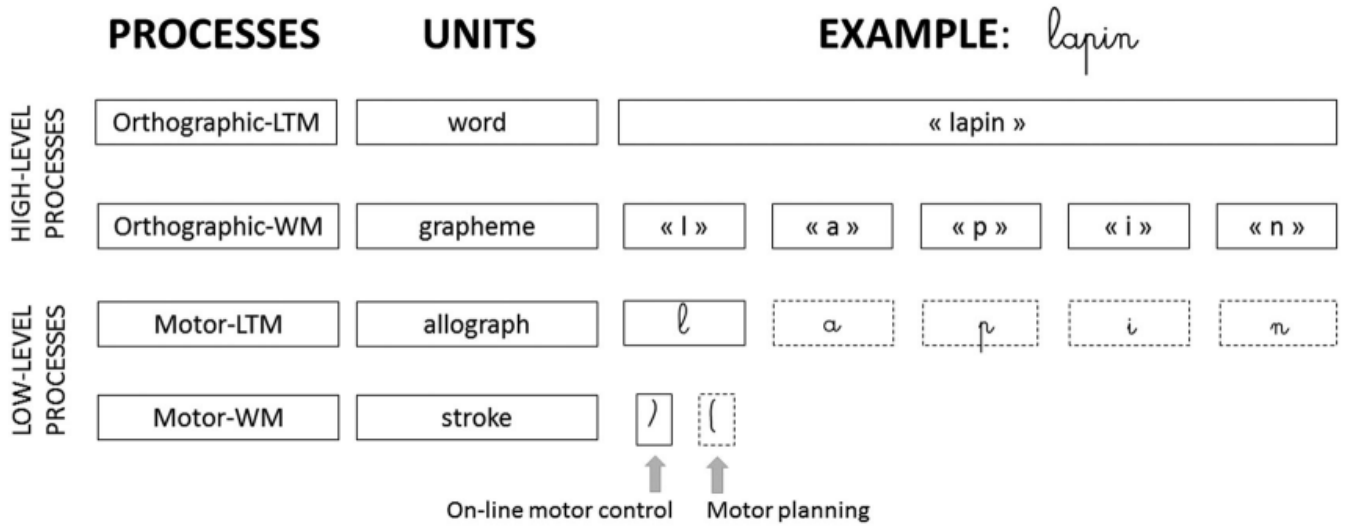
Online Handwriting

Analysis of Human Movement

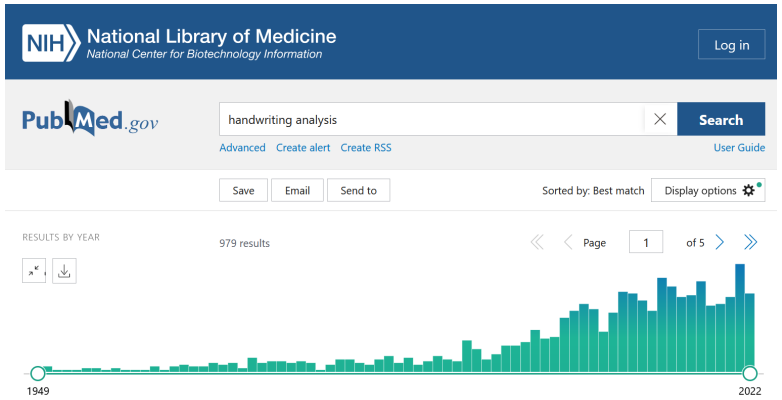
Serena Starita, PhD Student @ BioingTS

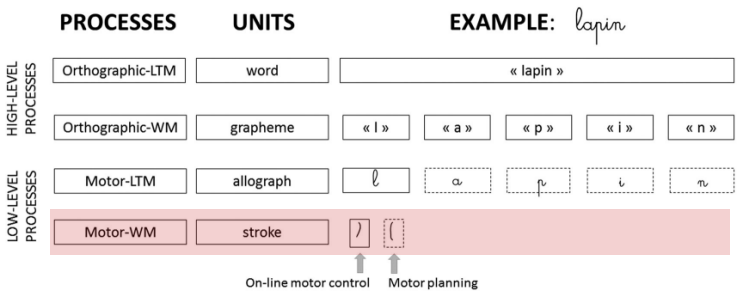
What is Handwriting?



Sarah Palmis, et al (2017) Motor control of handwriting in the developing brain: A review. *Cognitive Neuropsychology*, 34:3-4,187-204

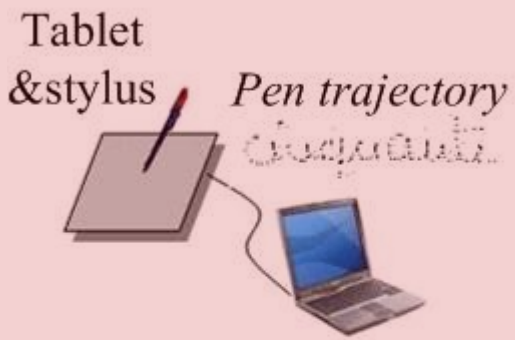
Handwriting in Clinical Research





How Handwriting Research is done?

online



Real time recognition based on traces of pen movement on a stylus

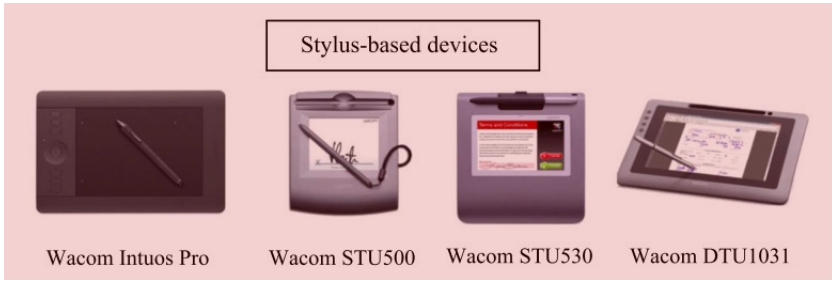
offline

Recognition of scanned images from hand printed materials

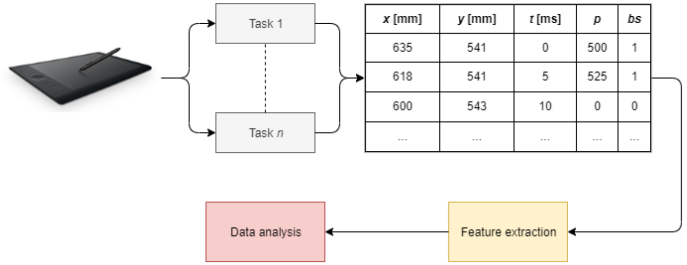
Ahmad, Abdul. (2008). On-line Handwriting Recognition using Support Vector Machines and Hidden Markov Models approaches.

How Handwriting Research is done?

Online handwriting is a digitized **bio-signal**…



- Position of pen tip in X-axis
- Position of pen tip in Y-axis
- On-surface/in-air pen position information
- Pressure applied by the pen tip
- Azimuth angle of the pen with respect to the tablet's surface
- Altitude angle (a.k.a. tilt) of the pen with respect to the tablet's surface
- Timestamp



Faundez-Zanuy, *et al.* (2020) Handwriting Biometrics: Applications and Future Trends in e-Security and e-Health. *Cogn Comput* **12**, 940–953

How Handwriting Research is done?

… and **engineering tools** for signal analysis can be implemented to study it

Kinematic Analysis of Movement

Spectral analysis
of kinematic signal

Non-linear analysis
of kinematic signal

Machine Learning
of extracted features

What BioingTS does?

Characterization of tremor presenting pathologies

Development of handwriting skills in normal children & understanding dysgraphia in school children

Kinematic Analysis of Movement

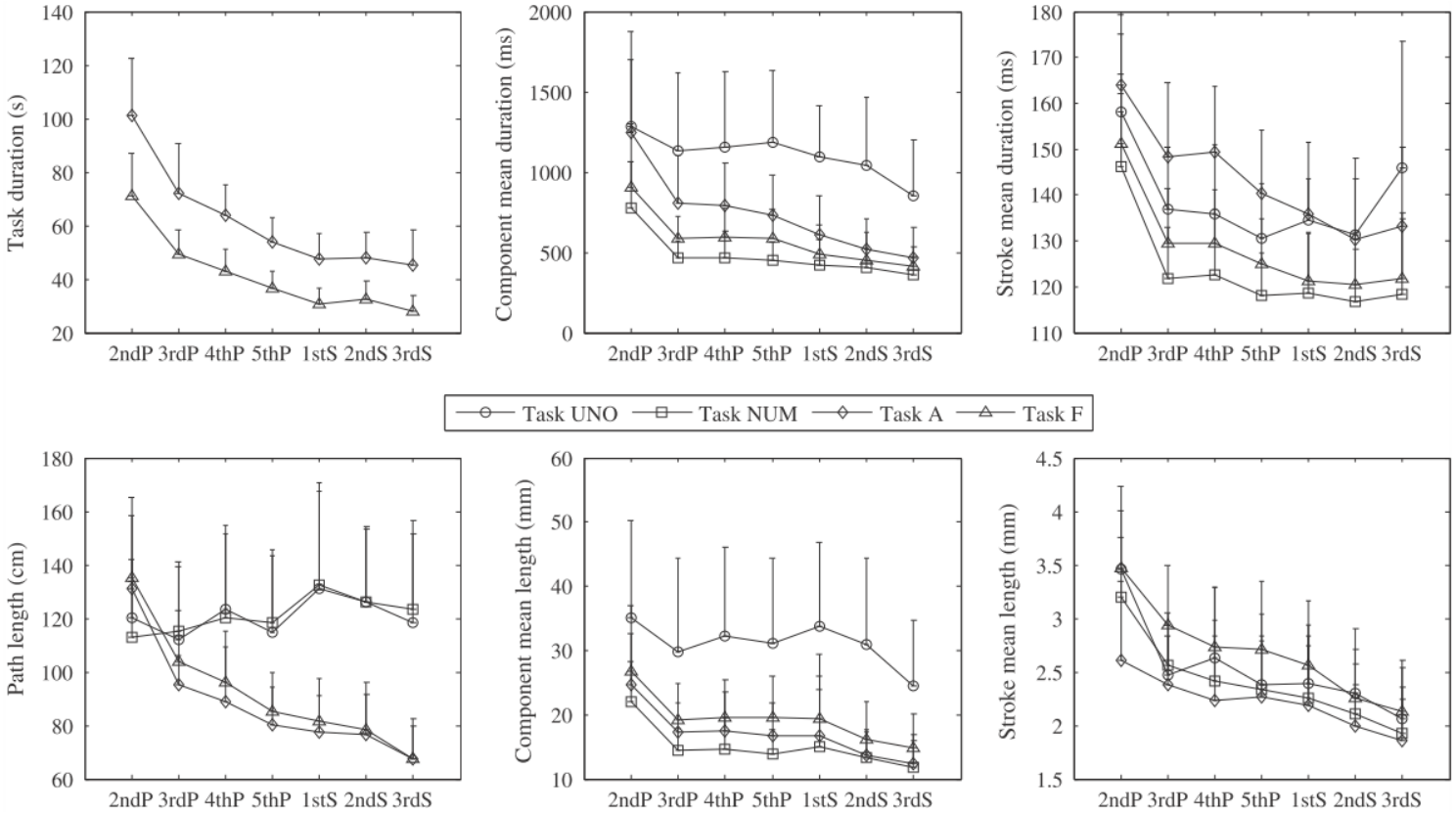
Spectral analysis
of kinematic signal

Non-linear analysis
of kinematic signal

Machine Learning
of extracted features

Characterization of tremor presenting pathologies

Development of handwriting skills in normal children & understanding dysgraphia in school children



Contents lists available at SciVerse ScienceDirect

Human Movement Science

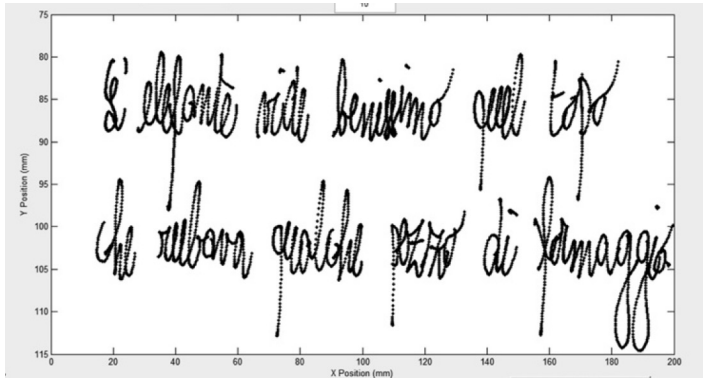
journal homepage: www.elsevier.com/locate/humov

Development, maturation and learning influence on handwriting kinematics

Agostino P. Accardo [a], Mariangela Genna [a,*], Michela Borean [b]

[a] Department of Industrial Engineering & Information Technology, University of Trieste, Via Valerio, 10 I34100 Trieste, Italy
[b] Institute for Maternal and Child Health – IRCCS Burlo Garofolo, Via dell'Istria, 65/1 I34100 Trieste, Italy

pangram



Characterization of tremor presenting pathologies

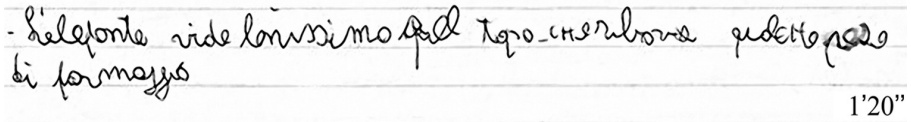
Development of handwriting skills in normal children & understanding dysgraphia in school children

	Fast test			
	Pre	*Post*	*t*	*p*
Total duration (s) TD	185 ± 178	183 ± 111	0.06	0.95
Overall length (cm) WL	172.3 ± 46.2	171.0 ± 46.2	0.14	0.89
Mean curvilinear velocity (cm/s) CV	1.27 ± 0.59	1.11 ± 0.44	1.45	0.16
# of letters/cm (1/cm) #L_cm	0.67 ± 0.19	0.68 ± 0.21	0.29	0.77
# of letters/s (1/s) #L_s	0.83 ± 0.35	0.74 ± 0.32	1.53	0.14
Pen lift mean duration (ms) PLD	0.72 ± 0.63	0.89 ± 0.65	1.33	0.20
Component mean duration (s) CD	0.86 ± 0.32	1.50 ± 0.73	3.85	0.0009
Component mean length (mm) CL	15.8 ± 4.0	23.0 ± 9.9	3.45	0.002
# of strokes/letter (–) #SL	5.5 ± 4.6	5.7 ± 2.9	0.19	0.85
# of strokes/s (1/s) #S_s	3.5 ± 1.0	3.6 ± 1.3	0.59	0.56
Stroke mean duration (ms) SD	173 ± 34	190 ± 51	2.31	0.031
Stroke mean length (mm) SL	3.6 ± 1.4	3.2 ± 1.1	1.98	0.061
Horizontal peak velocity of stroke (mm/s) SHVp	13.3 ± 5.2	11.4 ± 4.6	1.73	0.098
Vertical peak velocity of stroke (mm/s) SVVp	20.8 ± 9.2	16.6 ± 7.5	2.53	0.02
Curvilinear peak velocity of stroke (mm/s) SCVp	24.2 ± 9.8	19.9 ± 8.1	2.28	0.033

IEEE TRANSACTIONS ON HUMAN-MACHINE SYSTEMS, VOL. 47, NO. 2, APRIL 2017 249

The Influence of the Spatio-Temporal Terzi Treatment on the Kinematics of Cursive Writing of Dysgraphic Subjects

Agostino Accardo, Flavia Costa, and Iolanda Perrone



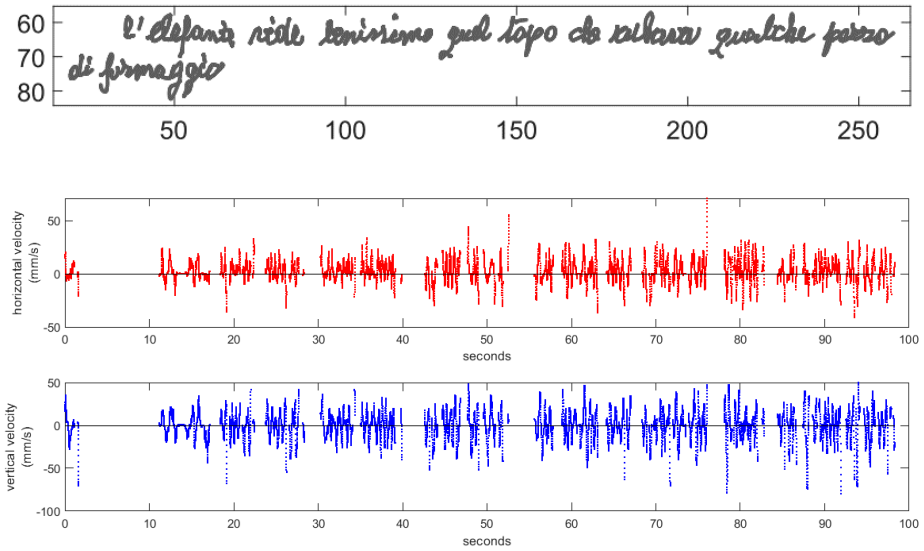
Characterization of tremor presenting pathologies

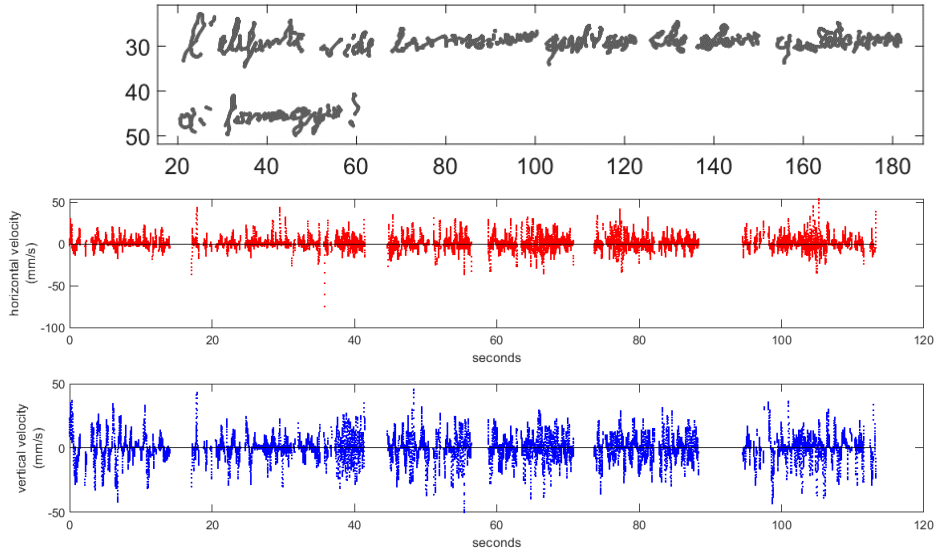
Development of handwriting skills in normal children & understanding dysgraphia in school children

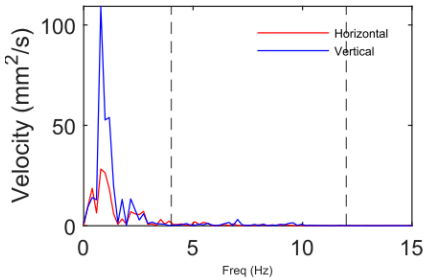
Digitized handwritten track

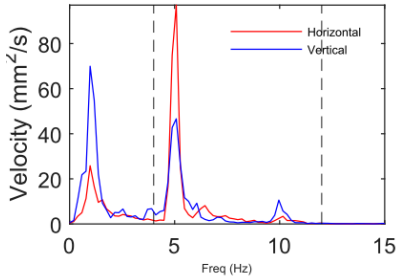
Velocity Profiles

Power Spectral Densities









CEI CENTRAL EUROPEAN INITIATIVE

Dipartimento di Ingegneria e Architettura

BioingTS

Standard research is mainly on people writing in Latin alphabet but…

Are protocols, data and clinical results obtained from this research suited to be applied to patients writing with an **alphabet different from Latin**?

To address this question

studying **digraphia** would be very useful

digraphia

the use of two (or more) writing systems for representing a single language (or varieties thereof). Examples are given of both *synchronic digraphia* (more than one writing system used contemporaneously for the same language) and *diachronic digraphia* (more than one writing system used for a given language in successive periods of time). For each example, consideration is given to the cultural and political factors (e.g., religion, modernization) which underlie the development of digraphia in a language community.

Dale, Ian R.H. (1980). "Digraphia". International Journal of the Sociology of Language. 1980 (26): 5–13.

npj | Science of Learning

www.nature.com/npjscilearn

ARTICLE OPEN

Check for updates

The transferability of handwriting skills: from the Cyrillic to the Latin alphabet

Thibault Asselborn[1✉], Wafa Johal[1,2], Bolat Tleubayev[3], Zhanel Zhexenova[3], Pierre Dillenbourg[1], Catherine McBride[4] and Anara Sandygulova[3]

Do handwriting skills transfer when a child writes in two different scripts, such as the Latin and Cyrillic alphabets? Are our measures of handwriting skills intrinsically bound to one alphabet or will a child who faces handwriting difficulties in one script experience similar difficulties in the other script? To answer these questions, 190 children from grades 1–4 were asked to copy a short text using both the Cyrillic and Latin alphabets on a digital tablet. A recent change of policy in Kazakhstan gave us an opportunity to measure transfer, as the Latin-based Kazakh alphabet has not yet been introduced. Therefore, pupils in grade 1 had a 6-months experience in Cyrillic, and pupils in grades 2, 3, and 4 had 1.5, 2.5, and 3.5 years of experience in Cyrillic, respectively. This unique situation created a quasi-experimental situation that allowed us to measure the influence of the number of years spent practicing Cyrillic on the quality of handwriting in the Latin alphabet. The results showed that some of the differences between the two scripts were constant across all grades. These differences thus reflect the intrinsic differences in the handwriting dynamics between the two alphabets. For instance, several features related to the pen pressure on the tablet are quite different. Other features, however, revealed decreasing differences between the two scripts across grades. While we found that the quality of Cyrillic writing increased from grades 1–4, due to increased practice, we also found that the quality of the Latin writing increased as well, despite the fact that all of the pupils had the same absence of experience in writing in Latin. We can therefore interpret this improvement in Latin script as an indicator of the transfer of fine motor control skills from Cyrillic to Latin. This result is especially surprising given that one could instead hypothesize a negative transfer, i.e., that the finger controls automated for one alphabet would interfere with those required by the other alphabet. One interesting side-effect of these findings is that the algorithms that we developed for the diagnosis of handwriting difficulties among French-speaking children could be relevant for other alphabets, paving the way for the creation of a cross-lingual model for the detection of handwriting difficulties.

npj Science of Learning (2021)6:6 ; https://doi.org/10.1038/s41539-021-00084-w

Would you mind helping with digraphia data acquisition?

Љубазни фењерџија чађавог лица хоће да ми покаже штос.

Ljubazni fenjerdžija čađavog lica hoće da mi pokaže štos.

Thank you!

Serena Starita, PhD Student

serena.starita@phd.units.it

CEI
CENTRAL EUROPEAN INITIATIVE

Dipartimento di
Ingegneria
e Architettura

BioingTS