

Online drawings for dementia diagnose: in-air and pressure information analysis

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Outline

- Introduction
- Diagnose potential of handwriting
- Preliminar experiments

Alzheimer



- the cost per year for a single patient is 35,000 USD in the USA and 24.000 € in Spain.
- One in ten patients is below 60 years old.
- The incidence of Alzheimer's is doubled for every five years after 65, and beyond 85 years old the incidence is between one third and half of the amount of population.
- If a solution is not found, this problem will be unbearable for society.
- Alzheimer's disease (AD) is the most common type of dementia and it has been pointed out that early detection and diagnosis may confer several benefits.

“Si no curamos el Alzheimer, nuestro estado del bienestar será insostenible”
Dra. Susan Greenfield, La Contra, La Vanguardia, 22-6-2011

Pathology detection:

- Usefulness of handwriting



"MINI-EXAMEN COGNOSCITIVO"

Paciente Edad 73
 Ocupación Amasadora Escolaridad La 1.ª Examinado por Fecha

ORIENTACION
 "Dígame el día 10 Fecha 30 Mes Junio Estación Invierno Año 2000"
 "Dígame el Hospital (o el lugar) de España Planta"
 Ciudad Burgos Prov. de Burgos Nación España

FIJACION
 "Repita estas 3 palabras: Peseta-Caballo-Manzana"
 (Repetirlas hasta que las aprenda) 2 (3)

CONCENTRACION Y CALCULO
 "Si tiene 30 pts. y me va dando de 3 en 3. ¿Cuántas le van quedando?" 5 (5)
 "Repita estos números: 5-9-2" (hasta que los aprenda) 2 (3)
 "Ahora hacia atrás"

MEMORIA
 "¿Recuerda las 3 palabras que le he dicho antes?" 2 (3)

LENGUAJE Y CONSTRUCCION
 Mostrar un bilingüa "¿Qué es esto?" Repetirlo con el reloj 2 (2)
 "Repita esta frase": "En un frugal había cinco perros" 2 (1)
 "Una manzana y una pera son frutas ¿Verdad? ¿Qué son el rojo y el verde?" 2 (2)
 "¿Qué son un perro y un gato?"
 "Coja este papel con la mano derecha, dóblelo y póngalo encima de la mesa" 2 (3)
 "Lea esto y haga lo que dice", **CIERRE LOS OJOS** 2 (1)
 "Escriba una frase" ¿Amor? 1 (1)
 "Copie este dibujo":



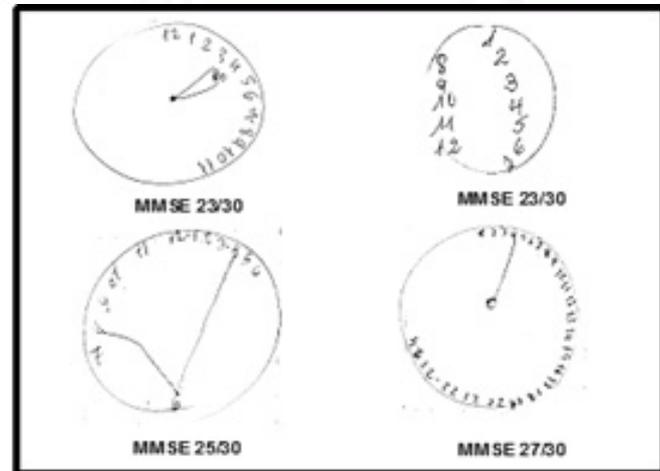
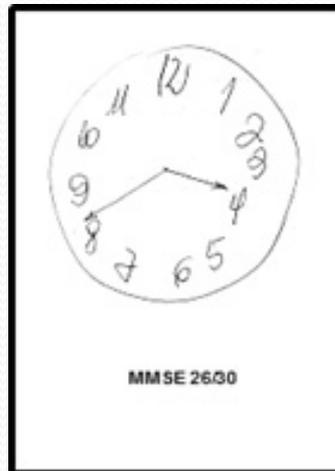
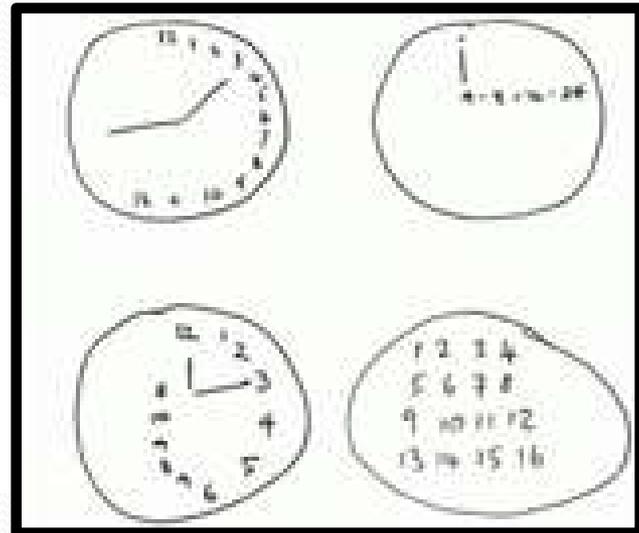
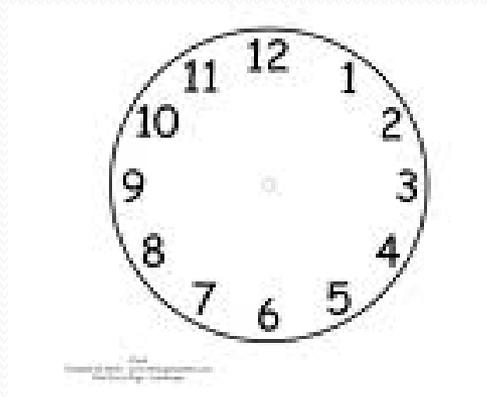

(*Un punto cada respuesta correcta)

	PUNTOS
"Dígame el día..."	5 (5)
"Dígame el Hospital..."	5 (5)
FIJACION	2 (3)
CONCENTRACION Y CALCULO	5 (5)
MEMORIA	2 (3)
LENGUAJE Y CONSTRUCCION	2 (2)
"Repita esta frase..."	2 (1)
"Una manzana y una pera..."	2 (2)
"Coja este papel..."	2 (3)
"Lea esto y haga lo que dice..."	2 (1)
"Escriba una frase..."	1 (1)
Puntuación Total	33 (35)
Nivel de conciencia	(Atencón)

Alerta, Obnubilación, Estupor, Coma

Lobo y Colaba, 1979-85.

Clock drawing test (1/2)



Clock drawing test (2/2)

Table 1

**A Partial Frequency Distribution of Ten-Point
by Diagnosis in a Series
or Psychiatric Consultation**

Figure 1

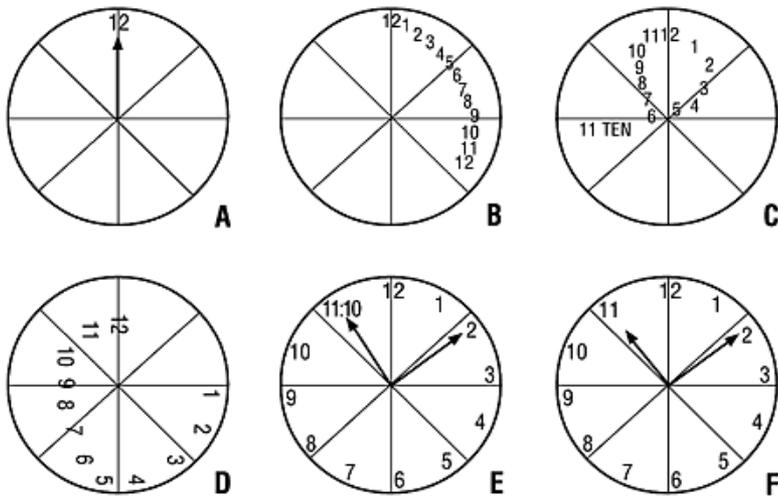


Figure 1. Scoring: A. Score = 0. **B.** The number 1 is in the correct position; score = 1. **C.** Numbers 1 and 2 are in the correct positions; score = 2. **D.** Numbers 7, 8, 10, and 11 are in the correct positions; score = 4. **E.** Numbers 1, 2, 4, 5, 7, 8, 10 and 11 are in the correct positions; score = 8. No points for hands of approximately equal length regardless of position. **F.** Numbers 1, 2, 4, 5, 7, 8, 10 and 11 are in correct position for 8 points. The little hand is on the 11 (1 point) and the big hand is on the 2 (1 point); score = 10 points

(modified from Manos PJ and Wu, 1994)

Score	% of Patients Score < 8	% of Patients Score < 5
10	92	40
9	90	70
8	70	40
7	64	39
6	25	0
5	13	0
4	5	0

Security – health implications

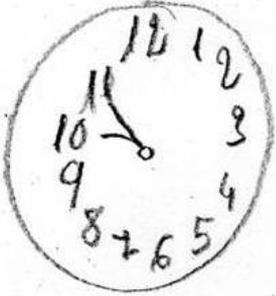
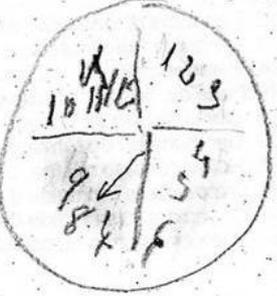
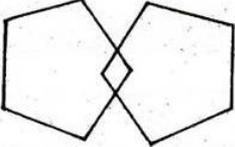
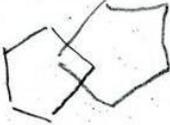
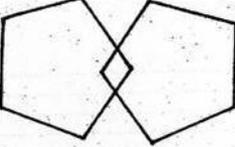
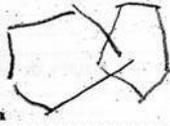
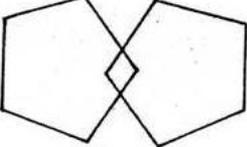
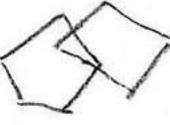
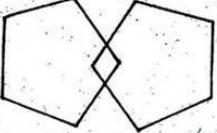
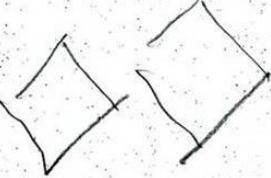
FIRMAS INDUBITADAS 1986

LOS AUTOS = NUMERO = *var*

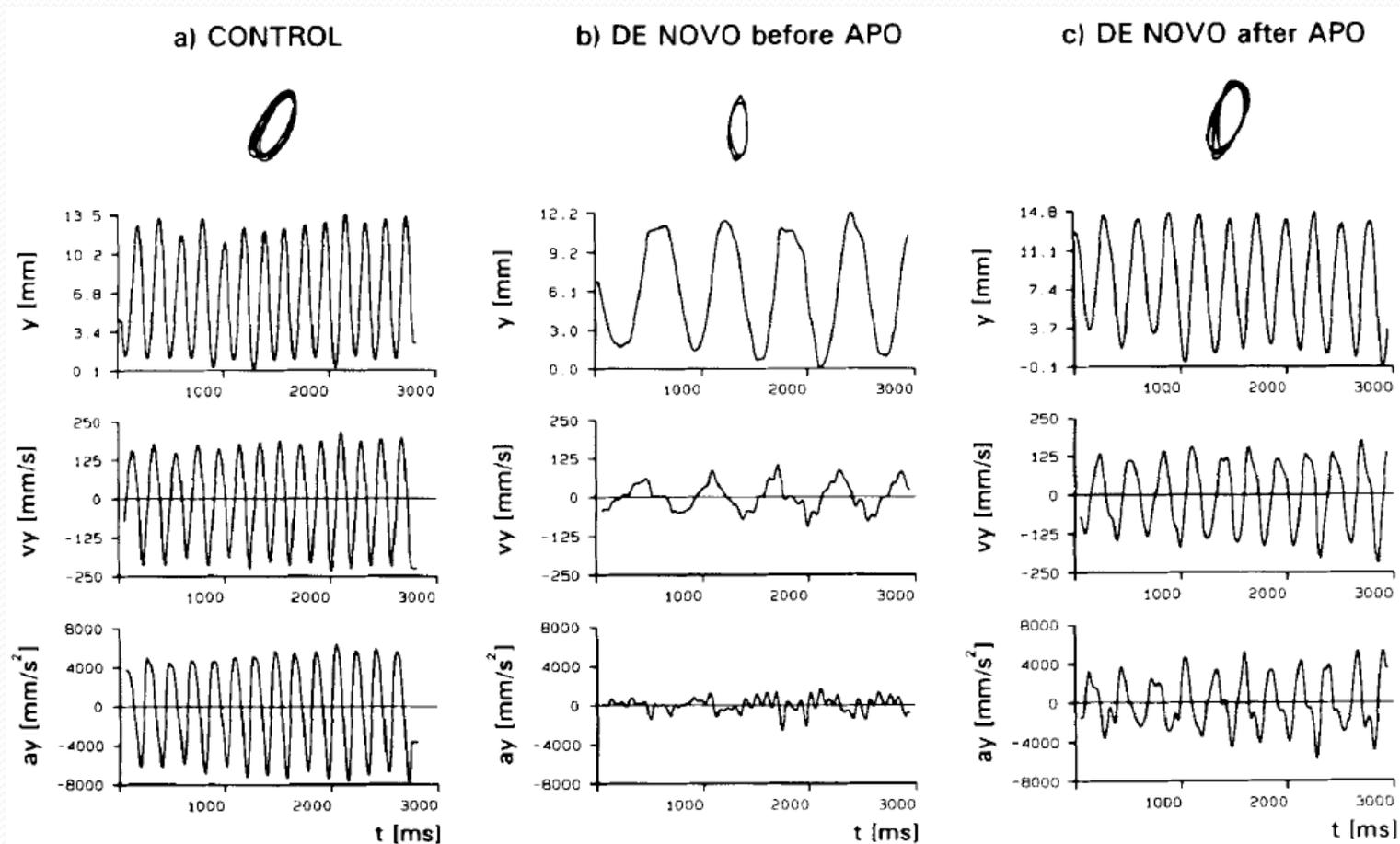
D^a CALUDIA HERNANDEZ ALTABELLA

FIRMA DUBITADA (fotocopia inicial) 1985

FIRMA DUBITADA nueva
(original aportado a los autos) 1985

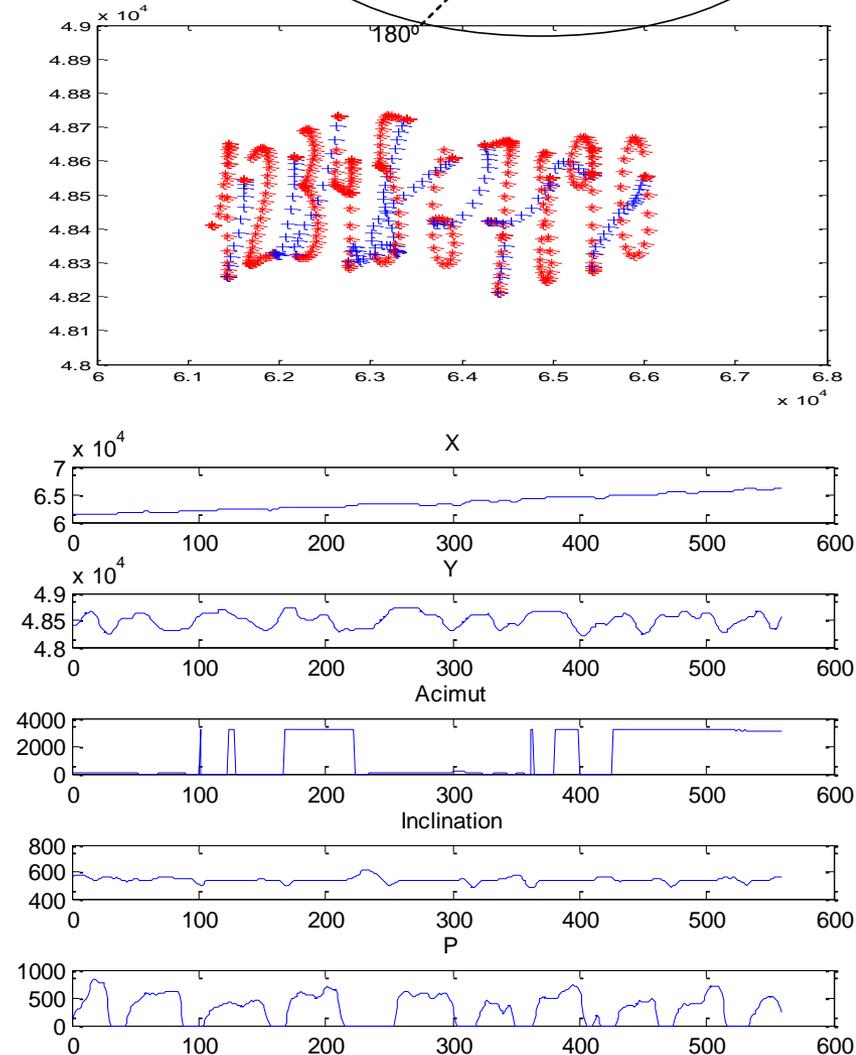
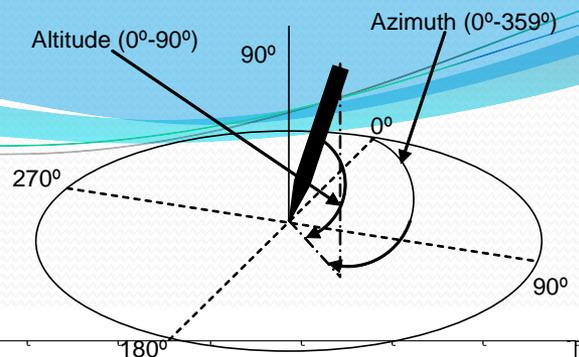
basal	6 months	12 months	18 months
			
 	 	 	 

Example: Study about the relevance of Apomorphine on Parkinson's disease

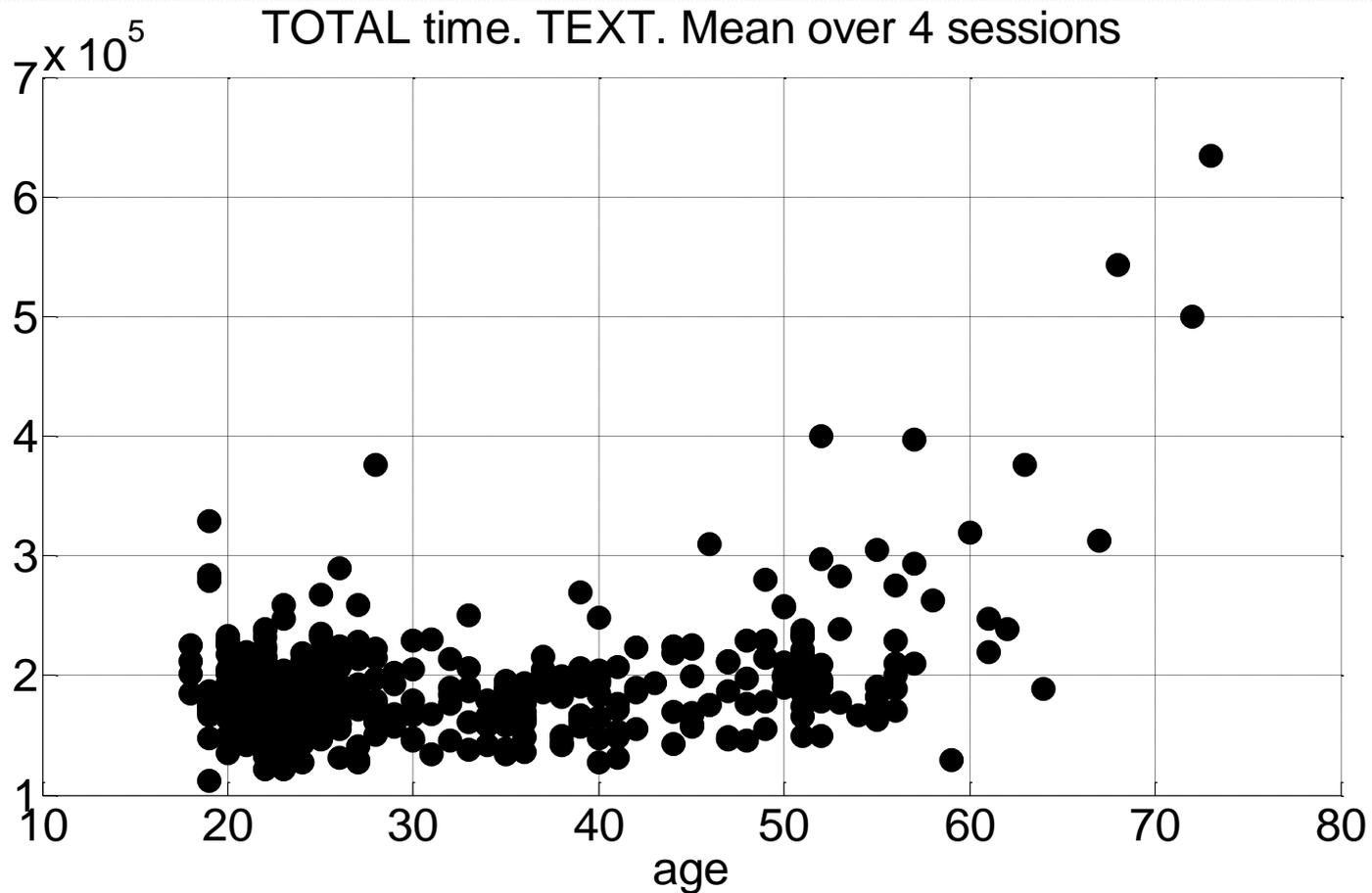


Online handwriting

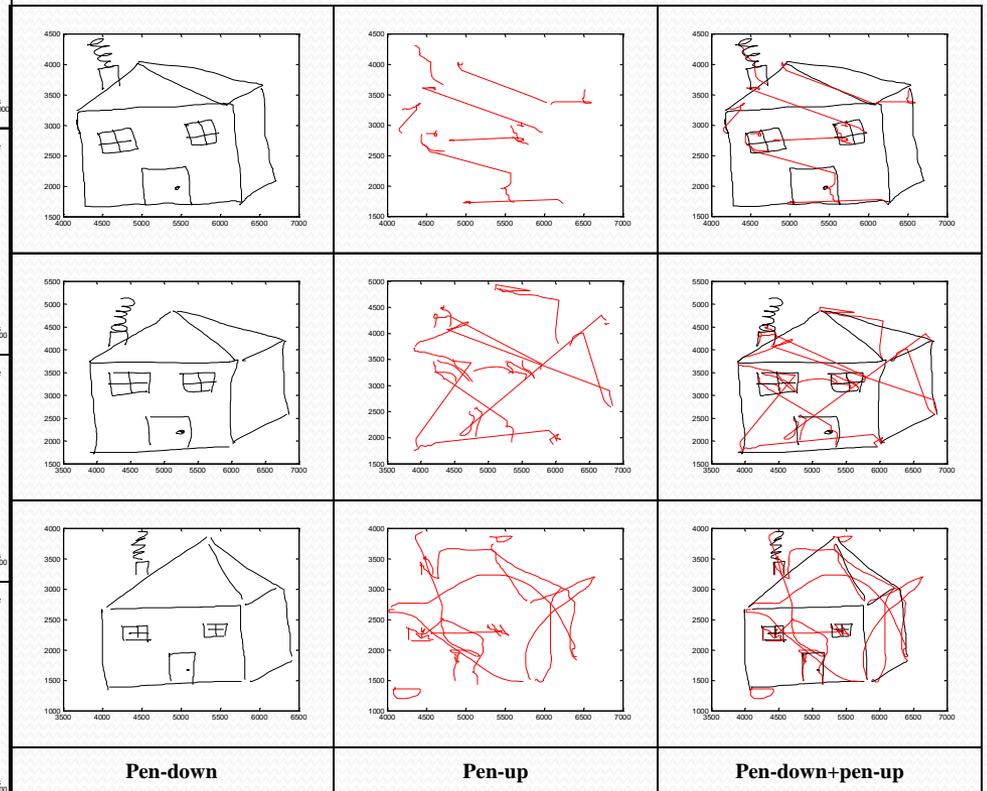
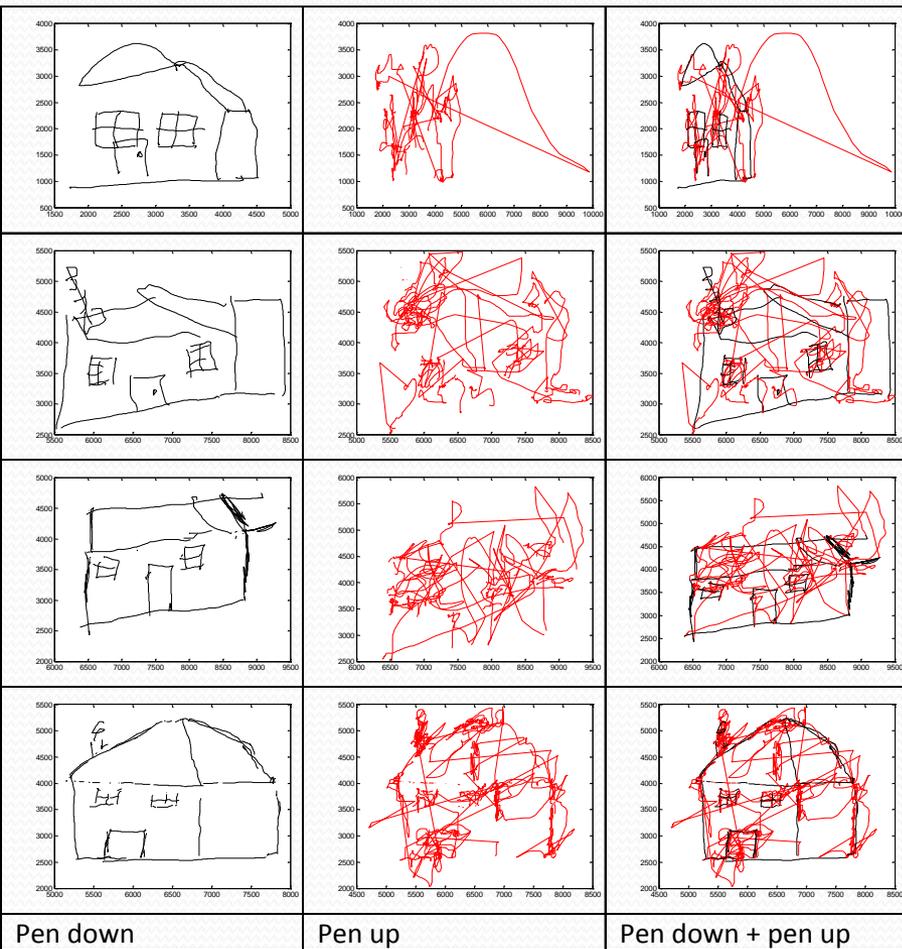
- *On-surface trajectories* (pen-downs), corresponding to the movements executed while the writing device is touching the writing surface. Each of these trajectories produces a visible stroke.
- *In-air trajectories* (pen-ups), corresponding to the movements performed by the hand while transitioning from one stroke to the next. During these movements the writing device exerts no pressure on the surface.



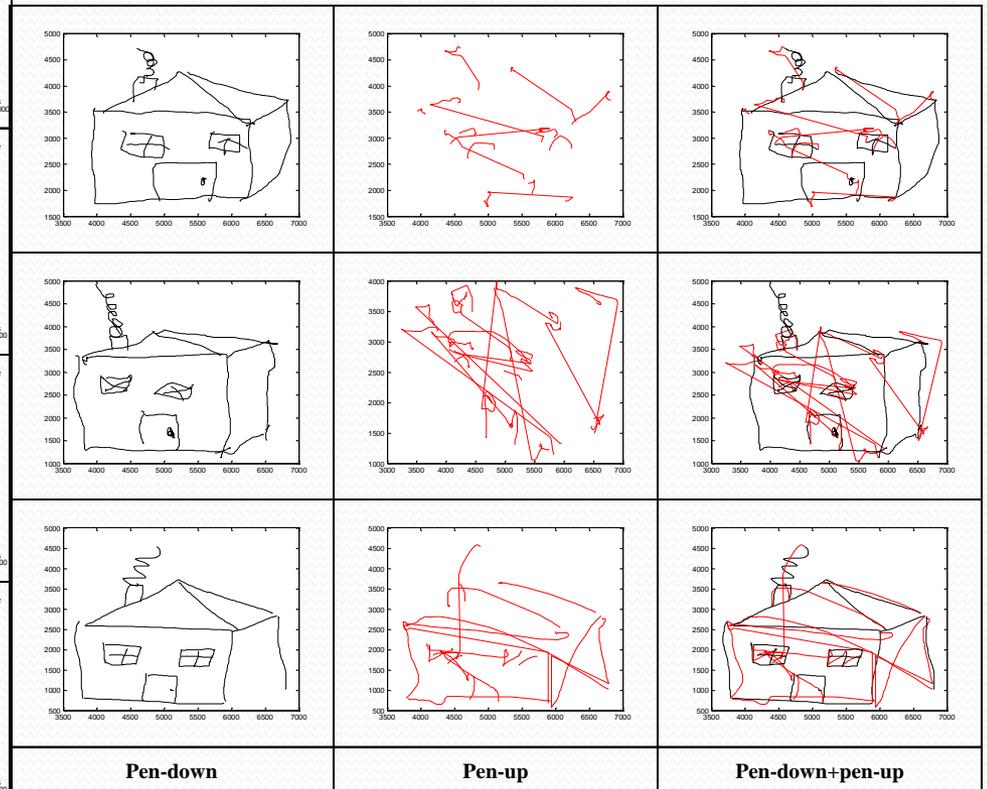
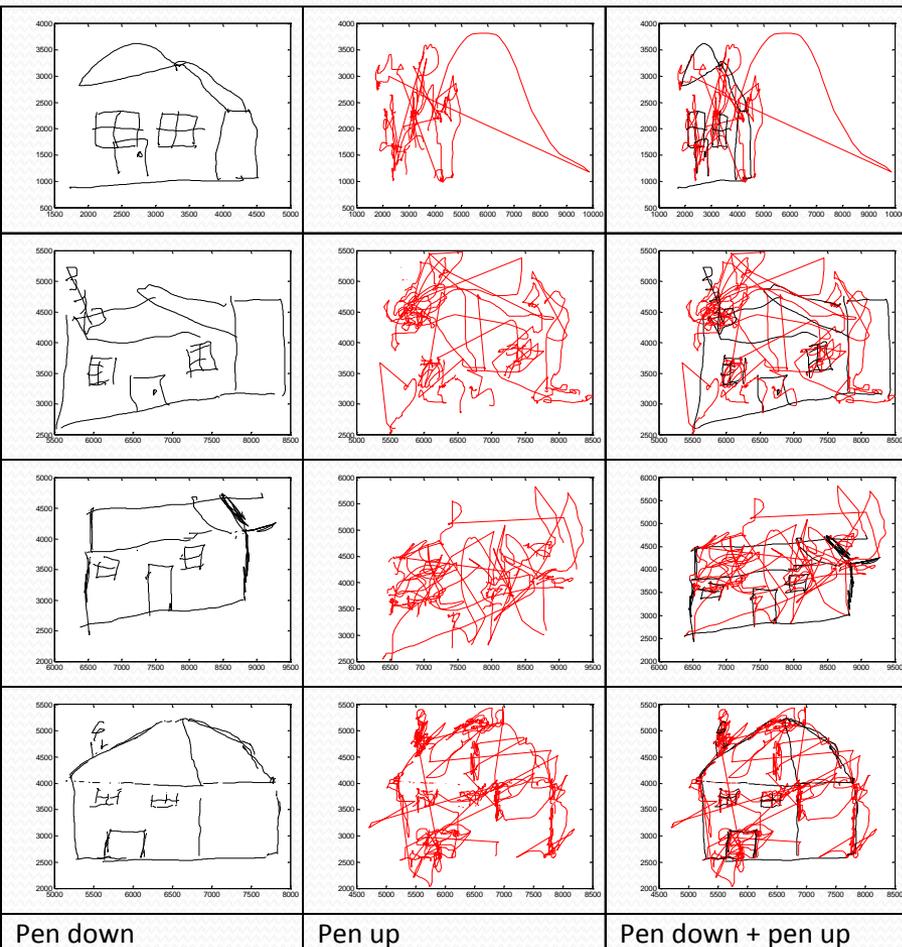
Realization time for control population when writing a text



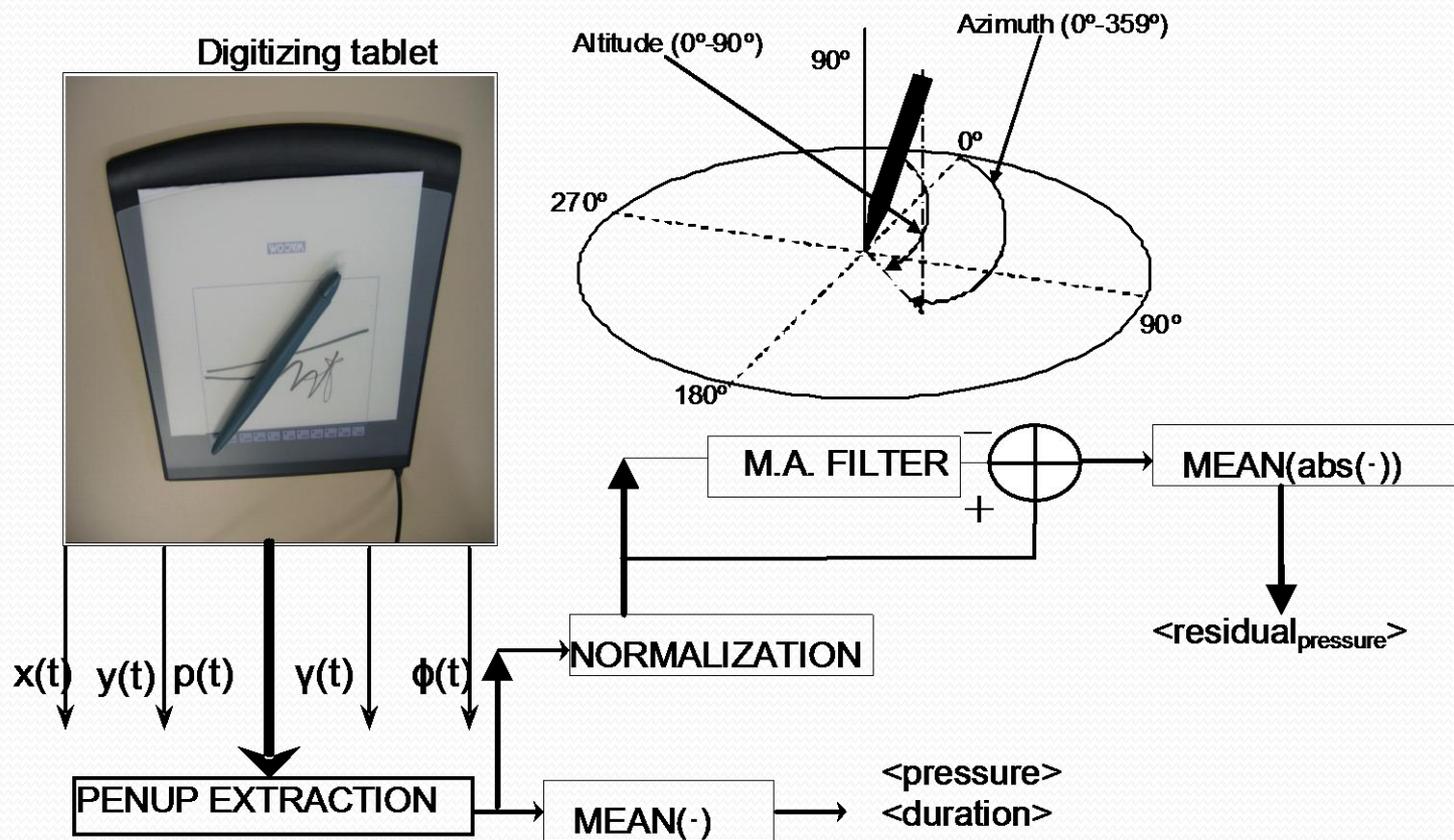
Alzheimer vs. Control group (dominant hand)



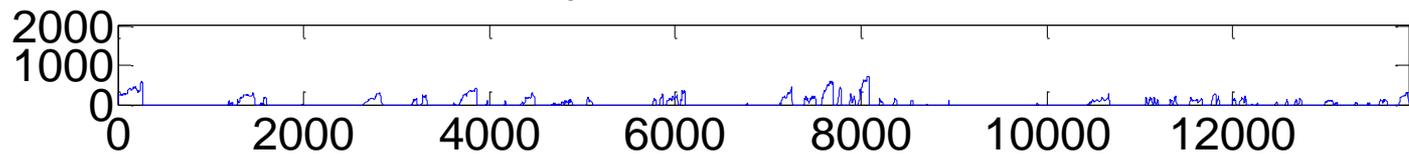
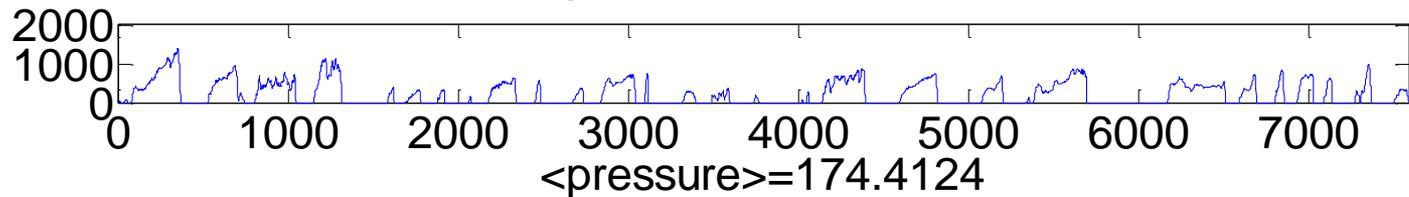
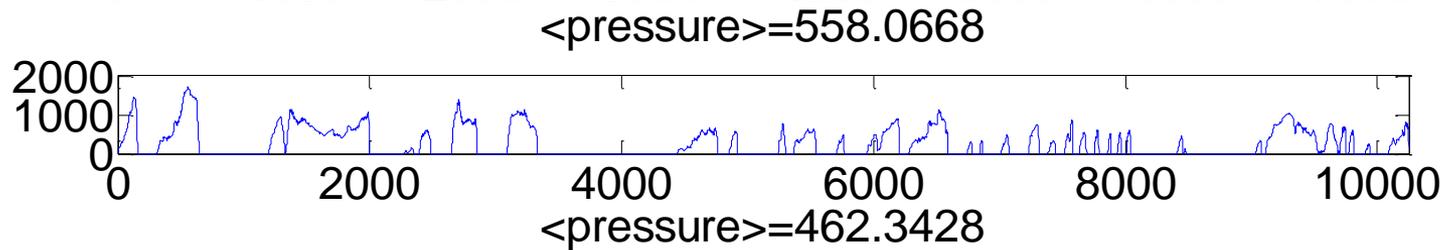
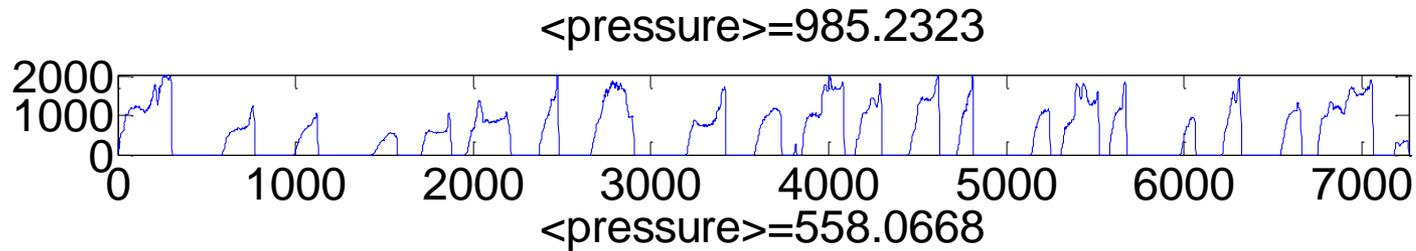
Alzheimer vs. Control group (nondominant hand)



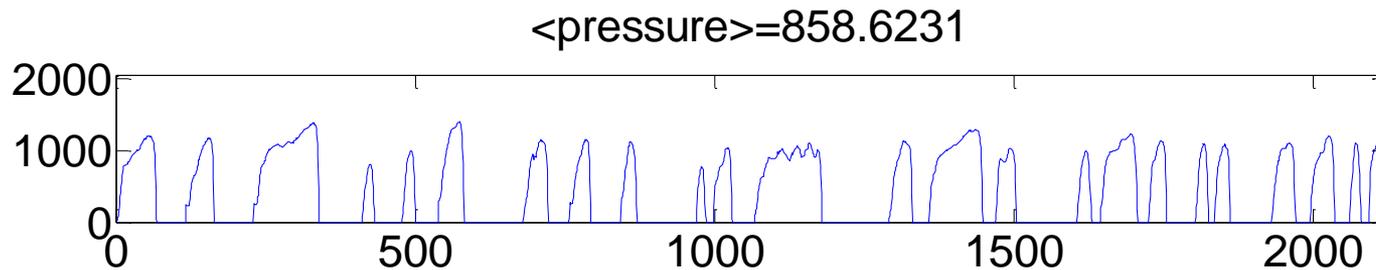
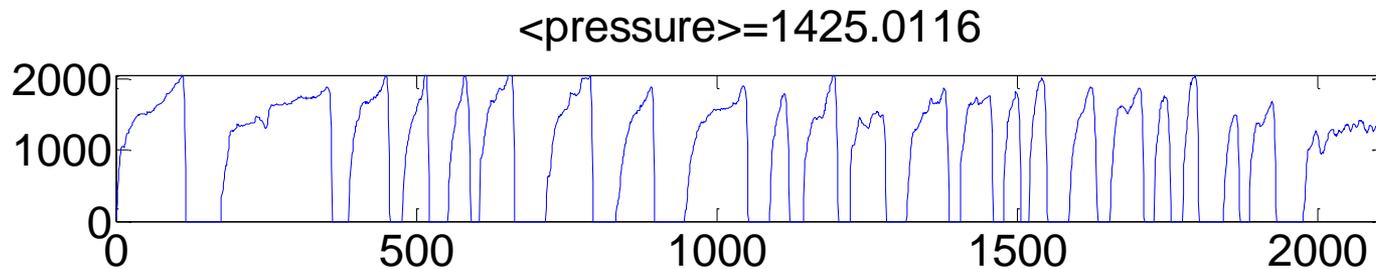
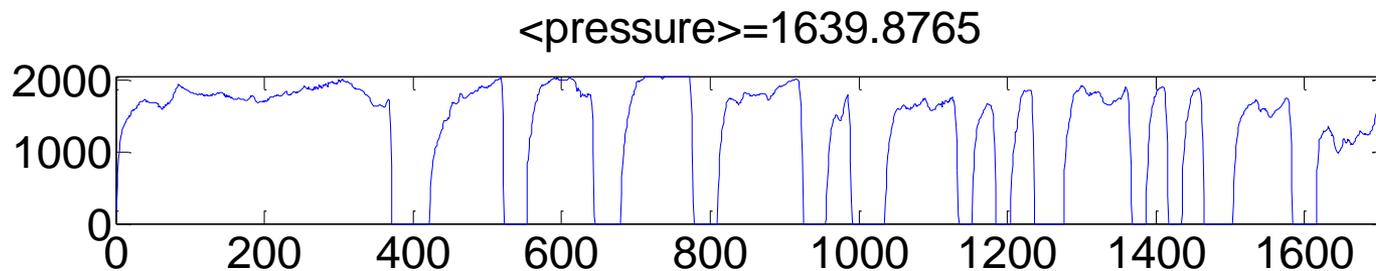
Pressure extracted measures



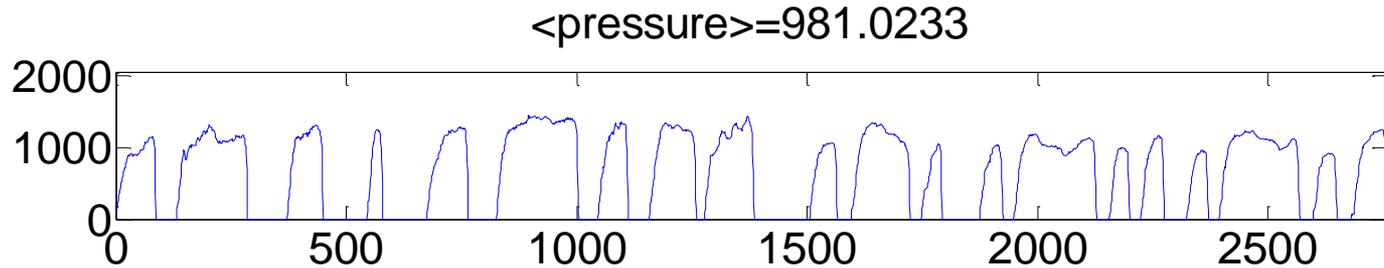
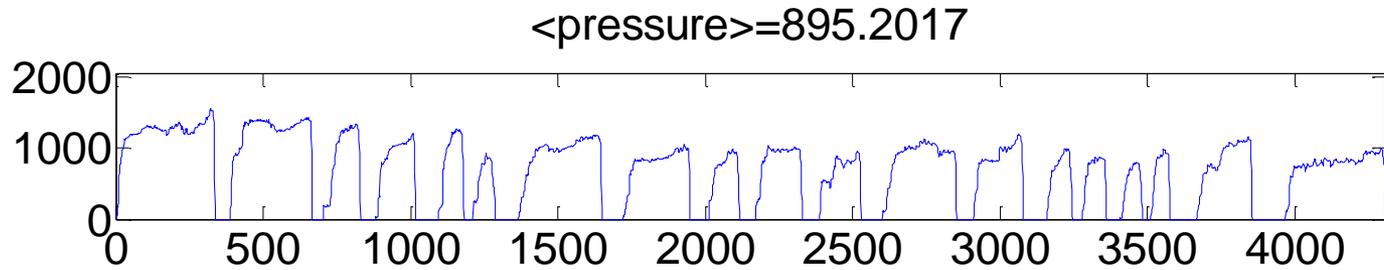
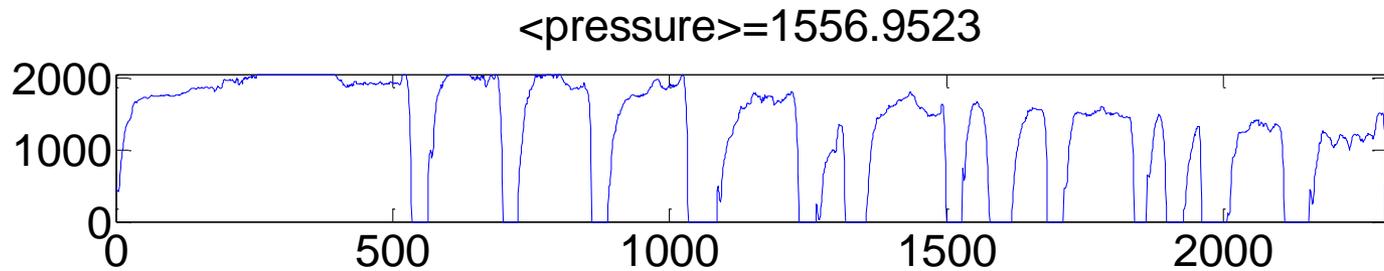
Pressure profiles for three AD patients



Pressure profiles samples for control group, dominant hand



profiles samples for control group, non-dominant hand

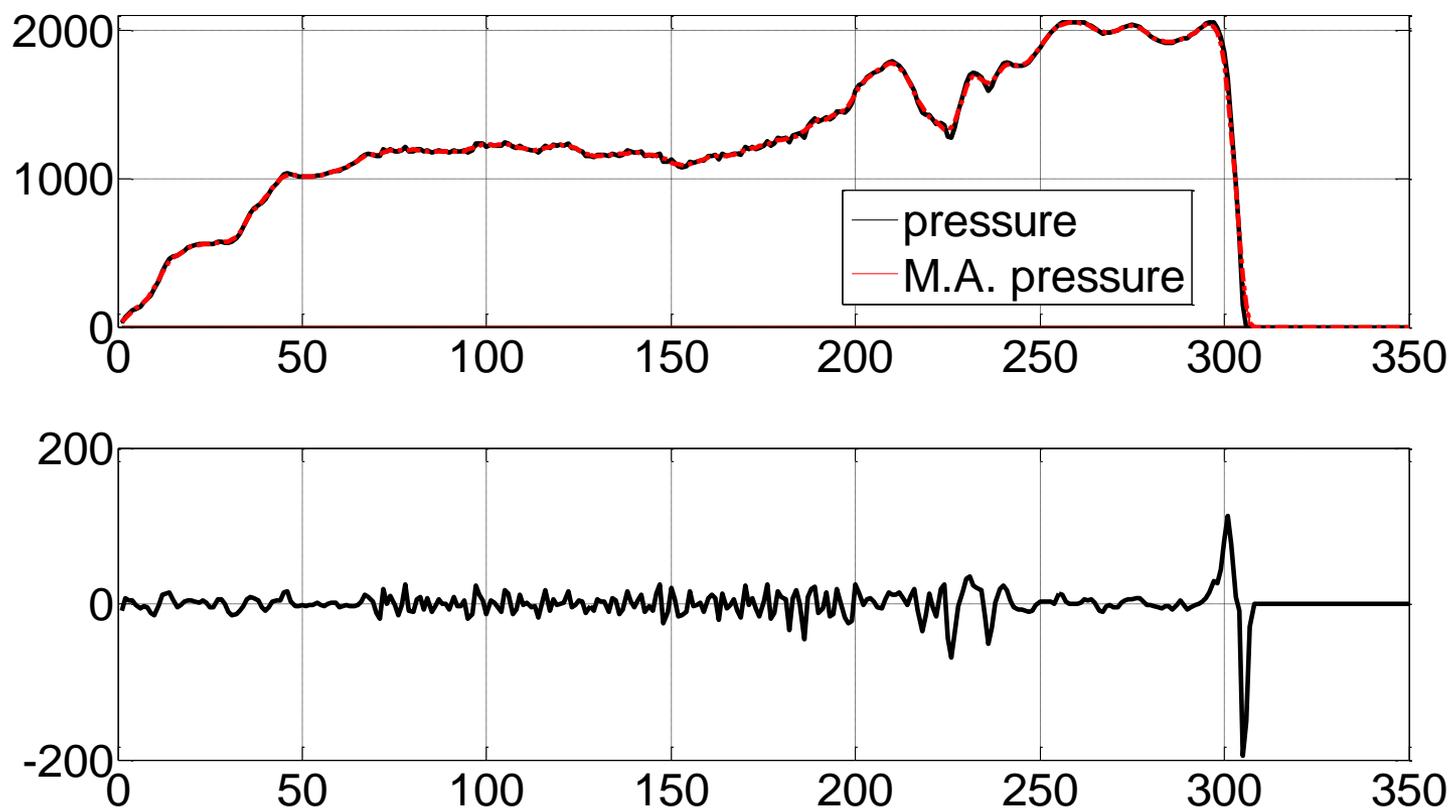


Statistical analysis/descriptives from the drawings

Measurement	control		pathological
	Dominant hand	Non-dominant hand	Dominant hand
Time in-air	8334	10927	61008
Time on-surface	9680	22177	31521
Total time	18014	33104	92259
<Pressure>	1307.8	1144.4	545.01
<abs(Residual error)>	22.49	12.89	10.27

- higher time for in-air movements for the AD group, which are around 7 times longer. On the contrary, the time on surface is just around 3 times longer. Thus, there are more differences between control and AD groups when looking at in-air movements.
- When comparing the non-dominant movements performed by the control group we obtained a 5.6 ratio and 1.5. Again, the in-air times are significantly higher for the AD group than the control group.
- mean pressure is 2.4 times higher for control group and dominant hand, and 2.1 for the non-dominant hand. About the mean absolute value of the residual error, the ratios are respectively 2.2 and 1.3.

Pressure information & MA on the top. The difference between both signals on the bottom.



Conclusions

- In-air movements seem more relevant than on-surface ones.
- Pressure information looks also interesting.