

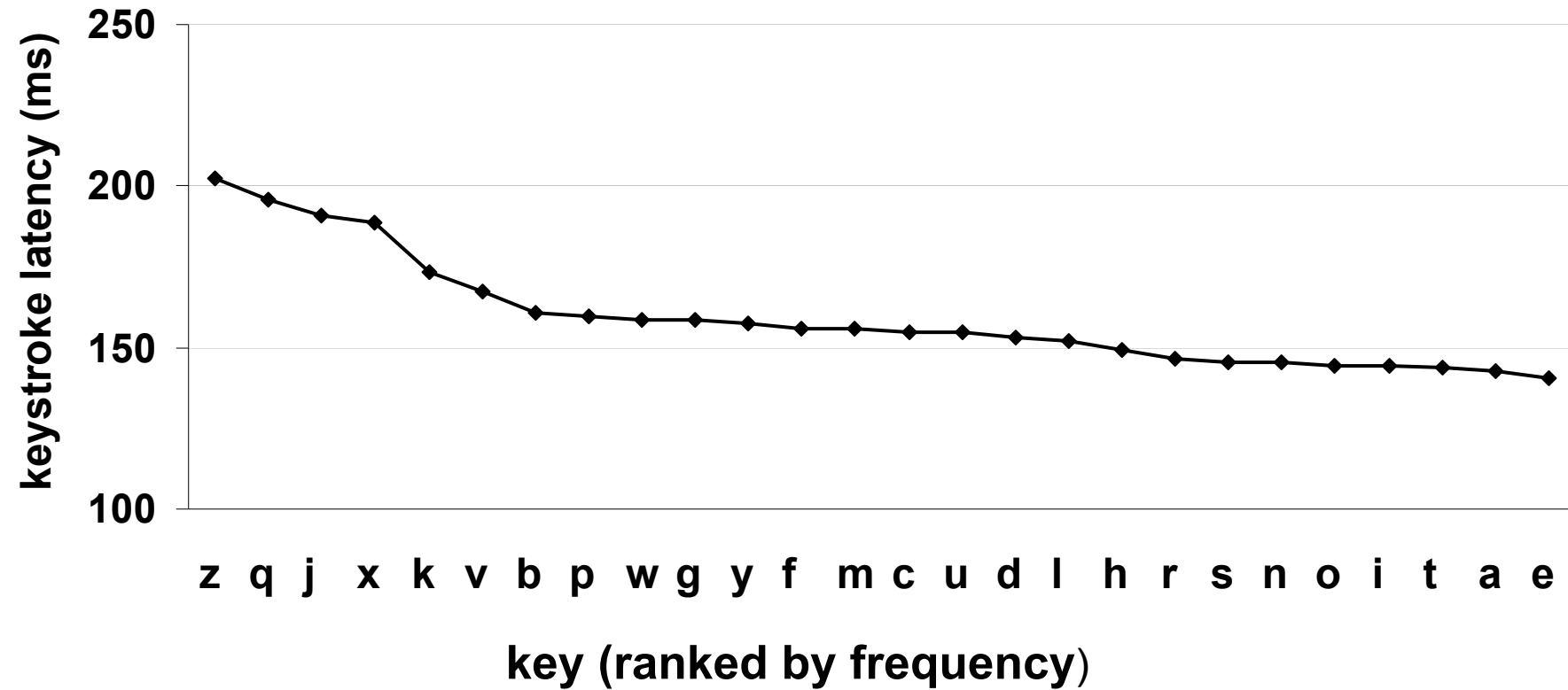
Analyzing eyetracking data: an introduction

Mark Torrance

$$\log\text{IKI}_{ij} = \beta_{0ij} \text{const} + 0.006(0.002)\text{length_x_pwdinit}_{ij} + 0.004(0.001)\text{pword_length}_{ij} + \\ -0.007(0.004)\text{freq_x_pwdinit}_{ij} + -0.033(0.002)\text{pword_logfreq}_{ij} + \\ 0.272(0.025)\text{ke_IsPwordInitial}_{ij} + -0.071(0.006)\text{ke_key_logfreq}_{ij} + \\ 0.100(0.011)\text{ke_IsEduInitial}_{ij} + 0.652(0.021)\text{ke_IsSentInitial}_{ij} + \\ 0.275(0.043)\text{ke_IsParaInitial}_{ij}$$

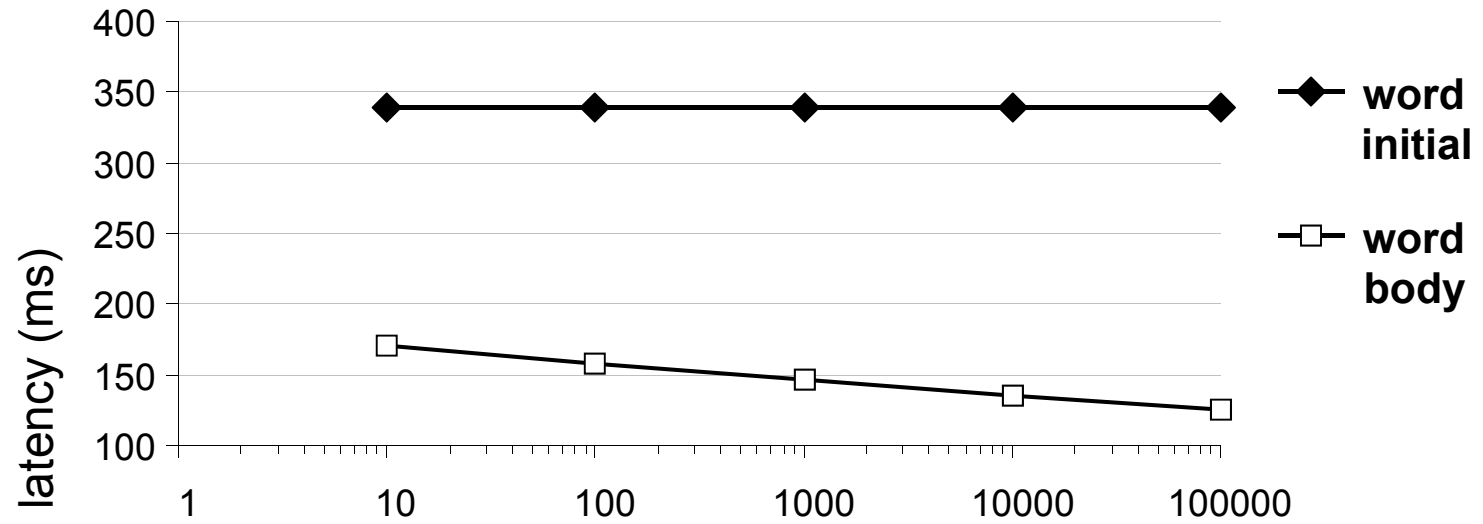
$$\beta_{0ij} = 2.725(0.044) + u_{0j} + e_{0ij}$$

Keystroke latencies: character level effects

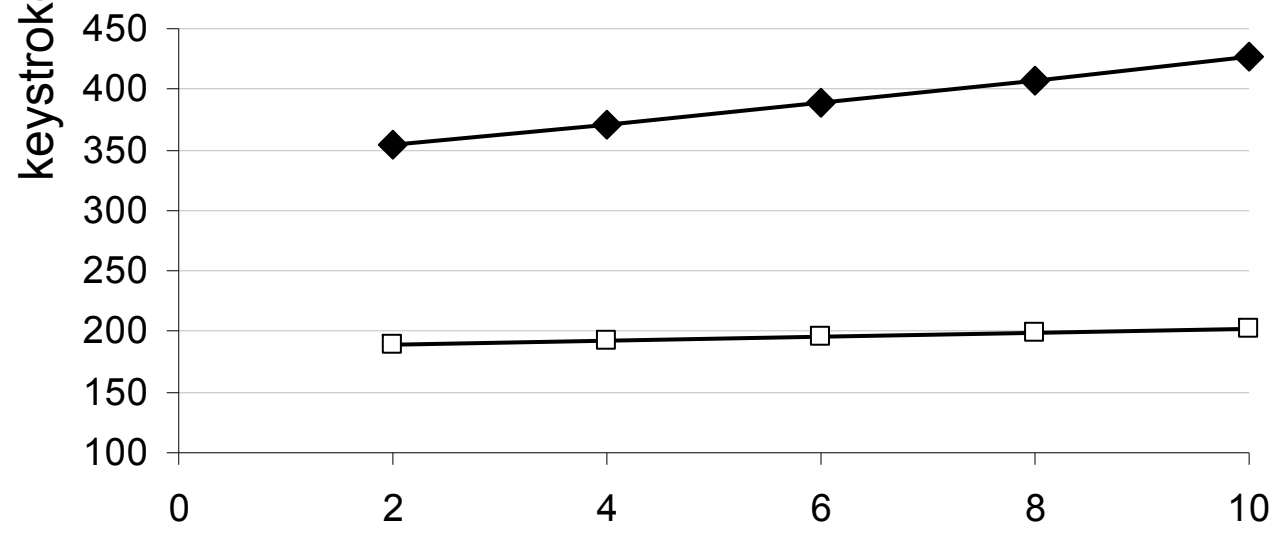


Keystroke latencies: word-level effects

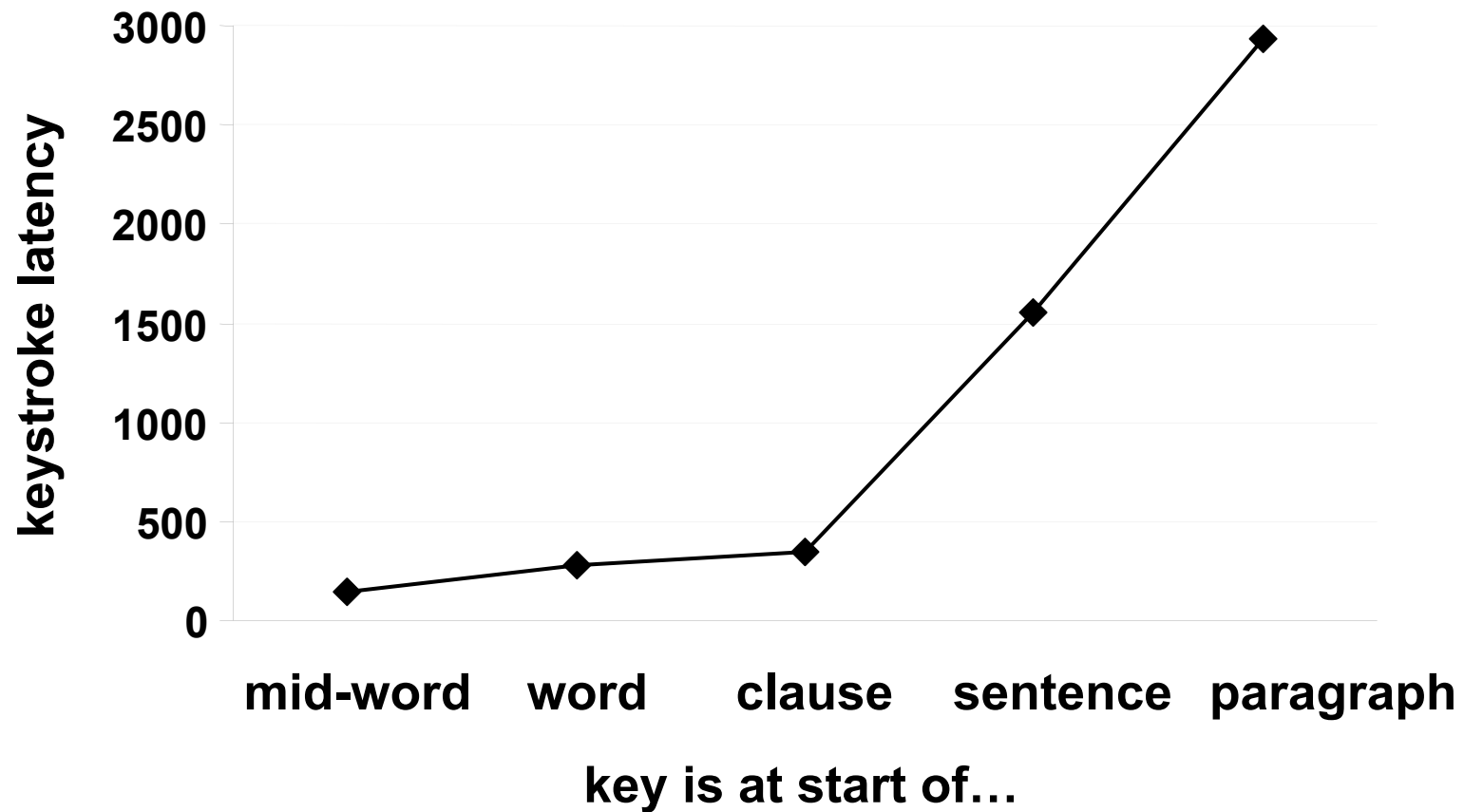
**Word
Frequency**

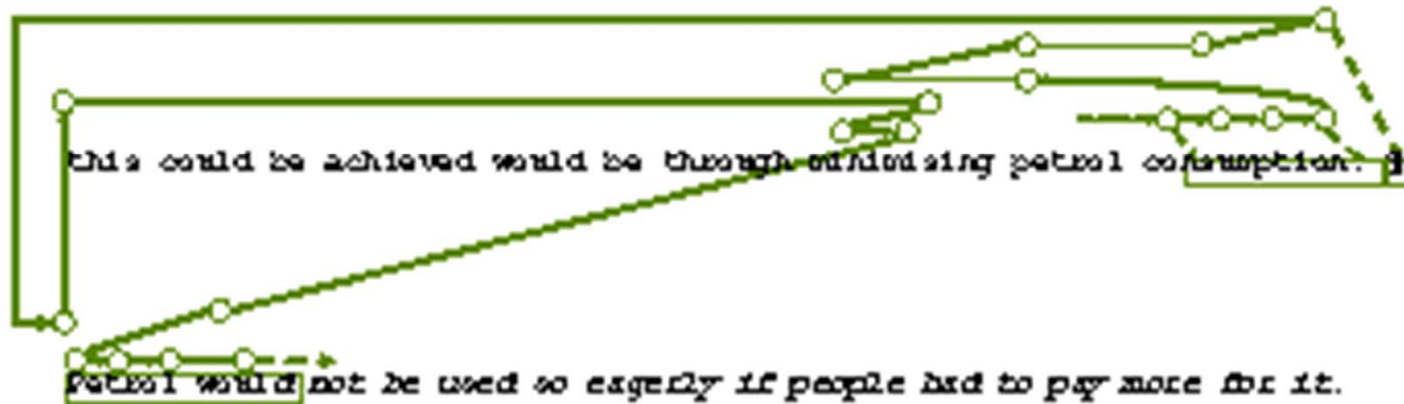
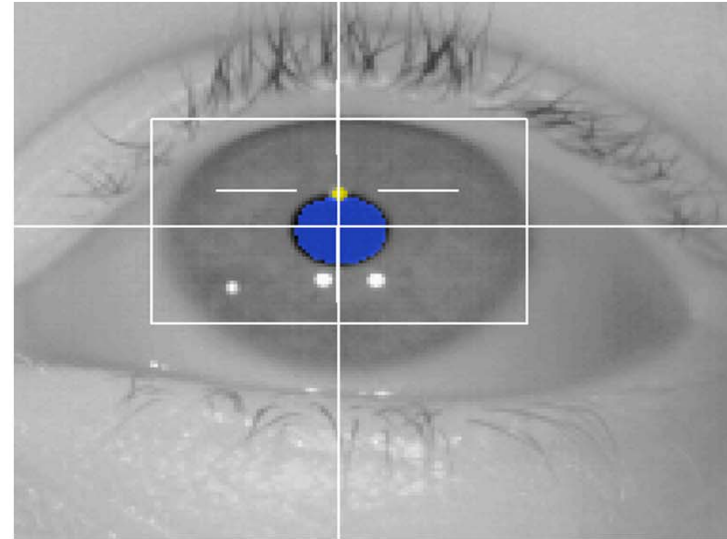


**Word
Length**



Keystroke latencies: macro effects





Writers' eye movements...

- **What** kinds of questions can be answered by tracking writers' eye movements?
- **How** do you do it?

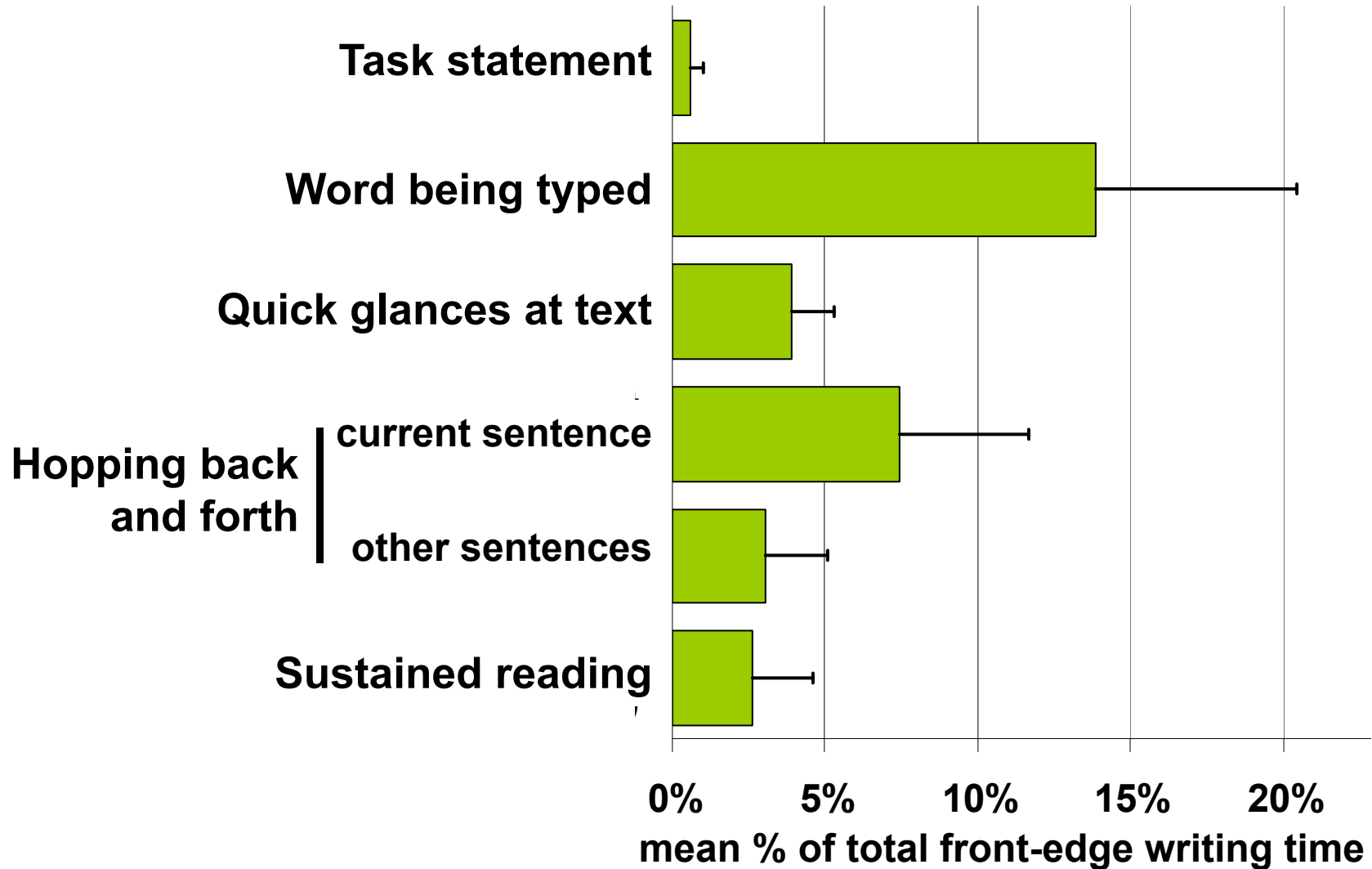
What kinds of questions can eye tracking help to answer?

- Describing writers' behaviour – what do writers do when?
- Developing theories about writers' cognitive processes – what information must have the writer have available before producing the next word / phrase / clause?

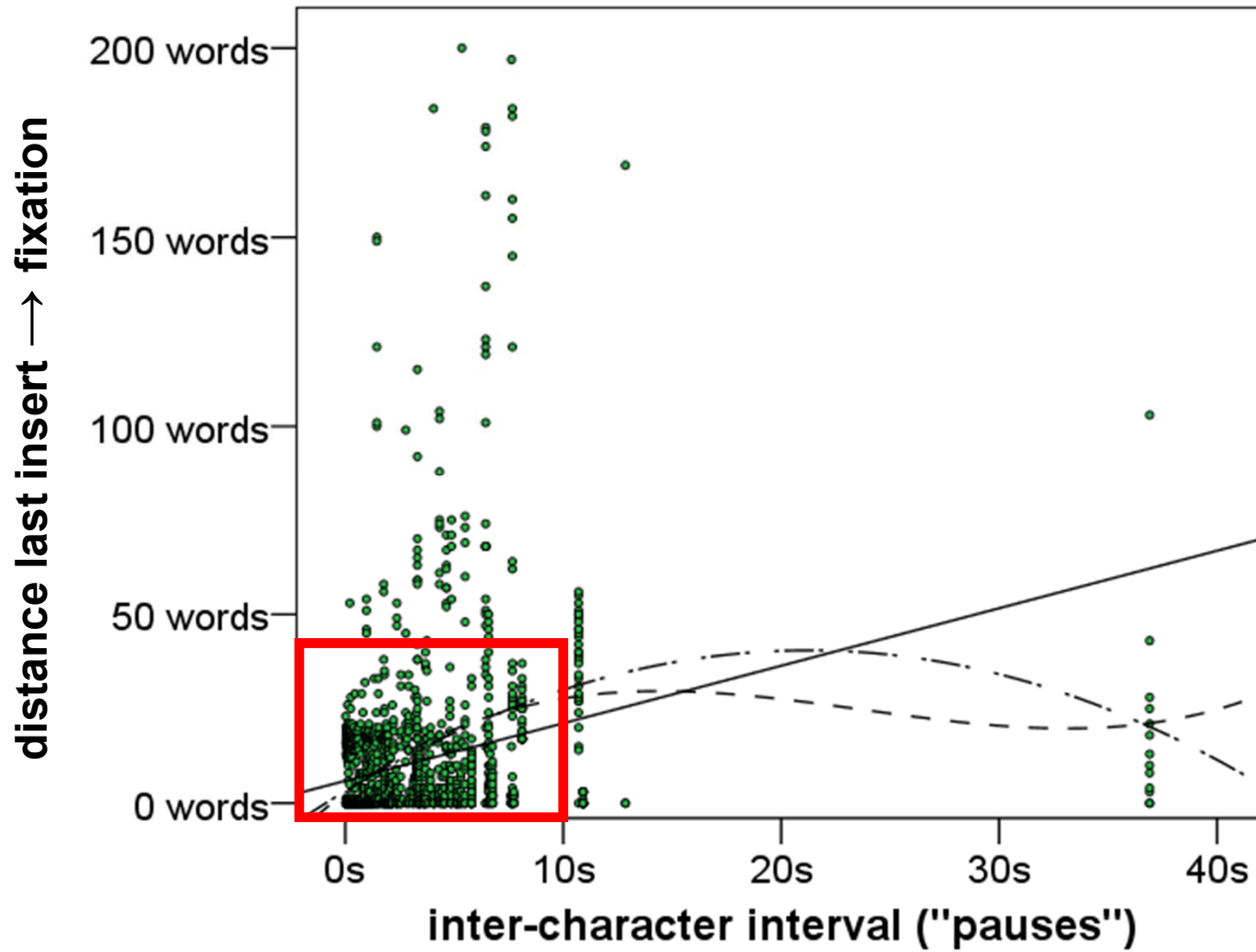
What kinds of questions can eye tracking help to answer?

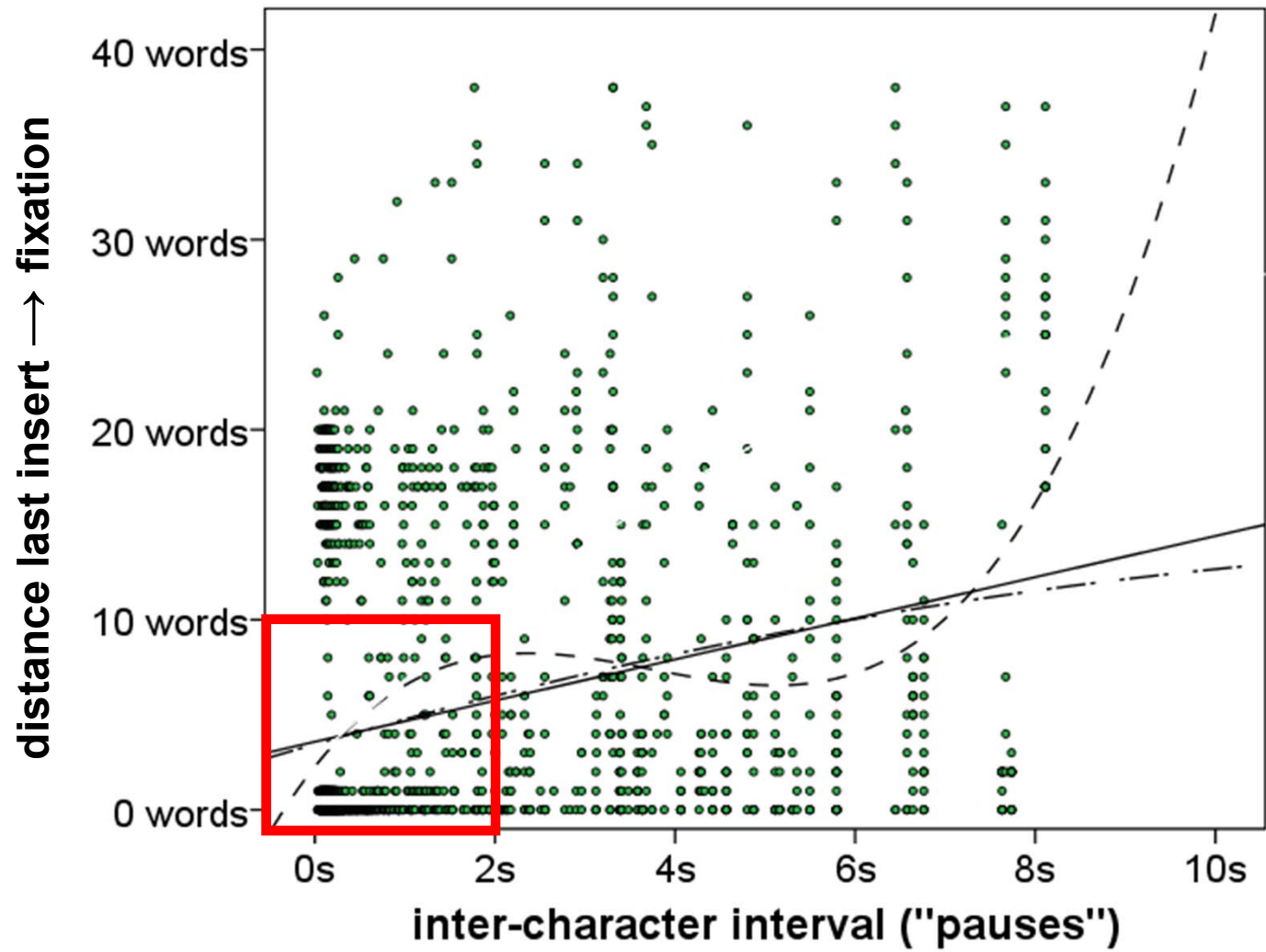
- Describing writers' behaviour – what do writers do when?
- Developing theories about writers' cognitive processes – what information must have the writer have available before producing the next word / phrase / clause?

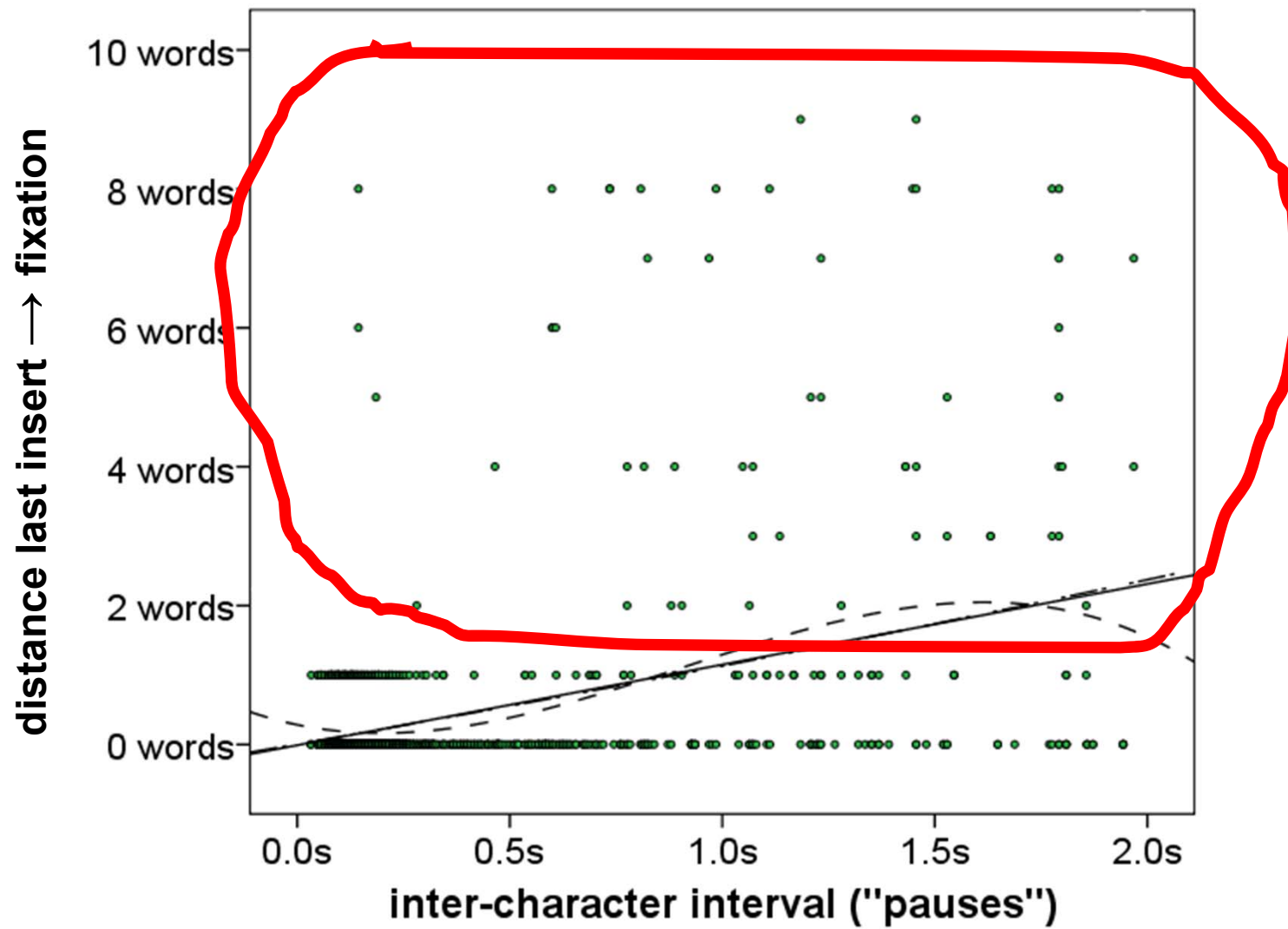
Where do writers' look?



Where do writers look when they pause?

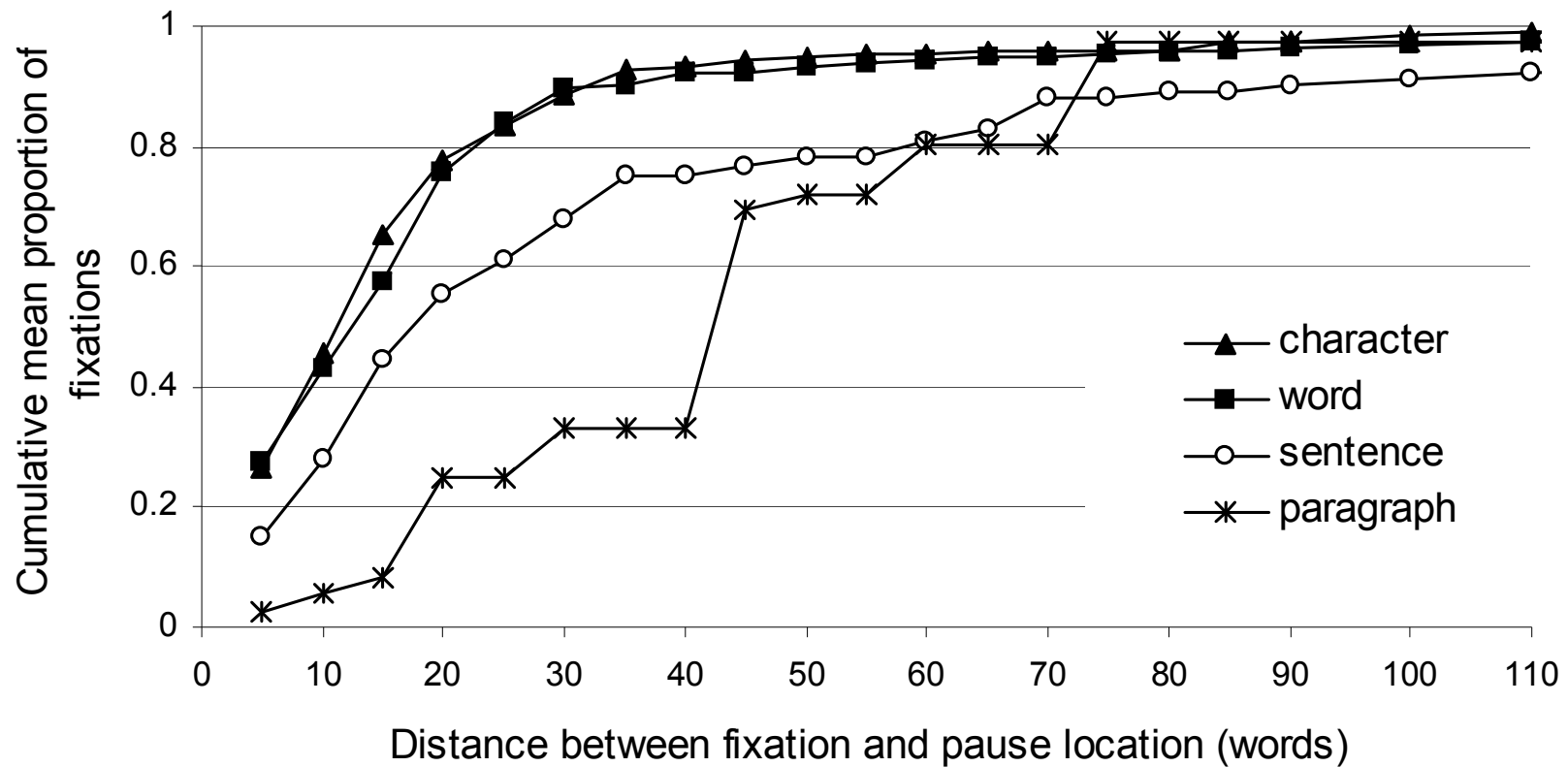






Where do they look at different pause locations?

Mean distance between pause location and fixation location, by nature of text-boundary at which pause occurred



Pause: 1.4s

this could be achieved would be through minimising petrol consumption. ¶

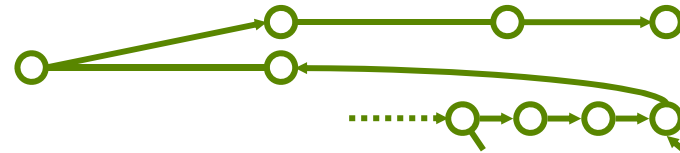
Pause: 3.7s

Petrol would not be used so eagerly if people had to pay more for it.

this could be achieved would be through minimising petrol cons

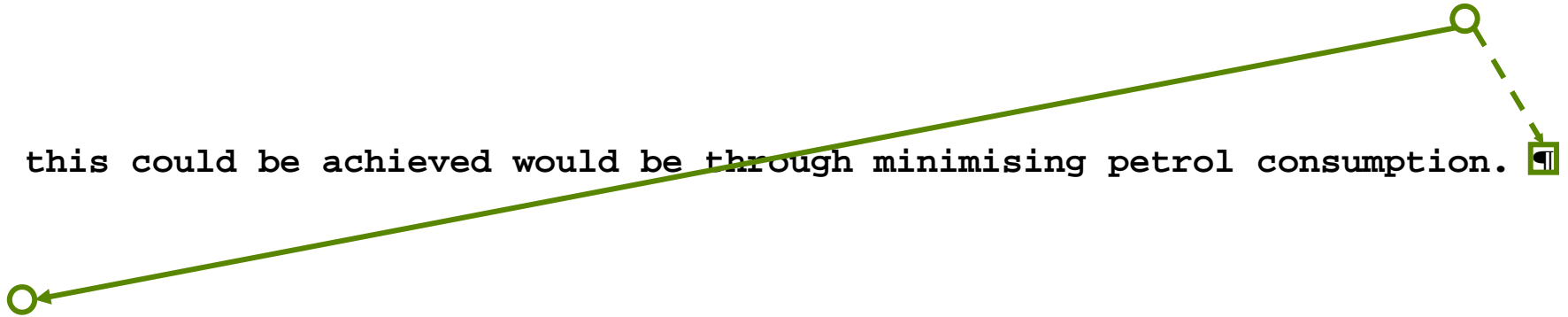


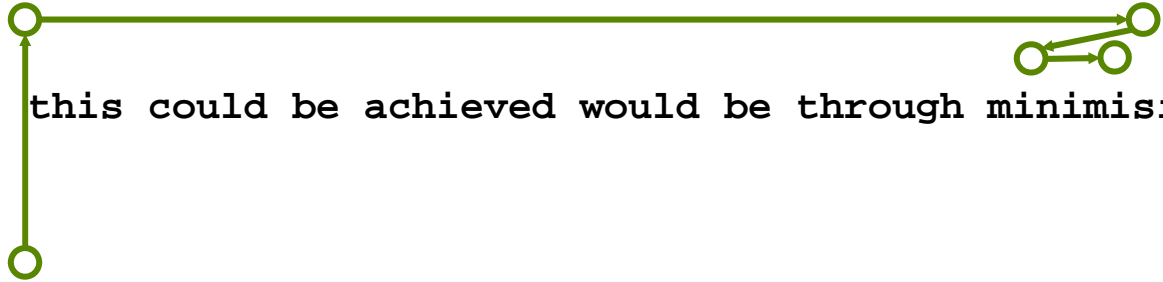
this could be achieved would be through minimising petrol consumption.



this could be achieved would be through minimising petrol consumption.

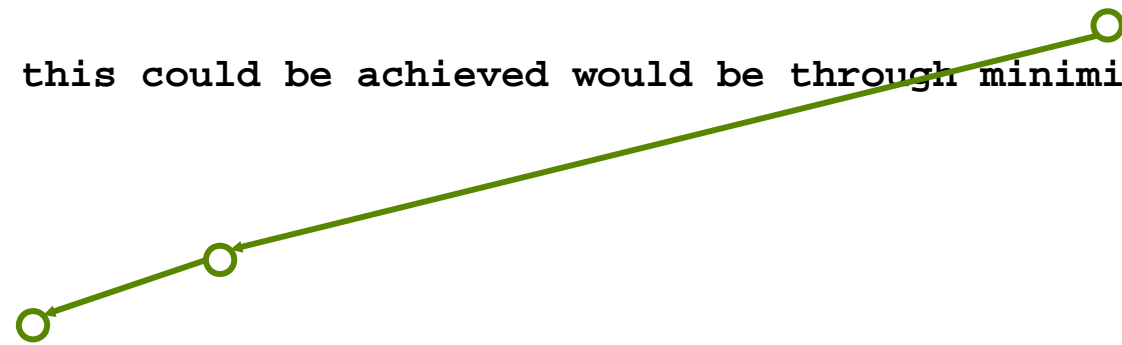
this could be achieved would be through minimising petrol consumption.



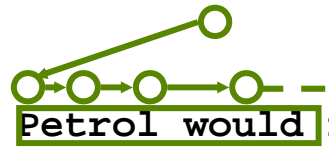


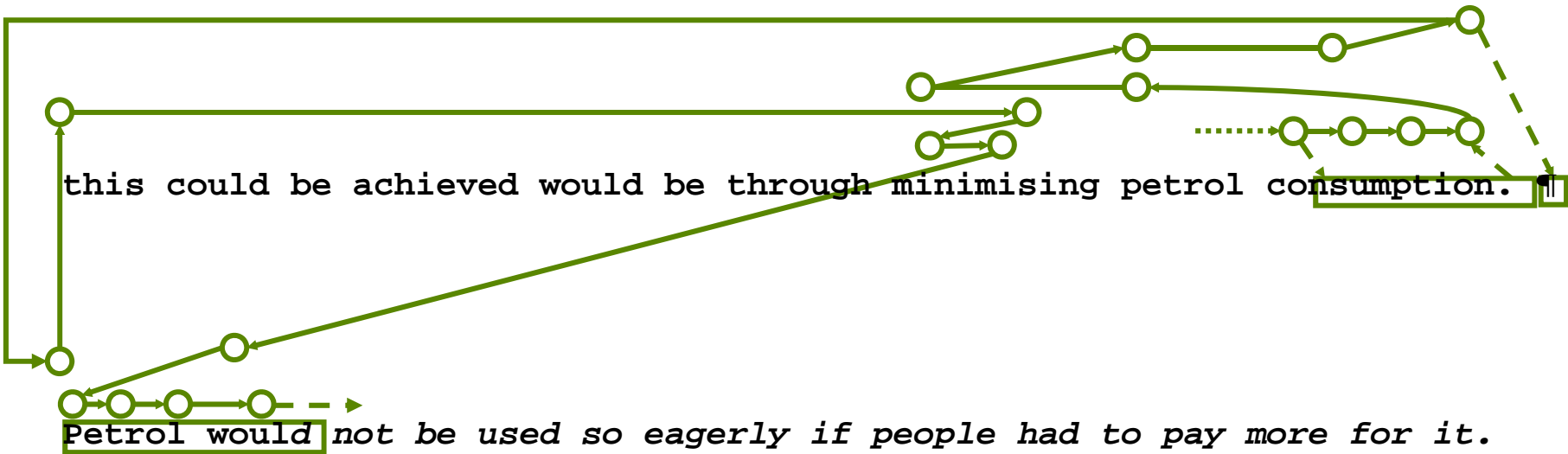
this could be achieved would be through minimising petrol consumption. ¶

this could be achieved would be through minimising petrol consumption. ¶

A green line with three circular markers pointing upwards and to the right. The line starts at a low point on the left, rises to a middle point, and then rises further to a high point on the right. The markers are small circles with a green outline.

this could be achieved would be through minimising petrol consumption. ¶





this could be achieved would be through minimising petrol consumption. ||

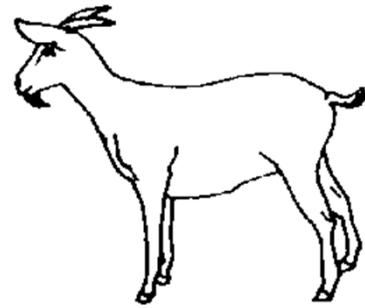
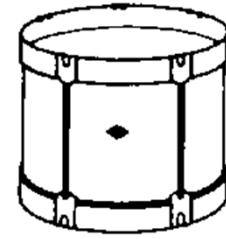
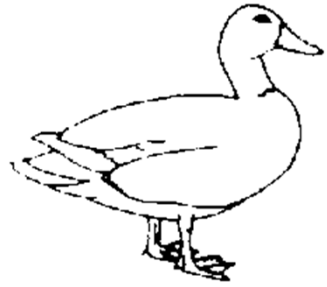
Petrol would not be used so eagerly if people had to pay more for it.

What kinds of questions can eye tracking help to answer?

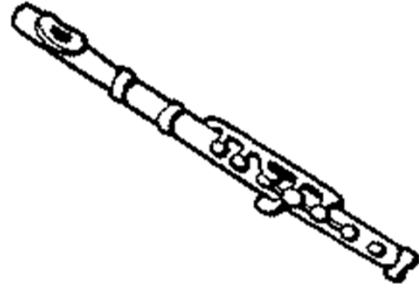
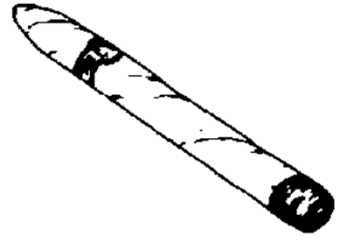
- Describing writers' behaviour – what do writers do when?
- Developing theories about writers' cognitive processes – what information must have the writer have available before producing the next word / phrase / clause?

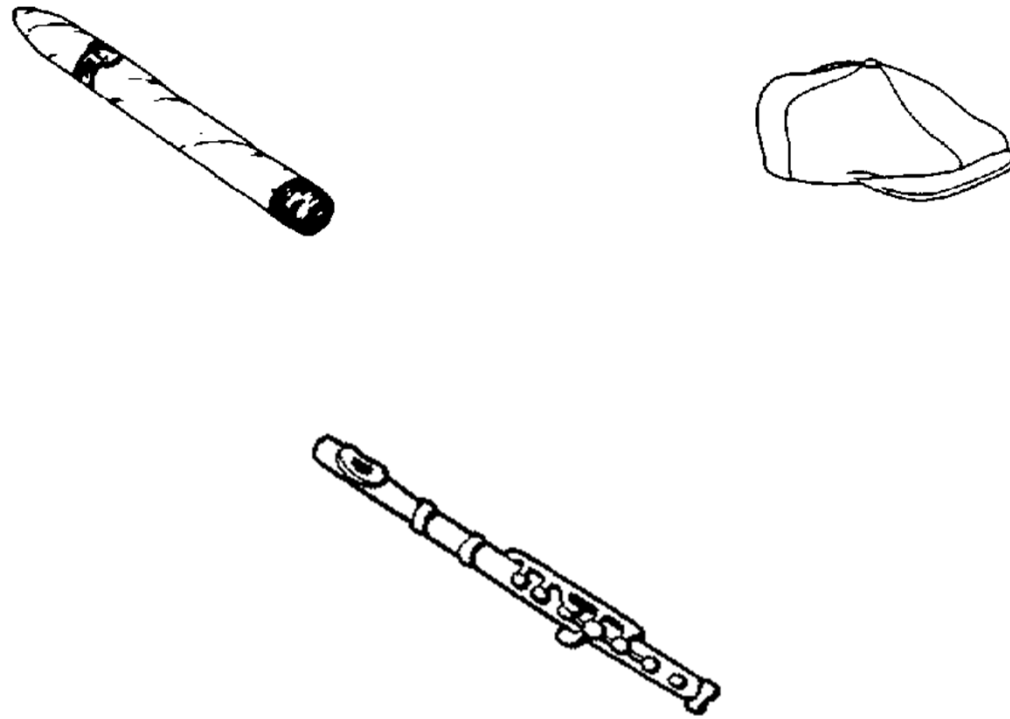
What kinds of questions can eye tracking help to answer?

- Describing writers' behaviour – what do writers do when?
- Developing theories about writers' cognitive processes – what information must have the writer have available before producing the next word / phrase / clause?



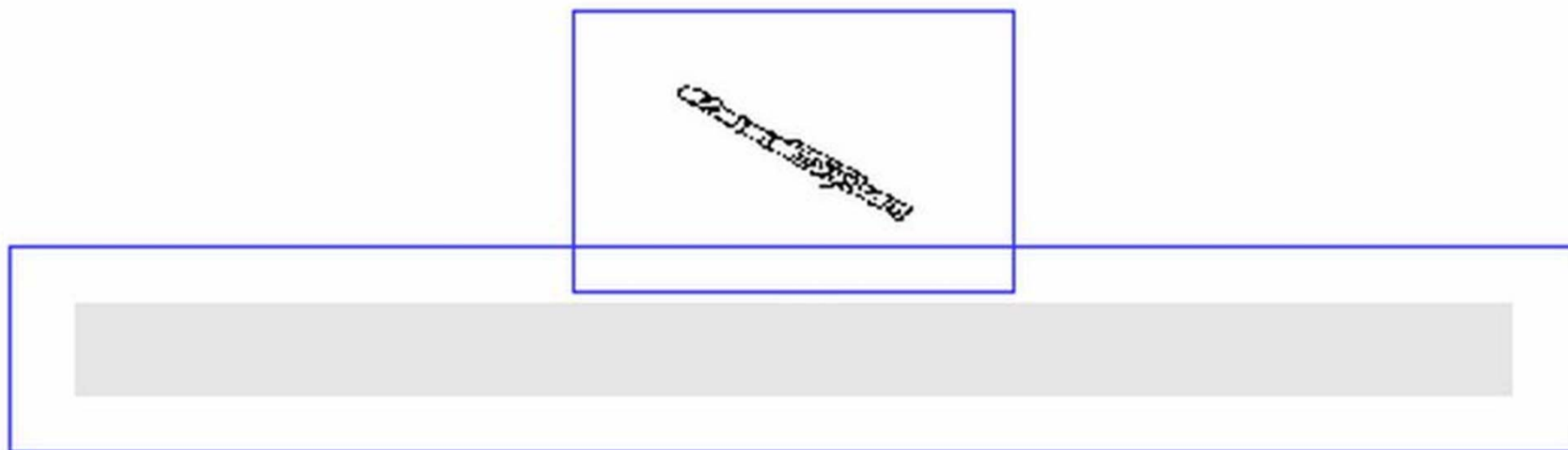
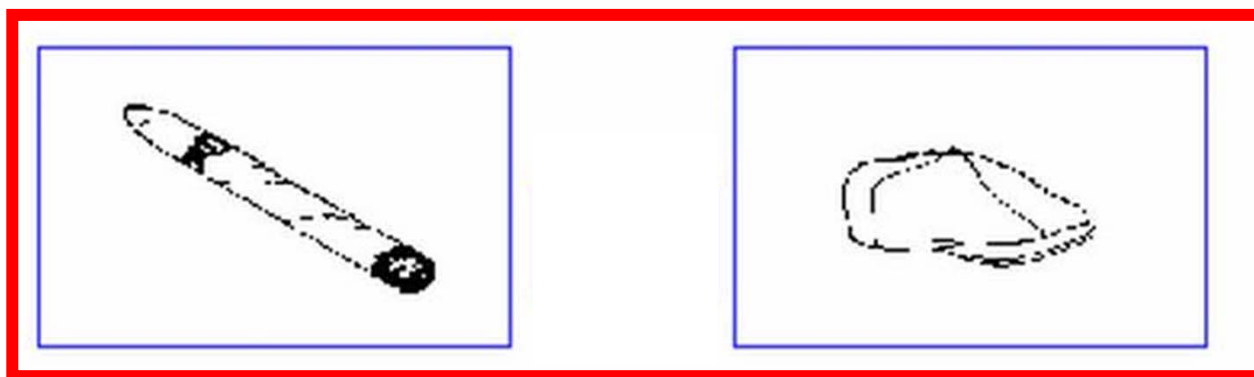




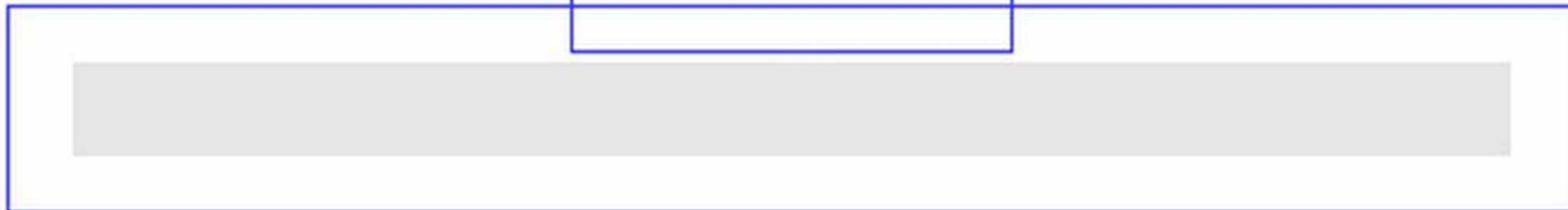
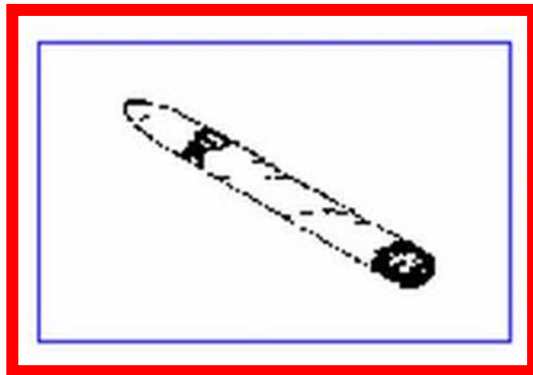


The cigar / cigarette and the cap are
above the flute

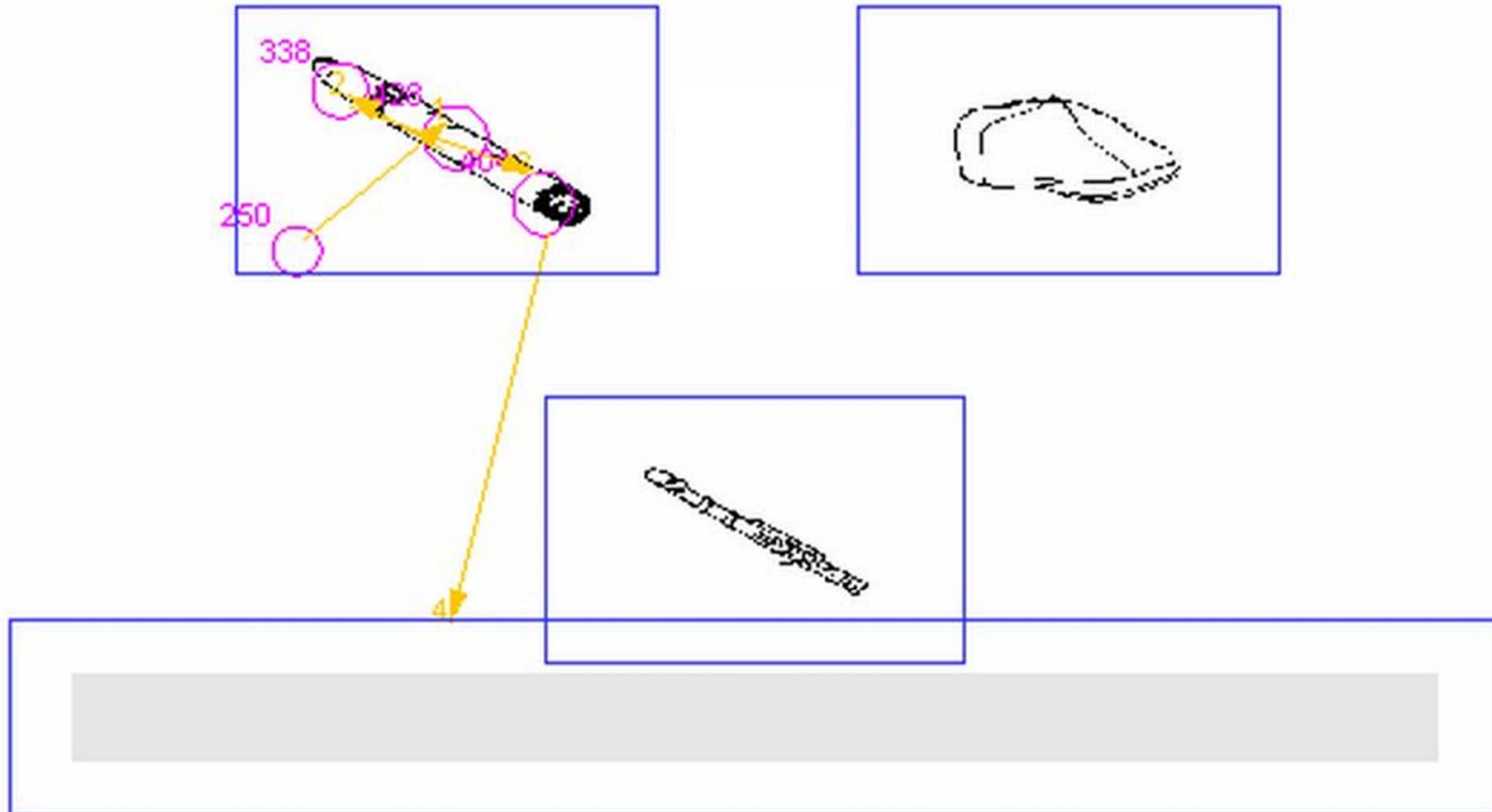
If “The cigar and the cap” is planned prior to writing then gaze will be here...



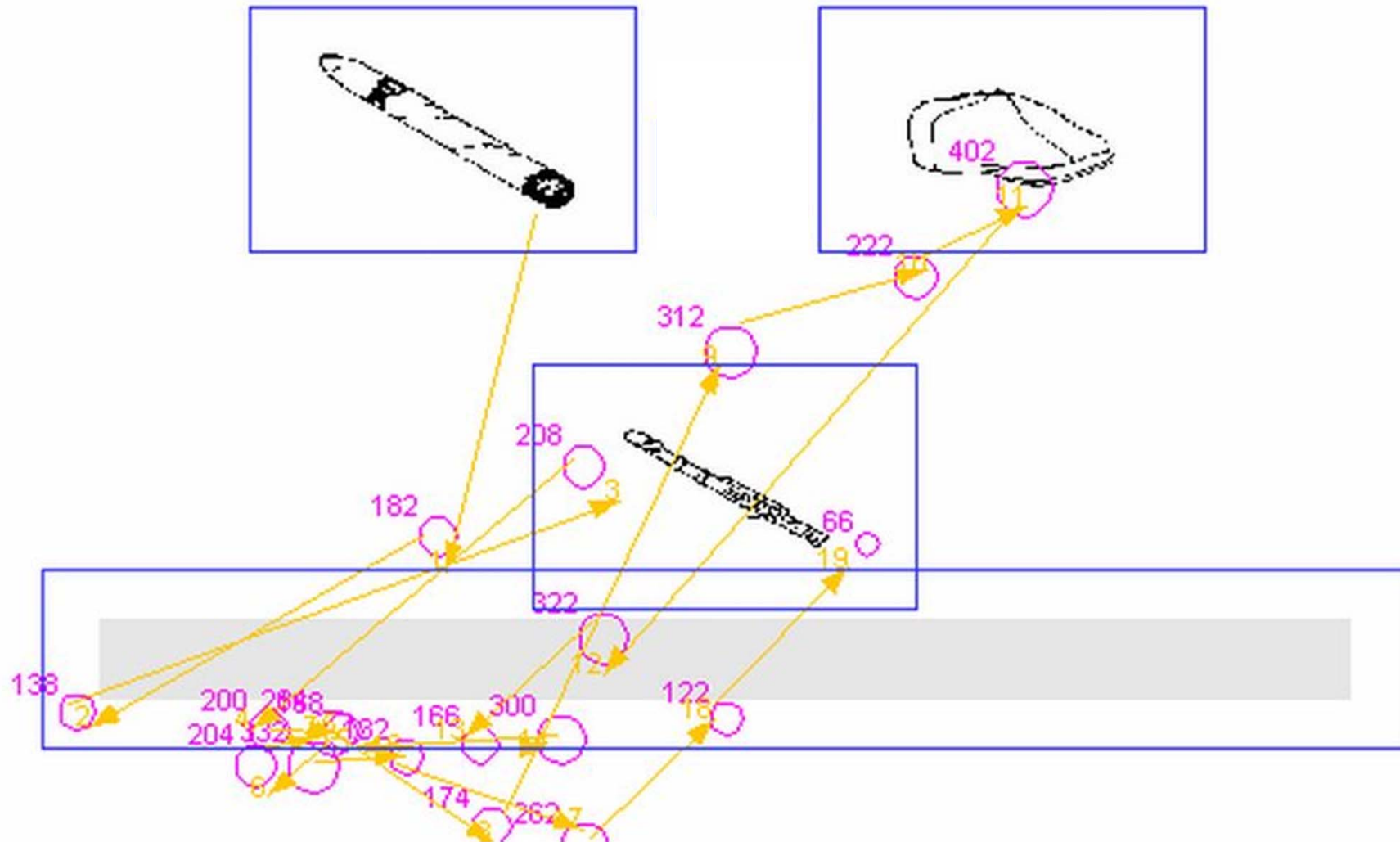
If just “The cigar” is planned prior to writing then gaze could be just here...



Fixations before first keystroke...



Fixations after first keystroke...



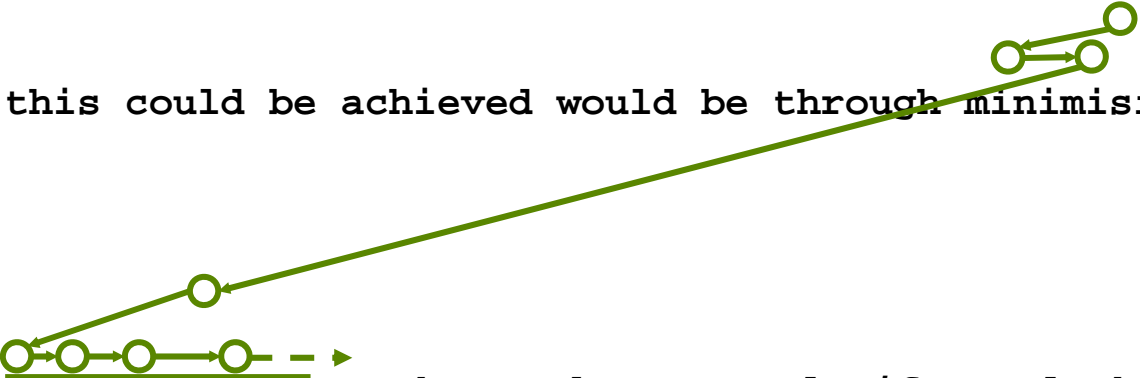
Global warming has been increasing the temperature of the world in recent years due to a phenomenon known as 'the greenhouse effect'. It is the cause for freak weather occurrences such as massive floods, and it also the reason for the significant...



Global warming has been increasing the temperature of the world in recent years due to a phenomenon known as 'the greenhouse effect'. It is the cause for freak weather occurrences such as massive floods, and it

Global warming has been increasing the temperature of the world in recent years due to a phenomenon known as 'the greenhouse effect'. It is the cause for freak weather occurrences such as massive floods, and it also the reason for the significant...

this could be achieved would be through minimising petrol consumption. ¶



Petrol would not be used so eagerly if people had to pay more for it.

Writers' eye movements...

- **What** kinds of questions can be answered by tracking writers' eye movements?
- **How** do you do it?



Problem...

- The text that appears on the screen is unpredictably dynamic (i.e. the words move around).
- Therefore analysis based on screen-coordinate defined areas of interest won't work.

So either...

- Code manually from video (prohibitively time consuming)
- or get the computer to do it for you

■ Show them a video of EyeWrite playback

EyeWrite – combined keystroke and eye-movement analysis

- Custom code (in Python) that runs within SR Research's "Experiment Builder" platform.
- Works just with SR eye trackers
- But – currently something similar being developed as part of Scriptlog (I think)
- Two parts
 - Data collection – simple text editor used in conjunction with an eye tracker
 - Data analysis – separate program (potentially stand-alone) that analyses editor output



How it works...



Editor uses a proportional font so each letter occupies the same proportion of screen.






study of mind and behaviour. Studies!

How it works...

-  Editor uses a proportional font so each letter occupies the same proportion of screen.
-  Editor collects times and locations for all keystrokes and all fixations.

SSACC R	9320092							
SBLINK R	9320100							
MSG	9320275	TE_PROC	g 103 0					
MSG	9320275	1 TES	0,8 0-10	INSERT	g 103 0	TEE	0,9 0-10	
MSG	9320278	-9	TEXT_DISPLAY_UPDATE					
EBLINK R	9320100	9320380	284					
ESACC R	9320092	9320388	300	-3.9	148.2	14.2	303.9	1.27
SFIX R	9320392							
EFIX R	9320392	9320412	24	552.6	2977.7	121	49.55	104.95
SSACC R	9320416							
SBLINK R	9320424							
MSG	9320603	TE_PROC	y 121 0					
MSG	9320603	1 TES	0,9 0-10	INSERT	y 121 0	TEE	0,10 0-10	
MSG	9320605	-15	TEXT_DISPLAY_UPDATE					
EBLINK R	9320424	9320688	268					
ESACC R	9320416	9320696	284	-3.9	148.2	14.2	303.9	1.37

How it works...

-  Editor uses a proportional font so each letter occupies the same proportion of screen.
-  Editor collects times and locations for all keystrokes and all fixations.
-  Analysis program knows font size, line spacing, and display characteristics, and the xy coordinates and times for fixations and keys events.
-  Uses this information to recreate writing session, calculating as it goes a set of variables describing each event
-  Outputs data file with one row per events (fixation or key).

Write an essay designed to convince people that petrol prices should be increased to reduce global warming.

Global warming is becoming a massive issue for a lot of people around the globe. It will affect everyone and therefore everyone should become involved in trying to reduce it. One of the ways this could be acheived **w**



Trial: 1/1
EDF Time: 2788978
Elapsed Time: 51455
Current E Type: TEXT
Key Event: 27716326
Fixation: 132/4723
Stepping Mode: NEXT

EVENT_ID: 408
EVENT_TIME: 2788978
EVENT_TYPE: INSERT
PREV_EVENT_TYPE: FIXATION
EYE_STATE: FIXATION
Report Page 1/4

TEXT_CHAR_COUNT: 217
TEXT_WORD_COUNT: 39
TEXT_SENTENCE_COUNT: 3
TEXT_PARAGRAPH_COUNT: 1
KE_KEY: o

PREV_CHAR_SEQUENTIAL: True
PREV_CHAR_INTERVAL: 168
PREV_CHAR_CURSOR_RC: [2, 24]
PREV_CHAR_TIME: 2788810
PREV_CHAR_KEY: w

NEXT_CHAR_SEQUENTIAL: True
NEXT_CHAR_INTERVAL: 40
NEXT_CHAR_CURSOR_RC: [2, 26]
NEXT_CHAR_TIME: 2789018
NEXT_CHAR_KEY: u

Output example (on handout)

A	B	C	D	E	F	G	H	I	J	K	L	M	N
EVENT TIME	EVENT TYPE	EYE STATE	KEY	CURSOR WORD TEXT	CURSOR PREV TEXT	CURSOR NEXT TEXT	TEXT WORD COUNT	FIXATION INDEX	FIXATION DURATION	START TEXT INDEX	FIXATION START WORD TEXT	FIXATION START PREV TEXT	FIXATION START NEXT TEXT
17122707	INSERT	FIXATION	v	v		V tn	1	38	174				
17122772	FIXATION	FIXATION		v		V tn	1	39	260	0			
17123515	INSERT	BLINK	i	vi		Vi tn	1	39	260	0			
17123798	FIXATION	FIXATION		vi		Vi tn	1	40	214				
17123835	INSERT	FIXATION	o	vio		Vio tn	1	40	214				
17124016	FIXATION	FIXATION		vio		Vio tn	1	41	1096	2	vio		Vi otn
17124459	INSERT	FIXATION	l	viol		Viol tn	1	41	1096	2	vio		Vi otn
17124667	INSERT	FIXATION	e	violen		Violen tn	1	41	1096	2	vio		Vi otn
17124843	INSERT	FIXATION	n	violence		Violence tn	1	41	1096	2	vio		Vi otn
17125164	FIXATION	FIXATION		violence		Violence tn	1	42	312				
17125307	INSERT	FIXATION	c	violence		Violence tn	1	42	312				
17125500	FIXATION	FIXATION		violence		Violence tn	1	43	256				
17125531	INSERT	FIXATION	e	violence		Violence tn	1	43	256				
17125796	FIXATION	FIXATION		violence		Violence tn	1	44	794	5	violence		Violence
17126131	INSERT	FIXATION		violence		Violence tn	1	44	794	5	violence		Violence

Note: This is a small subset of the variables available in the output (and you can add your own too)

Research process...

- Identify clear and precise research question

e.g., *“When writing a first-and-only draft of a text, does the kind of text you are writing affect the extent to which you read back what you have written as part of the drafting process (i.e. ignoring reading back to check over the complete draft).”*

Research process...

- Identify clear and precise research question
- Collect data (EyeWrite Editor program)
- Produce fixation / keystroke log (EyeWrite Analysis program)
- Identify and operationalise (precisely define) variables that you are interested in.

e.g. DV = The extent to which a writer spends time in sustained reading of their text

Sustained reading: Sequences of three or more short forward saccades* within the existing text, spanning more than one word, with no intervening keystrokes. Sequence may also include within-word saccades (but these do not count towards total).

*Short forward saccade: target is three or less words distant from launch site.

Research process...

- Identify clear and precise research question
- Collect data (EyeWrite Editor program)
- Produce fixation / keystroke log (EyeWrite Analysis program)
- Identify and operationalise (precisely define) variables that you are interested in.
- Implement this definition to create new variable (SPSS syntax / Python / ...)
- Generate summary statistics (SPSS) and / or statistical model (MLWin)
- Interpret results, write and publish paper
- Collect awards, apply for better job
- Get some sleep