Typing and handwriting performance of university students

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Why comparing handwriting and keyboard typing?

- handwriting is largely automated in adults
- frequent obligation to keyboard use for students
- touch-typing method mastery not obligatory
- different motor patterns:
  - hand: different trajectories and acceleration patterns of letters
  - keyboard: similar movements but different spatial targets
- in case of little automation:
  low-level processes interfere with planning

What is interesting about copying?

- different processes involved depending on strategy
  - grapho-motoric execution
  - reading/recognizing linguistic symbols
  - reading/understanding words
  - memorizing (sequences of) patterns/letters/words/phrases
  - orthographical realization
  - coordinating input and output units („eye and pen“ task)
  - monitoring for correctness and completeness
  - no planning and formulating needed

Copying in the context of writing tasks

- cognition-transforming writing
  - narration (to make the reader experience something)
  - description (to make the reader know something)
  - instruction (to enable the reader to do something)
  - argumentation (to make the reader believe something)
- inter-textual writing
  - copying
  - excerpting
  - paraphrazing
  - summarizing
  - quoting
  - commenting/criticizing
  - translating

Disclaimer

- The issue is solely on different means of generating graphical traces; we are not concerned with text processing software, spell-checkers etc.
- However: The virtual-visual trace produced by keyboard and screen creates qualitatively different possibilities for correction and revision.

Methodology

- handwriting
  - camera from above and full-angle view
  - split-screen record
  - keeping the writing situation as natural as possible (→ comparability with school research)
- typing
  - keystroke logging (ScriptLog)
  - camera full-angle view
  - no mouse
  - no formal editing

Baseline handwriting and typing

- n = 30 university students
- copying a well-known nursery rhyme 12x:
  Alle meine Entchen schwimmen auf dem See.
- handwriting: M = 150 strokes/min (min 87; max 214)
- typing: M = 199 strokes/min (min 118; max 294
  within words: M = 324 strokes/min (min 176; max 500)
- typing saves about 12 per cent of time
- correlations handwriting – keyboard
  - speed handwriting – total time keyboard: r = .41
  - speed handwriting – typing speed within words: r = .39

Components of keyboard mastery

- measures of keyboard operation
  - (1) total time on task
  - (2) deviation from the correct number of characters in final text (→ correctness)
  - (3) number of linear keystrokes
  - (4) number of deleting operations (→ precision)
  - (5) number of cursor movements (→ revision)
  - (6) mean transition time within words (writing fluency in a narrower sense)
  - (7) time per keystroke (→ general keyboard mastery)
  - (8) keyboard efficiency (linear keystrokes / characters in final text)

Factor analysis of keyboard measures

- keyboard operation measures reflect different partial abilities
- clear simple structure of factor loads
- 3-factor solution (87,9% cumulated variance explained
  - keyboard efficiency 40,6% (main variable: efficiency)
  - writing speed 33,1% (main variable: time per keystroke)
  - typing precision 14,1% (main variables: characters in final text, deletes)
- even copying comprises of distinguishable ability components

A copying experiment

- 2 × 2 × 2 design
  - copying a German or Finnish text (1170 characters each) (= comprehension-oriented vs. letter-oriented strategy)
  - one by hand, one on the keyboard
  - systematic variation of task order
- main results
  - Finnish text takes longer in both modalities
  - handwriting and keyboard speed equal in both modalities
  - more mistakes in the keyboard condition
  - more mistakes for Finnish text only in keyboard condition
  - characters per gaze to original:
    handwriting 5,0 Finnish 20,6 German
    keyboard 7,0 Finnish 16,7 German
  - overall small efficiency advantage for handwriting

A replication study

- n = 32 university students
- performing on three keyboard tasks
  - baseline 12x nursery rhyme
  - copying a 1170 characters text
  - free route description
- factor-analysing 8 keyboard operation measures

Some descriptive results (copying a 1170 characters German text)

variable	min	max	M	sd
total time	166,99	632,91	411,69	97,39
edited chrs.	1061	1183	1160,22	26,58
keystrokes	1109	2021	1375,5	218,52
deletes	2	114	42,22	26,51
cursor move	0	718	113,38	175,59
t transition	.140	.240	.18	.29
t / keystroke	.14	.44	.30	.07
effiency	58%	99%	86%	11%

Factor analyses

- copying from memory (nursery rhyme)
  - 2 factors (cumulative explanation of 77,2%)
  - keyboard activity/efficiency (47,4% explained)
  - speed (29,8% explained)
- copying from text
  - 3 factors (cumulative explanation 84,8%)
  - keyboard activity/efficiency (45,5% explained)
  - speed (26,7% explained)
  - precision (12,6% explained)
- text production
  - 3 factors (cumulative explanation 89,3%)
  - amount (42,2% explained)
  - efficiency (25,9% explained)
  - speed (21,3% explained)

Discussion and implications

- the typing even of experienced and successful students is not as fast and precise as it could be
- in direct comparison still a small advantage of handwriting
- it matters whether handwriting or typing is used, particular when it comes to tasks more complex than copying
- typing skills comprise of more than mastering or not a touch-typing method
- typing speed and keyboard efficiency are two mutually independent sources of variation

Practical implications

- if keyboard use is not yet automated: draft by hand
- teaching keyboard proficiency is more than (or even different from) touch-typing training
- revision may be due to keyboard operation
- separate editing from planning
- switch spell-checker off