The development of neural systems supporting handwriting and letter perception from kindergarten to adulthood

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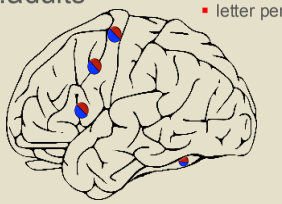
Background

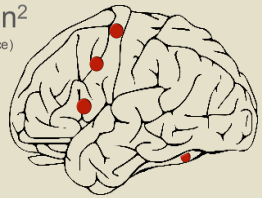
❖ Handwriting and letter perception in …

…adults[1]

- handwriting
- letter perception



…children[2]
(after printing practice)



❖ Handwriting produces several levels of visual input[3]

❖ Study questions

1. How does the brain system supporting handwriting change with experience?

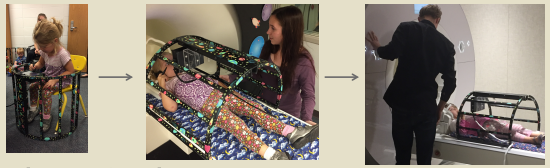
2. What does the brain extract from the letterforms produced during handwriting – does this response change with experience?

Methods

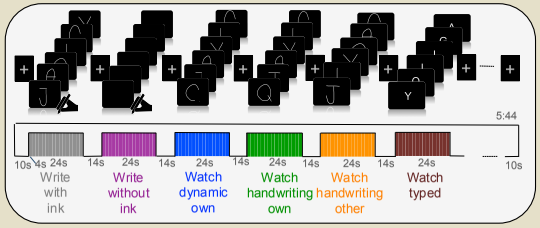
Participants

Early-literate children (5 – 6 years, n = 14) | Literate children (7 – 8 years, n = 14) | Literate adults (19 – 25 years, n = 14)

Materials and procedure



Scanning protocol



Standard preprocessing

Slice scan time correction, 3D motion correction, Spatial smoothing (FWHM = 6mm), Temporal high-pass filtering

Additional motion correction

- Spike regression[4]: 2.00 mm threshold
- Motion regression[5]: 6 rigid-body motion parameters

Whole brain contrasts

- Motor component: Write with ink > Watch dynamic
- Visual component: Write with ink > Write without ink
- Unfolding: Watch dynamic(own) > Watch handwriting(own)
- Own handwriting: Watch handwriting(own) > Watch handwriting(other)
- Variability: Watch handwriting(other) > Watch typed
- Letters: Watch typed > fixation

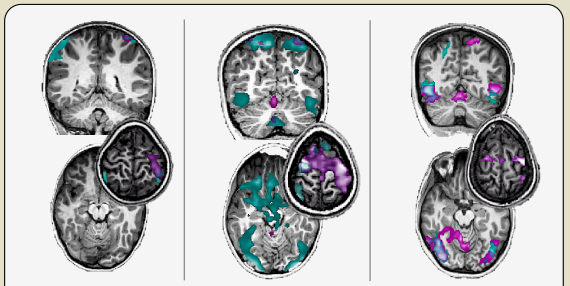
Results & Discussion

1. The neural response during handwriting changes with experience.

… progression from a frontal-parietal system to including the ventral visual stream.

… overlap in L IPS/SPL is replaced by overlap in the ventral visual stream in adults.

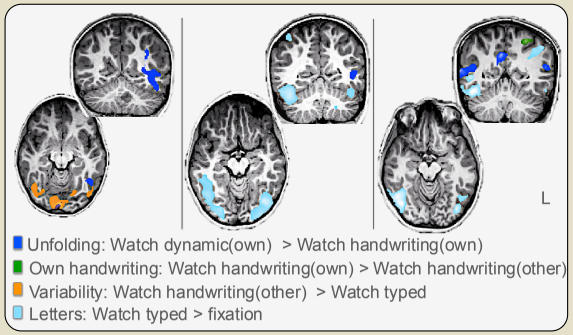
Early-literate children | Literate children | Literate adults



2. What the brain extracts from the letterforms produced during handwriting changes with experience.

… before a letter-category response is established, variability prevails.

… after a letter-category response is established, a new category emerges.



$p_{vox} < .01$, $p_{clust} < .05$

References

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