Analysis of Handwriting and Eye Movements: The Eye and Pen project

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A glimpse of history

Interest for handwriting processes study in real time emerged in the early 80's mostly within the Nijmegen Institute for Cognition and Information (NICI) group (The Netherlands) with Teulings, Maarse, van Galen and Thomassen.

In the late 80's the **E**uropean **A**ssociation for **R**esearch on **L**earning and **I**nstruction (EARLI) sets its **S**pecial **I**nterest **G**roup-**Writing**.
The 1st Conference of SIG Writing was held in Padova (Italy) in 1988.

Poitiers' psychology laboratory has been involved in this field since this time.
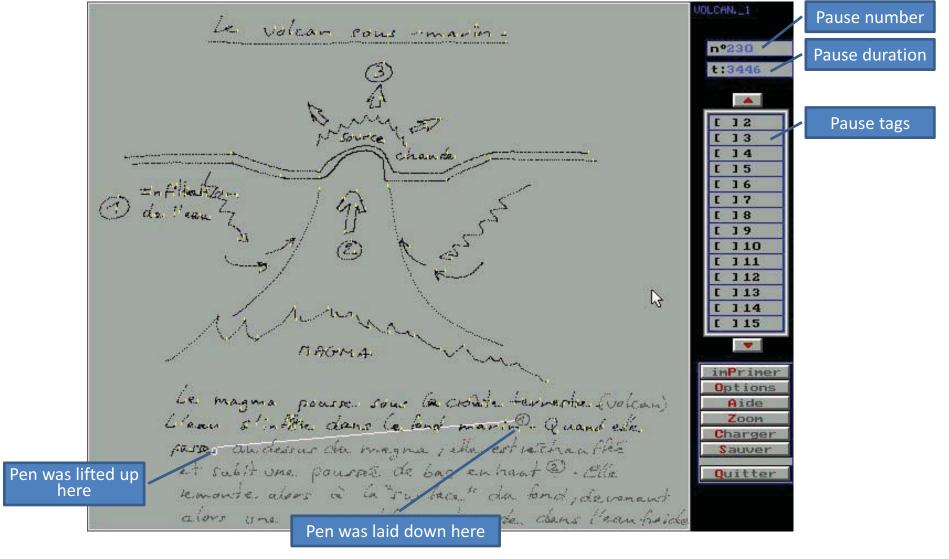
Required tools were few, so home-made software was built to record handwriting pauses in real time:

Espéret E., Passerault J.-M. (1991). On-line study of planning processes in writing texts on a digitalizing tablet: Methodological and theoretical issues. *SIG Writing, 4th EARLI Conference, 24-28 august*, Turku (Finland).
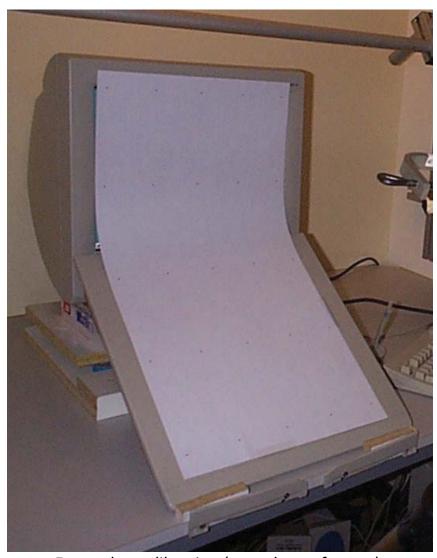
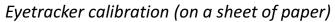To be able to record the whole writing dynamics, a new software was built:

Chesnet, D., Guillabert, F. & Esperet, E. (1994). G-Studio: un logiciel pour l'étude en temps réel des paramètres temporels de la production écrite. *L'Année Psychologique, 94, 283-294*.
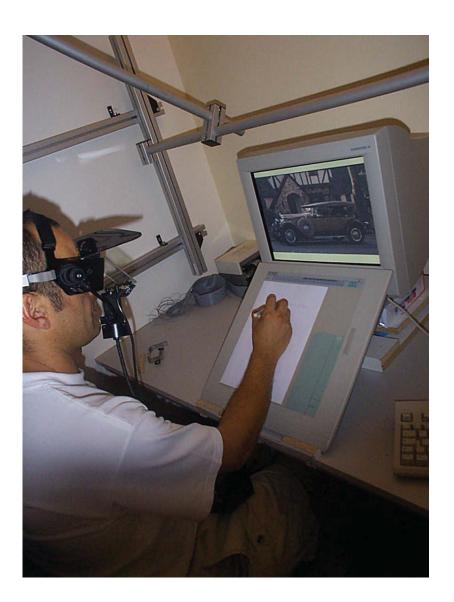
G-Studio was an MS-Dos based software, able to locate, tag and measure pauses, as well as to compute some tracing dynamics parameters.
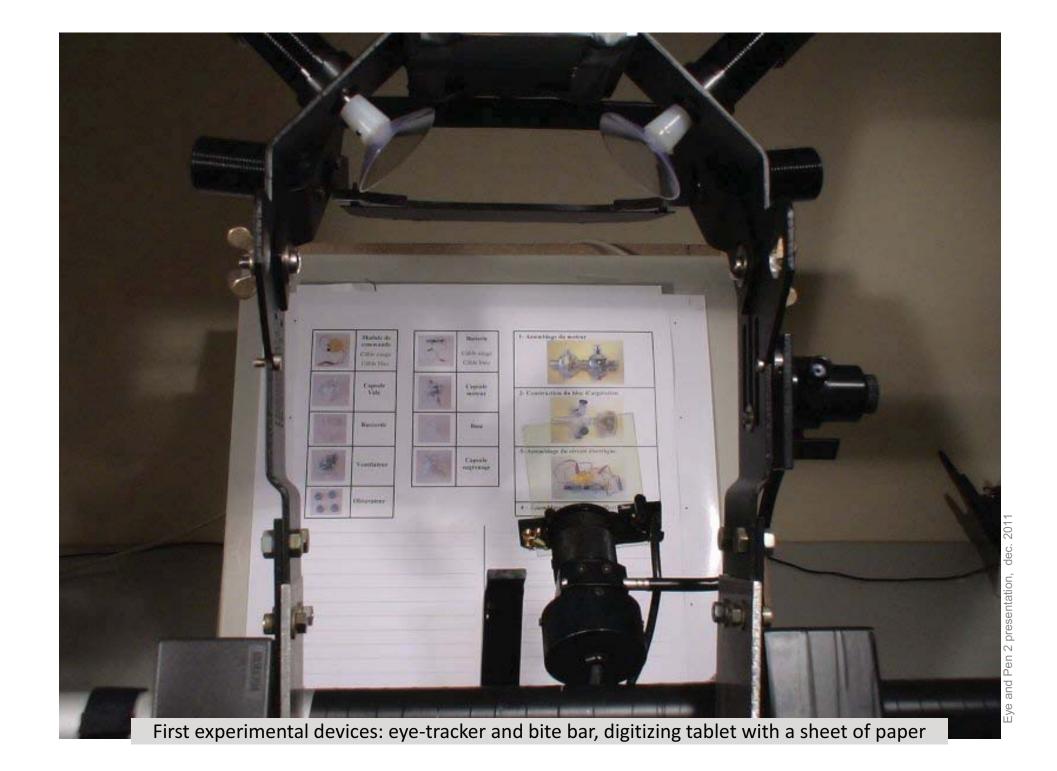

Pause number

Pause duration

Pause tags

Pen was lifted up here

Pen was laid down here

A new version supporting MS-Windows and an eyetracker was needed.

Eyetracker calibration (on a sheet of paper)

First experimental devices: eye-tracker and bite bar, digitizing tablet with a sheet of paper

With hardware evolution, implementation became more friendly…

... and can be used with children

Eye and Pen supports a wide range of LCD and classic tablets, as well as TabletPC

What tablet for which usage ?

Liquid **C**rystal **D**isplay tablets:
- record eye movements while writing / drawing
- manipulate writing feedback (time, size, masking, etc.)

Classic tablets:
- more "ecological" context (pen and paper)
- Higher sampling rate (200Hz) and resolution

Writing may be Shown / hidden on screen during recording to manipulate visual feedback to participant

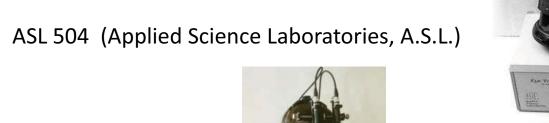"Natural" feedback can be ensured by using inking pen and sheets of paper, on a classic tablet

Classic pen

Inking pen

Eye and Pen supports eyetracking devices

➢ EyelinkII and Eyelink 1000 (S.R. research, Ltd.)
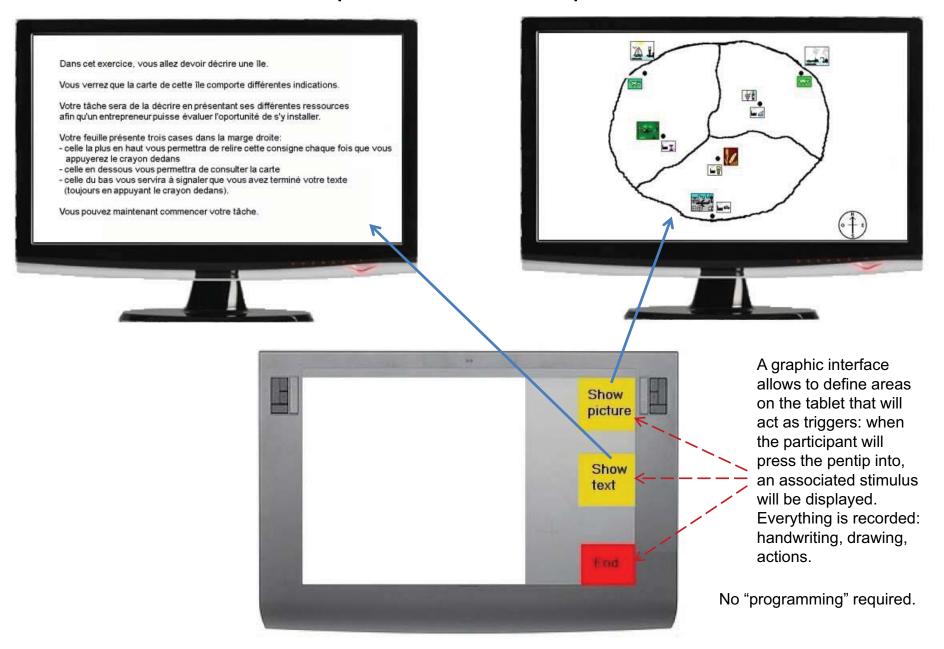
➢ i-ViewX HED (SensoMotoric Instruments GmbH, S.M.I.)

➢ ASL 504 (Applied Science Laboratories, A.S.L.)

➢ EyePuter (Alphabio)

➢ Tablet (Pen Tracking)
   Records pen movement data (even when pen is "in the air") as if it were eytracking data.

Data acquisition

Acquisition with "Simple"

Dans cet exercice, vous allez devoir décrire une île.

Vous verrez que la carte de cette île comporte différentes indications.

Votre tâche sera de la décrire en présentant ses différentes ressources afin qu'un entrepreneur puisse évaluer l'oportunité de s'y installer.

Votre feuille présente trois cases dans la marge droite:
- celle la plus en haut vous permettra de relire cette consigne chaque fois que vous appuyerez le crayon dedans
- celle en dessous vous permettra de consulter la carte
- celle du bas vous servira à signaler que vous avez terminé votre texte (toujours en appuyant le crayon dedans).

Vous pouvez maintenant commencer votre tâche.

A graphic interface allows to define areas on the tablet that will act as triggers: when the participant will press the pentip into, an associated stimulus will be displayed. Everything is recorded: handwriting, drawing, actions.

No "programming" required.

Scripted acquisition

Eye and Pen has a script language that allows one to "program" an acquisition, when "Simple" is not enough.

A script editor helps to write commands and set parameters.


```
Script editor - C:\Users\Public\Documents\Eye and Pen 2\scripts\V2_iterating_labels.txt

File   Edit   Command   Script   ?

 1  ;This is an example to demonstrate counting
 2
 3  SetLabelCounter(Start,2)
 4  WaitForKeyPressMsg(Starting value: %I:Start%,-1,-1,FALSE)
 5
 6  :Start
 7   :Start2
 8   WaitForKeyPressMsg(Iteration %I:Start2% : %I:Start%,-1,-1,TRUE)
 9   JumpToIfNumberIs(Stop,6,FALSE)
10   JumpTo(Start,FALSE)
11
12  :Stop
13  DisplayMsg(Thanks !,1000,-1,-1,TRUE)
14

Modified   1:44   Insert
```

Basically, script allows:

Manipulate **stimuli**

- ✓ display picture, text file, single line message
- ✓ play sound file, video

Interact with participant (alone or in network managed group)

- ✓ wait for keyboard key presses
- ✓ wait for pentip to be pressed into specified tablet areas

Manipulate **feedback**

- ✓ mask/unmask display
- ✓ Timeshift writing display on screen
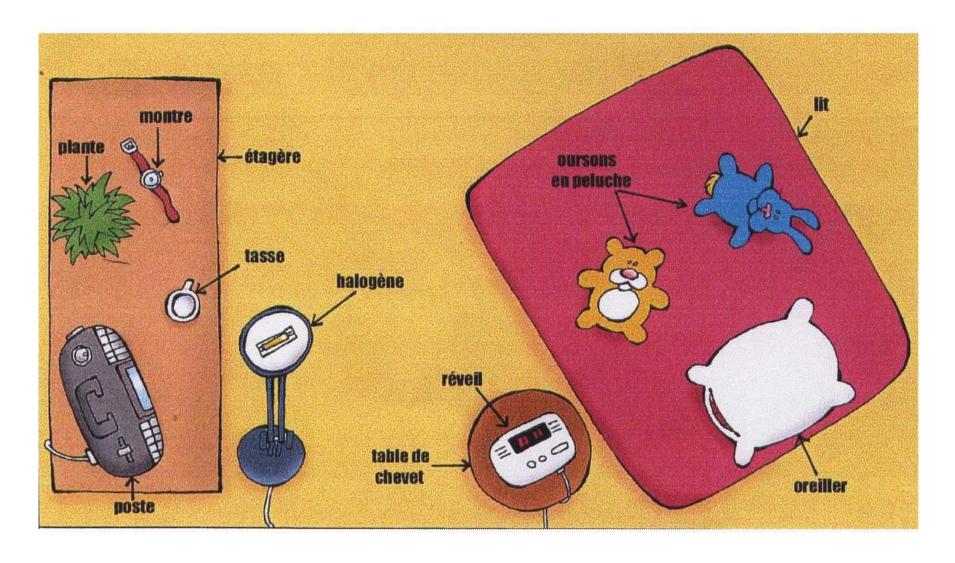- ✓ shift location of writing display on screen
- ✓ change size of writing display

Setup a **list of items** and its randomization (full or partial).

And much more….

The whole set is about 70 commands.

Examples of experiments

Scene description from a picture

Error detection and correction

Tu a regardé la télévision trop lontemps et tu es arrivé en retard.

a**s**

lon**g**temps

copying words

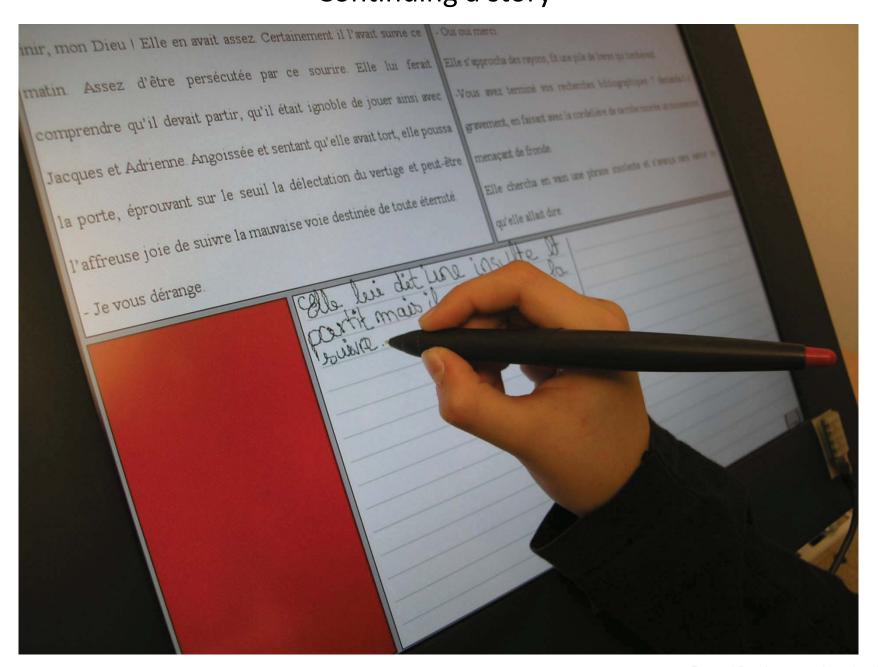
bouffée   corridor   blockhaus   sixième
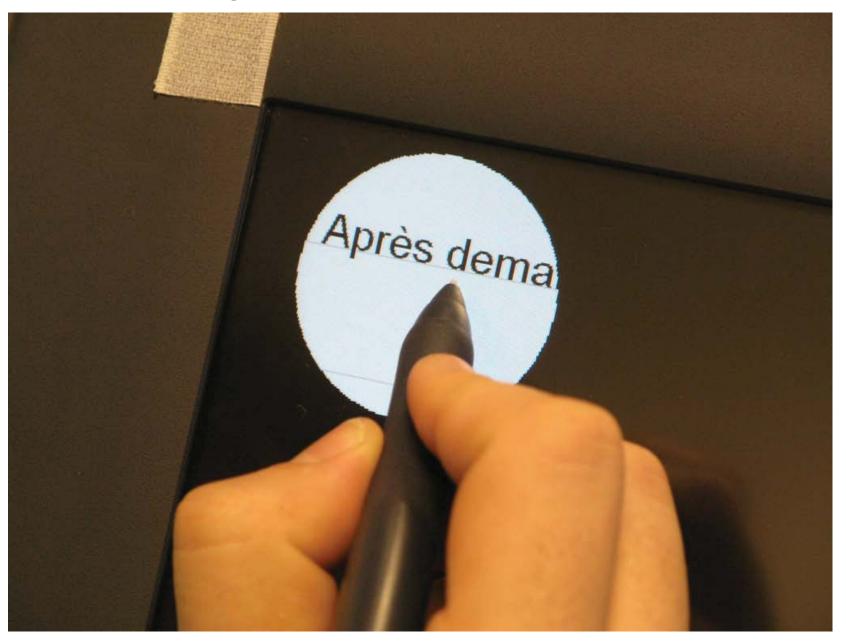
FIN

Sentence dictation (here, subject-verb agreement)

3D shape recognition and selection

Continuing a story

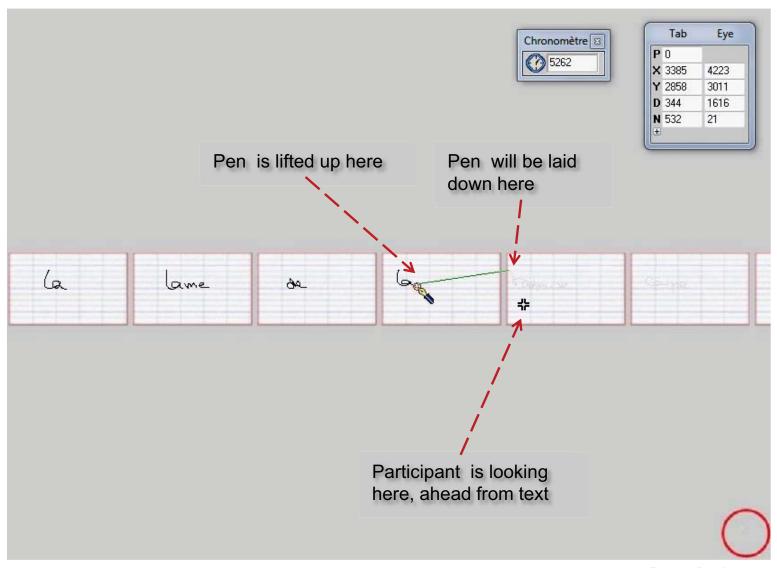# Writing with feedback on a masked screen

Writing with unattended speech

Sound is played in headphones while writing

Eye and Pen can manage acquisition in group within a dedicated network.

Data visualization

Eye and Pen can replay data, with behavior "highlighting":

- a circle located at pause beginning grows with duration
- a line joins the place where pen was lifted up and where it was laid down again
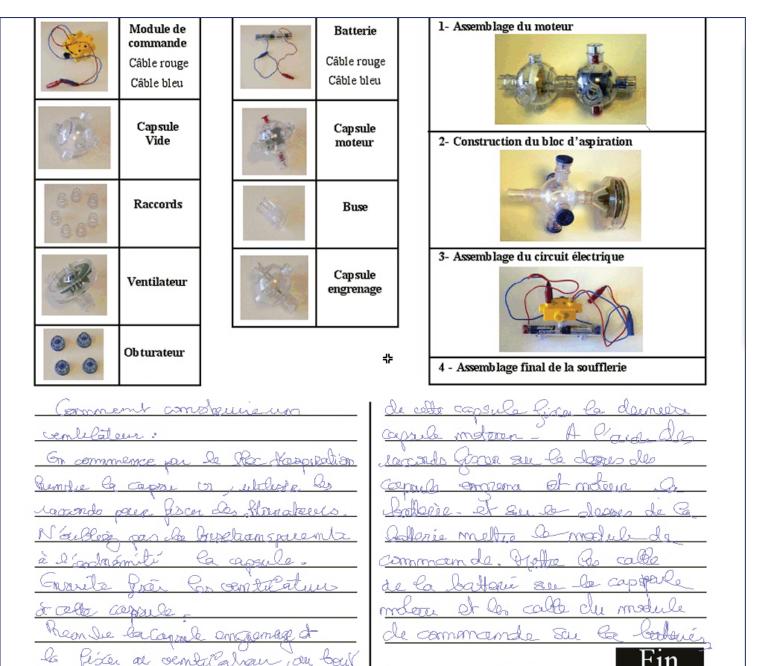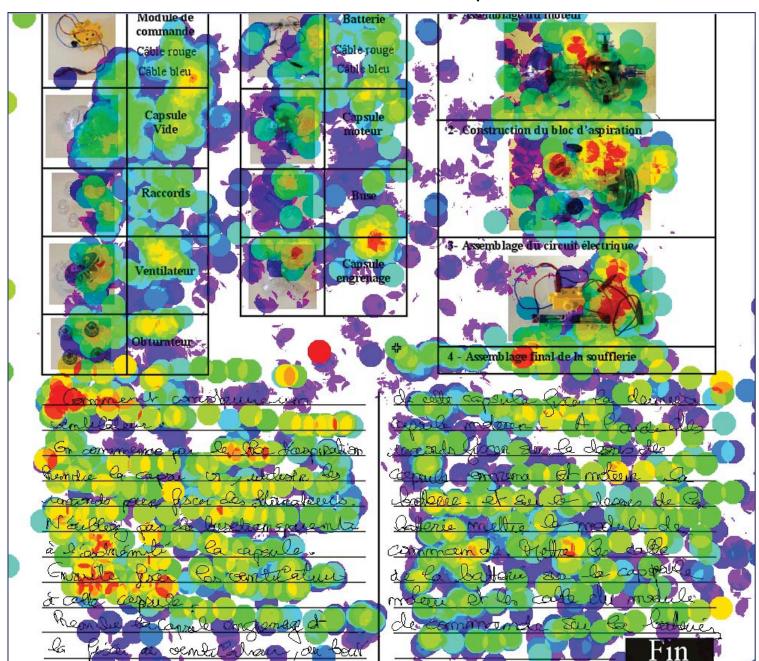
Copy of a pseudo-word

Participant is looking here…

pricor

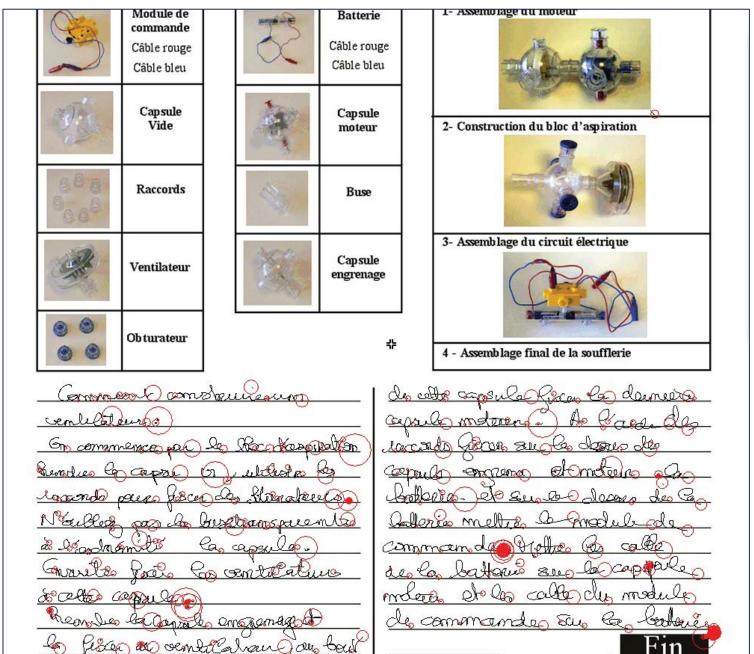… and writing here

Eye and Pen has a number of data visualization features
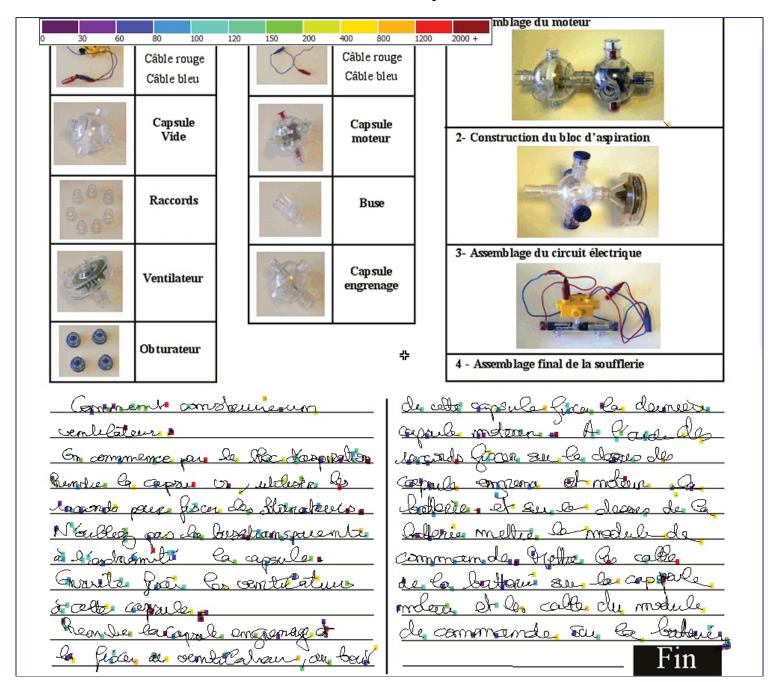
Fixations as heat map

Pauses durations as circles
(the larger the circle, the longer the pause)

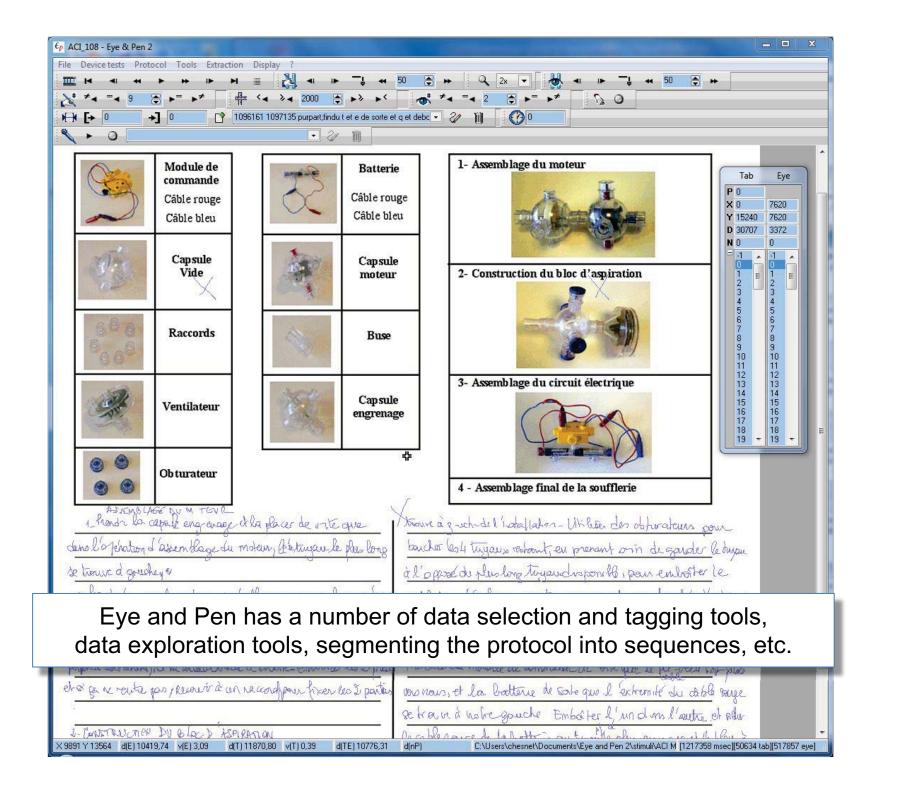# Pauses classified by durations

Data analysis

Eye and Pen has a number of data selection and tagging tools,
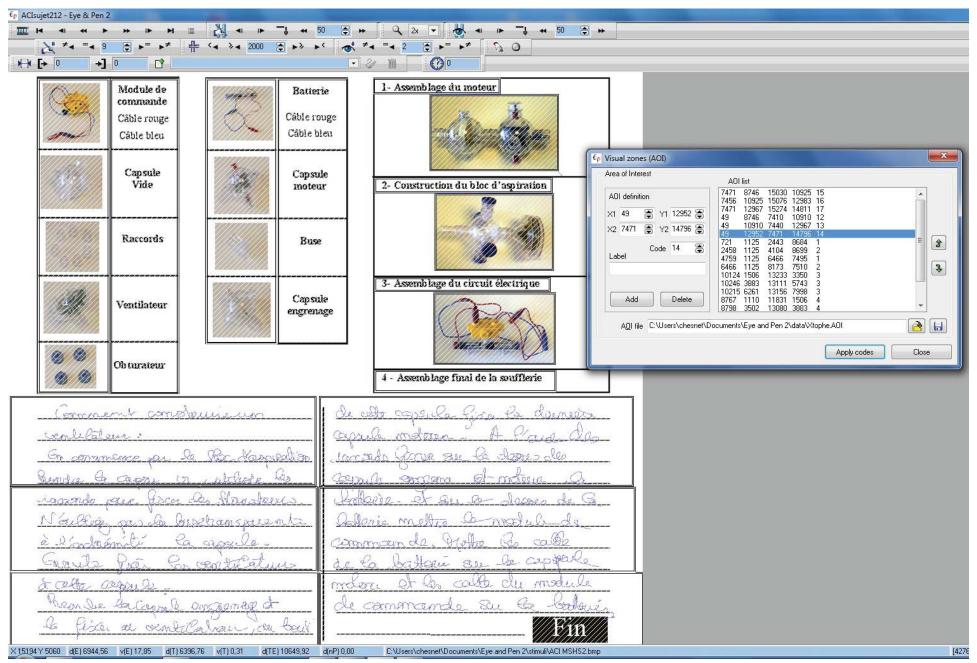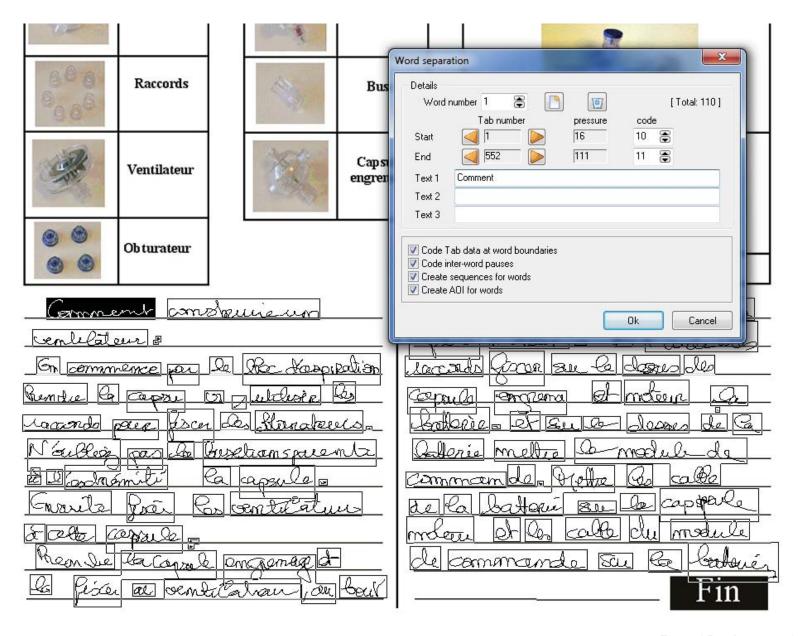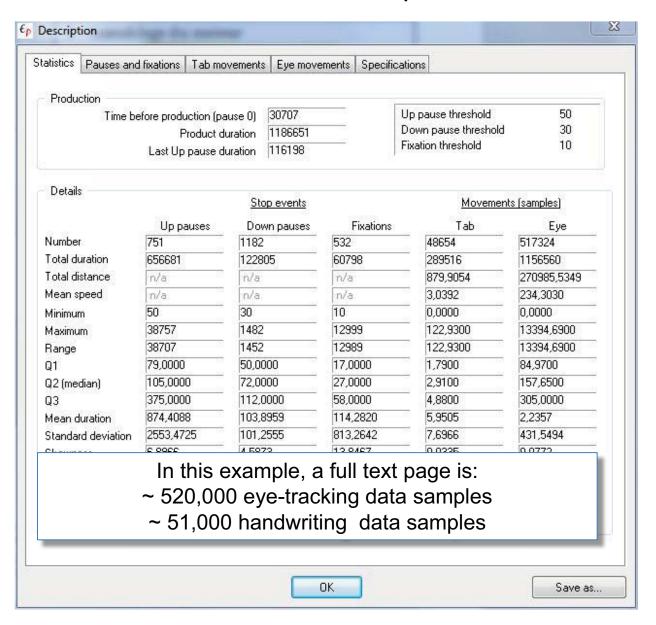data exploration tools, segmenting the protocol into sequences, etc.

AOI definition for eye movement data

Semi-automated word separation

Protocol description

Data extraction
(main categories)

Events
- ✓ All events
- ✓ Pauses during fixations and fixations during pauses
- ✓ Activated trigger zones on the tablet (Simple)

Pauses
- ✓ Pauses only
- ✓ Eye movements during pauses
- ✓ Fixations during pauses

Fixations
- ✓ Fixations only
- ✓ Eye movements in AOI
- ✓ Fixations in AOI

Tracing dynamics

Publications

Papers on method

- ✓ Alamargot, D., Chesnet, D., Dansac, C. & Ros, C. (2006). Eye and Pen: a new device to study reading during writing. *Behaviour Research Methods, Instruments and Computers*, **38**(2), 287-299.

- ✓ Chesnet, D., & Alamargot, D. (2005). Analyses en temps réel des activités oculaires et graphomotrices du scripteur: intérêt du dispositif 'Eye and Pen'. *L'Année Psychologique,* **105**(3), 477-520

Recent research papers

- ✓ Lambert, E., Alamargot, D., Laroque, D. & Caporossi, G. (in press). Dynamics of spelling process during a copy task. Effect of frequency and regularity. *Canadian Journal of Experimental Psychology.*

- ✓ Alamargot, D., Caporossi, G., Chesnet, D., & Ros, C. (2011). What Makes a Skilled Writer? Working Memory and Audience Awareness during Text Composition. *Learning and Individual Differences*.

- ✓ Alamargot, D., Plane, S., Lambert, E. & Chesnet, D. (2010). Using Eye and Pen Movements to Trace the Development of Writing Expertise: Case Studies of a Seventh, Ninth and Twelfth Grader, Graduate Student, and Professional Writer. *Reading and Writing, 23, 853-888.*