license	11	<b>28.3</b>	15	<b>26.9</b>	26	<b>27.5</b>
Undecided; refer to DMV	1	27	1	29	2	28

# Motor free visual perception test

## Results

- pts for whom no MVPT performed had higher driving fail rate
- more impaired pts may have been less likely to have test done
- skews results & hence inherent bias

	<b>Total</b>	<b># passed</b>	<b># failed</b>	<b>% fail</b>	<b>ave Age</b>	<b>ave MMSE</b>
<b>Pts w/out a MVPT</b>	21	10	10	47.6%	76	23.9 (n12)
<b>Pts w/ a MVPT</b>	67	39	26	38.8%	78.1	25.2 (n28)

# Visual processing speed

## Results

- VPS may be slower in those who fail driving test
- **VPS significantly slower than norm for age in those who fail**

	VPS (sec) (average)	Slower than age norm	
n	50	52	
Average / # slower	8.52	45/52	<b>86.5%</b>
pass, no restrictions	7.27	4/10	40%
pass, recommendations	7.43	4/7	57.1%
pass, w/ restrictions	8.22	9/14	64.3%
combined passes	<b>7.75</b>	17/31	<b>54.8% *</b>
fails	<b>9.91</b>	16/19	<b>84.2% *</b>

\* Chi-Square Test,  $p < 0.05$



# Other tests

## Results

- remaining tests completed sporadically (low n)
- predictive value to be assessed at later time

Test	# completed
<b>ABCS 100</b>	16
<b>Trails A</b>	39
<b>Trails B</b>	15
<b>Bells test</b>	27
<b>Planning (maze)</b>	30

- of total sample size 88

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# Discussion

## ■ Gender differences

### □ M:F = 2:1

- Not representative of dementia population, but
- In elderly, likely  $M > F$  drivers
- Gender difference in willingness to give up license?

### □ Women older, but not significant

- 75 y males, 80 y females

### □ \* Males have significantly higher pass rates

- **64% vs 38%**
  - More driving experience?
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## Discussion (2)

- Referrals for driving assessments
    - > 50% for early dementia / MCI
    - More males referred for EtOH-related & vascular
      - Not statistically significant
    - More females referred for early dementia / MCI
      - Not statistically significant
-

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# Discussion (3)

## ■ Driving outcomes & gender

- 56% of all pts passed road test (43% failed)
  - Males:
    - referred for early dementia / MCI have significantly higher pass than fail rates
    - males who **pass** tend to be **younger**, but not significant
  - Women:
    - lower pass than fail rates for all referral sources, but not significant
    - **Age** seems **not** to be a factor
-

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# Discussion (4)

- **Driving outcomes & referral reason**
    - AD-type referrals had 50% fail rate
      - **Not** significantly worse than early dementia/MCI – 47%
    - Vascular (20%), EtOH (0%), other (11%) – not SS
  - **Driving outcomes & MMSE**
    - Full MMSE only performed for minority (45%)
    - average score same for sexes (25/30)
    - Average **score** in **pass** group **not** better than fail
      - 25.7 / 30 vs 24/30
    - **Bias** in who gets a full MMSE performed?
-

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# Discussion (5)

## ■ Driving outcomes & MFVPT

- Higher n (76% of pop'n)
- No difference in scores b/t genders (28/36)
- **No** difference in **pass** vs **fail** groups (28/36)
- Possible bias – higher fail rates in those who didn't get test

## ■ Driving outcomes & VPS

- **Slower** in those who fail, not significant (7.8s cf 10s)
- \* Significantly slower **than norm** for age in **fail** group
  - 55% of pass group were slower; 84% of fail group

## ■ Other tests

- Insufficient n to reasonably compare
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# Bias?

- Referral source bias?
    - MD more likely to send male over female?
    - Can refer only those whom we see...
  - Gender bias?
    - Fewer elderly women than male drivers
    - Women more likely to surrender license to MD?
  - Testing bias?
    - More impaired pts w/ poorer outcomes less likely to get full battery of tests
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# Implications for clinical practice

- For O.T.
    - MVPT & VPS may be better predictors than MMSE
    - Maximize efficiency, shorten wait list
  - For MD
    - MMSE still routine in monitoring cognitively impaired pts, & for ChEI funding
    - No obvious office-based test that predicts driving
    - Collateral hx important & frank discussion w/ pt
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# Suggestions for further research

- Larger sample size
  - Validity of other tests
  - Compare tests to each other
  - Non-elderly cognitively impaired
    - TBIs, CVAs, etc
    - Differences?
-

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## Thanks to...

- Michelle Osmond, O.T.
  - Dr. Howard Strong
  - Shannon Coombes, Psychology, LAMC
  - Dr. Michelle Ploughman
  - Dr. Heather Arnold
-