

Turku Meeting | 23 – 27 February 2010

Intro

During our stay we had the opportunity to extensively discuss the themes mentioned below with prof. dr. Jukka Hyönä [hyona@utu.fi] and dr. Johanna Kaakinen at the University of Turku (Finland). We appreciate it very much that they welcomed us so cordially at their home university. Without any hesitation we can say that the meeting was extremely useful and that it helped us very much to further pursue the WG4' objectives of our COST action.

Objectives

Prior to our visit we collected an elaborate set of data of writers producing texts in different controlled conditions. We collected both online keystroke logging data, eyetracking data, and product data of these writing processes.

During our stay we had the opportunity to intensively discuss these data from different perspectives with the experts from the University of Turku. Thanks to the extensive expertise of the research group in reading research we had a very fruitful discussion. The following main topics were dealt with:

1. **Main objective: How can we describe reading during writing?**

To what extent is reading during writing different from, for instance, reading for comprehension; proofreading; repeated reading, etc.?

2. **Secondary objectives: Which eyetracking measures should we use to describe reading during writing?**

More detailed discussion about variables and measures used in reading research and how to transfer them to reading-writing research.

Examples:

- fixation density (spread of fixations) ~corrections needed
- scan paths (fixation patterns in function of time)
- regressions
- etc.

[see Appendix]

3. **Technical objectives**

- Demonstration of Inputlog 4.0 Beta to the researches in Turku.
- Visit the Turku research lab.

4. **Project objectives**

We discussed the possibilities for a joint project proposal in 2011.

Documents

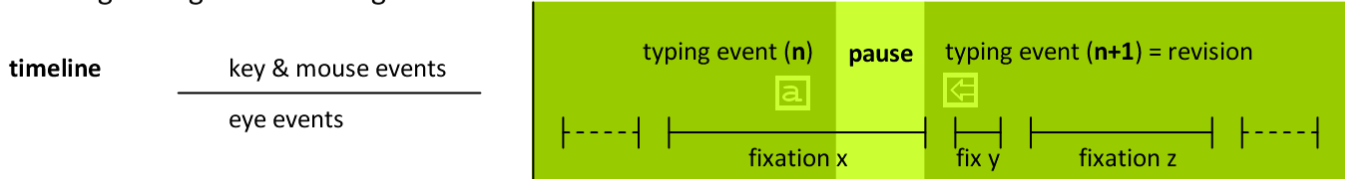
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1. Reading during Writing: concept
 2. Reading during Writing: flow chart
 3. Eyetracking and keystroke patterns
 4. Rereading during typing errors
 5. Appendix: Eye movement measures
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Reading during writing

This study aims at characterizing reading activities during writing processes. The simultaneous logging of eyetracking data and keyboard-and-mouse events, enables us to analyze the interaction between both activities. The main objective is to get a better insight into the function of – different types of - reading that feed and support the distinct subprocesses of writing.

In the study we mainly focus on the reading activities that occur during critical events, i.e. when fluent text production is interrupted either by a revision or a pause. In Figure 1 we represent a snapshot of both critical events, viz. a revision (fluent writing) and a pause (non-fluent writing).

Reading during fluent writing

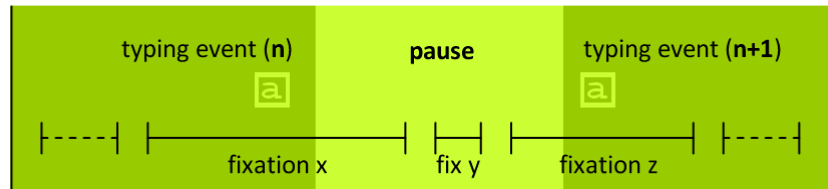
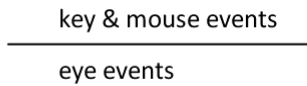


The timeline represents the synchronicity of reading and writing related to two keystroke events. The top line shows the keystrokes with a short pause in between (on average between 50 and 250ms), indicating a – more or less - fluent typing episode. The first key is identified as a last keystroke of a series of typing activities that relate to production of new text; the second key on the timeline is identified as the first keystroke that initiates a revision activity (e.g. the correction of a typing error). We hypothesize that the characterisation of the fixations that proceed this critical event deviate from the fixations that relate to fluent text production. Fixations might be related, for instance, to identifying the typing error in the text or evaluating a phrase in the TPSF that might need revision.

The second timeline in Figure 2 represents the synchronicity of reading and writing related to two keystroke events that are interrupted by a significant pause (e.g. significantly deviating from the normal interkey interval in fluent writing). There is ample support in writing research that longer pauses that interrupt fluent text production indicate a cognitive complex situation for the writer. During this kind of pauses usually certain ‘reading’ activities take place that can be identified by a series of fixations and saccades. These are instances where the writer interacts with the text produced so far. Of course, depending on the situation writers can also consult secondary sources or can be distracted by an external event during these writing inactivity periods.

Reading during non-fluent writing

timeline



To characterize the fixations in relation to the writing activities, we have built an algorithm (Figure 3). This algorithm enables us to describe each fixation on different levels taking into account the online dynamics described in Figure 1 & 2. The top of the scheme relates directly to the first event in the timeline (n) and the bottom of the scheme relates to the first event that follows the critical incident (revision or pause). The zone in between characterizes the fixation that preceded and/or coincide with the revision or the pause.

<see also examples of TPSF and report writing – data via Eyewrite analysis program>

Chart 1: reading pattern of monitor gazer

- 1 = writing (key events)
- 2 = reading during fluent writing
- 3 = rereading (regular & evaluative)
- 4 = reading
- 5 = revisions (recursiveness via movements and deletions)
- 5' = monitoring (monitor screen before error correction ●, no monitor of screen before error correction ○, visual search *)

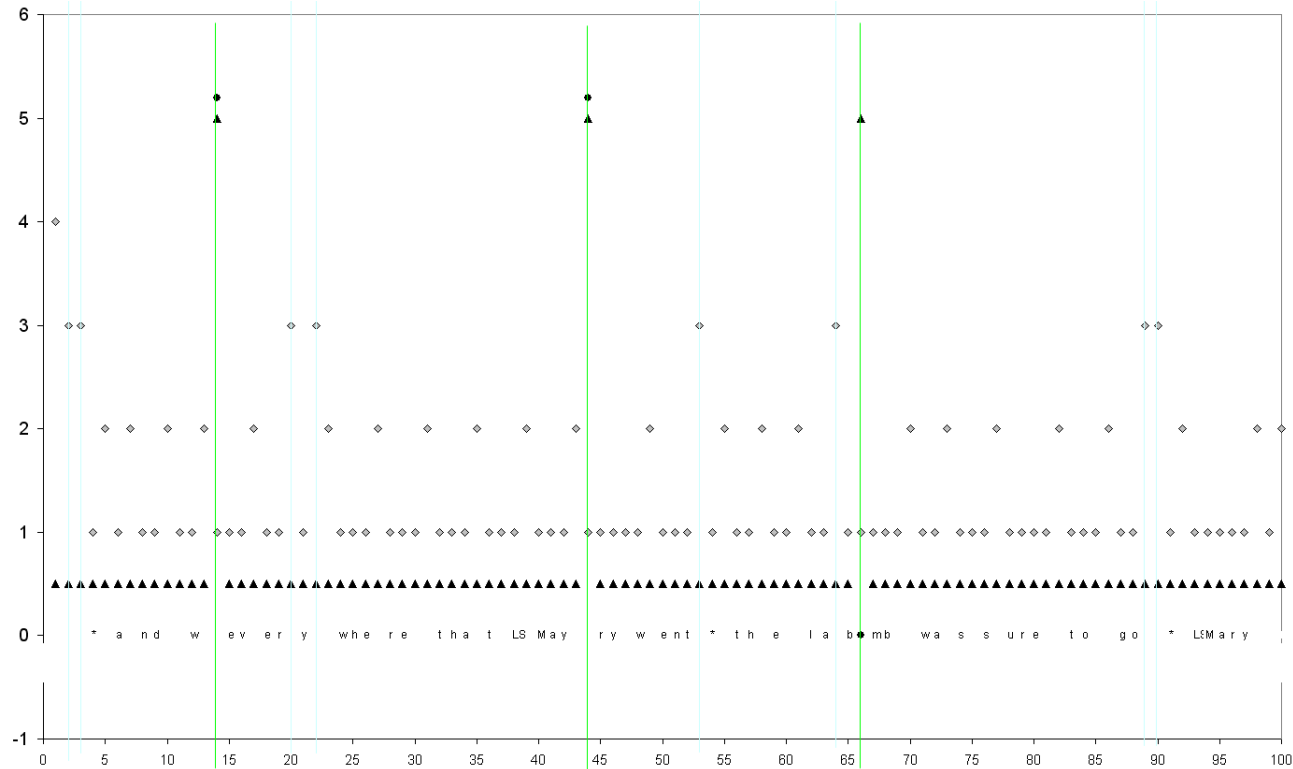
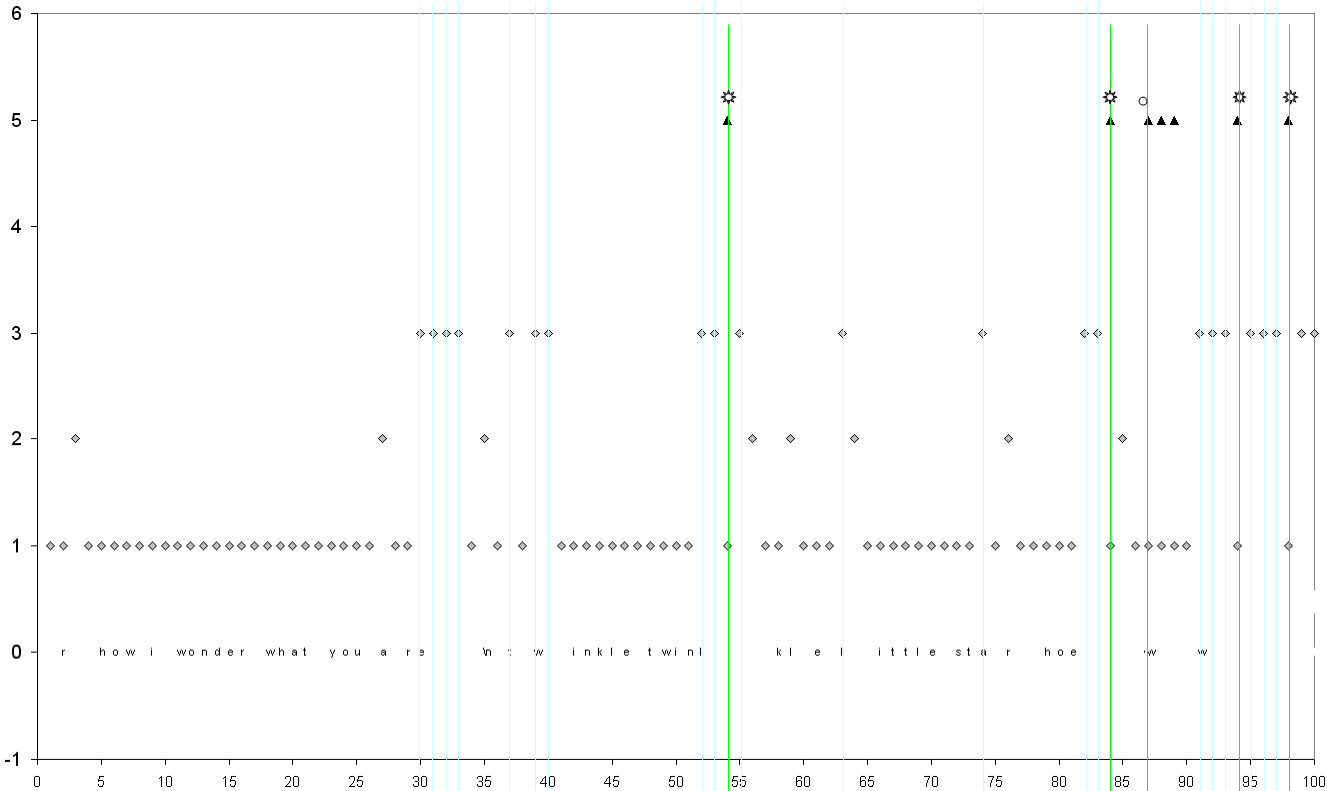
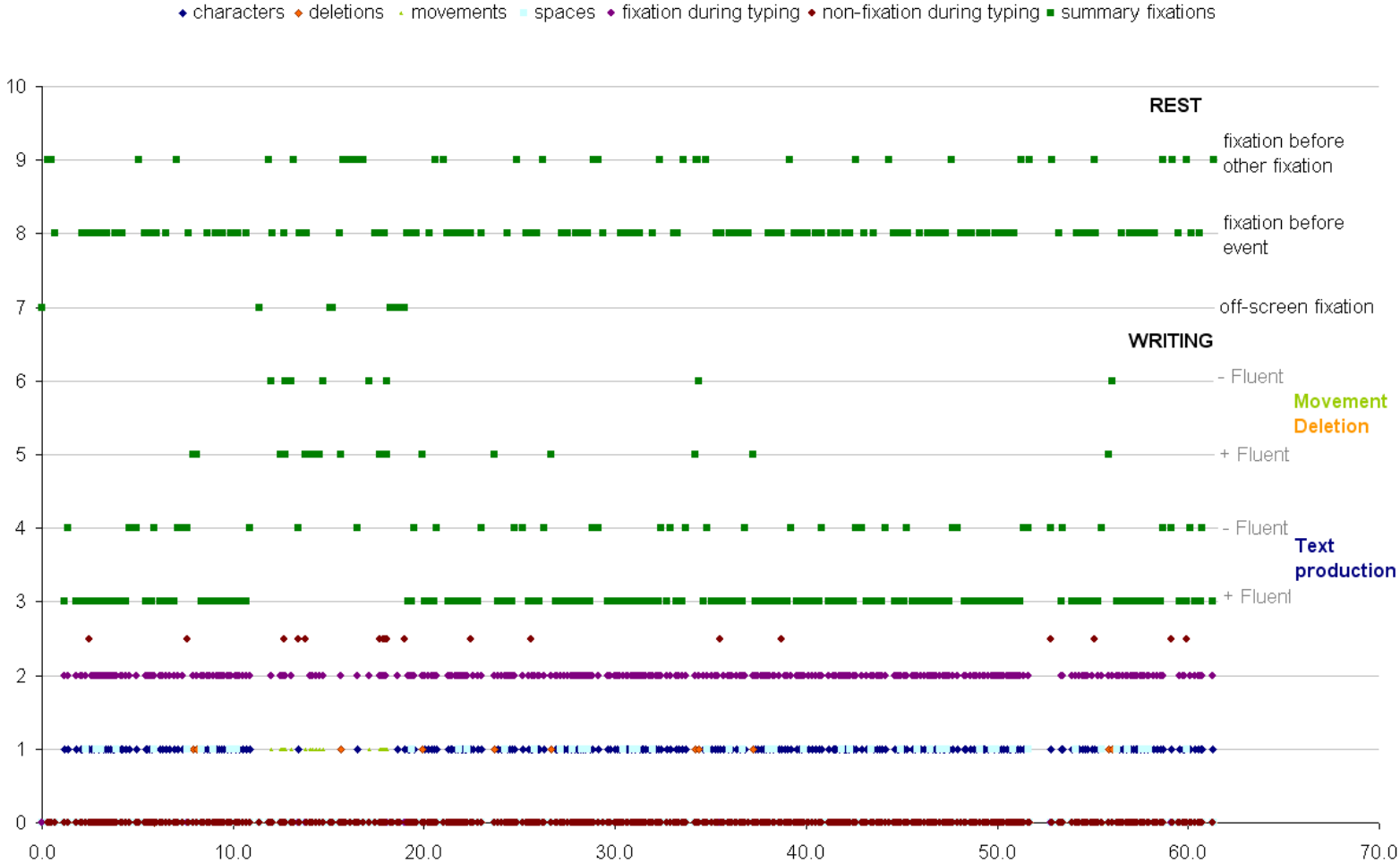


Chart 1: reading pattern of hunt-and-peck typist

- 1 = writing (key events)
- 2 = reading during fluent writing
- 3 = rereading (regular & evaluative)
- 4 = reading
- 5 = revisions (recursiveness via movements and deletions)
- 5' = monitoring (monitor screen before error correction ●, no monitor of screen before error correction ○, visual search *)



Distribution of fixation types | monitor gazer



Distribution of fixation types | hunt-and-peck typist



- Legend:
1. Key events: charactes, spaces, movements and deletions
 2. Reading during writing
 3. Reading during fluent writing
 4. Reading during non-fluent writing
 5. Reading during fluent writing (revisions)
 6. Reading during non-fluent writing (revisions)
 7. off-screen monitoring
 8. on-screen monitoring before key (mouse) event

Rereading during typing errors

Nursery rhyme: Mary had a little lamb

Option 1 : insert (typing error) – fixation – delete

			key transition time	duration of fixation	output
INSERT	FIXATION		216	536	M
INSERT	INSERT		200	536	a
INSERT (typing error)	INSERT		648	536	y
FIXATION	INSERT	evaluative		1340	N/A
DELETE	FIXATION		240	1340	
INSERT	DELETE		144	1340	r
INSERT	INSERT		176	1340	y
INSERT	INSERT		128	1340	
INSERT	INSERT		168	1340	w
FIXATION	INSERT			452	N/A
INSERT	FIXATION		216	452	e
INSERT	INSERT		200	452	n
INSERT	INSERT		648	452	t
				428	
			240		

2 patterns of rereading during typing errors

1. Evaluation [insert – **FIX** – delete]
2. Anticipation [**FIX** – insert - delete]

Option 2: fixation – insert (typing error) – delete

			key transition time	duration of fixation	output
INSERT	FIXATION		88	332	l
INSERT	INSERT		192	332	a
FIXATION	INSERT	anticipate/verify		992	N/A***
INSERT (typing error)	FIXATION		384	992	b
DELETE	INSERT		240	992	
INSERT	DELETE		88	992	m
INSERT	INSERT		208	992	b
INSERT	INSERT		152	992	
FIXATION	INSERT			292	N/A
INSERT	FIXATION		176	292	w
INSERT	INSERT		192	292	a

***Fixation starts here, but continues during typing (992)

Hypotheses

The length of the fixation increases when a typing error is fixated.
The keytransition time deviates when a typing error is made (mean keytransition time +/- 1SD).

Both type of fixations has the same characteristics (and function?).

**Contact
information**

Mariëlle Leijten – University of Antwerp

marielle.leijten@ua.ac.be

<http://webhost.ua.ac.be/mleijten>

Luuk Van Waes – University of Antwerp

luuk.vanwaes@ua.ac.be

<http://webhost.ua.ac.be/lvanwaes>

Eye movement measures: the reading perspective in relation with 'reading-during-writing'

Reading Measures | <Eye movement measures to study global text processing>

Level of measurement

- word level
- clause level
- sentence level

First fixation duration	Word	Immediate	Duration of first fixation on the target word
Gaze duration	Word	Immediate	Summed duration of all fixations on the target word before exiting it
First fixation duration after leaving	Word	Delayed	Duration of first fixation after leaving the target word
Regression	Word	Delayed	Fixation of previously processed target word, usually associated with "backward" eye movement
Regression time	Word	Delayed	Duration of all regressions back to the target word
Total fixation time	Word	Delayed	Sum of gaze duration and regression time time
Regional gaze duration (First- pass fixation time)	Region (word, phrase, clause, sentence)	Immediate	Summed duration of all fixations on the target region before exiting it
Lookback fixation time (Second-pass fixation time)	Region	Delayed	Duration of all regressions back to the target region
Regression path reading time	Region	Delayed	Summed duration of all reinspective fixations before exiting target region to the right
First-pass rereading time	Sentence	Delayed	Summed duration of all reinspective fixations on the target sentence during its first-pass reading
Lookback	Sentence	Delayed	Any fixation on text prior to the most recently fixated target sentence, including backward and forward fixations as long as they do not return to the target sentence
Lookback time	Sentence	Delayed	Duration of lookbacks
Extended first pass fixation time	Sentence	Immediate and delayed	Sum of first-pass fixation time and additional fixation times on target sentence, time delayed if (a) lookbacks occur before completing the target sentence and (b) eyes return to remaining part of sentence before fixating later sentences
Total text fixation time	Sentence	Immediate and delayed	Sum of all fixations on complete text
Eye movement matrix	Sentence	Immediate and delayed	Contingency table containing the and frequencies or durations of all between-sentence movements, from any starting sentence to any destination sentence
Scan path sequence	Sentence	Immediate and delayed	? Frequency of a particular sequence, in which the sentences are fixated. (in function of time?)
Probability of skipping	Word	Immediate and	? (number of words that are not fixated)

		delayed	
Probability of regression	Sentence	immediate and delayed	? (number of regressions at a sentence level, during target sentence processing)
Fixation density			?

Reading during writing measures | <Reading during sentence composing and error correction
A multilevel analysis of the influences of task complexity>

The eye fixation data (from the Eyelink II) was processed by the Gazetracker software, which enabled us to identify the location of fixations within three zones of interest: a) the partial sentence, b) the error, and c) the point of inscription (i.e., production of new content).

To capture aspects of reading behavior, the eye fixations were measured as follows

gaze duration	sentence	immediate and delayed	total sum of duration of all fixations that occurred during reading and completing the trial sentence
number of fixations	sentence	immediate and delayed	total number of fixations (threshold?)
number of fixations in error zone	word	immediate and delayed	total number of fixations per zone (error, rest of the partial sentence, and production)
gaze duration	word	immediate and delayed	total length of fixations in error zone (correct vs. incorrect)
total distance saccades (x-value, number of horizontal pixels)	sentence	immediate and delayed	total horizontal distance of saccades between the successive fixations (as a measure of rereading) cf. scan path?
fixation in error zone before text completion (yes/no)	word	immediate	number of fixations during prewriting (cf. first pass fixation – what about skipping probability (word length)?)
number of fixation in TPSF zone during preparation time	clause	immediate	number of fixations during prewriting (cf. first pass fixation; what about visual searching, gestalt identification?)
fixation duration in either TPSF or Error zone during preparation time	word, clause	immediate	length of fixation: comparison between TPSF-words and 'Error zone' words (first pass only? density? extended first pass fixation time)
duration between first and second fixation in error zone	word	delayed	duration between the first and the second fixation (cf. difference between regression path and regression time)
duration between first and last fixation in error zone	word	delayed	duration between first and last fixation in the error zone
transitions to error zone	region	immediate and delayed	total number of zone crossings in an item, frequency of movements in or out of the error zone, and frequency of transitions to the error zone in the prewriting phase
transitions to error zone within TPSF	region	immediate and delayed	idem, but within TPSF
transitions to error zone from production zone	region	immediate and delayed	idem, but between Production zone and Error zone
number of fixations in error zone	word	immediate and delayed	total number of fixations in the Error zone (first and later passes, regressions)
duration of fixation in error zone	word	immediate and delayed	summed duration of fixation in the Error zone

Reading during writing measures | <Measures based on Reading during sentence production study (Leverhulme visiting fellowship, M. Leijten at Staffordshire University)>

Target word in this table is 'error word (lexical/typing) and correct equivalent'

First fixation duration	Word	Immediate	Duration of first fixation on the target word
Gaze duration	Word	Immediate	Summed duration of all fixations on the target word before exiting it Problem: error rate of target word
First fixation duration after leaving	Word	Delayed	Duration of first fixation after leaving the target word Measure needed in reading during writing?
Regression	Word	Delayed	Fixation of previously processed target word, usually associated with "backward" eye movement Measure based on target word (fine-grained) Measure to explain recursiveness in writing process (sentence production/text production) (global measure) Percentage of regressions (in reading 10-15%)
Regression time	Word	Delayed	Duration of all regressions back to the target word: for initial detected errors and errors that were not detected (duration between last character and positioning on target word) Duration of all regressions back into the TPSF (flexible, moving point of utterance) Problem: return sweeps
Total fixation time	Word	Delayed	Sum of gaze duration and regression time
Regional gaze duration (First- pass fixation time)	Region (word, phrase, clause, sentence)	Immediate	Summed duration of all fixations on the target region before exiting it. Density measure?
Lookback fixation time (Second-pass fixation time)	Region	Delayed	Duration of all regressions back to the target region Also: flexible measure during writing
Regression path reading time	Region	Delayed	Summed duration of all reinspective fixations before exiting target region to the right ?
First-pass rereading time	Sentence	Delayed	Summed duration of all reinspective fixations on the target sentence during its first-pass reading Within TPSF and go back into TPSF (? Usefull measure? We have refined the regression measure by calculating a median reading span, based on a reading task). How is this calculated?

Lookback	Sentence	Delayed	Any fixation on text prior to the most recently fixated target sentence, including backward and forward fixations as long as they do not return to the target sentence Target sentence to be defined as sentence with error, or partial sentence with error? Is this measure transferable to reading-during-writing?
Lookback time	Sentence	Delayed	Duration of lookbacks
Extended first pass fixation time	Sentence	Immediate and delayed	Sum of first-pass fixation time and additional fixation times on target sentence, time delayed if (a) lookbacks occur before completing the target sentence and (b) eyes return to remaining part of sentence before fixating later sentences
Total text fixation time	Sentence	Immediate and delayed	Sum of all fixations on complete text Divide by TPSF and production part.
Eye movement matrix	Sentence	Immediate and delayed	Contingency table containing the frequencies or durations of all between-sentence movements, from any starting sentence to any destination sentence In report-writing-experiment: relation between sentences? Moment of error correction: code as starting and destination sentences. (useful?)
Scan path sequence	Sentence	Immediate and delayed	Frequency of a particular sequence, in which the sentences are fixated. ?
Other			
Forward reading (based on Lund)			Three consecutive forward readings
Regression			Distance between X-values is negative (no threshold integrated) should we take a threshold into account?
Regression (larger than median reading span – based on reading task)			In a short typing test of 1 minute this measure is already half of the previous one (31 versus 14)
Regression (larger than median of moving average reading task)			
Fixations			We have not used a threshold, but we have read that you use a threshold for a fixation: in the literature we see 30, 250 etc. What are these measures based on? Are they calculated per person? Would this be worthwhile (paper reading patterns for adults (4; 2002 paper – we could not access this paper)