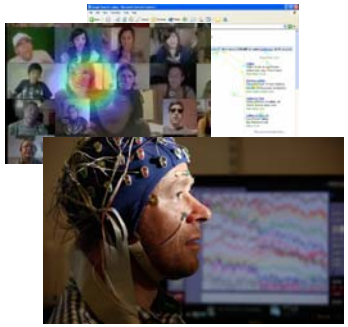
case studies in design informatics

Lecture 13: Biophysical Data



design informatics

NRlabs neuropolitics research

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Multimodal communication

Move more into the real world

Static stimuli

↓

Dynamic stimuli

↓

Interaction

⇣

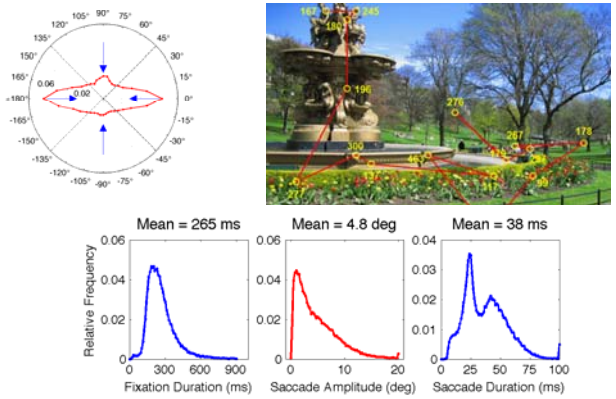
How do we do examine any of this empirically?

Static stimuli

- Text & traditional media (e.g. newspaper adverts)
- Web pages
- Photographs
- Paintings / art / illustrations
- 2d or 3d images
- Visual illusions
- etc

Static stimuli (snapshots)

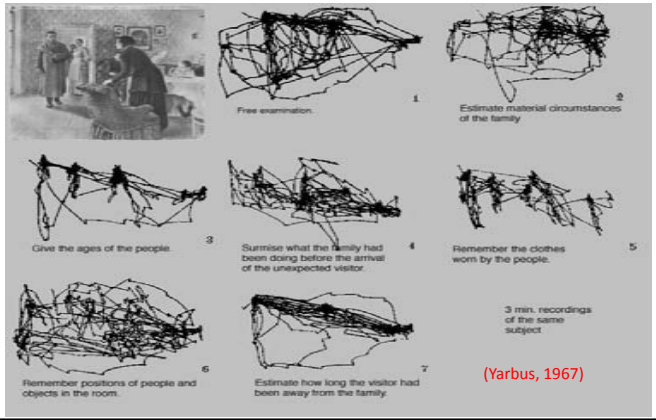
Scene Viewing



The Unexpected Visitor
Ilya Repin (1884) [artist]

(Yarbus, 1967)

Task Effects



(Yarbus, 1967)

In terms of reading

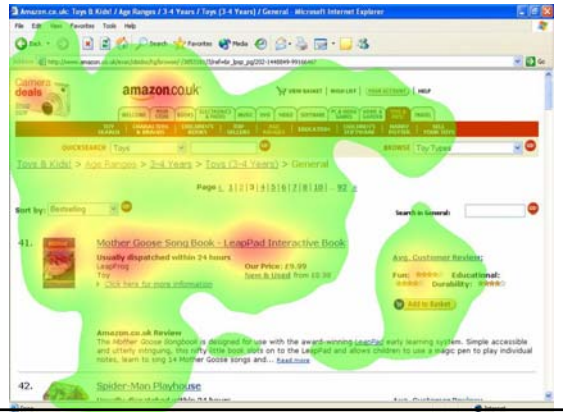
- Fovea: central 2° of vision
- Parafovea: from foveal region to about 5.0º from fixation
- Periphery: everything beyond parafoveal region

Fig. 1 The foveal, parafoveal, and peripheral regions when three characters make up 1° of visual angle. The eye icon and dotted line represent the location of fixation

Schotter et al. (2012)

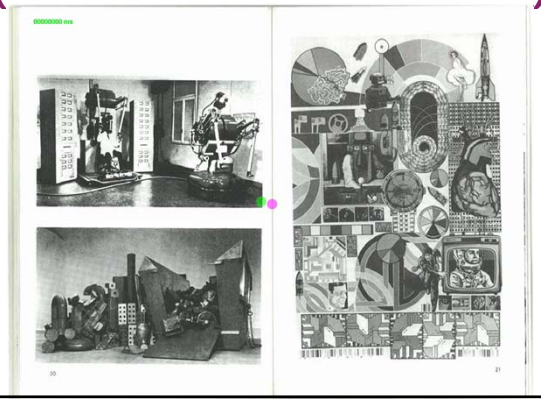
Browsing / Interface Design

Visualising attention & perception



Visualising attention & perception

Two Eyes on Paolozzi (The view of an art critic)



Dynamic Stimuli

- The real world
- Films / movies / TV / Web videos
- Human - Computer (Robot) interaction
- Human (inter)action and social behaviour

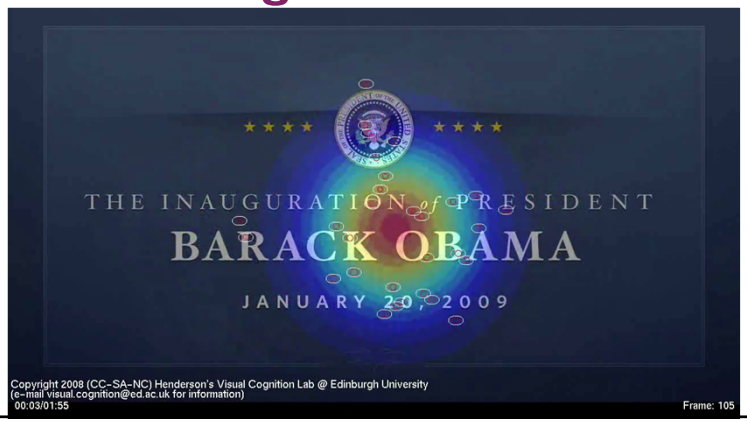
Real world is dynamic

One moment is not the whole story.

Social interaction

Face-to-face communication

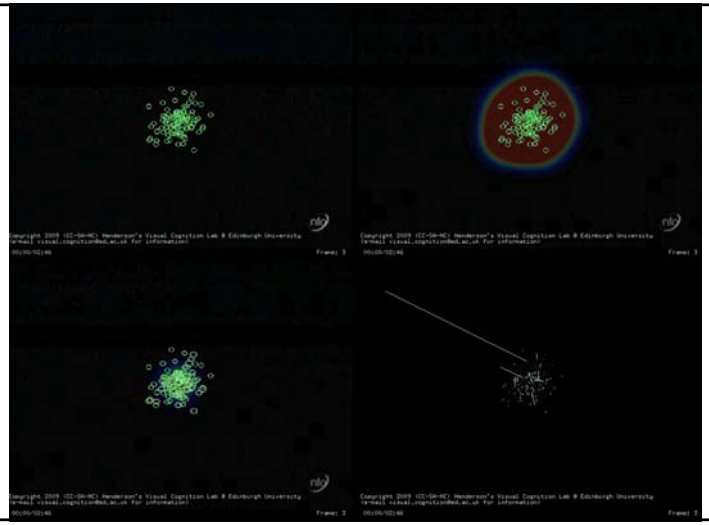
Inaugural address

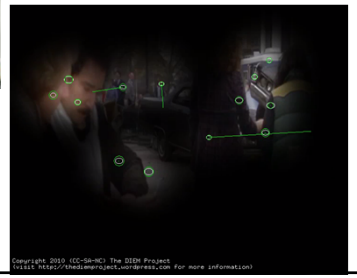


Instruction giving / following

Dialogue: competitive play

Attention and performance





Alternative audience participation

Members of the audience for the Film Festival 2011 showing of "The Eyes of Laura Mars" were invited to be tracked while watching a clip from the film.

Dynamic Images & Eye Movements

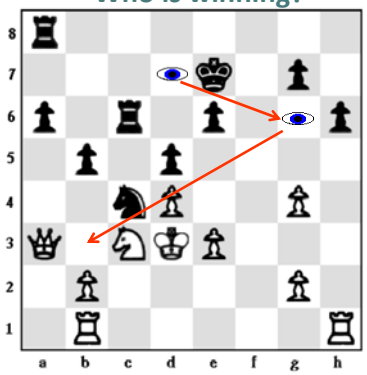
Further information: thediemproject.wordpress.com

Examples (>300,000 views): www.vimeo.com/visualcognition

- Dynamic heat maps for moving images.
- Show where people are mostly looking and how tightly clustered they are.
- So determine if there is a consensus view or not at any moment in time (and then try and find a reason).

Contingent change

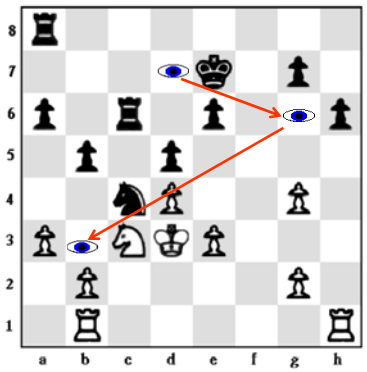
Who is winning?



Knowing where someone is looking also means knowing where someone is **not** looking (converse situation).

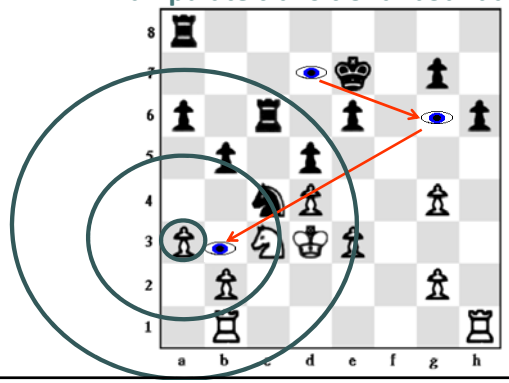
Contingent change

Unseen switch

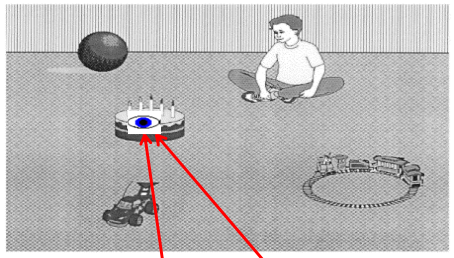


Contingent change

Manipulate transitional boundary



Anticipation in language



Visual grounding (multimodal processing)

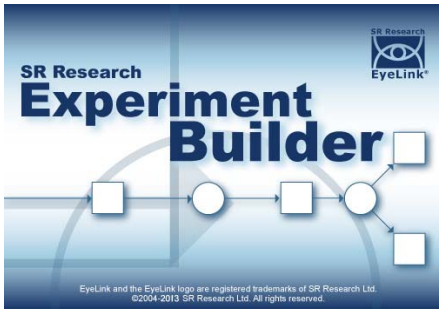
While viewing the scene, participants heard:

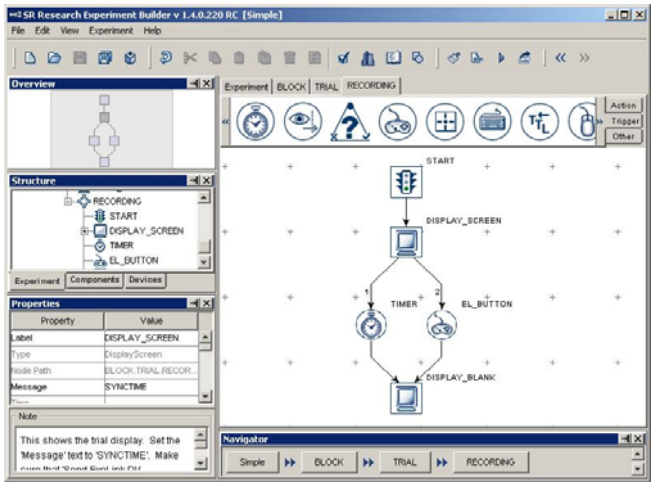
1) The boy will move the cake; or
2) The boy will eat the cake

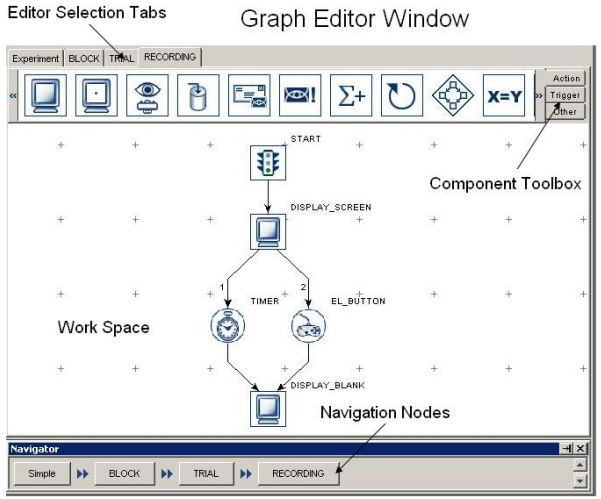
(Altmann & Kamide, 1999)

Experiment Builder

- EyeLink presentation software (but can use E-Prime, Matlab or bespoke software). Can add customised Python scripts.







Eyetracker output

```
        x     y       x     y
825554 77.7 219.7 1037.0 79.2 249.5 1088.0
825555 77.1 219.1 1037.0 79.3 249.1 1088.0
825556 77.0 218.6 1037.0 79.1 247.9 1087.0
825557 77.0 218.6 1037.0 79.2 247.0 1086.0
825558 77.2 218.6 1037.0 79.3 246.2 1085.0
825559 77.4 218.6 1036.0 78.8 245.8 1086.0
825560 77.4 219.0 1036.0 78.1 245.4 1086.0
825561 77.5 219.4 1036.0 77.4 244.9 1087.0
825562 77.5 219.9 1036.0 77.6 244.8 1086.0
825563 77.4 219.8 1036.0 77.9 245.3 1085.0
825564 77.1 220.0 1036.0 78.2 246.3 1085.0
825565 77.0 220.3 1036.0 78.3 247.3 1086.0
825566 77.4 220.5 1037.0 79.0 247.5 1088.0
825567 77.7 220.5 1037.0 80.1 247.2 1089.0
825568 78.3 220.5 1037.0 81.2 246.8 1088.0
825569 79.0 220.5 1037.0 82.4 245.3 1087.0
825570 79.8 220.5 1037.0 83.3 243.9 1087.0
825571 80.6 220.5 1037.0 84.5 243.4 1087.0
```

- column 1: Time stamp (msec, internal eye-tracker clock)
- columns 2-4 = **Left** eye:
- column 2: *Horizontal* gaze position (pixels)
- column 3: *Vertical* gaze position
- column 4: Pupil diameter or area value
- columns 5-7 = **Right** eye:
- column 5: *Horizontal* gaze position
- column 6: *Vertical* gaze position
- column 7: Pupil diameter or area value

DataViewer

- Developed by the hardware manufacturer.

As the name suggests:

- Visualise (incl. heatmaps)
- Filter
- Manipulate
- Summarise

- No inferential stats, interp. or meaning

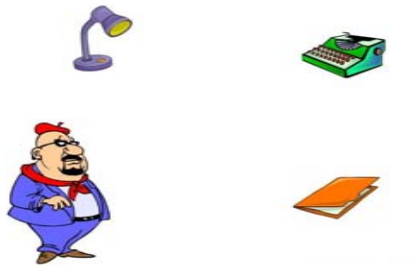
Areas of Interest

Target areas within the experimental stimuli.

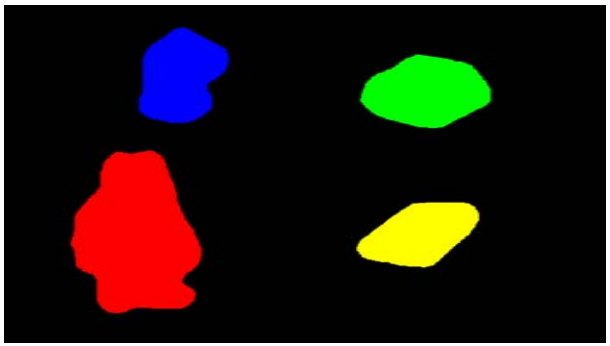
- Objects – including collections or parts
- Spatial regions
- Text boxes, windows, embedded images
- Words

Whatever you are interested in.

Visual World (1)

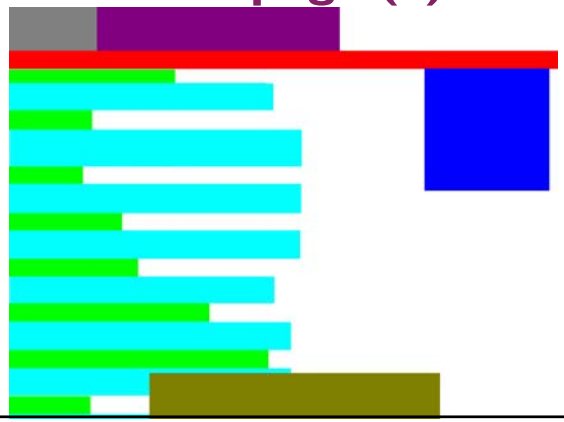


Visual World (2)

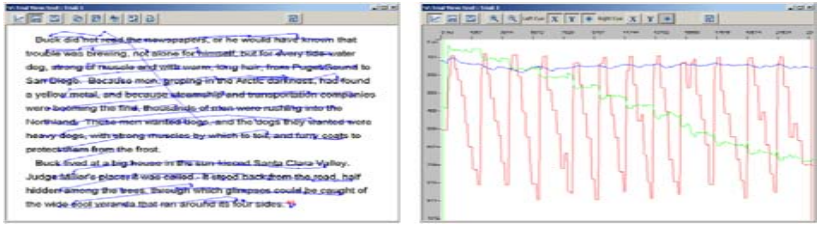


Web page (1)

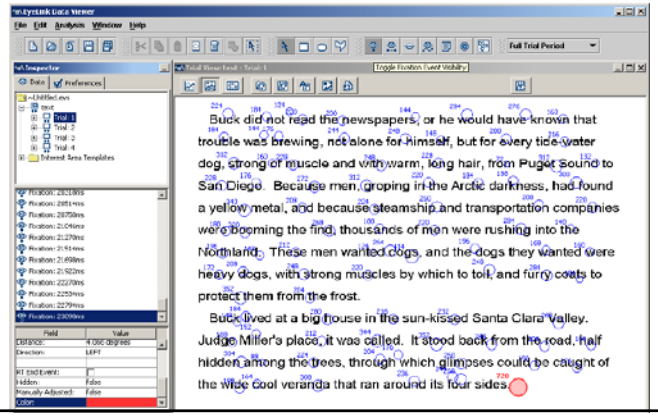
Web page (2)



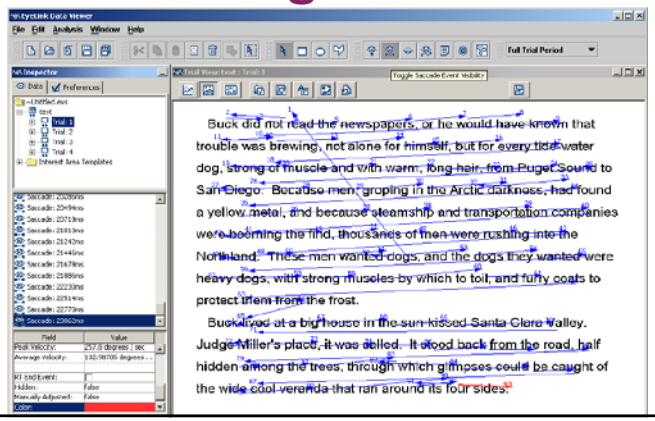
Reading



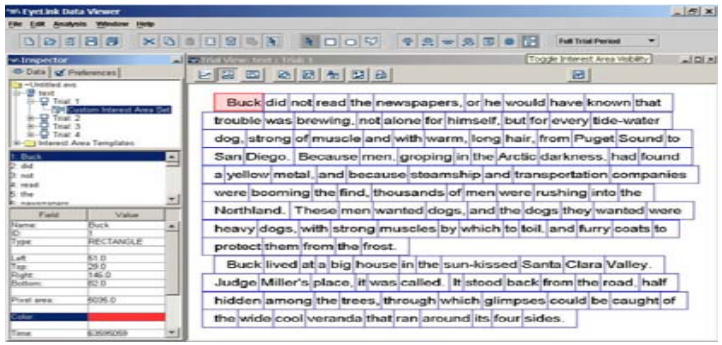
Reading: fixations



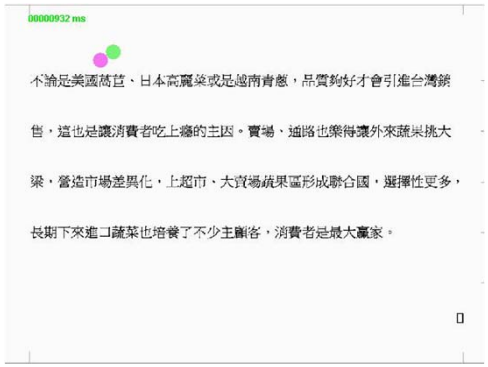
Reading: saccades



Reading: target words



Not just English



Task influence

	Mean Fixation Duration	Mean Saccade Amplitude
Silent reading	225 ms	2°
Oral reading	275 ms	1.5 °
Visual search	275 ms	3°
Music reading	375 ms	1°
Static scenes	287 ms	3.56°
Dynamic scenes	358 ms	3.54°
Films/movies	453 ms	4.24°
Joint tasks	322 ms	7.15°

Rayner (1998); Smith & Henderson (2007; 2008); Carletta et al. (2011)

Text influence

TABLE 4.1 Mean fixation duration, mean saccade length, proportion of fixations that were regressions, and words per minute (WPM) for 10 good college-age readers reading diferent types of text.

TOPIC	FIXATION DURATION[a]	SACCADE LENGTH[b]	REGRESSIONS (%)[c]	WPM
Light fiction	202	9.2	3	365
Newspaper article	209	8.3	6	321
History	222	8.3	4	313
Psychology	216	8.1	11	308
English literature	220	7.9	10	305
Economics	233	7.0	11	268
Mathematics	254	7.3	18	243
Physics	261	6.9	17	238
Biology	264	6.8	18	233
M	231	7.8	11	288

[a] In msec.
[b] In character spaces (4 character spaces = 1° of visual angle).
[c] Percentage of total fixations that were regressions.

Rayner (1989)

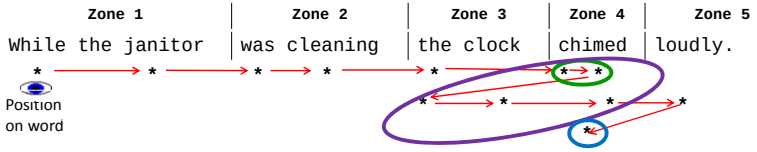
Word-level measures

Table 48.1 Dependent measures typically reported in eye movement studies examining word recognition processes. Early processing measures are often referred to as *first-pass measures*

Early processing measures	Definition
First fixation duration	The duration of the very first fixation on the target word during the first pass, irrespective of number of fixations
Single fixation duration	The duration of the first fixation on the target word if it only received one fixation during the first pass
Gaze duration	The sum of all first pass fixations on the target word
Skipping rates	The percentage of cases in which the target word is not fixated on the first pass
Later processing measures	
Spillover duration	The duration of the next fixation after a reader moves their eyes off a target word (usually excluding regressions from the target word)
Regression rates	The percentage of regressions into a target word (**regressions in**) or out of a target word (**regressions out**)
Second pass duration	The amount of time spent re-reading a target word after first pass reading
Total fixation duration	The total time spent reading a target word (a sum of gaze duration and second pass duration)

Juhasz & Pollatsek (2011)

Sentence-level measures



Range of measures with different implications for cognitive processing. For example:

Zone 4
"First Pass" = sum of two fixations (GREEN)
"Go Past" = sum of five fixations (PURPLE)

Second Pass (re-reading of sentence) = last fixation here but may involve many more. (BLUE)

Generate output

- Fixation reports
- Saccade reports
- Interest area report
- Trial report
- Interest period report
  - e.g. first 3 seconds, onset of a spoken word, before/after a button press)

VISUALISATIONS

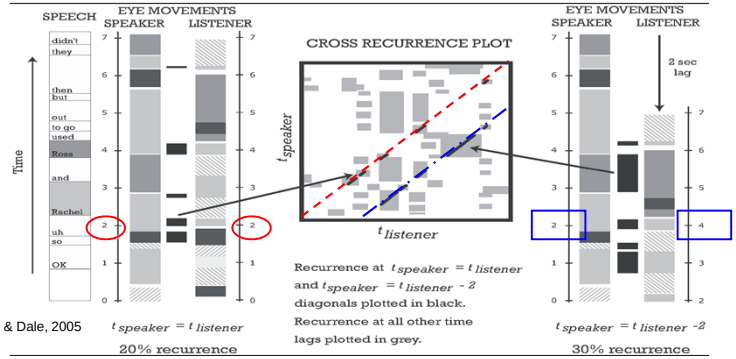
- Heatmaps
- Videos

Results

- Load reports into SPSS, R, whatever analysis package that you like.
- Crunch the numbers and you've done real science.

Alignment

Cross recurrence analysis



Richardson & Dale, 2005

Assistive technology / Augmentative & Alternative Communication (AAC)

Brain-Computer Interfaces (invasive or non-invasive)