On Cognition and the Digital in the Study of Ancient Textual Artefacts

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Cognition & the Digital: Interpreting Ancient Textual artefacts

1. Knowledge creation as interpretation
   a. Example in papyrology
   b. Digitized artefacts are avatars (not surrogates, not facsimiles)

2. Perceptual processes in cognition
   a. Materiality and Digitization
   b. Kinaesthetic engagement in reading
   c. Aural feedback in reading

3. Conceptual processes in cognition
   a. Semantic memory
   b. Knowing: conscious and unconscious structural knowledge
   c. Insights
What do papyrologists* do?
*[resp. epigraphers, assyriologists, palaeographers]

- Papyrology is about producing a transcription and an interpretation of a textual document
- Requires expertise in:
  - Ancient language
    - Latin, Greek, Coptic
  - Palaeography
    - Letter shapes and their evolution through time
  - Linguistics
    - Occurrences of words, letters, typical formulae
    - Lexical field, grammar
  - Ancient history and Archaeology
    - Context of the artefact

Tracings of the text on the front of the tablet; in blue, the 1917 tracing; in black, the 2009 tracing.

[Vollgraff 1917; Bowman et al. 2009]

Commonality (strict overlap) between the 1917 and 2009 tracings of the front of the tablet. It consists in 45.3% of the 1917 tracing, and in 60.6% of the 2009 tracing.
Levenshtein distance between the two transcripts: 103 (strings of length respectively 200 and 163, including spaces).

Proportion of characters in common (excluding spaces) consists in 43.6% of the characters in the 1917 reading and in 55.5% of the characters in the 2009 reading.
Digitization is already interpretative

- Digitized versions of an artefact are *digital avatars* of the artefacts:
  - they are encoded
  - they are embedded into the real
  - they influence the real

- Digital avatars:
  - Express a *certain form of presence* of the artefact (re-materialization)
  - Are *contingent on the intention* of the act of digitization
  - Have an expected *performative value*
Why Cognition in Digital Humanities? And How?

- Direct porting to the humanities of digital methods used in the sciences
  - Often port methods without consideration for their domain of validity
    - e.g. image processing!!?!

- How do scholars conduct their research (with or without digital tools)?
  - Understand the needs and expertise of Humanities scholars
    - Ethnographic approaches
    - Cognitive sciences approaches
    - Bridging cognitive and ethnographic approaches/findings
Materiality and Digital Avatars of Textual Artefacts

- Reflectance Transformation Imaging
  - Emulates physical interaction with the artefact
  - Expresses an aspect of materiality that supports a knowledge generating cognitive process

Visual process
Depth perception via monocular parallax motion

[Malzbender et al., 2001; Earl et al., 2011]
[Rogers & Graham, 1982]
The Artemidorus papyrus

• **Intriguing document**
  - Greek text, sketches and drawings, map
  - Date: 1\(^{\text{st}}\) cent BC [or 19\(^{\text{th}}\) cent forgery according to some?]
  - Nature: treatise of geography?, collection of texts and miscellaneous excerpts, “édition de luxe” (possibly illustrated)?, sketch book?
  - Made of 4 segments

[Perceptual processes in Cognition]

[Gallazzi & Kramer, 1998]
The Artemidorus papyrus

Virtual access to the papyrus only
- IR images
- Mirror-images through ink transfers
  - Virtually evaluate how the papyrus was rolled
  - Virtually compute its length
  - Virtually reposition the fragments
- Re-materialization of some aspects of the papyrus

[Tarte, 2012]
[D’Alessio, 2012]
[Latour & Lowe, 2011]
Mirror effect
Aligning recto and (mirrored) verso images
Modelling the roll as a spiral

Archimedes spiral:
- \( r \) radius
- \( \Theta \) angle
- \( g \) gap between coils (thickness)

\[
r(\theta) = \frac{g}{2\pi} \cdot \theta
\]

- Length of the spiral:

\[
s(\theta) = \frac{g}{2\pi} \int_0^\theta \sqrt{1 + t^2} \, dt
\]

\[
s(\theta) = \frac{g}{4\pi} \left[ \theta \sqrt{1 + \theta^2} + \ln \left( \theta + \sqrt{1 + \theta^2} \right) \right]
\]

- Length of a coil:

\[
L_{n+1} = s\left(2(n+1)\pi\right) - s\left(2n\pi\right)
\]

<table>
<thead>
<tr>
<th>COIL NUMBER</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
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</thead>
<tbody>
<tr>
<td>COIL LENGTH</td>
<td>11.73</td>
<td>12.02</td>
<td>12.30</td>
<td>12.59</td>
<td>12.86</td>
<td>13.15</td>
<td>13.43</td>
<td>13.71</td>
</tr>
<tr>
<td>COIL NUMBER</td>
<td>9</td>
<td>10</td>
<td>11</td>
<td>12</td>
<td>13</td>
<td>14</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>COIL LENGTH</td>
<td>14.00</td>
<td>14.29</td>
<td>14.56</td>
<td>14.84</td>
<td>15.113</td>
<td>15.40</td>
<td>15.69</td>
<td>15.98</td>
</tr>
</tbody>
</table>
P. Artemid.: revised ordering of the fragments
Materiality and digital avatars of artefacts

Кροκόττας
An Indian wild beast, hybrid between wolf and dog – possibly a hyena
Tracing/Drawing texts (kinaesthetic approach)

- Drawing as a way of knowing
- Text as shape, text as meaning

- Kinaesthetic facilitation used as treatment for patients with pure alexia (aka word-blindness)
  - Valid for alphabetic, syllabic, and logographic scripts
- Reading activates pre-motor cortex area

Motor process

Familiarity as a prerequisite?

[Dejerine, 1892]
[Seki et al., 1995]
What happens for unknown scripts?

• Experiment with pseudo-letters
  – Viewing and recognition activates pre-motor cortex area when the learning of the letters was made by tracing their shapes (or by typing them)

[James & Atwood, 2009]

• Assyriologists use the drawing approach too

Louvre, Sb 15081; Source: http://cdli.ucla.edu/
The case of Proto-Elamite

- A yet undeciphered script
- Script from Ancient Persia (3100-2900 BCE)
- Contemporary of proto-cuneiform in Ancient Babylonia
- Overall corpus: 1600 clay tablets (10000 lines of text)

Louvre, Sb 02801; Source: http://cdli.ucla.edu/
What is currently known about Proto-Elamite

- Tablets are accountancy records
- Numerical system loan from proto-cuneiform

[Englund, 2004]
How experts (and future experts) work:

Perceptual processes in Cognition

Conceptual processes in Cognition
On sign identification

- M391, not visible on heliogravure, but clearly visible on still from RTI
- Sb 02801 compared with MDP 6, 213 a significant parallel
Texts as word puzzles (cruciverbalistic approach)

- As in crosswords, experts use:
  - Clues from already deciphered words/letters
  - The main visual clue, provided by the textual artefact

- Cognition and crosswords:
  - Word retrieval from semantic memory is the most facilitated when a syllabic unit is available
  - Word superiority effect
  - Connectionist model of cognition

Aural process and semantic memory

Familiarity as a prerequisite

[McClelland & Rumelhart, 1981]
[Goldblum & Frost, 1988]
Example of crossword puzzle solving in papyrology

What is this character? 🕔

“Clues” (images) and “filled in boxes”

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Supporting evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vowel</td>
<td>After QU</td>
</tr>
<tr>
<td>E</td>
<td>• Vowel</td>
</tr>
<tr>
<td></td>
<td>• Read so in 1917</td>
</tr>
<tr>
<td>A</td>
<td>• Vowel</td>
</tr>
<tr>
<td></td>
<td>• Makes a known name</td>
</tr>
<tr>
<td>L</td>
<td>Read so in 1917</td>
</tr>
<tr>
<td>A</td>
<td>Occurs in legal documents</td>
</tr>
<tr>
<td>L</td>
<td>Read so in 1917</td>
</tr>
<tr>
<td>A</td>
<td>Occurs in legal documents</td>
</tr>
</tbody>
</table>

(although somewhat atypical, the palaeography is that of a 1st century script)
Structural Knowledge: conscious vs. unconscious

- Artificial Grammar learning paradigm
  - Small alphabet (M,T,V,R,X)
  - Simple grammar
  - Subjects presented with list of words from the grammar as a training set (no specific instruction)
  - Later have to decide whether given words (some new, some not) belong to the grammar

- Ways to qualify how the grammar belonging decision was made:
  - Random
  - Intuition
  - Familiarity
  - Recollection
  - Rule enunciation

Expert practices and cognitive processes

Valid for any scripts

- Visual perception
  - Impact of materiality and “re-materializing” digitization

Valid when phonological and semantic knowledge

- Aural process
  - Cruciverbalistic approach

- Motor process
  - Kinaesthetic approach

Sensory feedback loops

Embodied cognition

- Structural knowledge acquisition
  - Exposure to the material

- Semantic memory
How to foster these cognitive processes?

• Scholarly knowledge characterized by communicability, so need for *conscious* knowledge!

• Transition from unconscious to conscious often happens via a “Aha!” moment.

• “Aha!” moments (insights) result from:
  – Relaxing self-imposed constraints
  – Reframing of the problem
  – Defamiliarization
  – Task switching
  – Self-cueing

[Bowden et al., 2005]
[Cushen & Wiley, 2011]
[Kirsh, 2009]
Suggested ways to digitally foster cognition

Cognitive triggers
- Self-cueing
  - Sensory feedback loops do that!

- Task switching

- Defamiliarization & reframing

Digital triggering
- Encourage activation of embodied cognition
  - Drawing/tracing
  - Sounding when possible
  - Visual triggers (e.g., 3D for non-planar texts)

- Encourage flexibility
  - Monitor time spent at a specific task?
  - Support non-linearity

- Encourage exchanges
  - Collaborative work
To summarize

• The digital medium brings our attention (back?) to:
  – The materiality of the artefacts
  – The performativity of the act of “reading” them
    • Text as shape
    • Text as sound
    • Text as object
    • Text as meaning

• Perceptual processes are intuitively and often unconsciously mobilized, reinforcing the cognitive feedback loops involving both perceptual and conceptual processes
The future of the Digital Humanities is Cognitive

• Bringing the Human back into Digital Humanities
  – Understanding cognitive involvement will allow to optimize the use of the digital and **support embodied sense-making practices**
  • Digitization **encapsulating strategies of interpretation**
  • Monocular parallax motion for 3D perception
  • Interactions with artefacts otherwise impossible,
  • Tracing facilitating kinaesthetic approach to reading
  • Other examples: virtual rolling of a papyrus (Artemidorus papyrus)
  • Sounding?
The future of the Digital Humanities is Cognitive

• Bringing the Human back into DH
  – Humans have useful expert cognitive creative powers that can’t be digitally emulated
  – The digital is always mediated by humans, thus interpretative
  – Understanding cognitive involvement will allow to optimize the use of the digital

• Well-rounded Humanities scholarship:
  – Digital Humanities: turn (large amounts of) data into information
  – Cognitive Humanities: turn information into knowledge and meaning
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Christian Dotremont “En écriture dans le texte”