

Overt Vs. Non-overt Units From Digital Cognitive Tests. 1 - Relations Between Paper And Pencil Test: the i3C Childhood CV Consortium

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Digital "*think-time*", that is the covert latency *between* pen strokes, tracked with *weaker language and memory performance* across three tests, even though overt "ink-time" and executive function largely did not. The pauses between strokes may index how efficiently cognitive resources are marshaled.

INTRODUCTION		METHODS	
A stylus-based digital test separates overt "ink-time" (time producing pen strokes) from non-overt "think-time" (covert latency <i>between</i> strokes) — a decomposition paper/pencil (PP) testing can't provide. Whether these discrete latencies reflect traditional, validated cognitive performance was unknown — and is the prerequisite for using them as biomarkers (Parts 2–3). OBJECTIVE: Test how digital think-/ink-time relate to standard PP performance across executive, language, and memory domains.		Figure 1. Participant flow and analytic design relating digital metrics to paper/pencil cognitive performance. EXPOSURES: PP indices, grand-mean composites <i>Executive</i> (letter fluency + digits backward); <i>Language</i> (Boston Naming + animal fluency); <i>Memory</i> (Logical Memory delayed free recall + recognition). OUTCOMES: Digital tests × 2 metrics <i>Cancellation</i> (think-time & ink-time) <i>dTrB</i> (think-time & ink-time) <i>dCDT-Command</i> & <i>Copy</i> (think-time & ink-time)	
RESULTS		CONCLUSION	
Language is the most-implicated domain. Slower Cancellation think-time → weaker language ($\beta=-0.366$, $p<0.001$, the largest effect), plus dTrB think-time ($\beta=-0.225$, $p<0.006$) and dCDT-Command think-time ($\beta=-0.244$, $p<0.002$). Memory tracks two metrics: slower Cancellation ink-time ($\beta=-0.264$, $p<0.001$) and dTrB think-time ($\beta=-0.233$, $p<0.003$). Think-time dominates — 4 of 5 significant associations involve think-time; ink-time was significant only once. Two notable nulls: the Executive index showed no significant relations, and dCDT-Copy (think or ink) showed none — useful for specificity claims.		Figure 2. Regression paths between digital pen metrics and paper/pencil cognitive indices. Significant standardized regression paths between digital pen metrics and paper/pencil cognitive indices (stepwise regression; digital metrics as outcomes; $n=244$). Line thickness $\propto \beta$. Think-time related to language and memory across tests; the executive index showed no significant associations.	
		- Digital time-based latencies relate to validated PP performance across all three tests, suggesting they index how efficiently neurocognitive resources are recruited to complete a task. - The signal concentrates in think-time and in language/memory, not executive function, pointing to a specific, interpretable construct rather than generic slowing. - Establishing this PP link is the foundation that licenses the biomarker (Part 2) and MRI (Part 3) findings.	