The Aim For the Top University Project

Eyes can talk—
See the truth from eyes

Develop low price and multiplayer eye trackers

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National Taiwan Normal University

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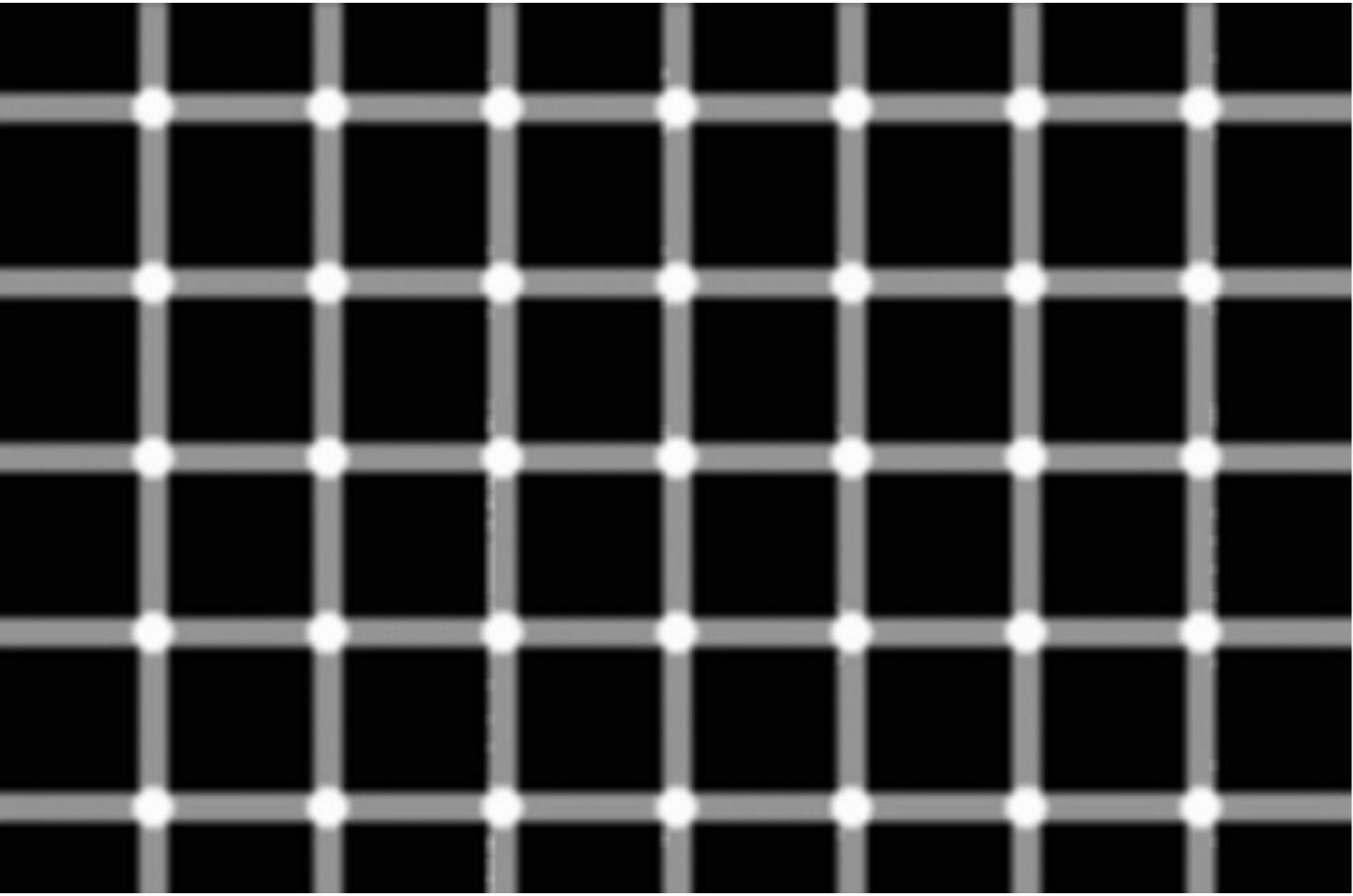
2015/03/23

What happen? Do you know?

- Foveo–peripheral illusion: scintillation effect produced by a variation of the standard Hermann grid illusion (attributed to L. Hermann (1870)), first discovered by Elke Lingelbach (at home). Adapted from Ninio and Stevens © 2000, Pion, London.



Web site of Our Lab

- https://sites.google.com/site/eyentnu/

Expensive Commercialized Eye Tracker

- Swedish eye tracker giant-Tobii (Apple as a major shareholder)
  - Head-mounted eye tracker-Tobii Glasses Eye Tracker
  - 30Hz。Only 30 or more of a second can detect rapid eye movement, less than 30 of a second is not detected
  - NT $ 1.8 million / sets

- German eye tracker giant SMI
  - iVIEW X™ HED is 200 Hz
  - NT $ 1.5 million / sets

Expensive and Uniplayer

- If for 50 people experiment
  - time-consuming
- Unable to engage in multiplayer experiments or cooperative research
  - Lacking pair or team learning

我們的硬體雛形

Our Eye Tracker
eyeNTNU-120
Hardware Scaffold

Eye Movement Data Analysis Software Tool

Software name	Main function	Project progress
Scan Path	Present gaze scan path	Completed
Hot Zone	Gaze hot zone colors	Completed
ROI Tool	Define region of interests conveniently	Completed
Fixation Calculator	Gaze statistical analysis	Completed
Saccade Analysis	Saccade scan path analysis	Completed

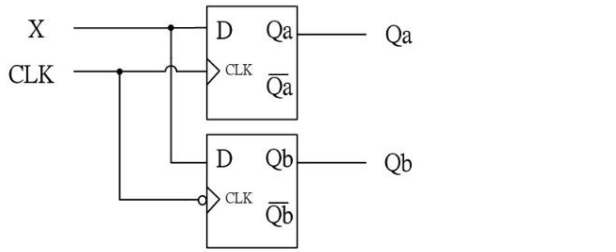
Precision Advantage

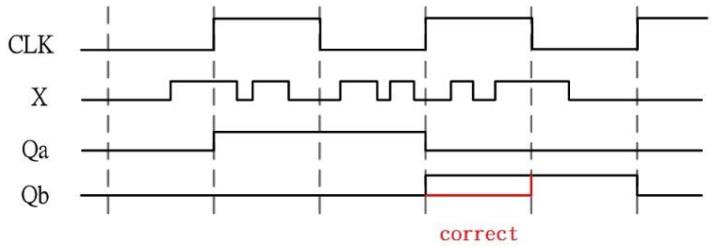
	Tobii (Adults)	Tobii (Infants)	eyeNTNU-120
Average deviation	1.27◦	1.22◦	0.3◦
SD (Standard Deviation)	0.73◦	0.44◦	0.4◦
Range (degree of angle error)	0.51 ~ 3.28◦	0.52 ~ 2.17◦	0.07 ~ 0.75◦

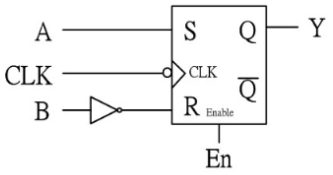
Price Advantage

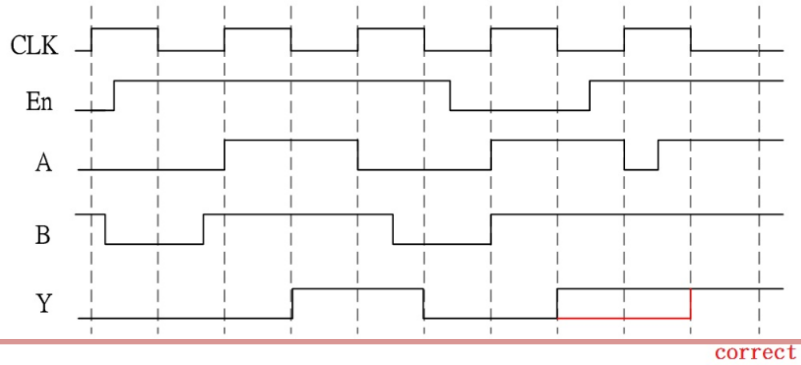
- Direct costs of R&D
  - about a few NT million
- Improve feasibility of simultaneous multiplayer usage
- Provide the world's leading research in multiplayer eye movement studies

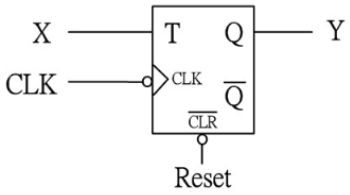
Application 1：Teaching





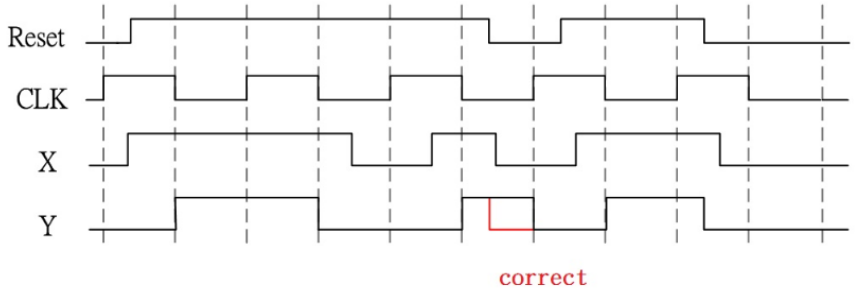


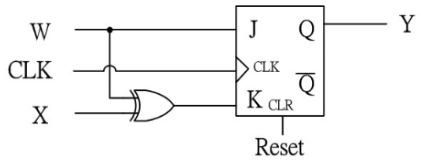




Function Table

T	Q_{n+1}
0	Q_n
1	$\overline{Q}_n$

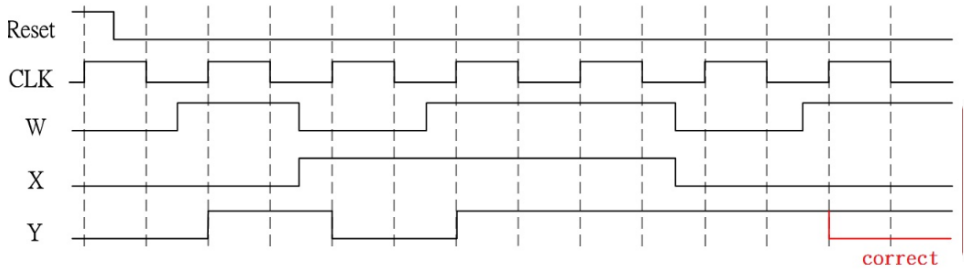




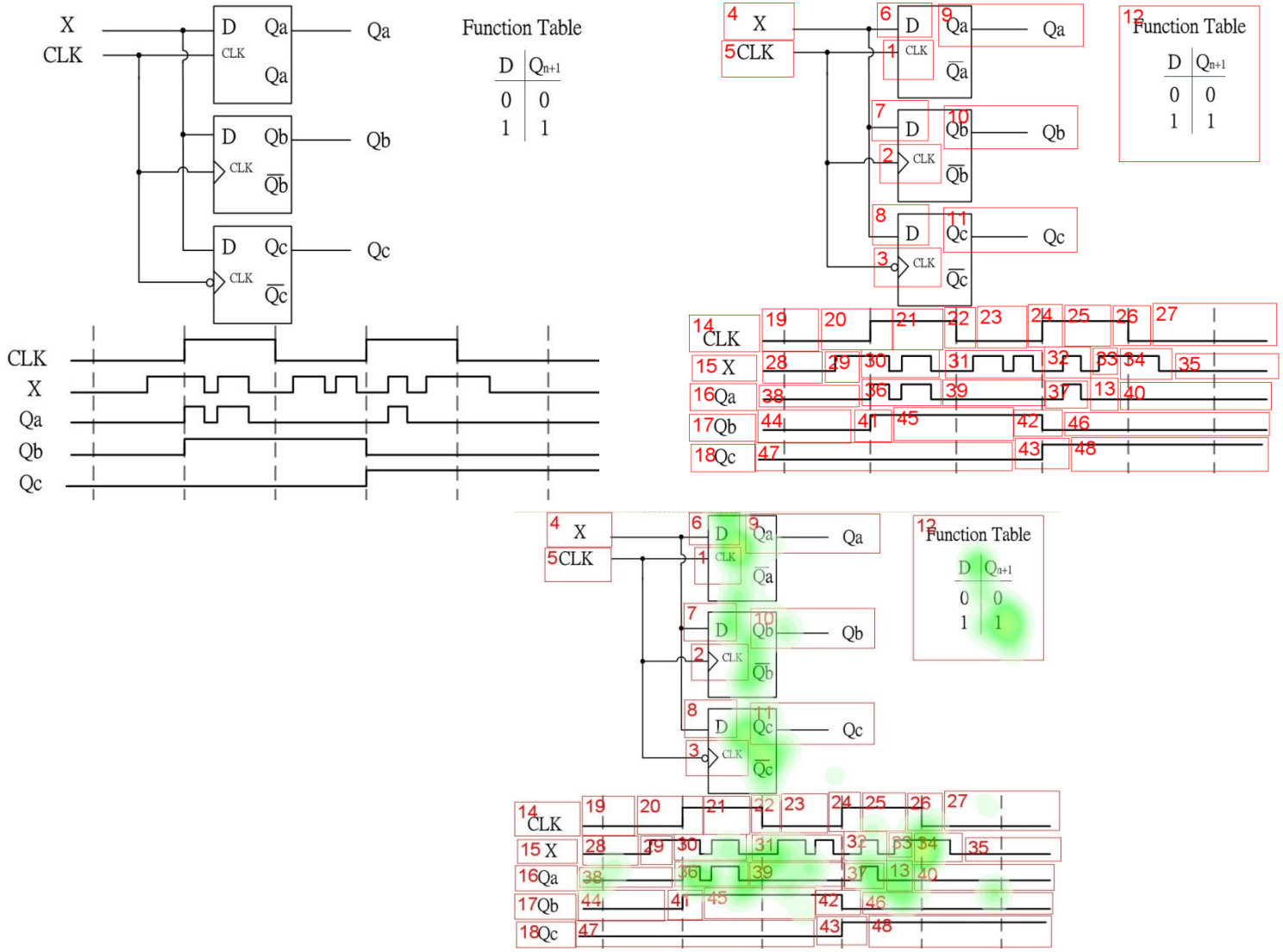
Function Table

A	B	F
0	0	0
0	1	1
1	0	1
1	1	0

J	K	Q_{n+1}
0	0	Q_n
0	1	0
1	0	1
1	1	$\overline{Q}_n$

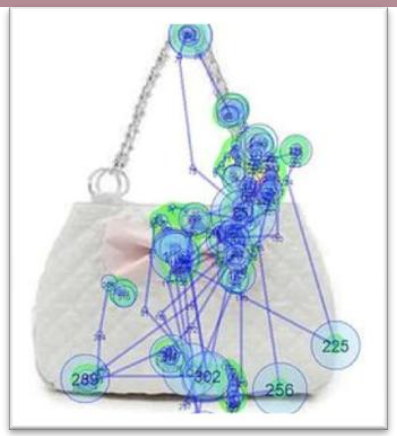


Reading Timing Diagram of Digital Logic Circuit



Application 2：Commercial Product

Women's Handbag and Gazing Pattern



Scan Path

Hot Zone

ROI Tool

	A	B	C	D	E	F
1	1	110	689	344	109	0
2	2	297	689	348	187	0
3	3	390	691	355	110	0
4	4	717	685	483	328	1
5	5	967	663	466	172	1
6	6	1185	641	468	202	1
7	7	1295	640	465	109	1
8	8	1498	647	455	125	1
9	9	1607	714	444	94	1
10	10	1732	718	441	124	1
11	11	1920	784	300	124	11
12	12	2045	784	297	109	11
13	13	2201	722	170	140	9

Fixation Analysis

Saccade Analysis

Knowing Consumers Better

- Graphic and fashion designer
  - more effective and time-saving to reach potential consumers
    - by understanding their viewing patterns
    - to design more attractive products
    - by stimulating consumer's desire.

Other Applications：Eye Tracking on Flying Fighter

Cooperative Research

We hope to cooperate with you for co-study, project proposal, design, experiment, analyze, and publish on SSCI

For your research interests, topics.

We provide:

- EyeNTNU experiment to your closest location.
- Experimental design discussions
- Experimental assistance (write software or apps for interested materials and staff training on devices)
- Data analysis (write software or apps if requested)
- Our team will rank next to you as a second author

New Opportunity ? Competitiveness ?

- Now we have eye trackers.
- We can assist in eye tracking experiments.
- Most researchers own one eye tracker, we have many sets.
- Analyze eye tracking data can be tough, we can assist.
- For your acknowledge field, new opportunities arise once added in eye tracking variables
- Used to do survey research, now we can use eye tracking instead.

Strategic Thinking, Idea

- Named any human eyes can see, EyeNTNU can try
  - E.g. Engineering, commerce, medicine
- Find ideas of existing SSCI papers, which did not use eye movement data
- Multiplayer eye tracking analysis

Brief on Published Research

- Not a detail report, but a rough one

- Please turn around for some children protected pictures

Memory span and contextual effects on lexical ambiguity resolution during Chinese sentence reading: evidence from eye movements

Graduate: Chih-yu Yang, Direct professor: Dr. Hwa-wei Ko

Graduate Institute of Learning and Instruction, National Central University

(2010, Master Thesis)

Abstract Given the fact that lexical ability and background knowledge play crucial roles in second language reading and yet less information is available for on-line reading processes, much empirical research is needed. In Study 1, 60 students of National Central University were tested in a read-aloud task. The results suggested that indices of both speed and accuracy significantly correlated with lexical ability, and accuracy could best represent for lexical ability. In Study 2, subjects' eye movements were monitored as they read scientific texts. The results indicated that lexical ability influenced the on-line reading processes, but background knowledge did not. Readers with higher lexical ability read faster, their forward and backward fixation duration was faster, and the regression rate was smaller. In addition, when subjects read twice, they had much reduced reading time, less fixations and longer forward saccade length in the second round. There was reading benefit. Overall, the eye movements of EFL college readers were quantitatively different from those of English native college readers.

Key words: polysemy, lexical ambiguity resolution, working memory, eye movements

Reading Ambiguity Result

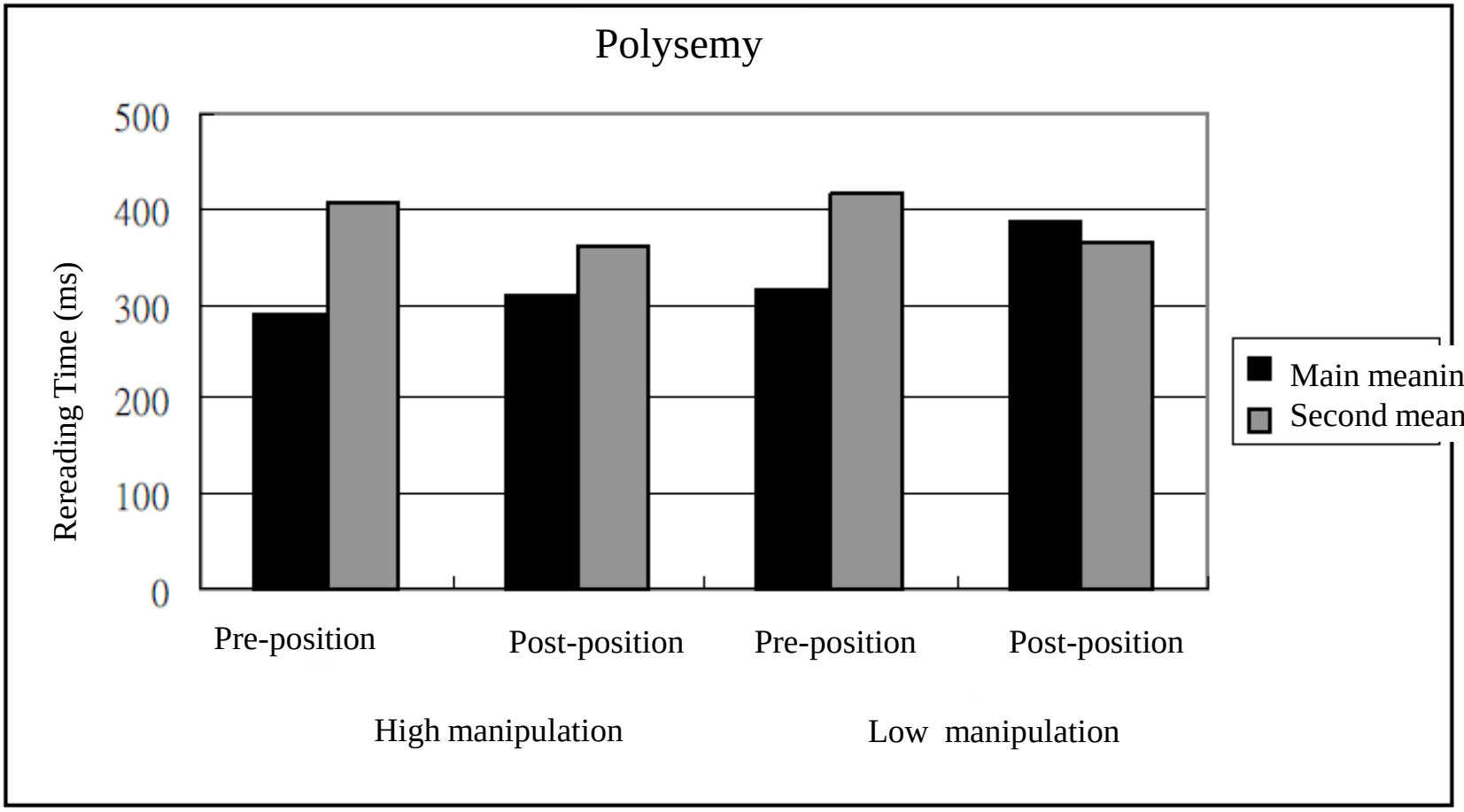


Figure 3-1-5 Polysemy bar chart on three RT variables, context position, relative frequency, and semantic manipulation

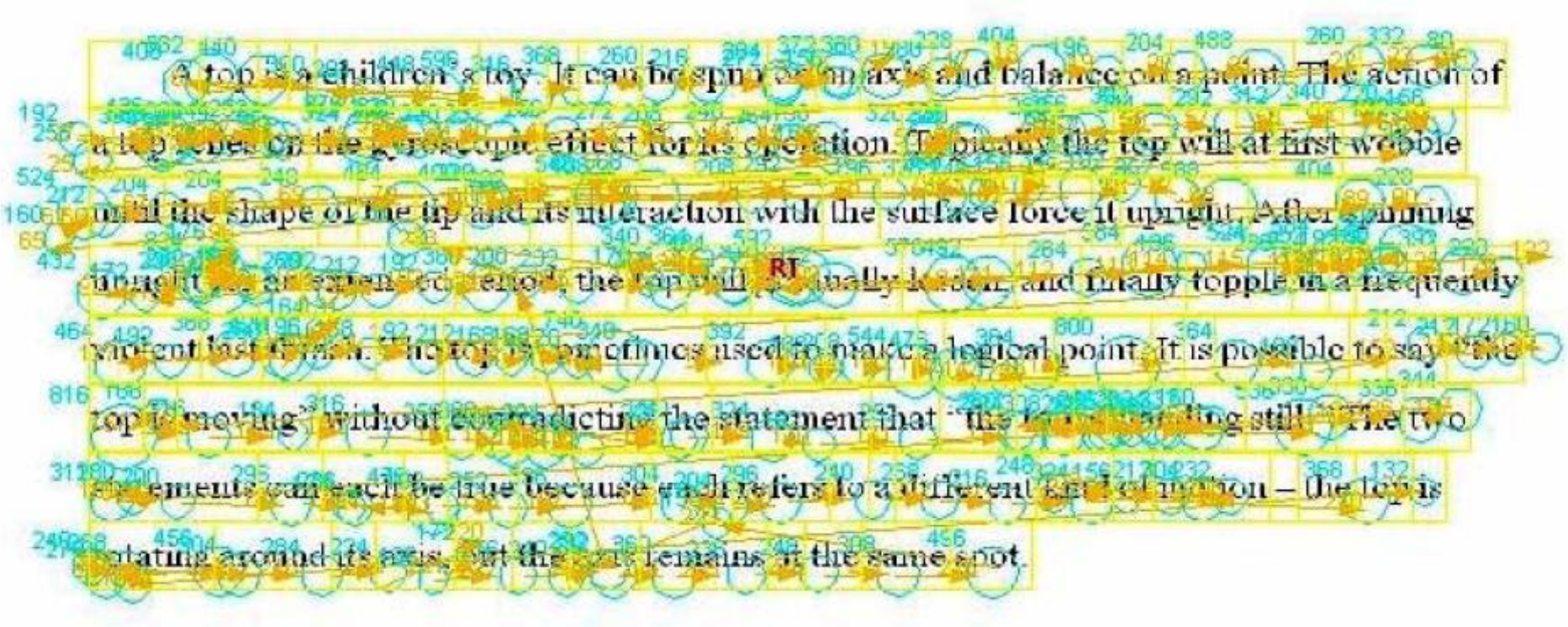
Analysis of EFL college students' eye movements

Postgrad student：Hsiao-Ting Tseng, Direct professor: Dr. Hwa-Wei Ko
Graduate Institute of Learning and Instruction, National Central University
(2006,Master Thesis)

Abstract This study examined the effects of using context to solve the lexical ambiguity in reading sentences by recording participants' eye movement. Variables such as the frequency (dominate and subordinate), the degree of meaning relatedness (high and low) of the ambiguous word, the location of disambiguating context (preceding and following context) and the participants' memory span were included in the study. Chinese Reading Span Test developed by Hue (1996) was administered to distinguish the memory span of participants. The purpose is to investigate how memory span influences reader's reading while they process the ambiguous word in a context supported sentence. This study focused on the influence of the location of disambiguating context in ambiguous sentences reading. If an ambiguous word is at the second part of the sentence (context-before condition), the preceding context serves as a prime to activate the meaning of the word. If an ambiguous word is at the first part of a sentence (context-after condition), multiple meanings of the word will be activated at different levels depending on the frequency and the degree of meaning relatedness of the ambiguous word. It was hypothesized that readers with low working memory span would suffer in the context-after condition. The results of the study provided experimental support for the location of disambiguating context, the frequency and degree of meaning relatedness of ambiguous words affected the reading processing of ambiguous sentences, and also revealed the different process depending on the individual's working memory capacity. The location of disambiguating context plays an important role in ambiguous sentences reading. In the context-before condition, all participants were not affected by the frequency and degree of meaning relatedness of ambiguous words. However, in the context-after condition, low working memory span readers were more affected by the frequency and degree of meaning relatedness when compared to high span readers, they fixated longer on disambiguating region. Based on these results, researcher suggested text writing to take advantage of the contextual location clues to help reading, especially for low memory span readers.

Keywords: Eye movements, lexical ability, background knowledge, reading benefit

Eye Movement Analysis Chart



Eye Movement Analysis Data

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20/23 21/24
400 440 340 204 448 596 368 260 216 304 372 360 980 228 404 196 204 488 260 332/220 80/156

A top is a children's toy. It can be spun on an axis and balance on a point. The action of

22/25 2627 28 29 30 31 32 33 34 35 36 37 38 39/46 47 48 49 50 51 52
192/256 436 442 224 484 220 232 150 272 206 240 292 190 320/256 200 280 292 342 340 156

40 41 42 43 44 45 53 54 55 56 57
324 320 540 268 254 196 456 224 220 402

a top relies on the gyroscopic effect for its operation. Typically the top will at first wobble

5859/65 6061/6667 62 63/68 64/69 7071 7273 67/74 75 76 77 78 79 80 81 82 83/89
524212/224 204176//240136 184/299 200/233 340 364/532184 208/156 352/148 384 362 588 524 584 932 220/392

until the shape of the tip and its interaction with the surface force it upright. After spinning

84 85/90 86 87 88/91 92 93 94 95 96 97 98 99 100 101 102103 104 105106
432 240/472 176 268 212/360 200 202 190 484 592 225 576 432 264 136 524 382 292 392 220

upright for an extended period, the top will gradually lessen, and finally topple in a frequently

Study Result Comparison

Appendix 5 Result compared with Lefton et al. (1979)

	Lefton et al. (1979)				Result (2006)	
Grade	Third	Fifth (Good)	Fifth (Poor)	College	College (Skilled)	College (Less-skilled)
Word Count	62	118		200	134	
Reading Speed (WPM)	87.4	146.9	95.0	184.2	93.4	69.5
Gaze Times	68.6	108.8	130.8	167.4	211	301
Gaze Time (ms)	458	249	497	272	414	450
Gaze Word Count	4.8	5.9	4.9	7.2	4.6	4.0
Return Gaze Times	18.7	17.8	51.1	35.1	64	117
Return Gaze Time	423	197	521	260	562	640
Regression Rate	21%	14%	28%	17%	23%	28%

Social Stimulation Scan Path Differences Between Normal and Autistic Individuals

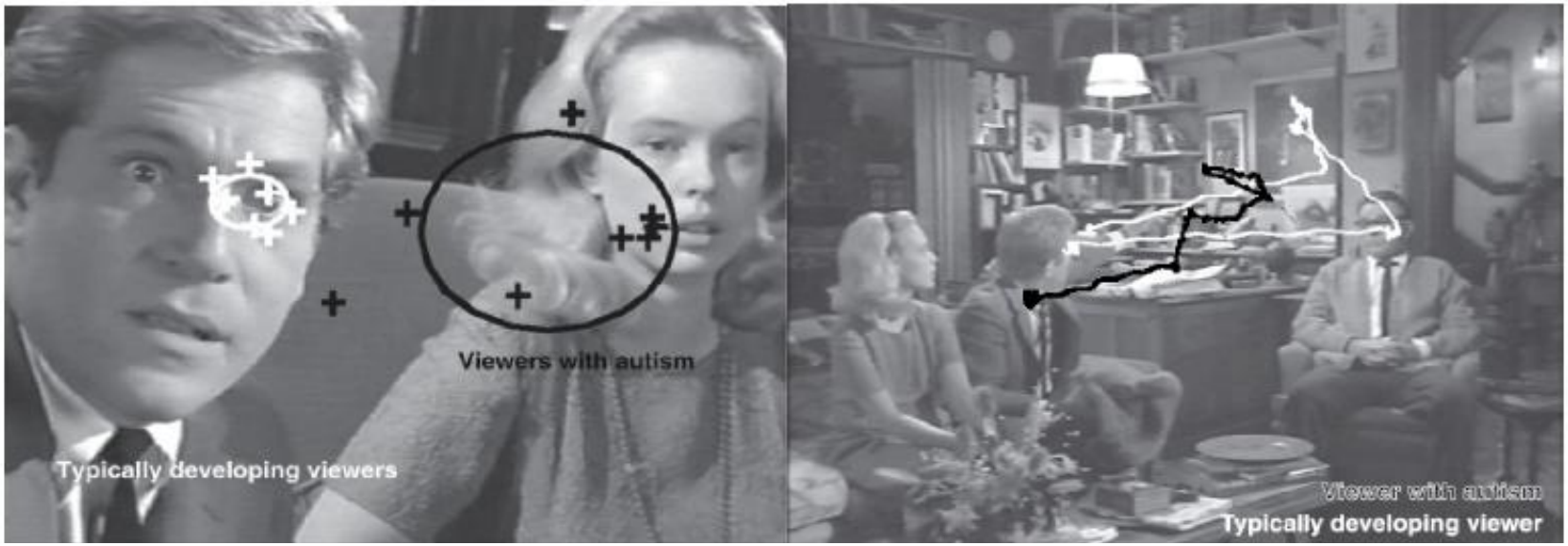


Figure 5 Social stimulation scan path differences between normal and autistic individuals

Resource: Klin et al. (2003)

Applying the eye-tracking approach to the study of information attention and decision bias

Postgrad student：Chiung-Wen Hsu, Direct professor: Dr. Feng-Yang Kuo
Department of Information Management, National Sun Yat-sen University

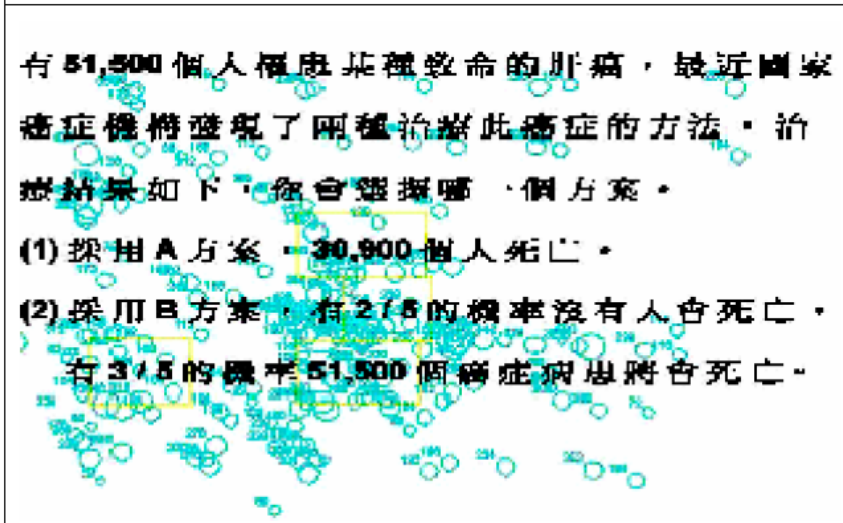
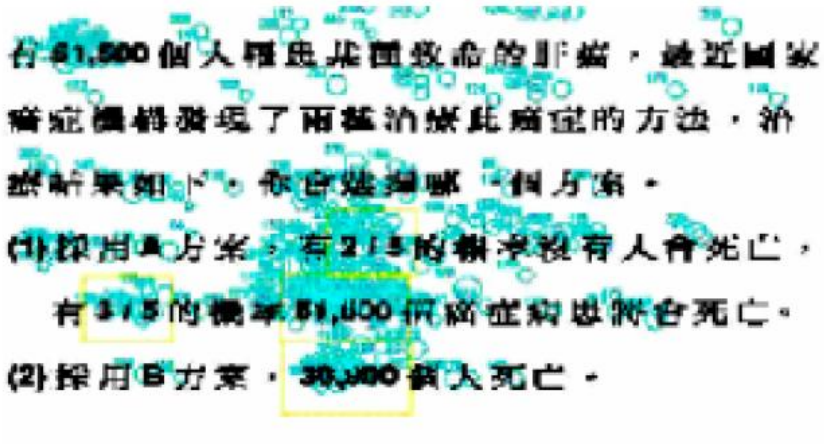
(2007,Doctor Thesis)

Abstract Based on the Prospect Theory by Kahneman and Tversky (1979) and the Impression Formation Theory by Fiske and Neuberg (1990), this research examines decision makers' information attention for subjects who are required to judge under framing. The eye-tracking technology is applied to evaluate decision makers' information attention. The results indicate that, as predicted by the Prospect Theory, the effect of framing is observed in both positive and negative framed conditions. Overall, the study finds that subjects in negative frames exert more effort in information attention than those in positive frames. Concerning the effect of the need for cognition (NC) trait in negative framing conditions, the finding shows that subjects who have a higher level of NC exert more effort in information attention than the low NC subjects. In addition, subjects with high a higher level of math ability focus exert more attentional effort on possible outcomes and probabilities in positive framing but not in negative framing. Finally, the result shows that there is no relationship between information attention and the framing effect, indicating that the framing effect is resilient to the influence of information attention effort induced by both the personality traits like NC and the mechanism like deep thought. Collectively, these results pave the way for future research to study cognitive processes under framing so that we can understand how different information representations may increase or lessen the effect of framing.

Keywords decision bias、framing effect、eye-tracking、information attention、perceptual process、cognitive process

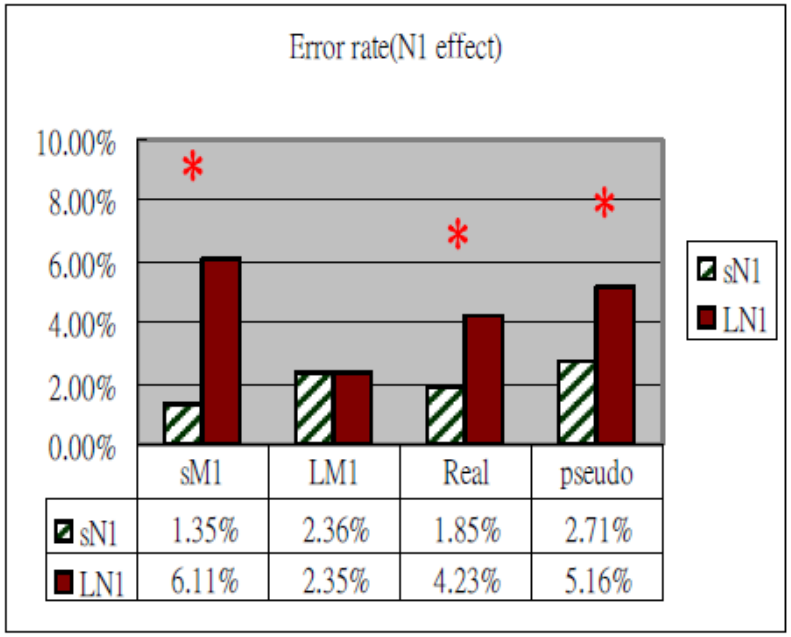
Example of the Experiment

Table 4-18 Eye tracker data and verbal data among testers

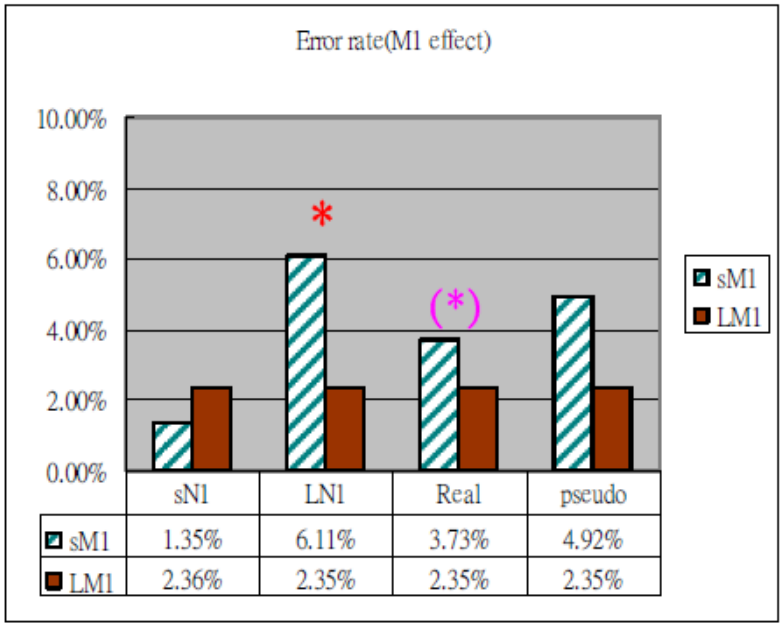
Eye tracker data	Verbal data
	我選擇第一個方案，因為第二個方案比較起來它的平均存活機率比較大。 (沒有框架效應)
	選擇第一個答案，就是看有沒有機會，其實不一定比較大，若已經有確定性質的話已經無法改變了。 (產生框架效應)

Neighborhood size effect of Chinese word recognition in LDT and reading

Postgrad student：Ying-chun Lin, Direct professor: Dr. Ovid J. L. Tzeng and Dr. Jie-Li Tsai
Institute of Neuroscience, School of Life Science, National Yang-Ming University
(2007, Master Thesis)



(a)



(b)

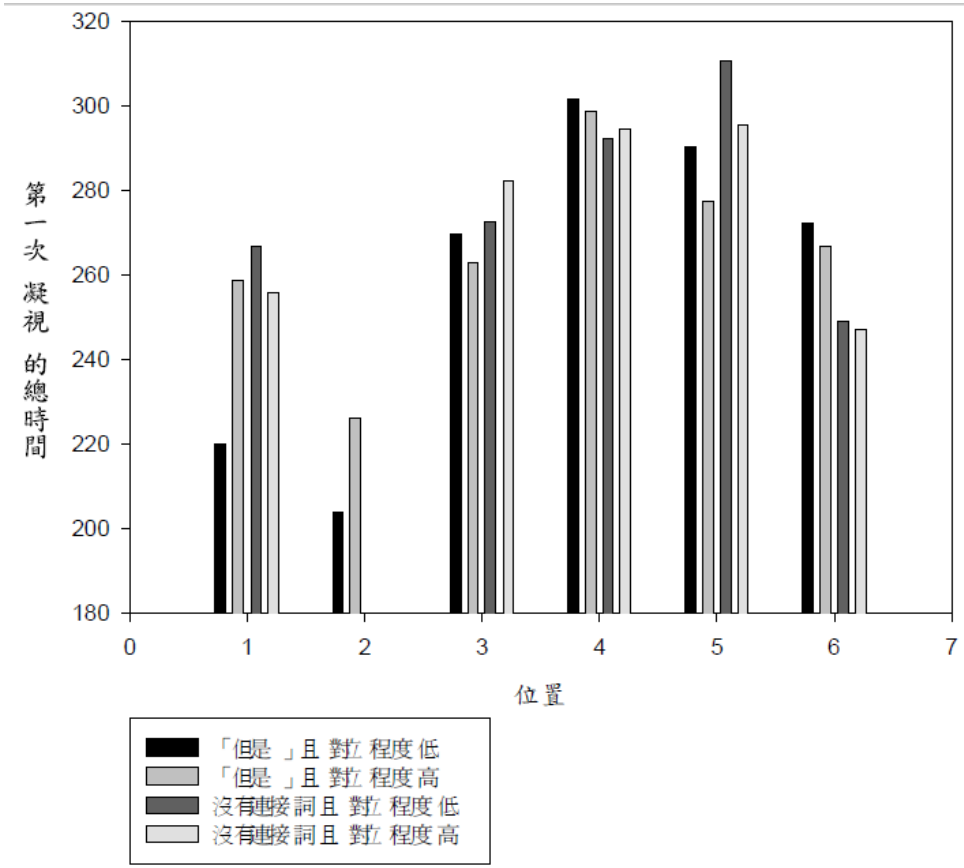
Figure 13 (a) Experiment 3 error rate: N1 M1 significant cross correlation, examined from N1

Figure 13 (b) Experiment 3 error rate: N1 M1 significant cross correlation, examined from M1

The relationship between connectives and reading processes: evidence from eye movements

Postgrad student：Yi-Ling Chan, Direct professor: Dr. Hwawei Ko
Graduate Institute of Learning and Instruction, National Central University
(2005, Master Thesis)

Abstract Three experiments examined the processes of connectives in sentence and text reading. The arguments about the processes of connectives are between delayed-integration hypothesis and incremental interpretation. According to delayed-integration hypothesis, readers process two clauses linked by a connective by interpreting each clause separately and combining them when they reach the end of the second clause. However, incremental interpretation considers semantic processing takes place incrementally. In the first experiment, adversative and causal connectives were found to be the most crucial in reading on the basis of a 5-1 scale rating. Afterward, readers' eye movements were monitored as they read sentences containing adversative connectives with different clausal semantic relatedness. The results showed readers spent more processing time on clauses with less semantic relatedness. Connectives could integrate clausal semantic information easily. There was no interaction between clausal semantic relatedness and connectives. Readers' first gaze duration on the end of second clause was not longer than any other content words. It seemed to indicate readers didn't integrate clauses at the end of the second clause. Readers integrated clause incrementally. In the third experiment, both adversative and causal connectives were inserted in text reading. The incremental interpretation was also observed These experiments support that connectives facilitate reading and readers integrate semantic units incrementally.



Mental imagery in problem solving: an eye tracking study

- Daesub Yoon and N. Hari Narayanan
- Intelligent and Interactive Systems Laboratory
- Department of Computer Science and Software Engineering
- Auburn University, Auburn, AL, 36849, U.S.A

- 2004, ACM ETRA Symposium Proceedings

Materials

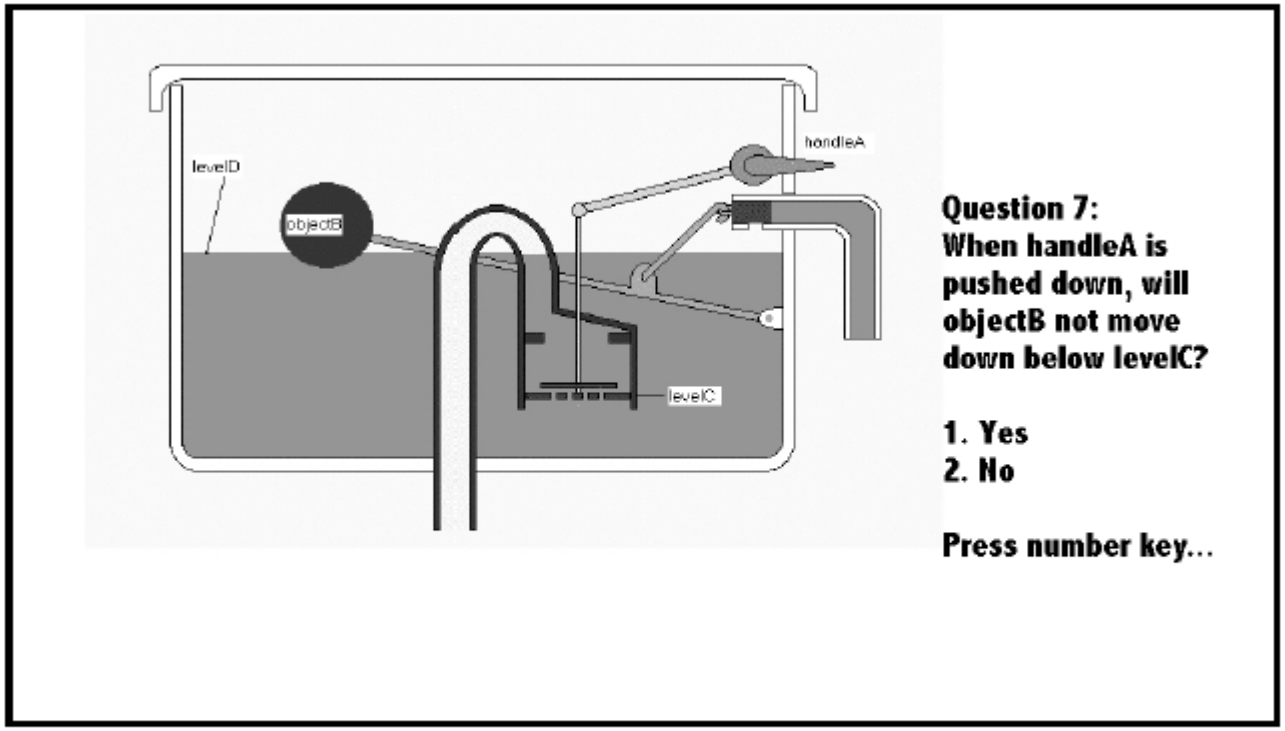
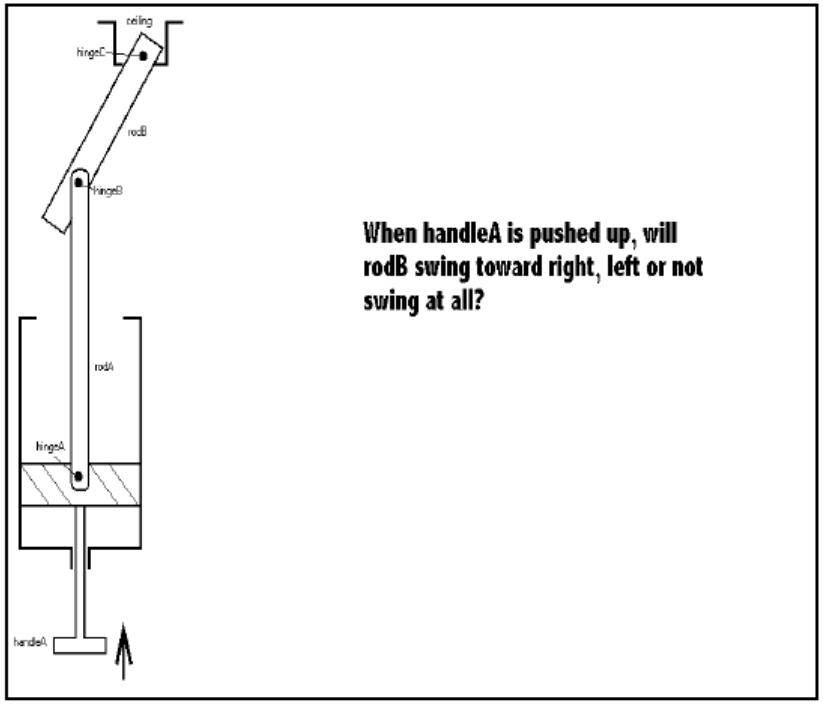


Figure 1. A visuo-spatial and causal reasoning problem.

Stimulus Display、Scan-path



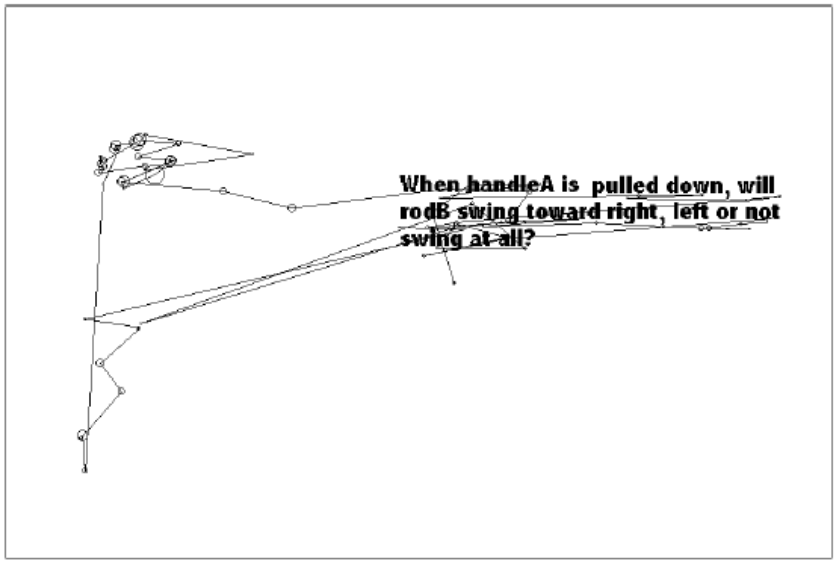
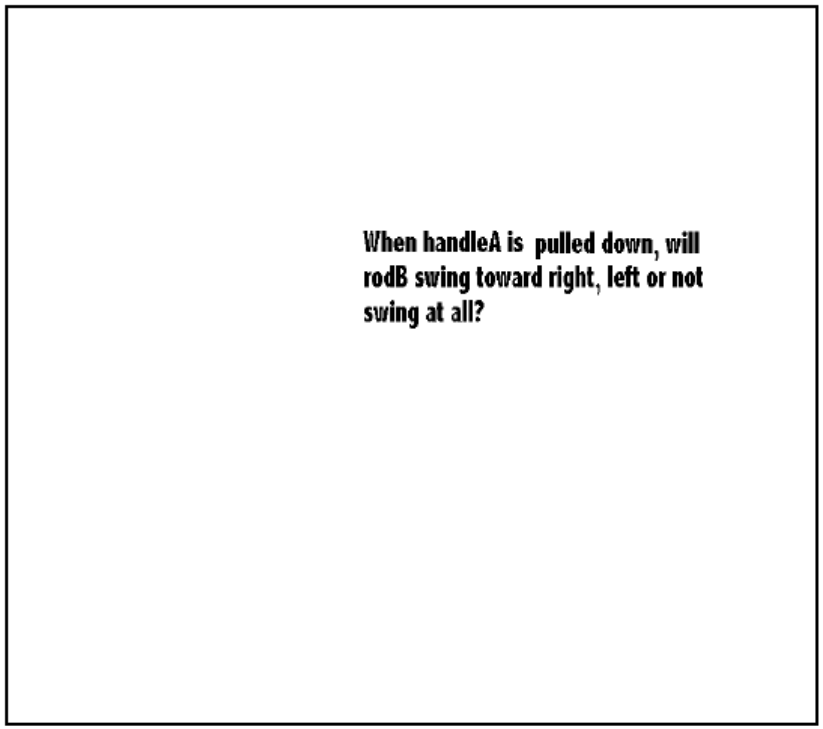


Figure 2. Stimulus display for the first problem.

Stimulus Display、Scan-path



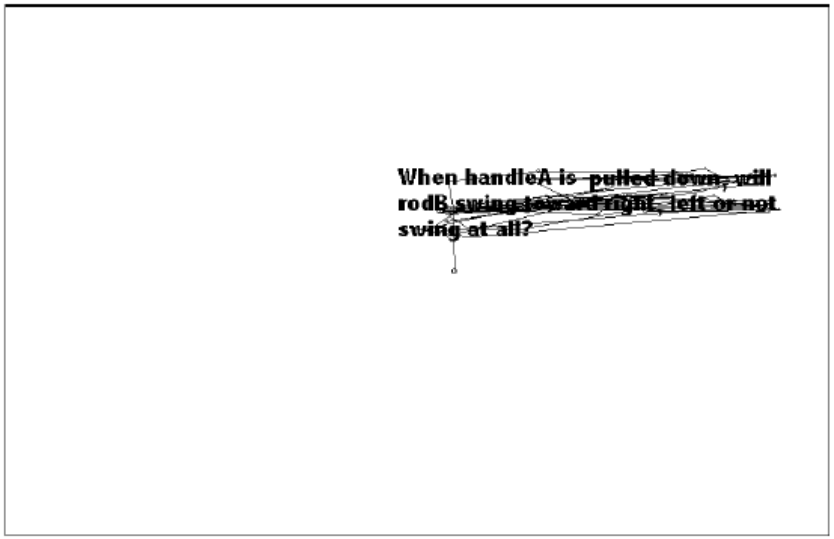
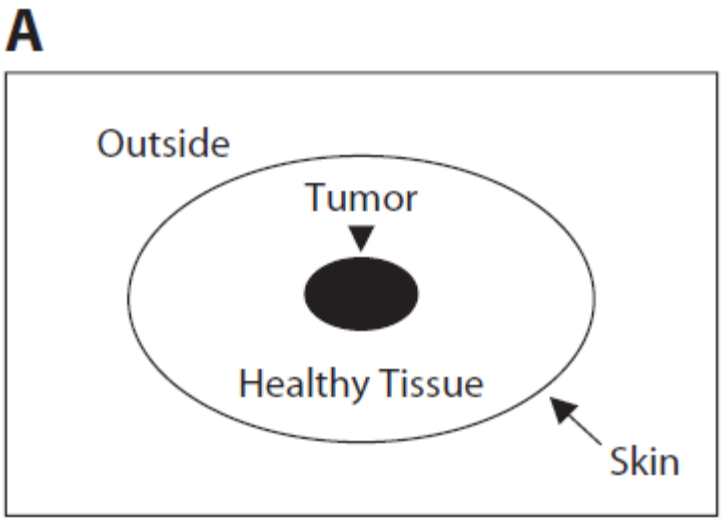


Figure 3. Stimulus display for the second problem.

Moving eyes and moving thought: on the spatial compatibility between eye movements and cognition

Laura E. Thomas and Alejandro Lleras
University of Illinois at Urbana-Champaign, Urbana, Illinois

Psychonomic Bulletin & Review
2007, 14 (4), 663-668



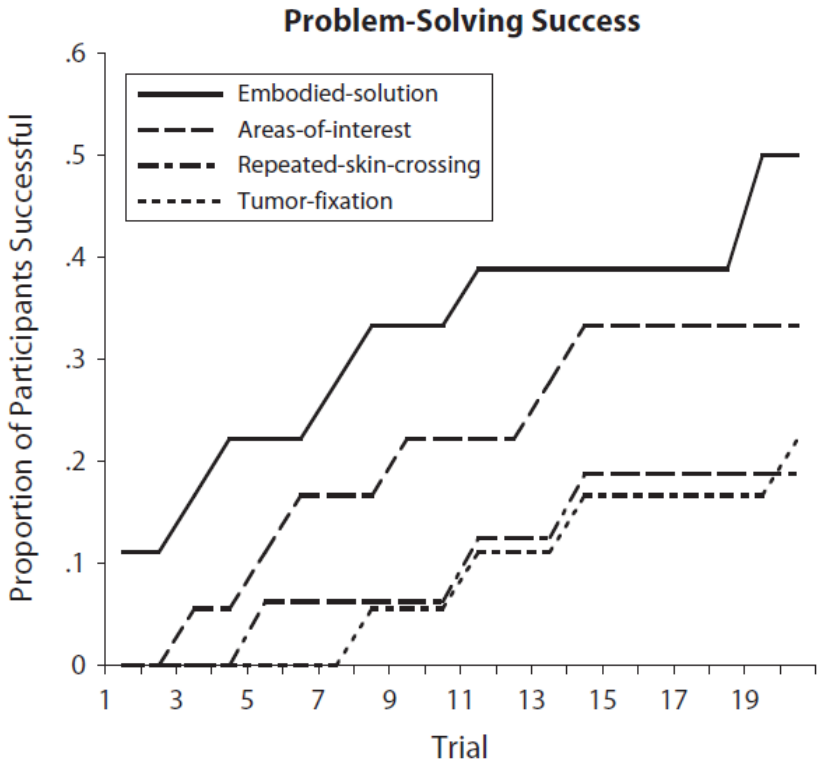


Figure 3. Proportion of participants in each group to successfully solve Duncker's (1945) radiation problem after each trial.

Application in e-learning

AdeLE (Adaptive e-Learning with Eye-Tracking): The System Architecture and Application Scenarios

by Christian Gütl, Maja Pivec, Christian Trummer, Victor M Garc, Juergen Pripfl, Martin Umgeher

Computer and Information Science › Miscellaneous Papers

Overview

References 51

Related research

IKNOW '04 (2004)

Volume: II(2005)

Available from www.eurodl.org

by exploiting real time eye-tracking and content-tracking analysis

Eye Movements in Language and Cognition: A Brief Introduction

- Daniel C. Richardson
  - Department of Psychology, Stanford University
- Rick Dale
  - Department of Psychology, Cornell University
- Michael J. Spivey
  - Department of Psychology, Cornell University

Eye Movements Disclose Decisions in Set

Joost Broekens [a] Walter A. Kosters [b] Timo de Vries [b]

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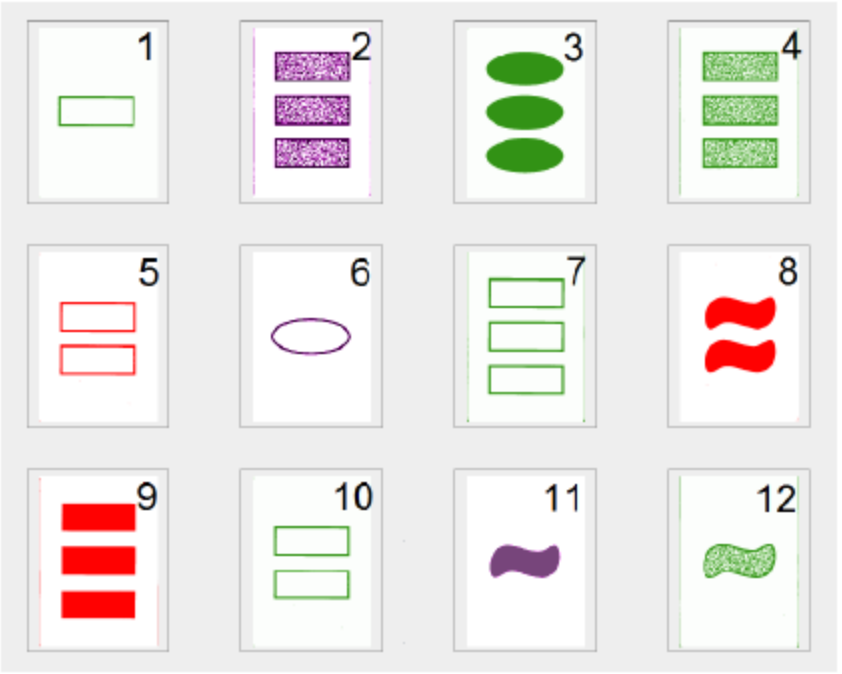
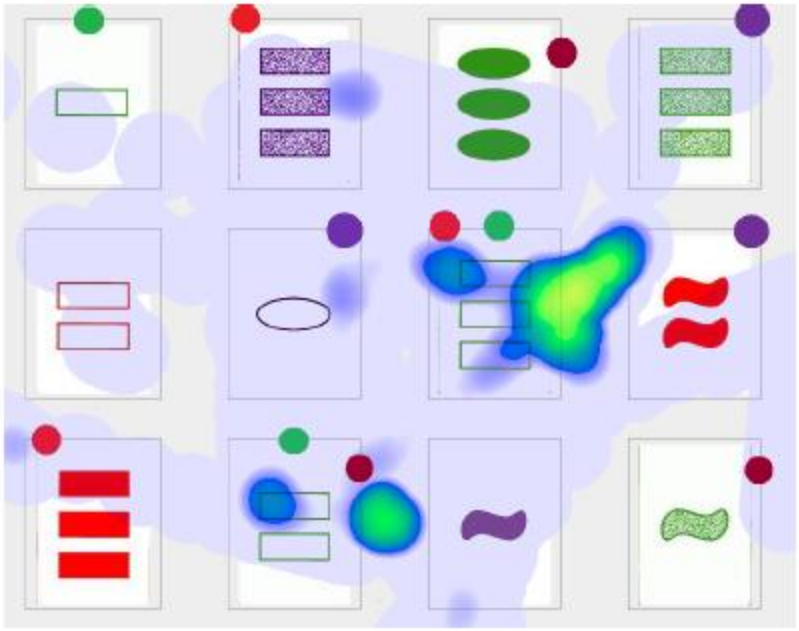
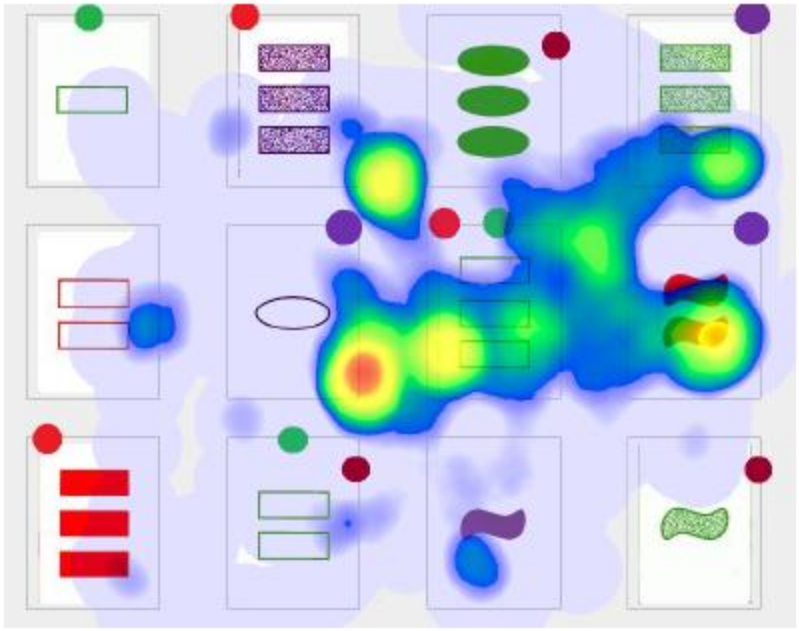
[b] *Leiden Institute of Advanced Computer Science, Leiden University, The Netherlands*
kosters@liacs.nl, vriestimo@gmail.com

Game

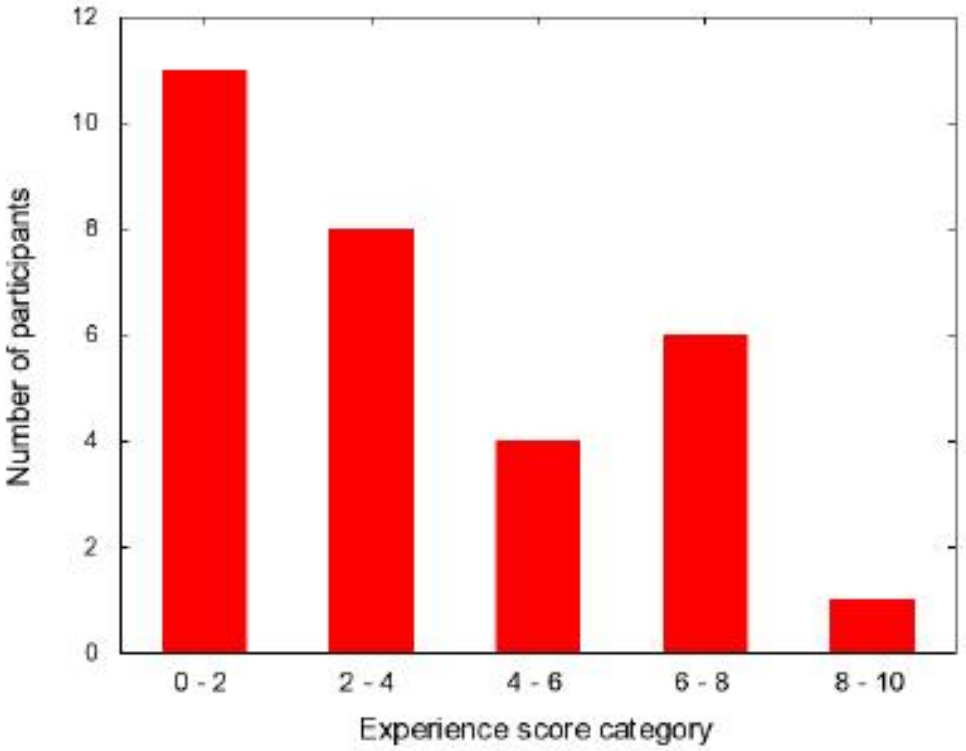


Hot Zone





Score and Facility



Eye movements on restaurant menus

International Journal of Hospitality Management 31 (2012) 1021–1029

Contents lists available at SciVerse ScienceDirect

International Journal of Hospitality Management

journal homepage: www.elsevier.com/locate/ijhosman

Eye movements on restaurant menus: A revisitation on gaze motion and consumer scanpaths

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Cornell University, School of Hotel Administration, G80p Statler Hall, Cornell University, Ithaca, NY 14853, United States

Previous Industry and Conventional Research

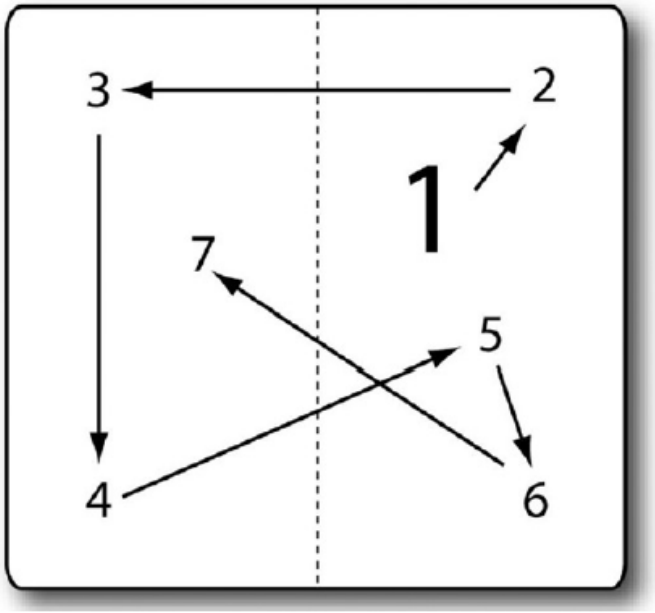


Fig. 1. Two-page scanpath (industry convention).

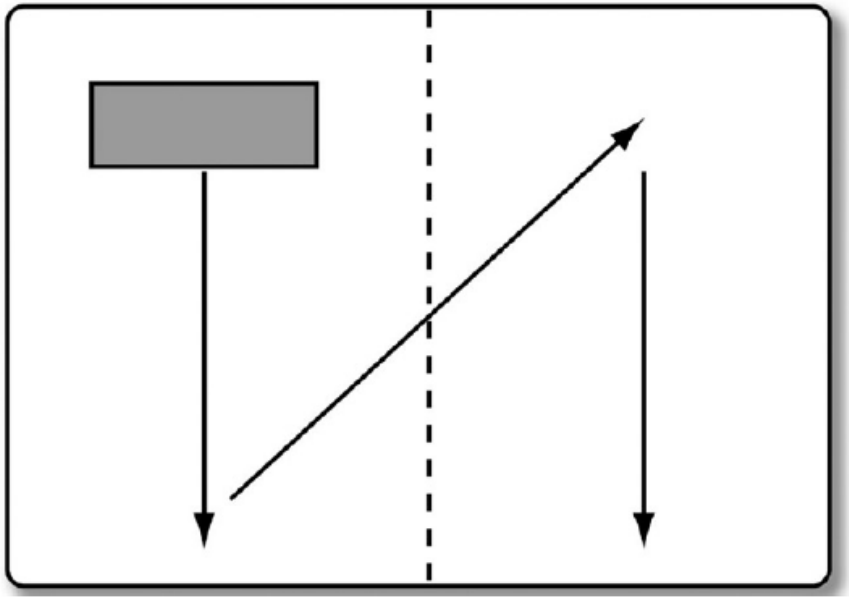


Fig. 3. Two-page scanpath (Gallup report).

Best Region and Experiment Divided Area

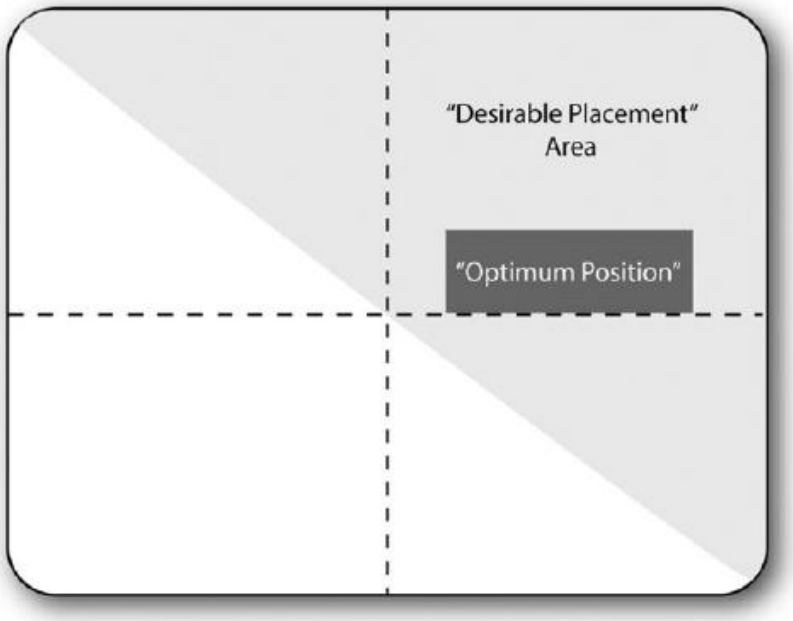


Fig. 2. Two-page menu focal areas (Doerfler).

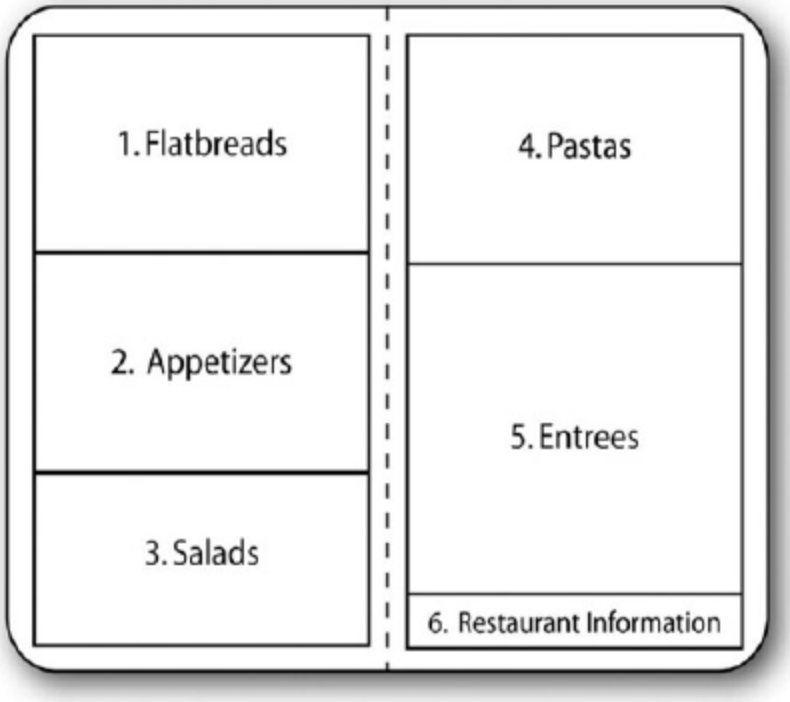


Fig. 4. Map of stimulus menu.

Menu Area	Total Fixations	Fixation Duration (sec)		Fixation Duration/Word (ms)		Fixations per Person		
		Mean	StDev	Mean	StDev	Median	Mode	Mean
1	47	21.7	19.8	434.1	396.4	2	2	1.9
2	50	24.7	18.3	385.9	286.6	2	2	2.0
3	27	18.9	14.3	394.4	297.2	1	1	1.2
4	46	26.6	20.3	345.1	264.3	2	2	1.7
5	51	42.6	36.5	409.3	350.8	2	2	1.8
6	9	5.1	3.0	183.0	108.5	0	0	0.3
Entire Menu		238.7	82.3	385.8	320.5	9	8	0.0

Fig. 5. Summary statistics of menu area fixation measures.

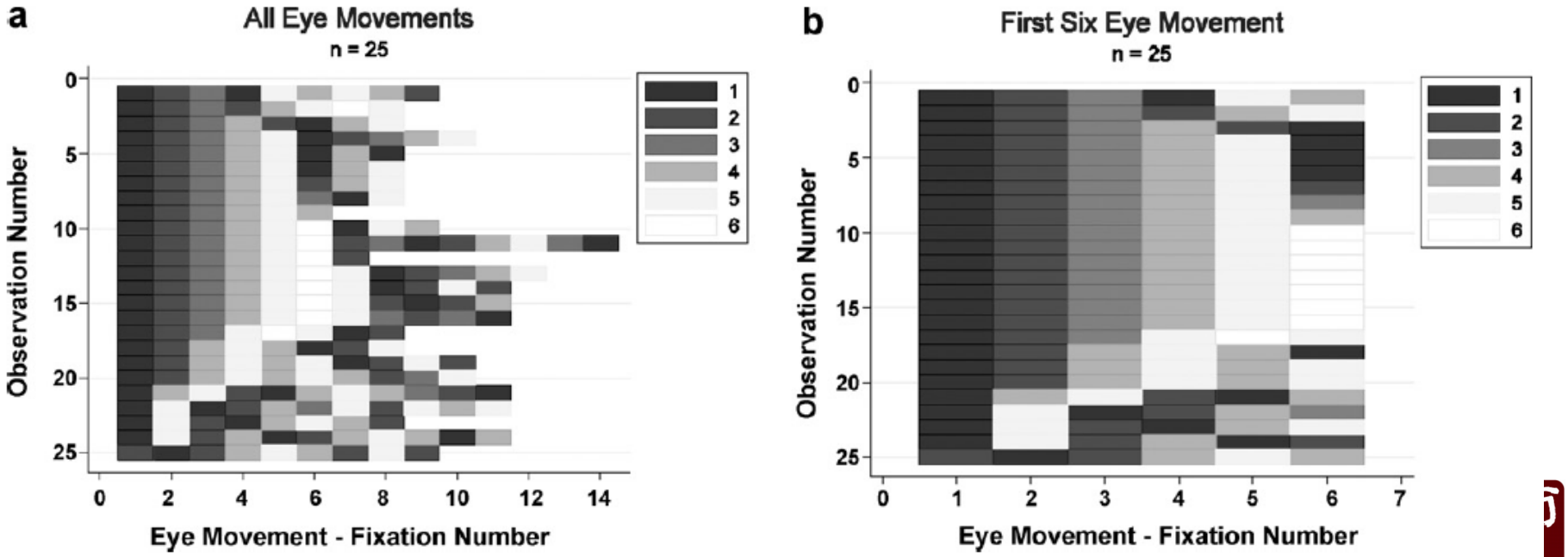
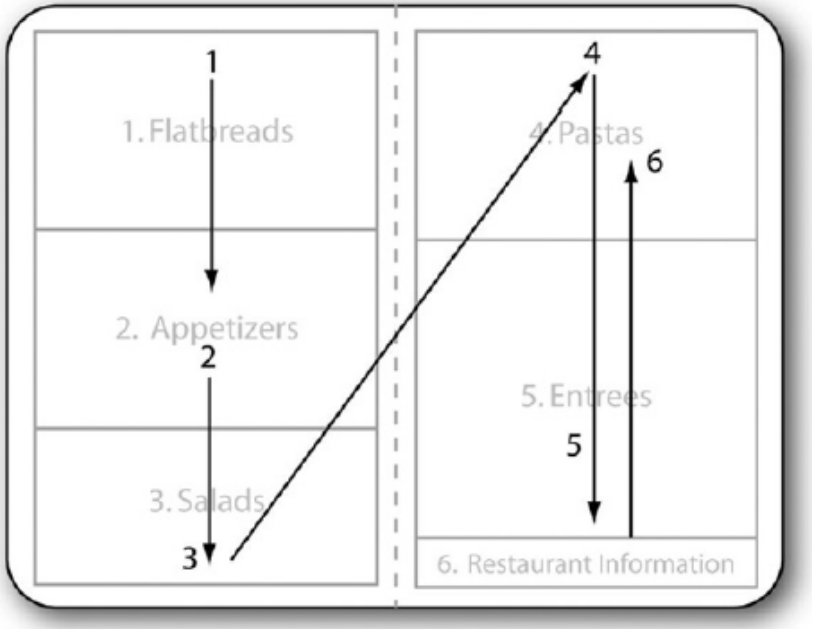


Fig. 6. Eye movement sequence by menu area.

Results



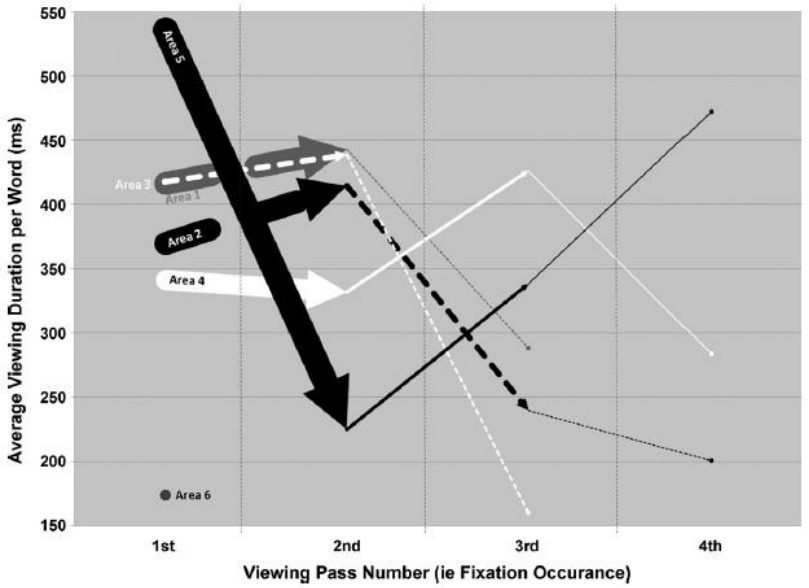


Fig. 8. Average gaze motion sequence by menu area.

EyeDraw: Enabling Children with Severe Motor Impairments to Draw with Their Eyes

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Eugene, OR 97403 USA
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Anna Cavender
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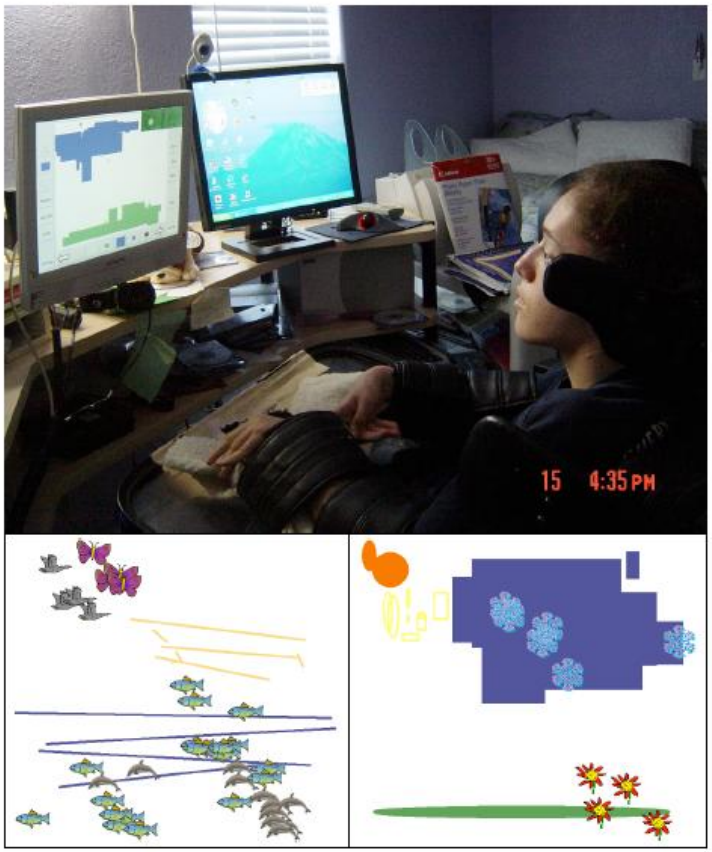

Famous Web Analytic (Taobao.Com)

2010 International Conference on System Science, Engineering Design and Manufacturing Informatization

An Evaluation Research on Usability of Taobao's Homepage and Main Search Engine Based on Eye tracking

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Fei Qian
User Experience Design Group
Taobao (China) software Co.,Ltd
Hangzhou, China
xiaoqian@taobao.com

Figure 1. *The first-30-second hot spot diagram of the homepage*

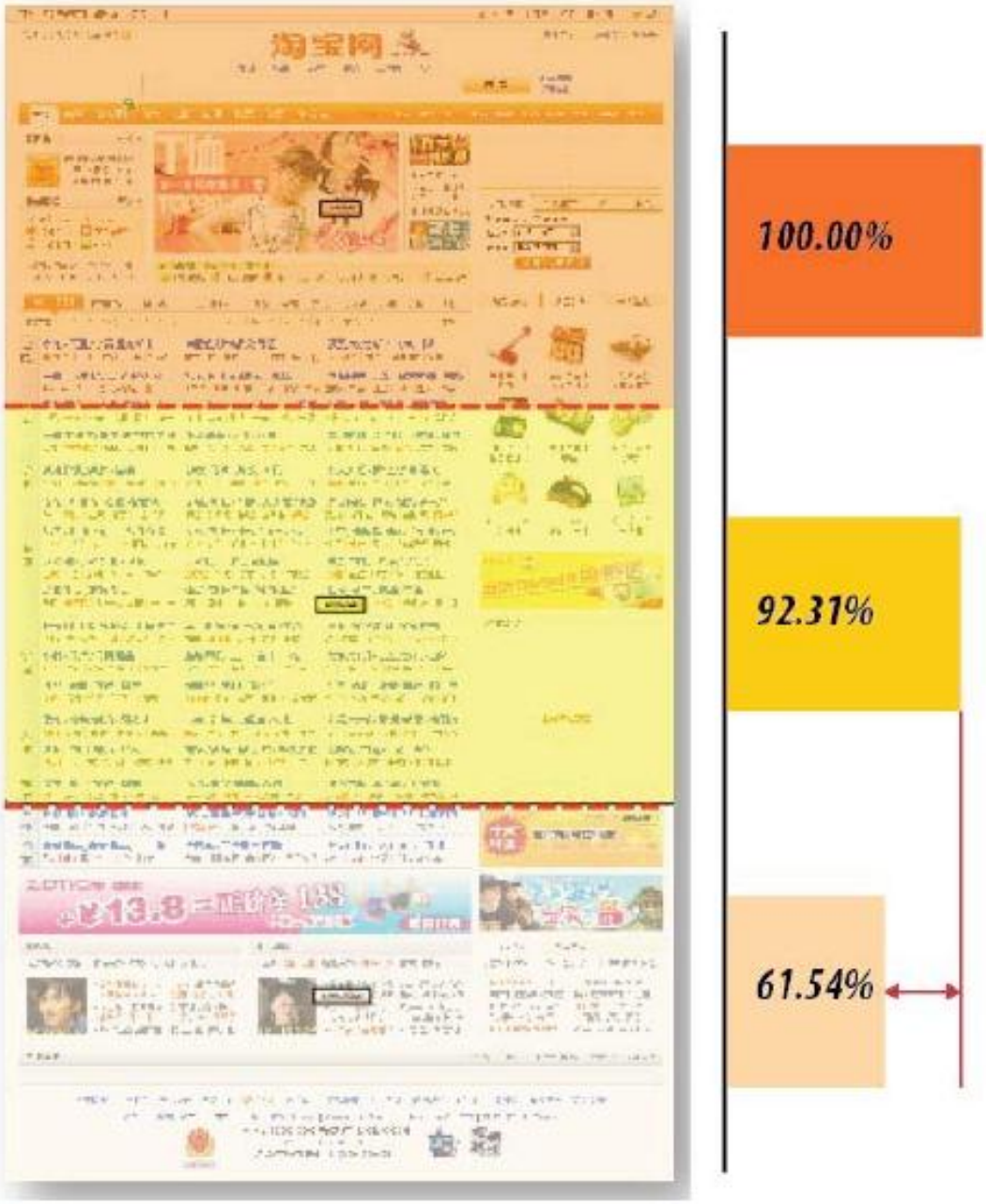

Figure 2. *The decrease in three folds of homepage*

Figure 3. *the habits of the female and male users*

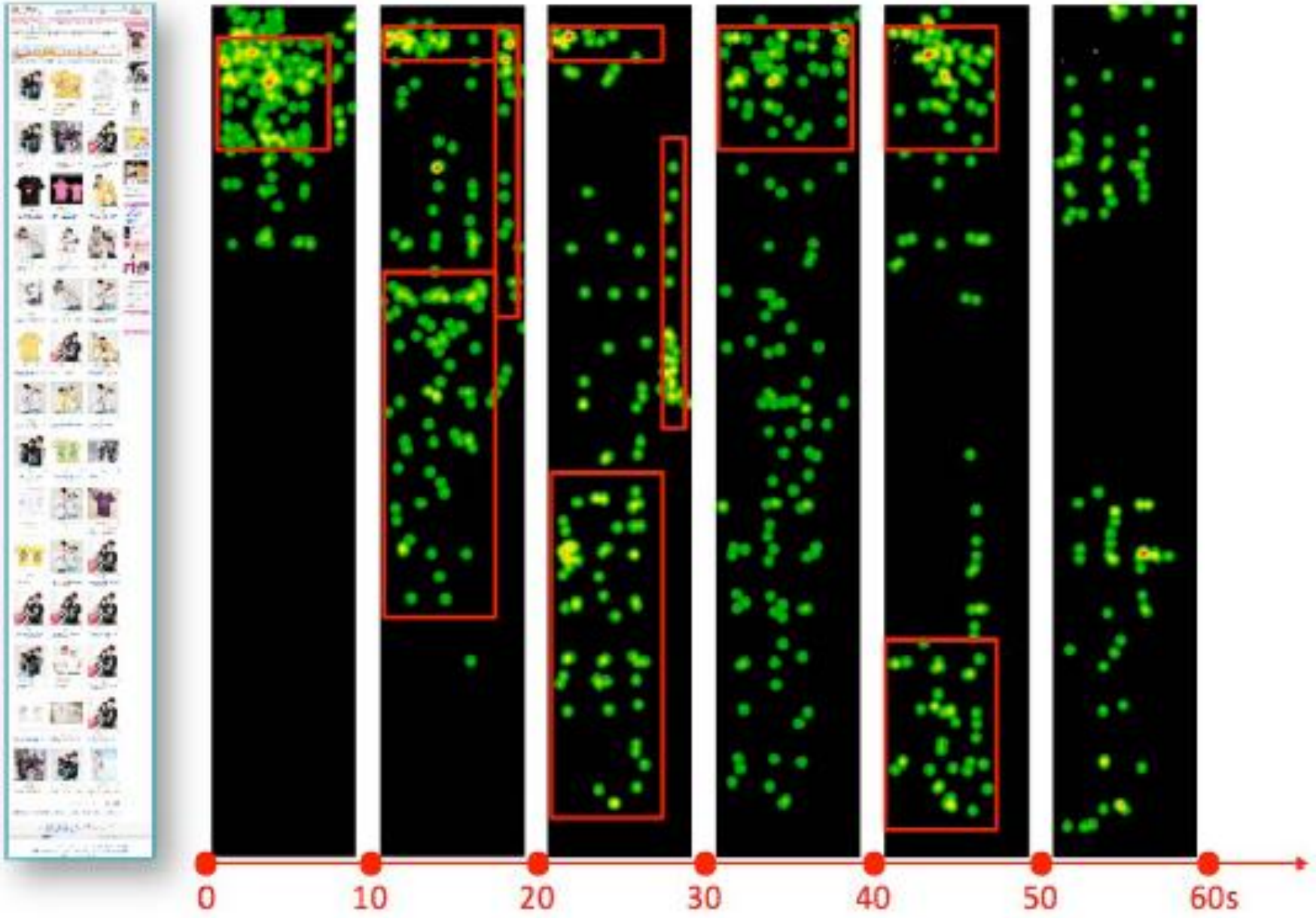

Figure 5. *the hot-spot shift presents the n-shaped*

satisfactory.

Figure 4. *the pull-down recommendation*

Figure 6. *the visual browsing habit*

Figure 7. *the diagram of picture position importance sequence*

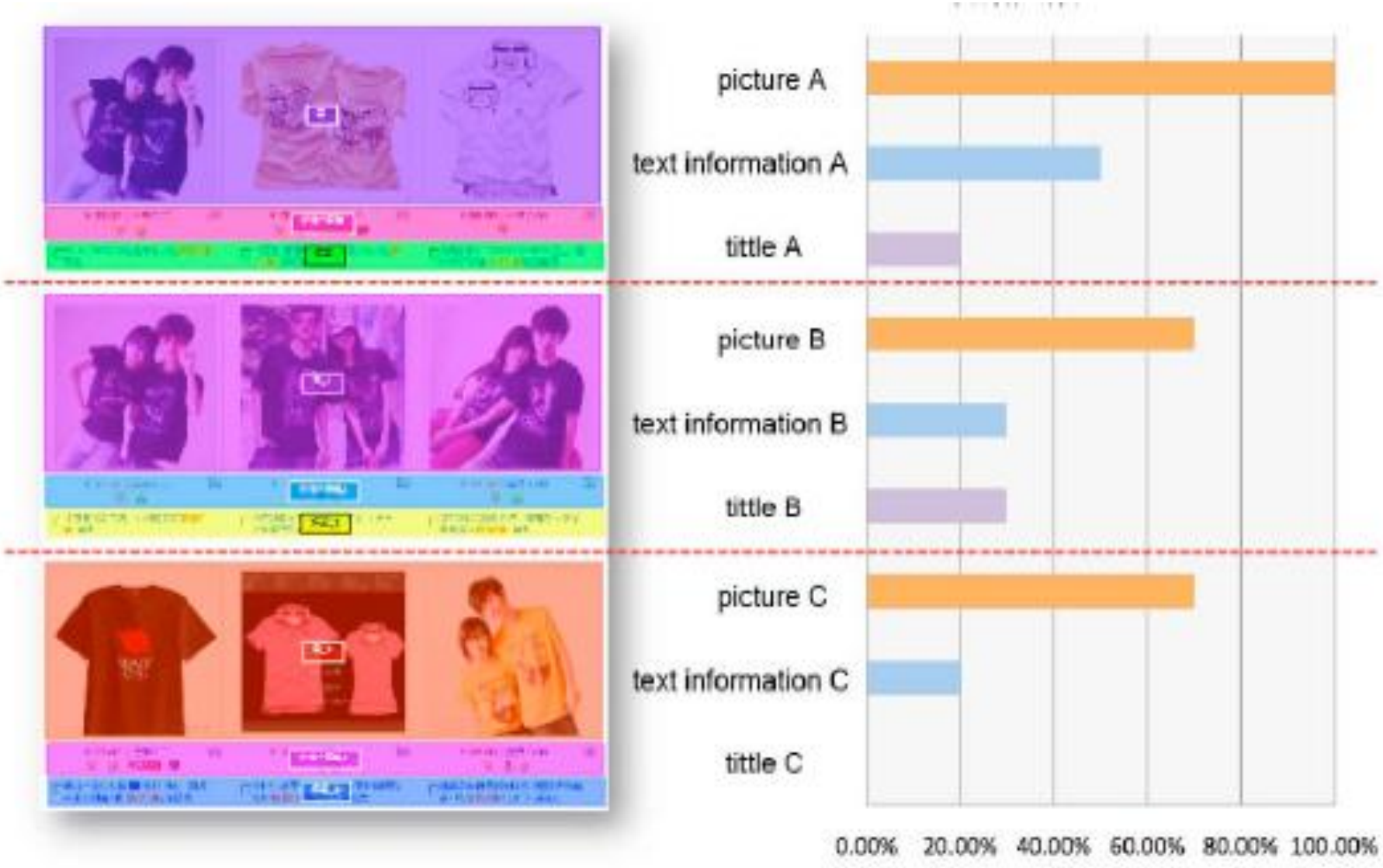

Figure 8. *Observation & comparison of picture and text information*

2011 Statistics on Reading

Proceedings of the 2011 IEEE/ICME
International Conference on Complex Medical Engineering
May 22 - 25, Harbin, China

The Impact of Different Forms of Statistical Information on Reading Efficiency, Effect, and Mental Workload: An Eye-tracking Study

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Maebashi-City, Japan
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3 *The School of Computer and Communication Engineering*
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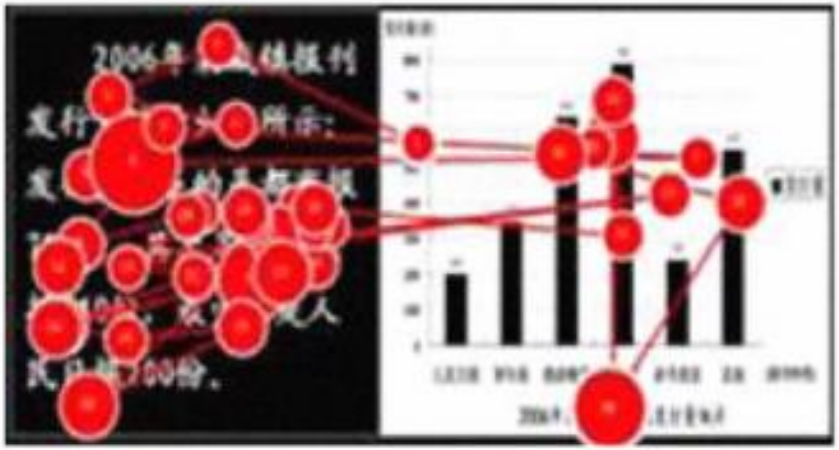
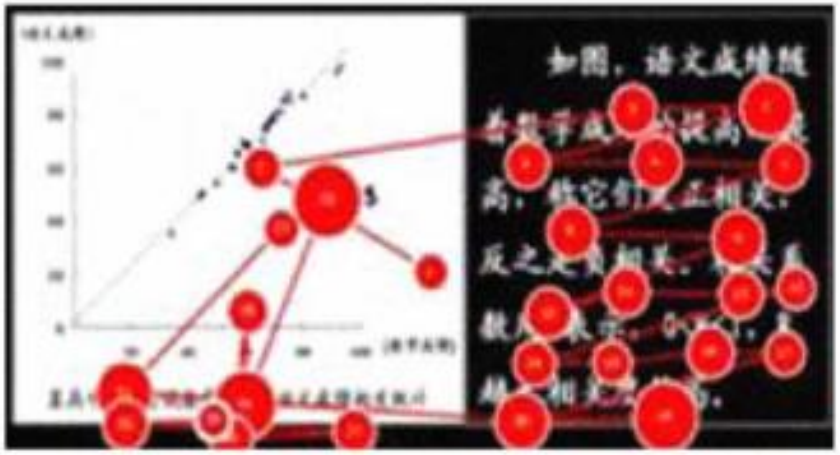
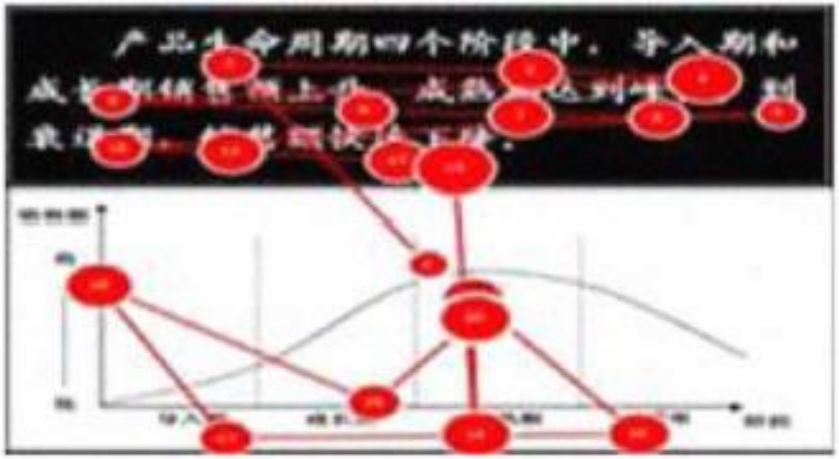


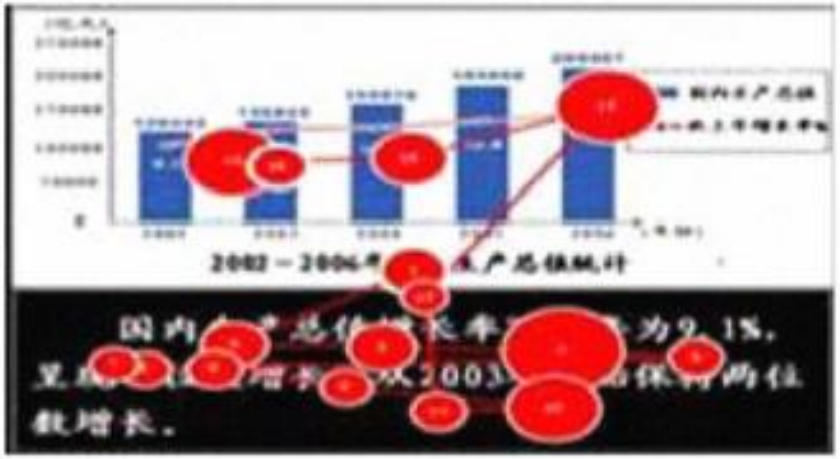
(a) text-left



(b) text-right



(c) text-upper



(d) text-lower

2003 Eye Tracking Supports Second Language Learning

Eye Movement Tracking to Support the Second Language Learners' Self-Learning in Comprehension of English Texts

Hidehiko Hayashi, Tutomu Maeno, and Susumu Kunifuji

School of Knowledge Science, Japan Advanced Institute of Science and Technology (JAIST)

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Perceptually optimised sign language video coding based on eye tracking analysis

D. Agrafiotis, N. Canagarajah, D.R. Bull and M. Dye

A perceptually optimised approach to sign language video coding is presented. The proposed approach is based on the results (included) of an eye tracking study in the visual attention of sign language viewers. Results show reductions in bit rate of over 30% with very good subjective quality.

a

2008 System Identified Eye Fixation From Users

Eighth IEEE International Conference on Advanced Learning Technologies

e5Learning, an E-Learning Environment Based on Eye Tracking

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Abstract

Users' eyes can be a meaningful source of information for e-learning systems. What we look at, and the way we do that, can in fact be exploited to improve the learning process, disclosing information which would otherwise remain concealed. In this paper we describe an e-learning environment where eye tracking is used to observe user behavior, in order to adapt content presentation in real-time. To achieve such purpose, we consider both the way learning activities are carried out and those eye signals that can be related to the user's "emotional states".

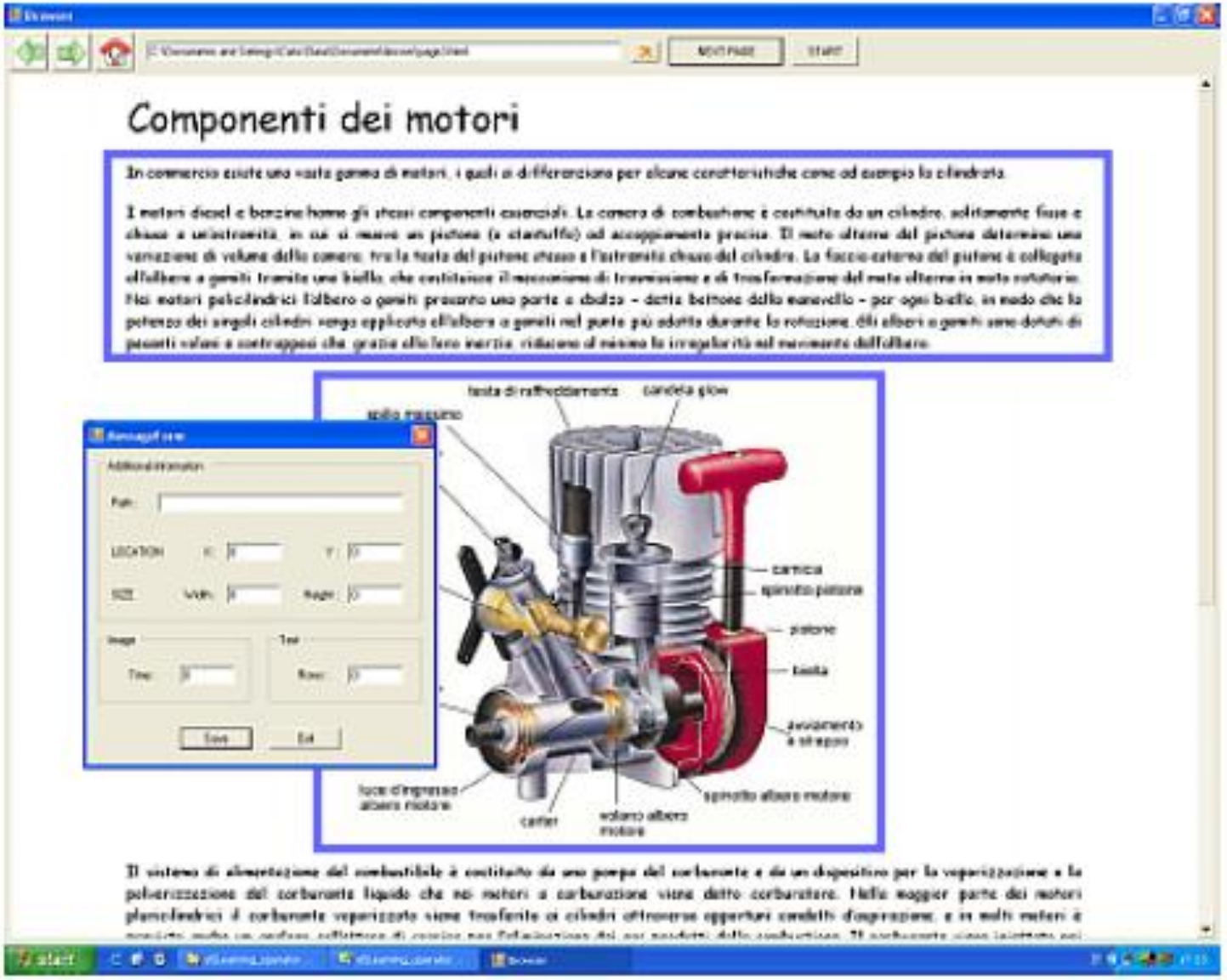

Figure 1. Rectangles identifying ROIs and dialog box for parameter input

Eye Pointing And Auto Content Display

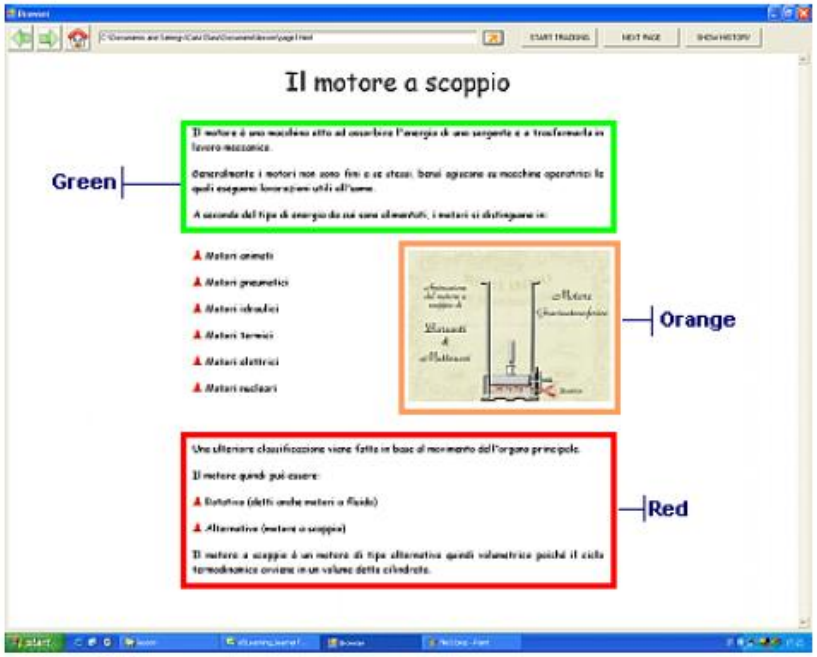

Figure 2. Colored rectangles highlighting ROIs which need attention

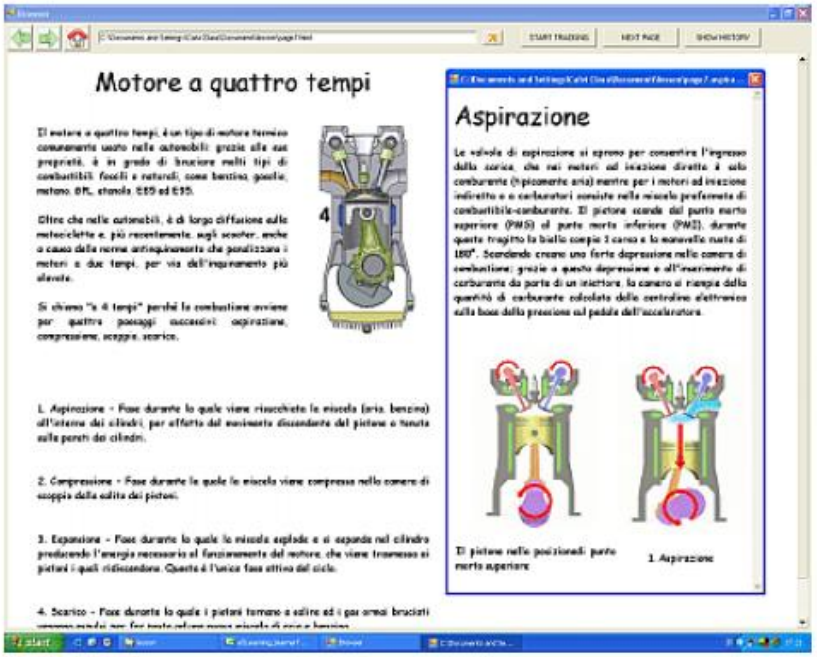

Figure 3. Additional content displayed when the user looks at a ROI

2009 System Understood Program Comprehension

Working Session: Using Eye-Tracking to Understand Program Comprehension

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Jonathan I. Maletic
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jmaletic@cs.kent.edu

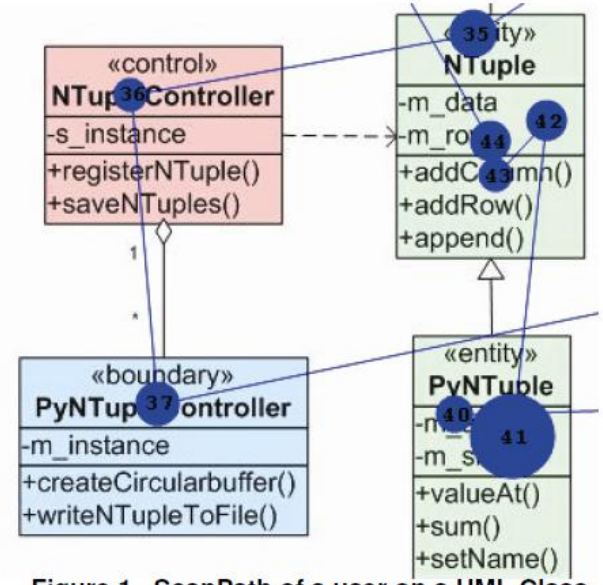

Figure 1. ScanPath of a user on a UML Class Diagram. Fixations are represented by the circles and saccades by the lines connecting the circles.

2009 Eye Tracking and Cognitive Style

2009 Ninth IEEE International Conference on Advanced Learning Technologies

Eye-tracking Users' Behavior in Relation to Cognitive Style within an E-Learning Environment

Nikos Tsianos[1], Panagiotis Germanakos[2,3], Zacharias Lekkas[1], Costas Mourlas[1], George Samaras[3]

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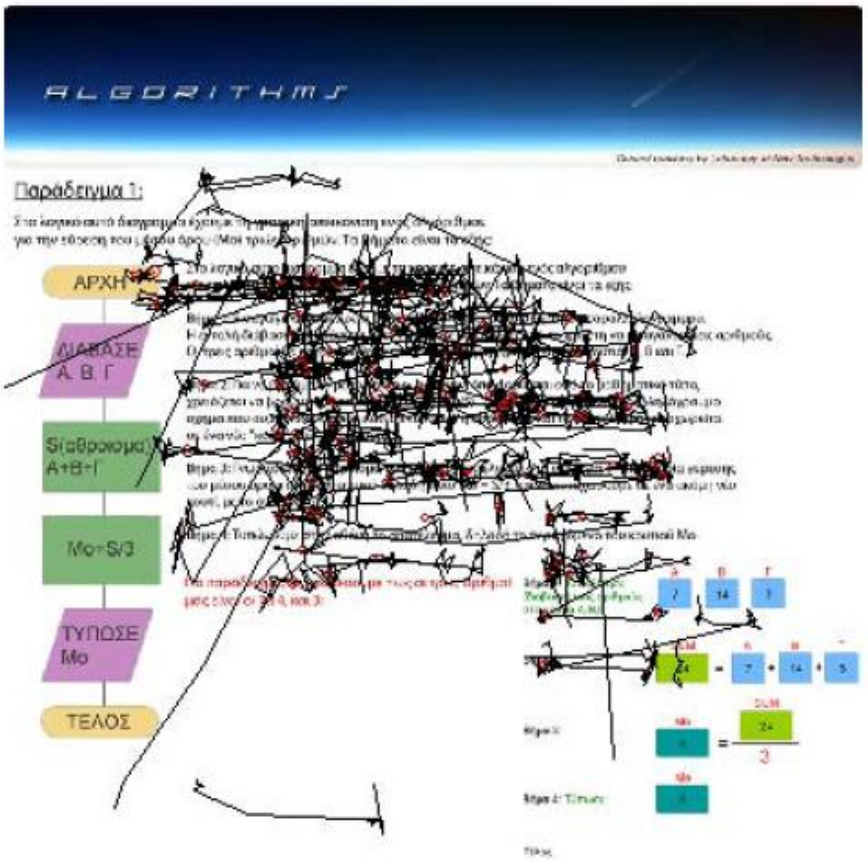
{ntsianos,mourlas}@media.uoa.gr, pgerman@cs.ucy.ac.cy, zlekkas@gmail.com, cssamara@cs.ucy.ac.cy

Verbalizer & Imager



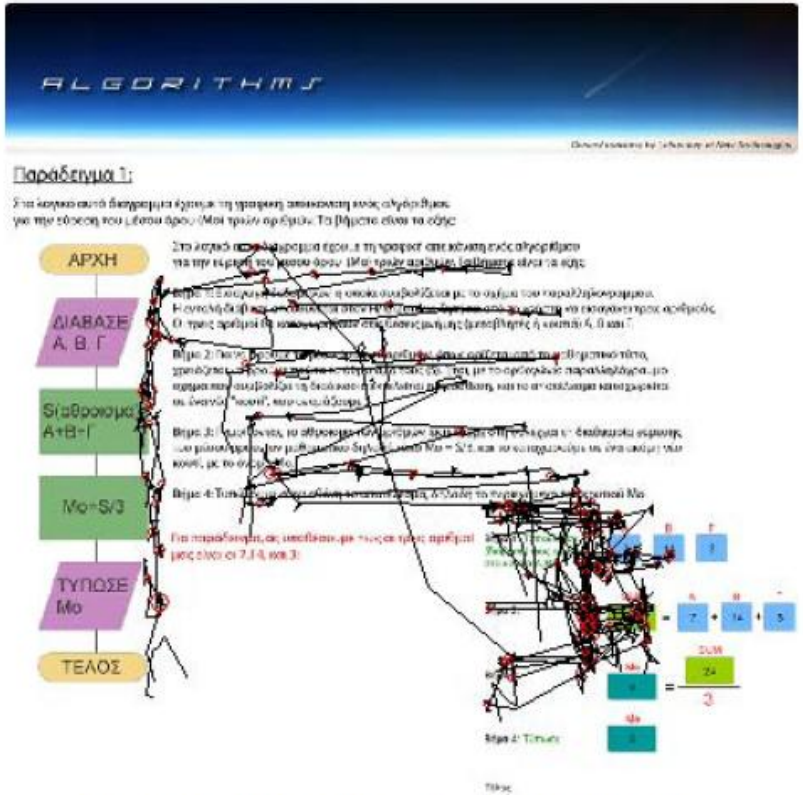


Figure 1. Differences in eye-tracking of a verbalizer (above) and an imager (below) within the same educational web-page.

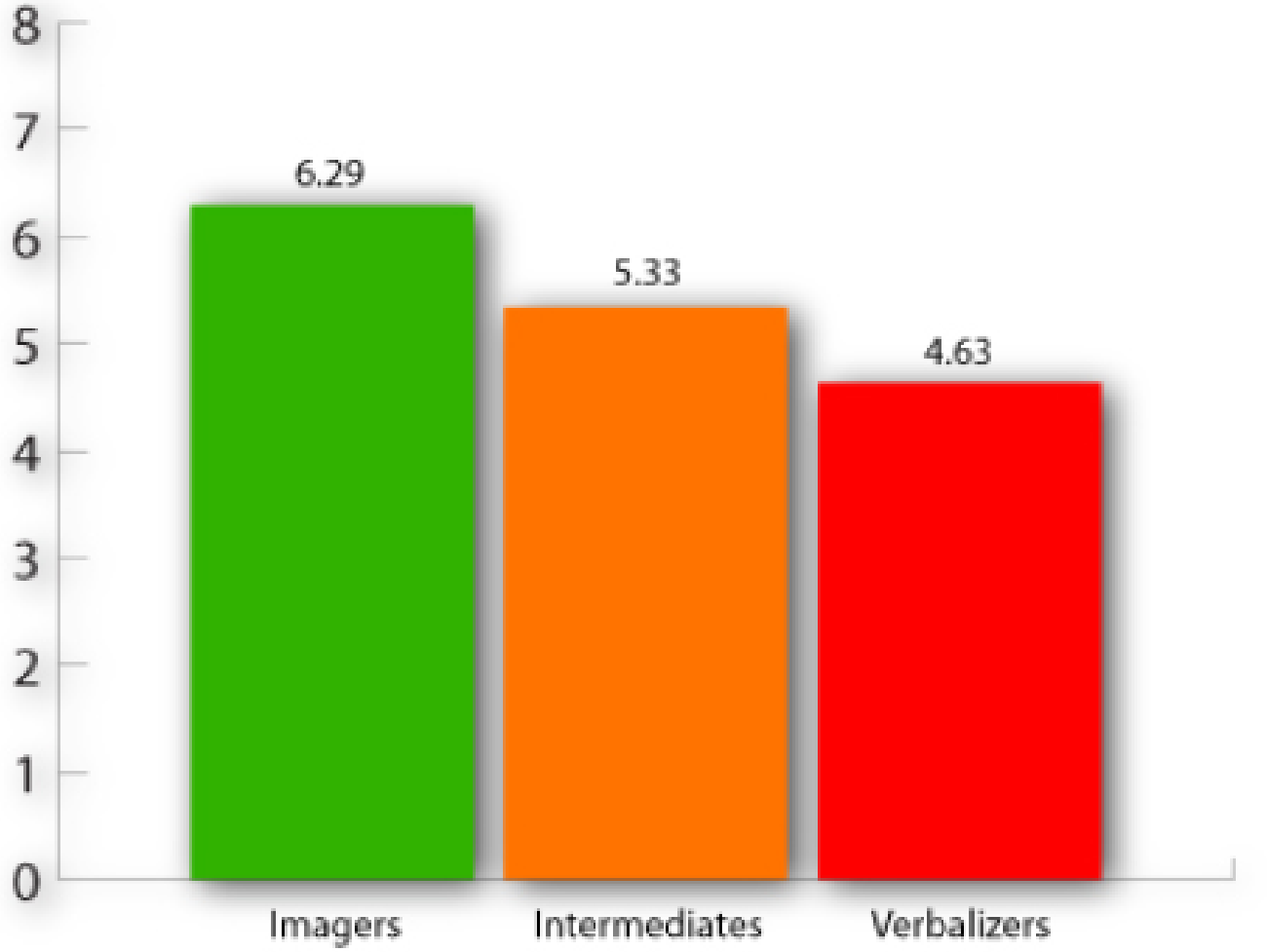


Figure 2. Calculated images to text ratio of eye fixations on a scale from 1-10 (textual to visual preference).

2009 IEEE

Eye-Tracking Viewers' Processing of Web-Based Multimedia Information

Han-Chin Liu
National Chiayi University
hcl@mail.ncyu.edu.tw

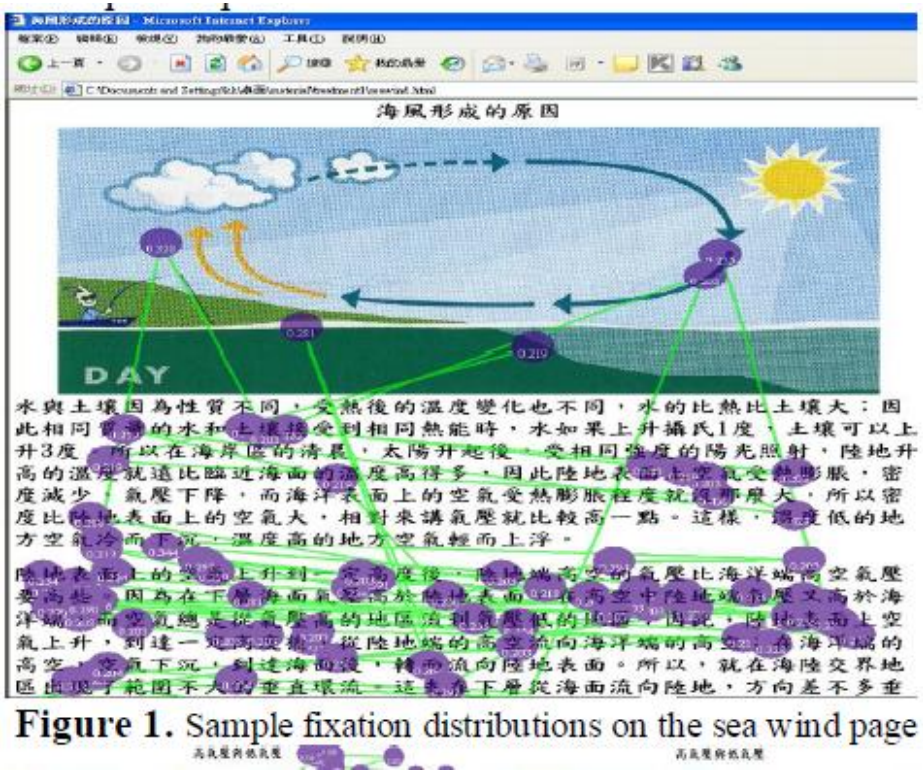


Figure 1. Sample fixation distributions on the sea wind page

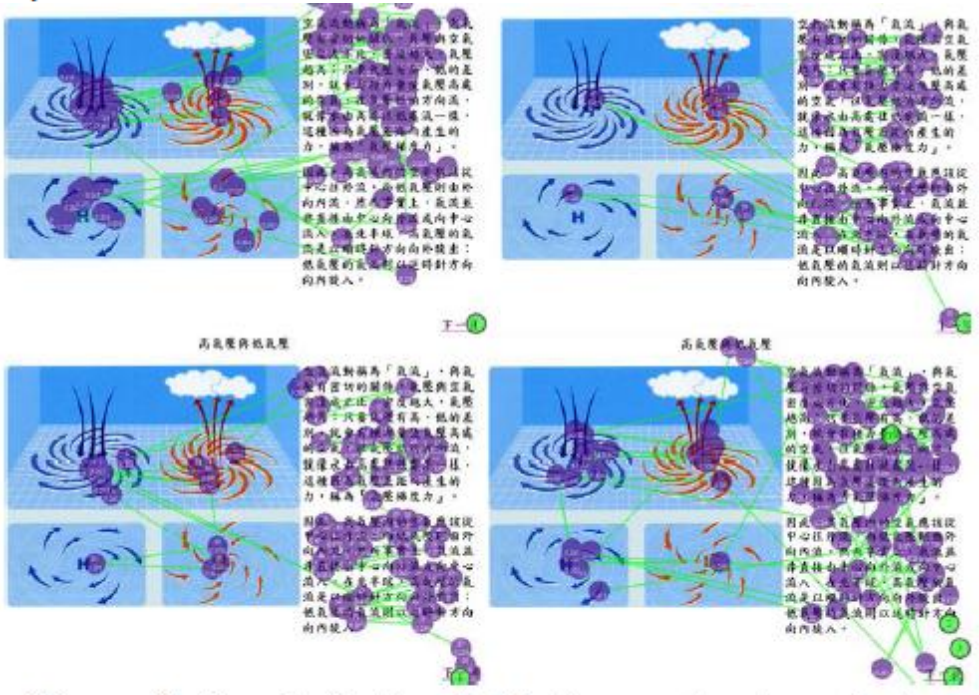


Figure 2. Sample fixation distributions on the atmospheric pressure page

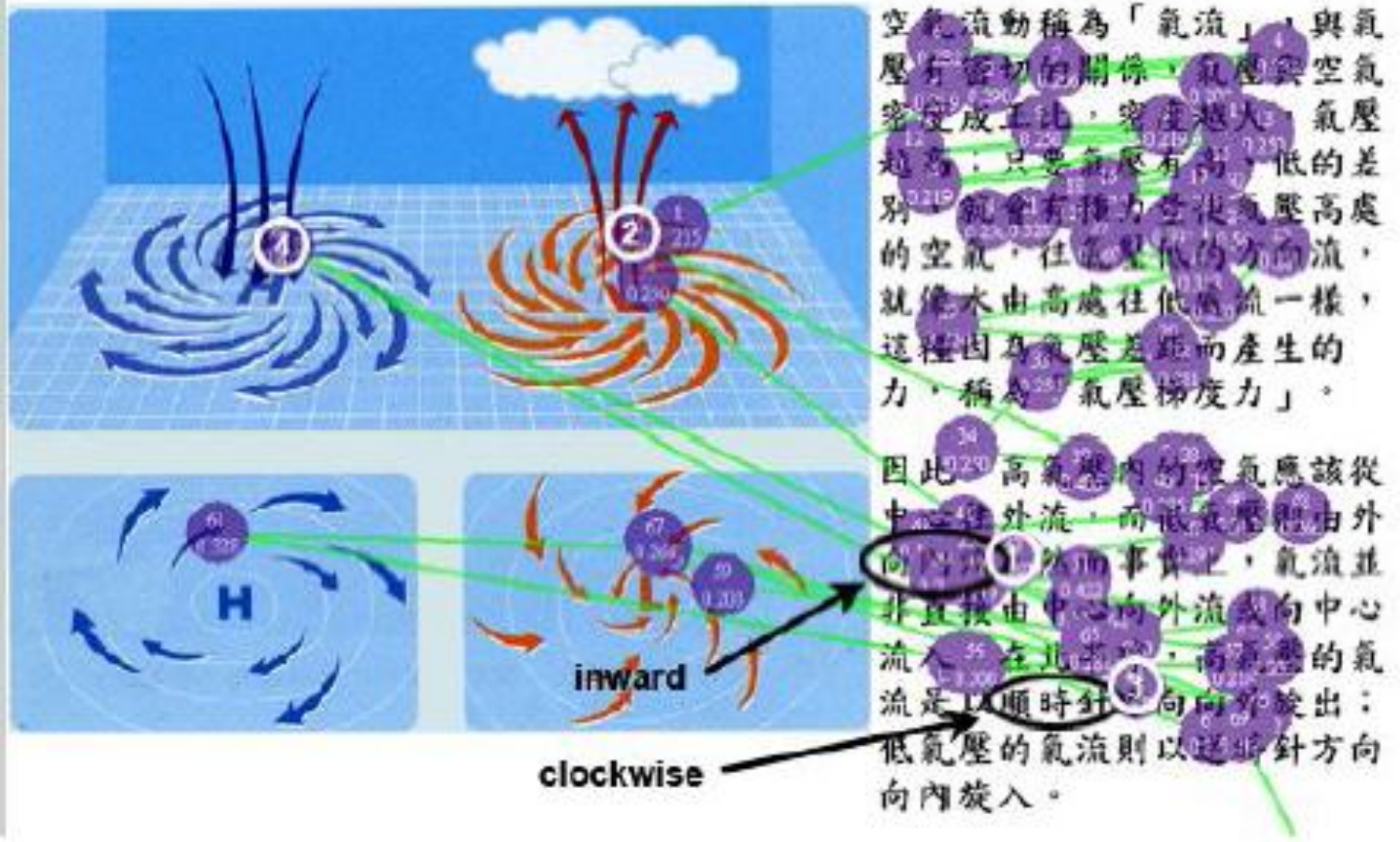


Figure 3. A representative scan path on the atmospheric pressure web page

2011 Autism

IEEE TRANSACTIONS ON NEURAL SYSTEMS AND REHABILITATION ENGINEERING, VOL. 19, NO. 4, AUGUST 2011

Design of a Gaze-Sensitive Virtual Social Interactive System for Children With Autism

Uttama Lahiri, *Student Member, IEEE*, Zachary Warren, and Nilanjan Sarkar, *Senior Member, IEEE*

Fig. 1. Screenshots of avatars demonstrating neutral (top), happy (middle), and angry (bottom) facial expression.

Fig. 4. Allocation of ROIs (Face_ROI, Object_ROI, and Othe

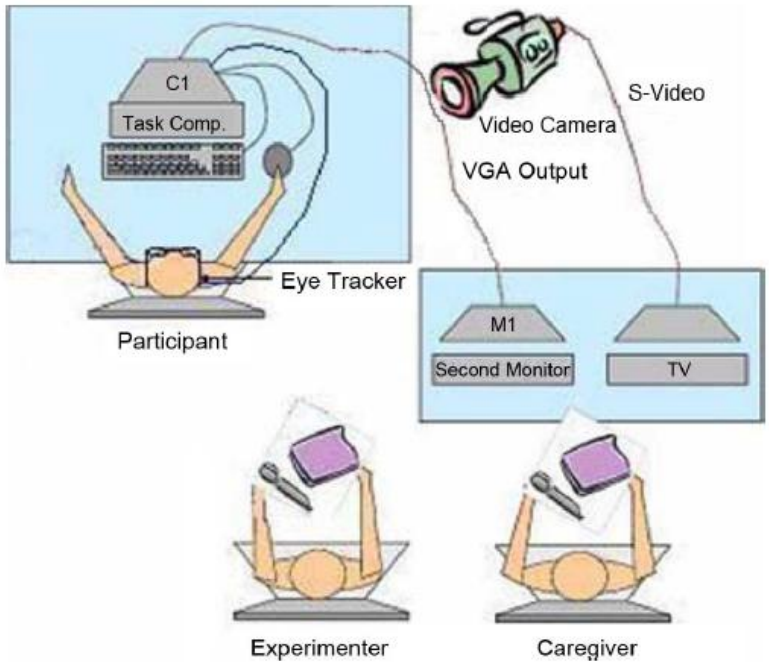


Fig. 6. Experimental setup.

2011 IEEE Identified Learning Style

USING EYE TRACKING TECHNOLOGY TO IDENTIFY VISUAL AND VERBAL LEARNERS

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Dept Computing, Maths & Physics, Waterford Institute of Technology, Ireland
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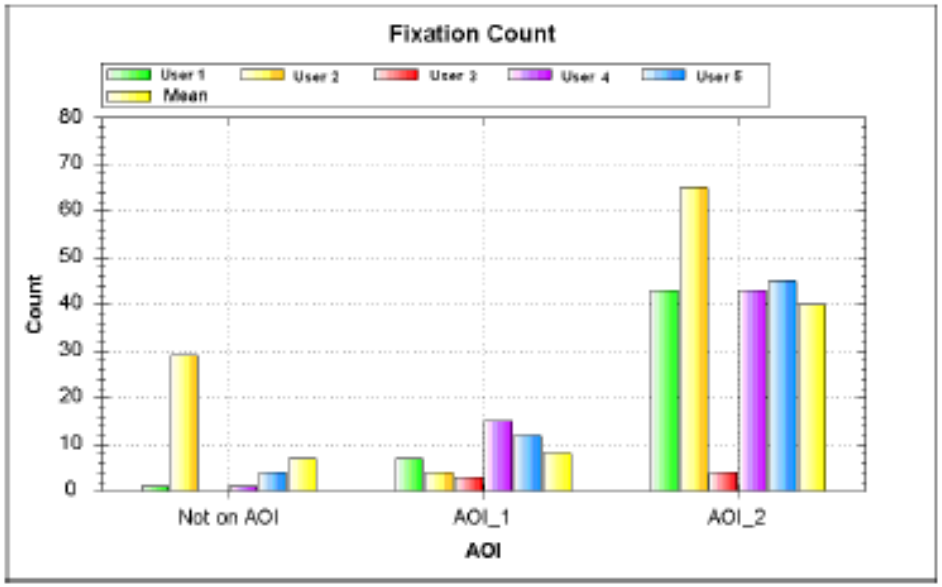


Fig. 1. Verbal Learners AOI Fixation Plot

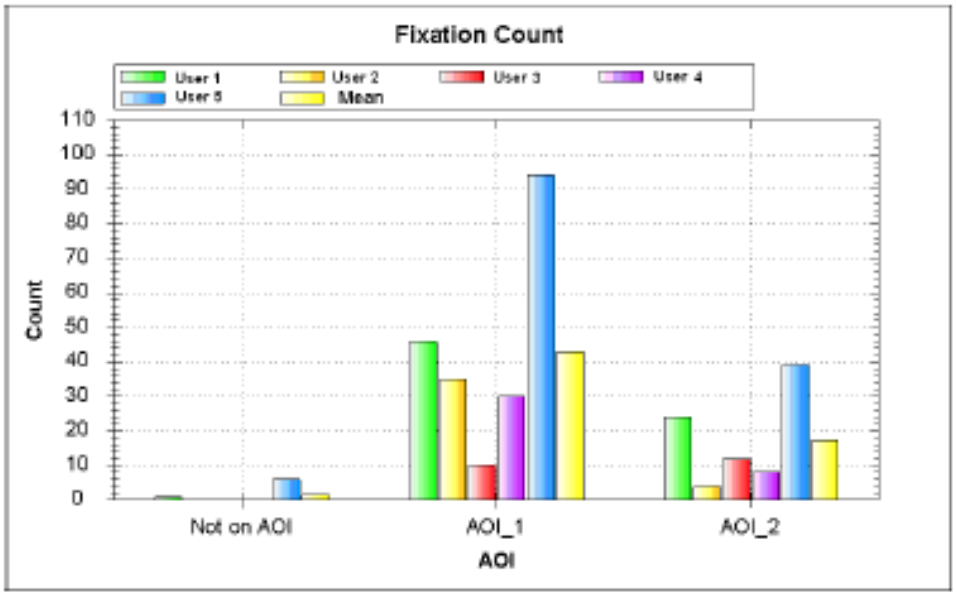


Fig. 2. Visual Learners AOI Fixation Plot

Visual & Verbal Learner

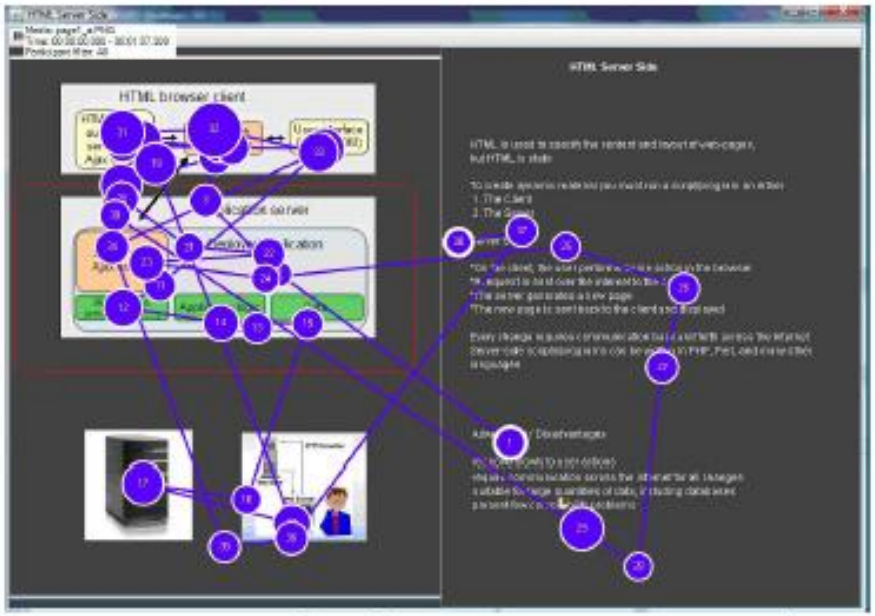


Fig. 3. Sample Visual Learner Gaze Path

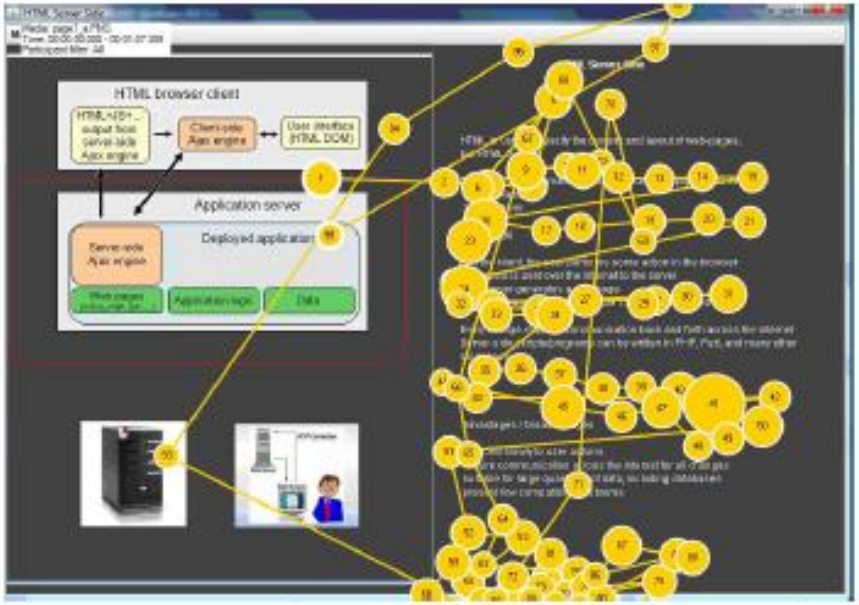


Fig. 4. Sample Verbal Learner Gaze Path

Visual & Verbal Learner

Fig. 5. Sample Visual Learner Heat Map

Fig. 6. Sample Verbal Learner Heat Map

Visual/Verbal Ratio

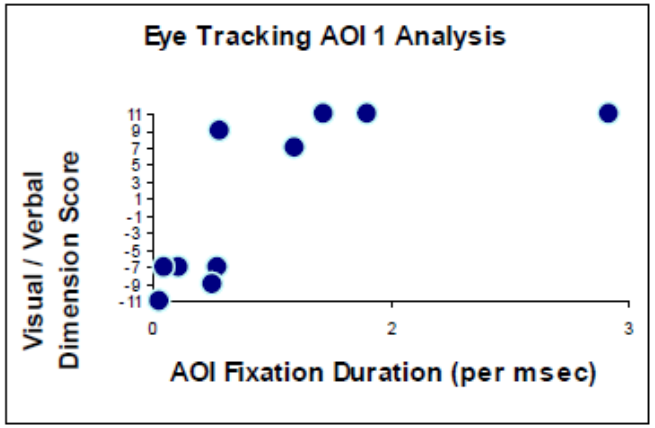


Fig. 7. Total Fixation Duration per msec AOI_1 vs. Visual / Verbal Dimension Score

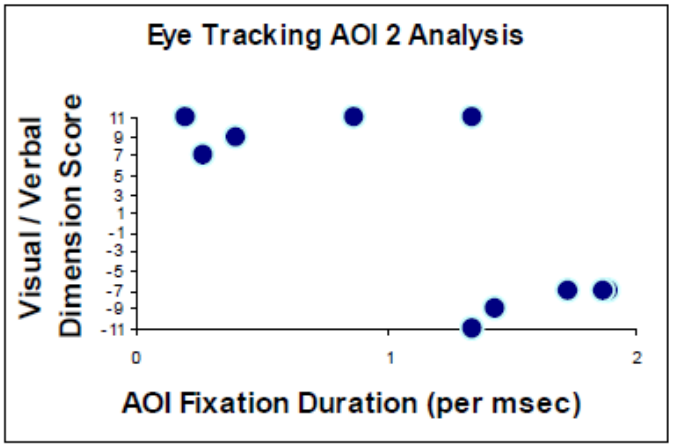


Fig. 8. Total Fixation Duration per msec AOI_2 vs. Visual / Verbal Dimension Score

2006 ACM Program Design

Analyzing Individual Performance of Source Code Review Using Reviewers' Eye Movement

Hidetake Uwano, Masahide Nakamura, Akito Monden and Ken-ichi Matsumoto

Nara Institute of Science and Technology
{hideta-u, masa-n, akito-m, matumoto}@is.naist.jp

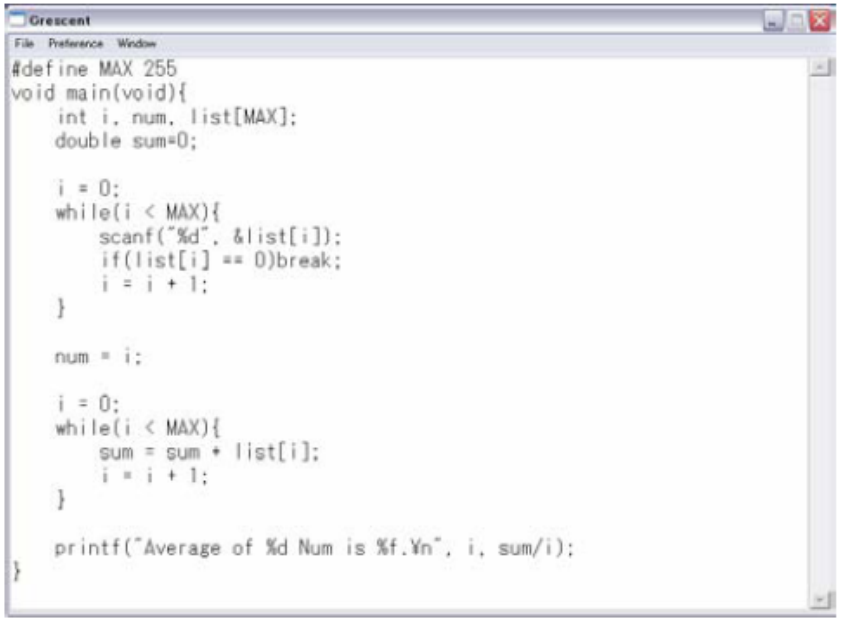


Fig. 3. Textbox for code review

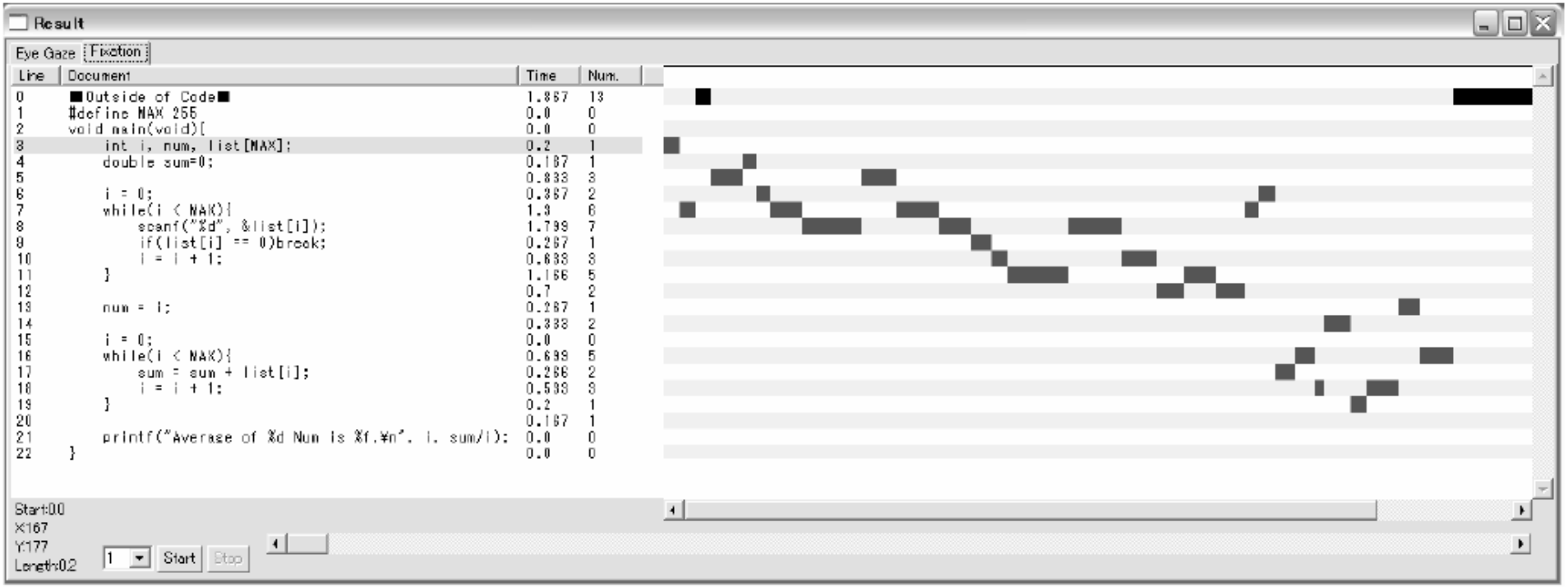
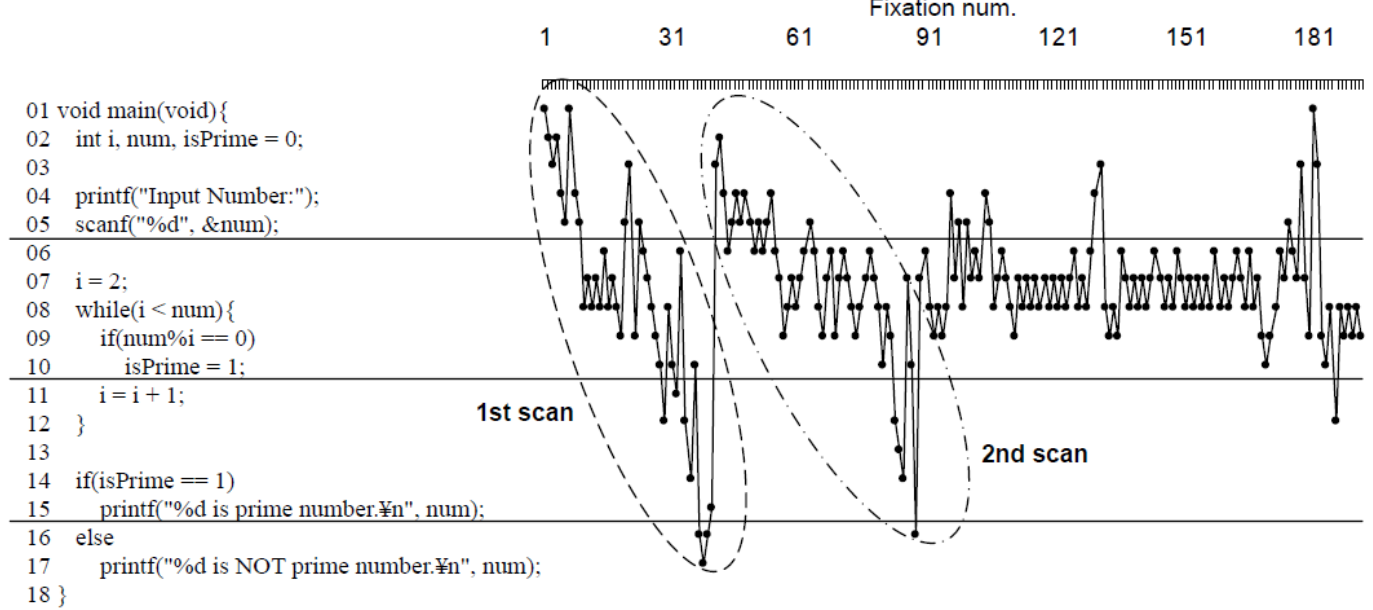
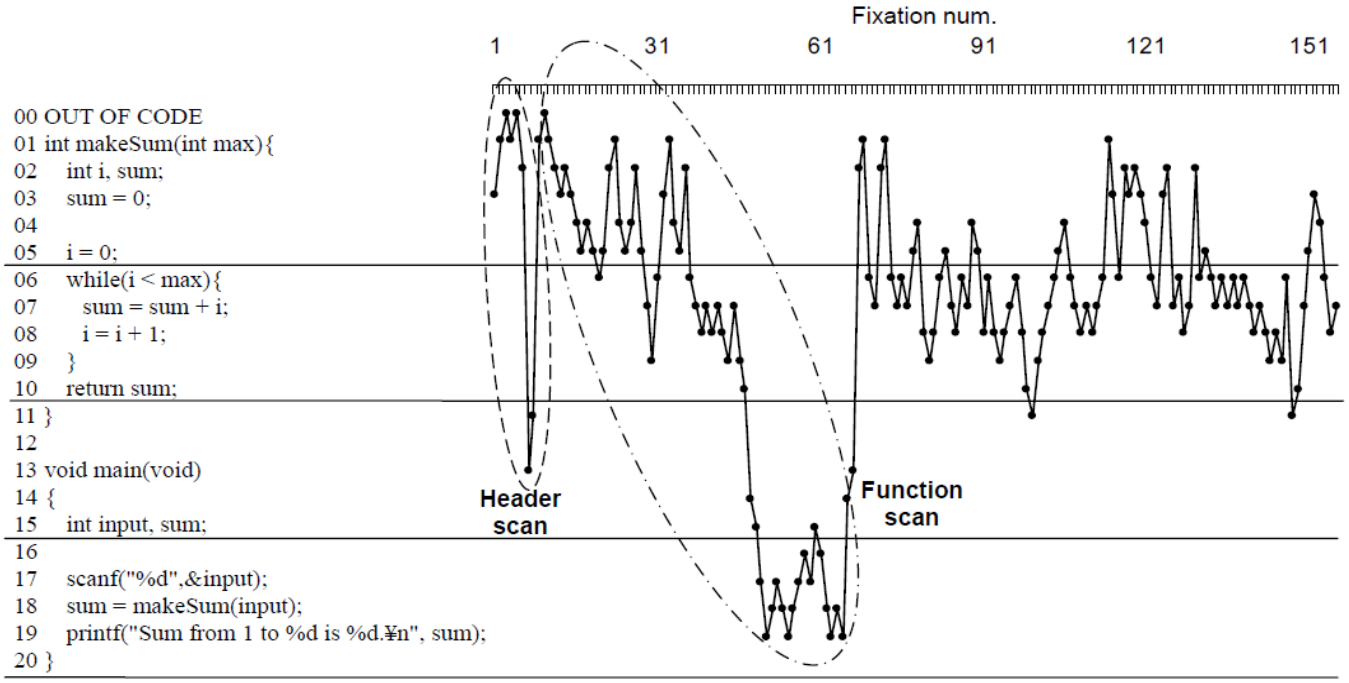


Fig. 4. Result viewer



a) Subject E reviewing `Prime`



b) Subject C reviewing `Accumulate`

Fig. 5. Eye movements involving scan pattern

2012 ACM Program Design

Shared Visual Attention in Collaborative Programming: A Descriptive Analysis

Sami Pietinen[1] Roman Bednarik[1] Markku Tukiainen[1]

[1]University of Eastern Finland
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Joensuu Campus
P.O. Box 111, FI-80101 Joensuu, Finland
+358 13 251 7928

firstname.lastname@uef.fi

Figure 1. No shared attention, therefore no apparent close co-operation.

Figure 2. Driver: This CommandListener is already in the constructor. Navigator: Hmmhi..

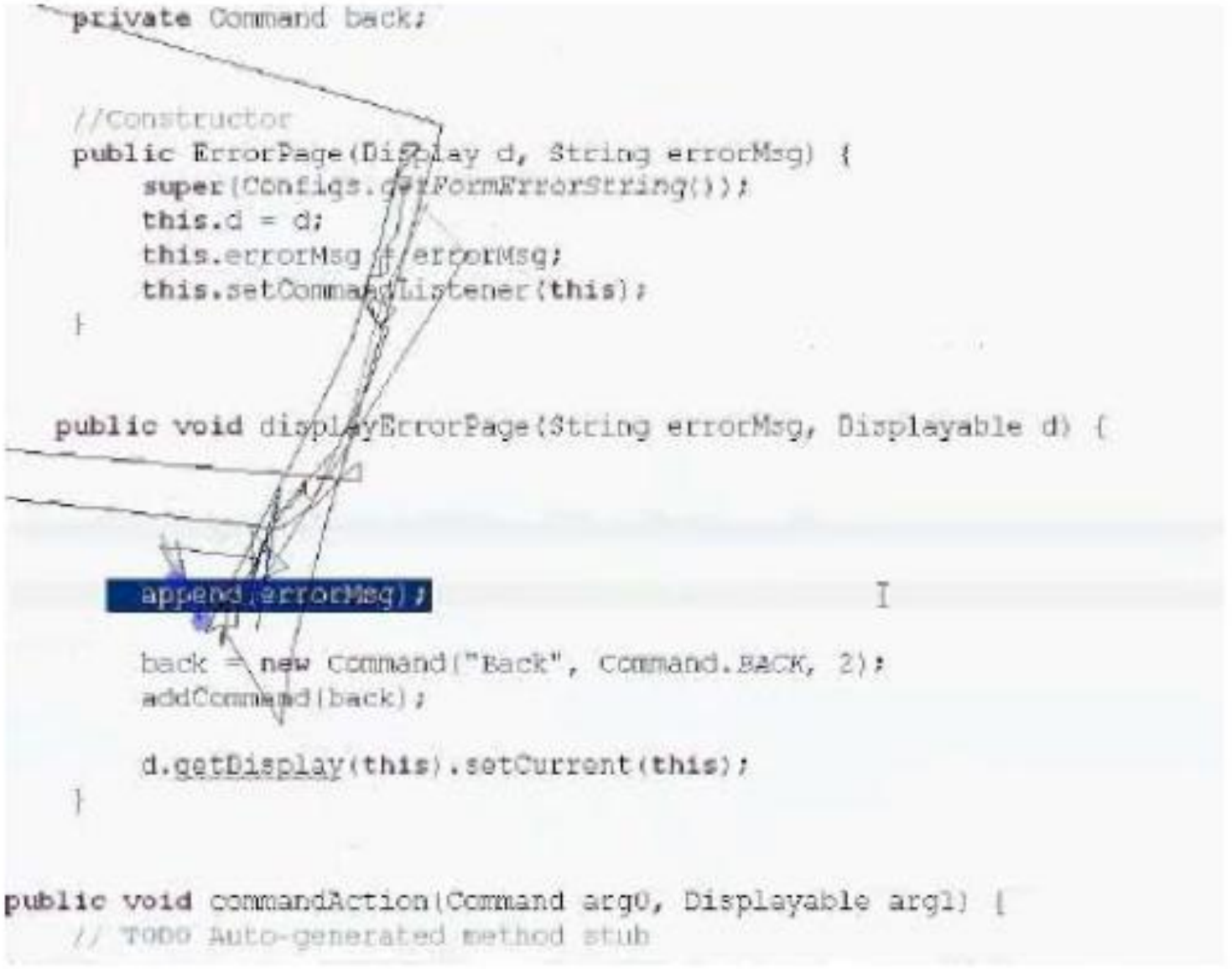


Figure 3. Driver: And we got the error message also in the constructor. Navigator: Hmmhi..

2012 ACM Medicine

Gaze Behaviour of Expert and Novice Microneurosurgeons Differs During Observations of Tumor Removal Recordings

Shahram Eivazi*
Roman Bednarik†
Markku Tukiainen‡
School of Computing
University of Eastern Finland

Mikael von und zu Fraunberg§
Ville Leinonen¶
Juha E Jääskeläinen‖
Neurosurgery/KUH NeuroCenter
Kuopio University Hospital

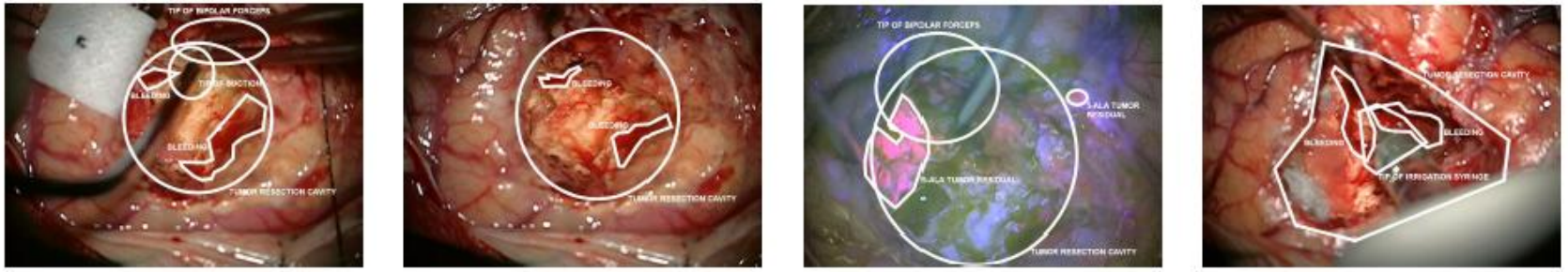


Figure 1: *The sequence of stimuli employed in the study with the areas annotated. For full resolution images, see a download link:* `https://docs.google.com/present/view?id=dzm5747_96c499hghn&interval=60&autoStart=true`

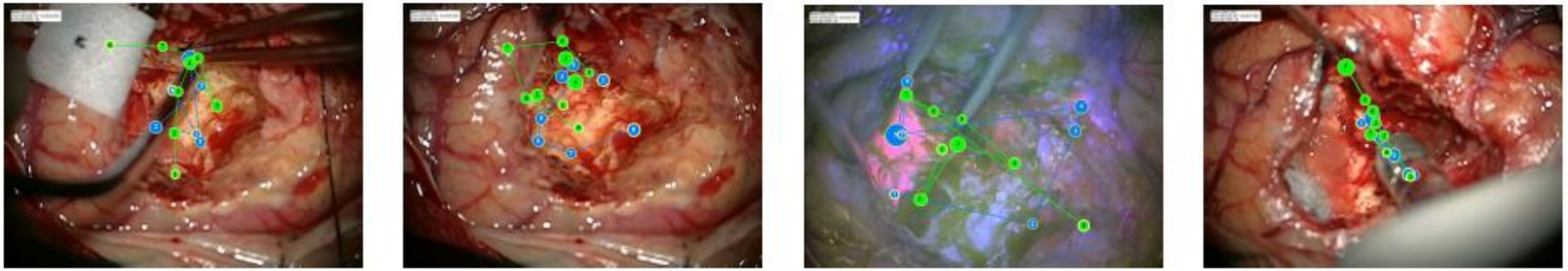


Figure 2: *The example of scanpaths of an expert (blue) and a novice (green).*

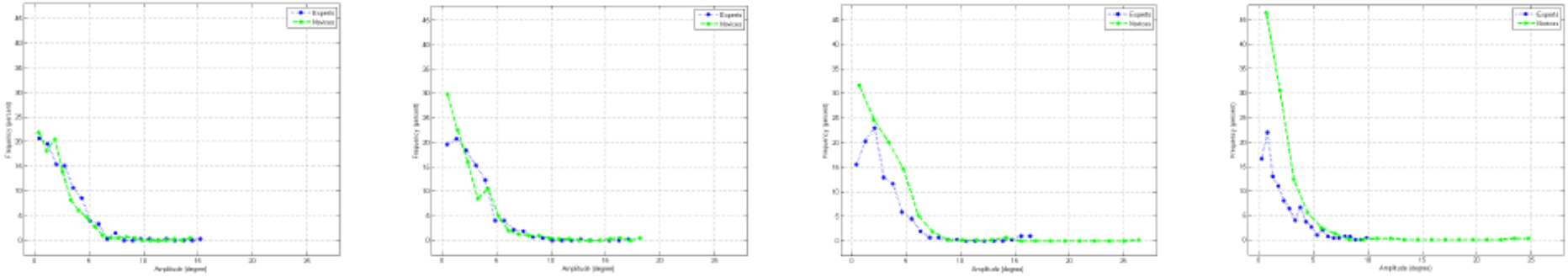


Figure 3: *Saccadic amplitude distributions for the stimuli images.*

2011 Music

Psychology of Music
40(3) 339–356

DOI: 10.1177/0305735610387777
pom.sagepub.com
SAGE

Eye movements and reading comprehension while listening to preferred and non-preferred study music

Roger Johansson
Department of Cognitive Science, Lund University, Sweden

Kenneth Holmqvist
Centre for Languages and Literature, Lund University, Sweden

Frans Mossberg
Sound Environment Centre, Lund University, Sweden

Magnus Lindgren
Department of Psychology, Lund University, Sweden

2011 Music

Psychology of Music
40(2) 216–235

DOI: 10.1177/0305735610394710
pom.sagepub.com
SAGE

Sight-reading expertise: Cross-modality integration investigated using eye tracking

Véronique Drai-Zerbib
Département de Psychologie, Université de Nice Sophia Antipolis, and LUTIN, Cité des sciences et de l'industrie de la Villette, France

Thierry Baccino
Université de Paris VIII, and LUTIN, Cité des sciences et de l'industrie de la Villette, France

Emmanuel Bigand
Université de Bourgogne, France

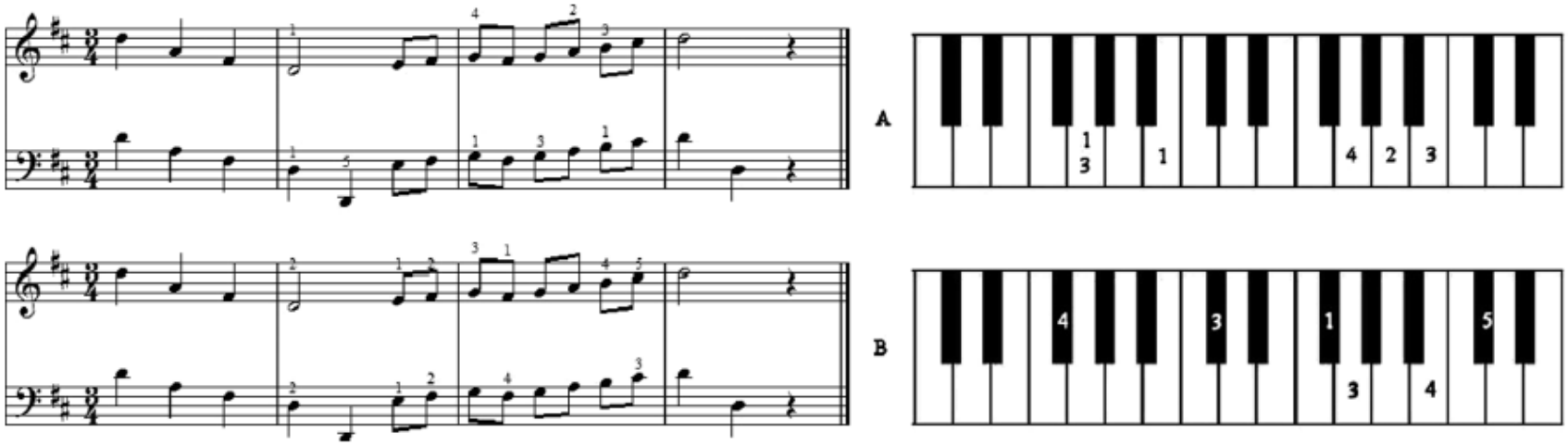


Figure 1. Diagram of fingering (measure 3 only) on an excerpt from Haydn's Menuetto and Aria. (A) Easy fingering; (B) difficult fingering. The numbers on the keyboard refer respectively to the following fingers 1 = thumb ; 2 = index; 3 = middle; 4 = ring finger; 5 = little finger.

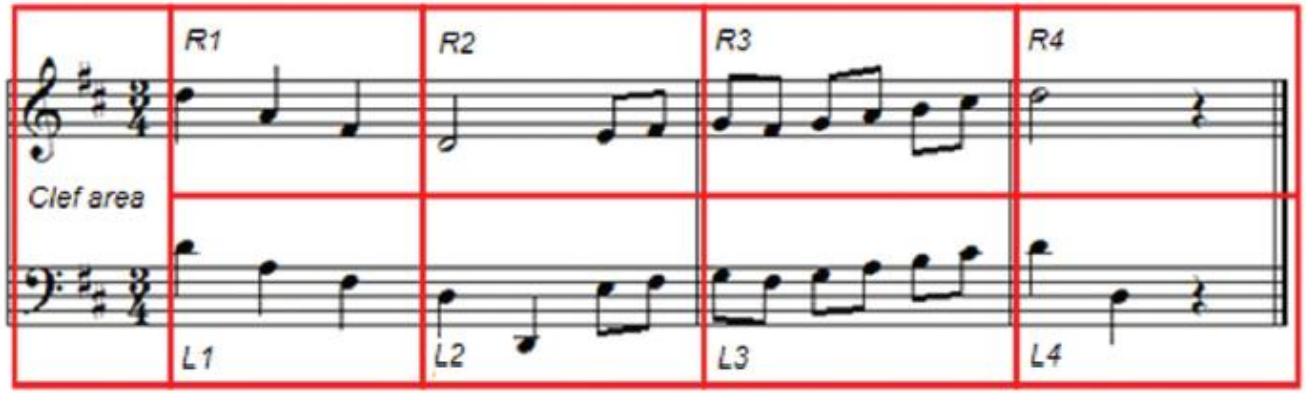


Figure 3. Breakdown of the excerpt into nine areas of interest: clef area, upper staff (right hand measures r1 to r4), lower staff (left hand measures l1 to l4).

2009 Art

Computational Aesthetics in Graphics, Visualization, and Imaging (2009)
O. Deussen and P. Hall (Editors)

Aesthetic appraisal of art - from eye movements to computers

C. Wallraven[1], D. Cunningham[2], J. Rigau[3], M. Feixas[3], M. Sbert[3]

[1]Max Planck Institute for Biological Cybernetics, Germany
[2]WSI-GRIS, University of Tübingen, Germany
[3]Graphics and Imaging Laboratory, University of Girona, Spain

Painting

Figure 1: *Example images for each art period from Gothics to Postmodernism.*

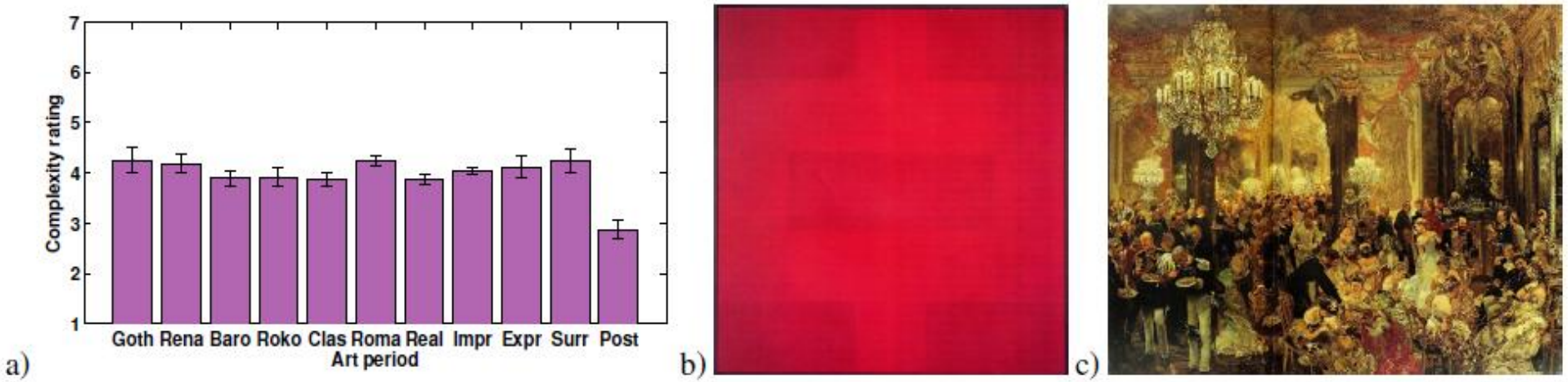


Figure 2: *a) Complexity ratings broken down by art period, b) least and c) most complex artwork.*

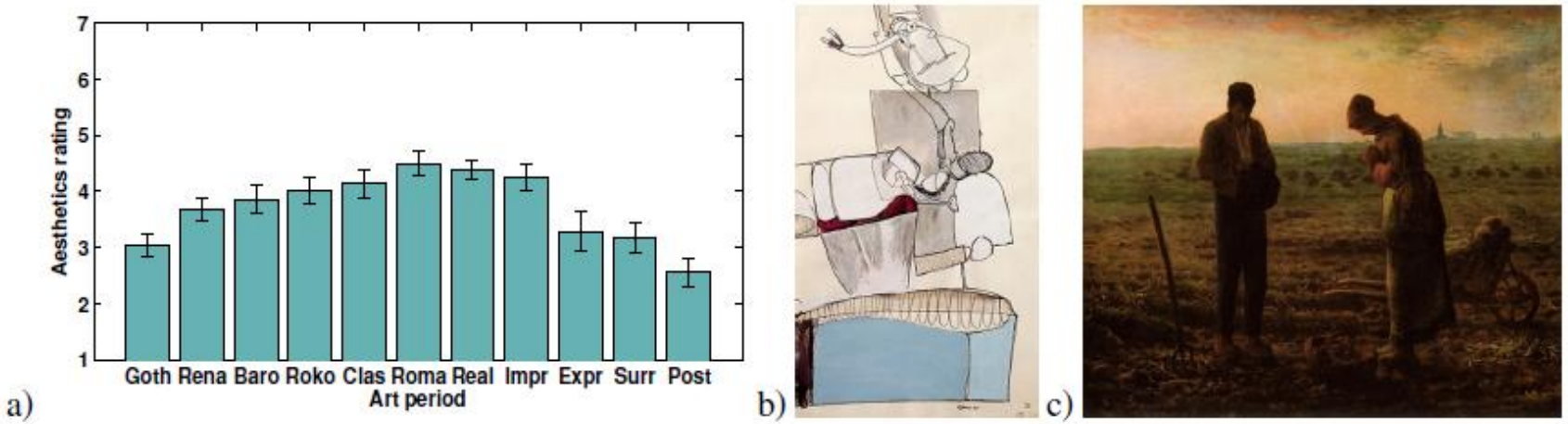


Figure 3: *a) Aesthetics ratings broken down by art period, b) least and c) most aesthetically appealing artwork.*

Hot Zone

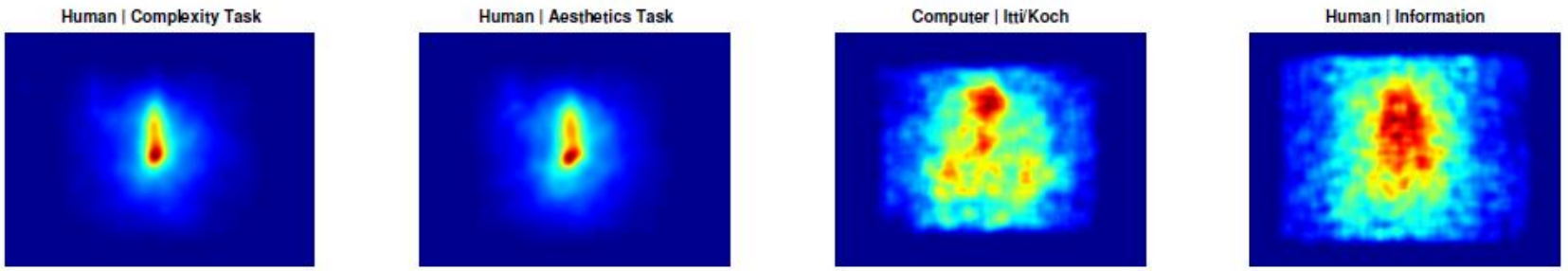


Figure 5: *Average fixation maps for the complexity and aesthetics task and the two computational models.*

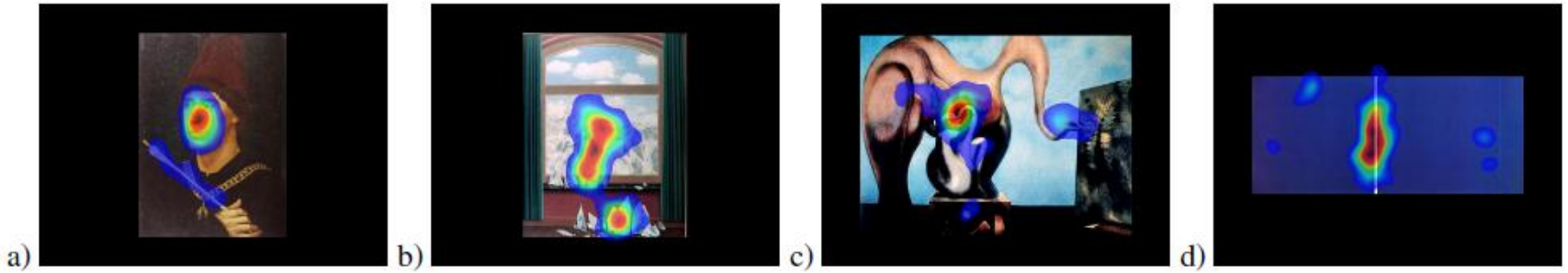


Figure 6: *Examples of fixation maps for four different images.*

2012 ART

OPEN ACCESS Freely available online

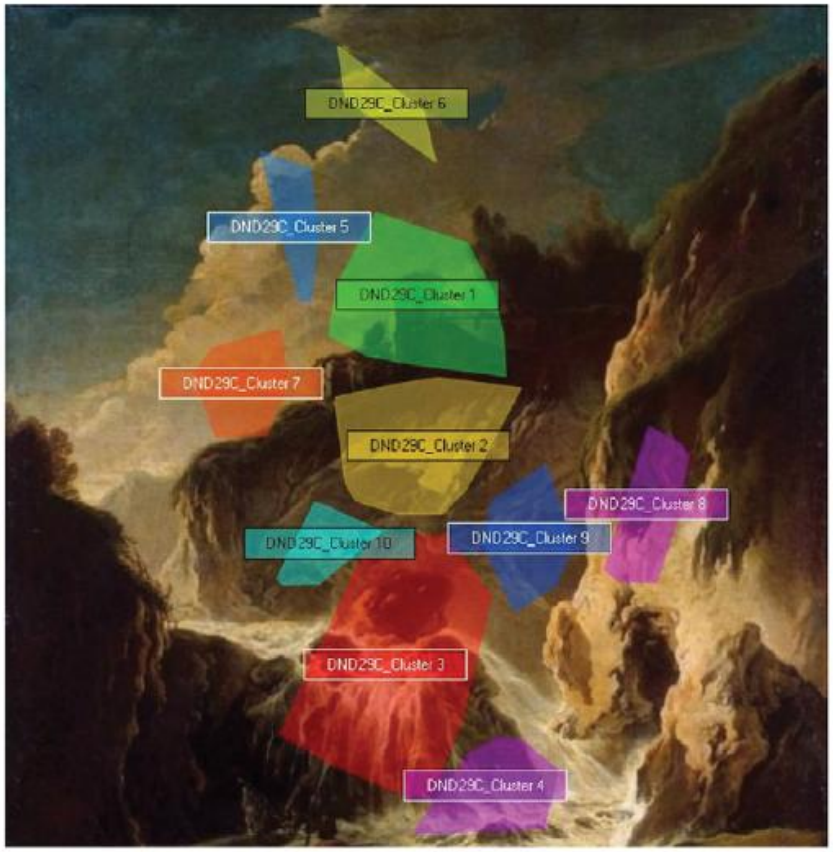
PLoS one

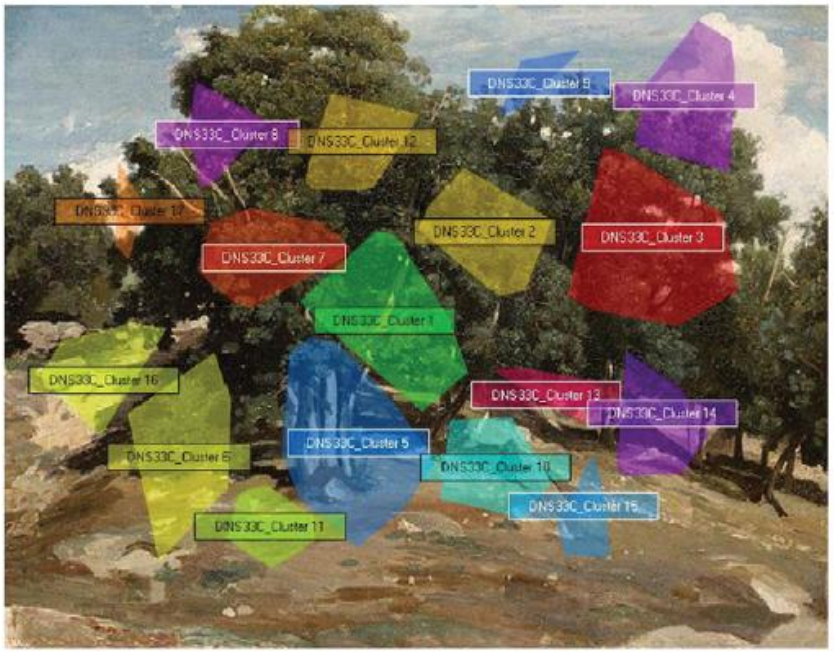
When Art Moves the Eyes: A Behavioral and Eye-Tracking Study

Davide Massaro[1]*, Federica Savazzi[2], Cinzia Di Dio[3], David Freedberg[4,5], Vittorio Gallese[3,4,6], Gabriella Gilli[2], Antonella Marchetti[1]

1 Research Unit on Theory of Mind, Department of Psychology, Università Cattolica del Sacro Cuore, Milan, Italy, **2** Research Unit on Psychology of the Art, Department of Psychology, Università Cattolica del Sacro Cuore, Milan, Italy, **3** Department of Neuroscience, University of Parma, Parma, Italy, **4** Department of Art History and Archaeology, Columbia University, New York, New York, United States of America, **5** The Italian Academy for Advanced Studies in America, Columbia University, New York, New York, United States of America, **6** IIT (Italian Institute of Technology) Brain Center for Social and Motor Cognition, Parma, Italy

Divided Region






DUD03C_Cluster 1_VISO
DUD03C_Cluster 7
DUD03C_Cluster 3
DUD03C_Cluster 2
DUD03C_Cluster 8
DUD03C_Cluster 4
DUD03C_Cluster 5
DUD03C_Cluster 9
DUD03C_Cluster 6
DUD03C_Cluster 10

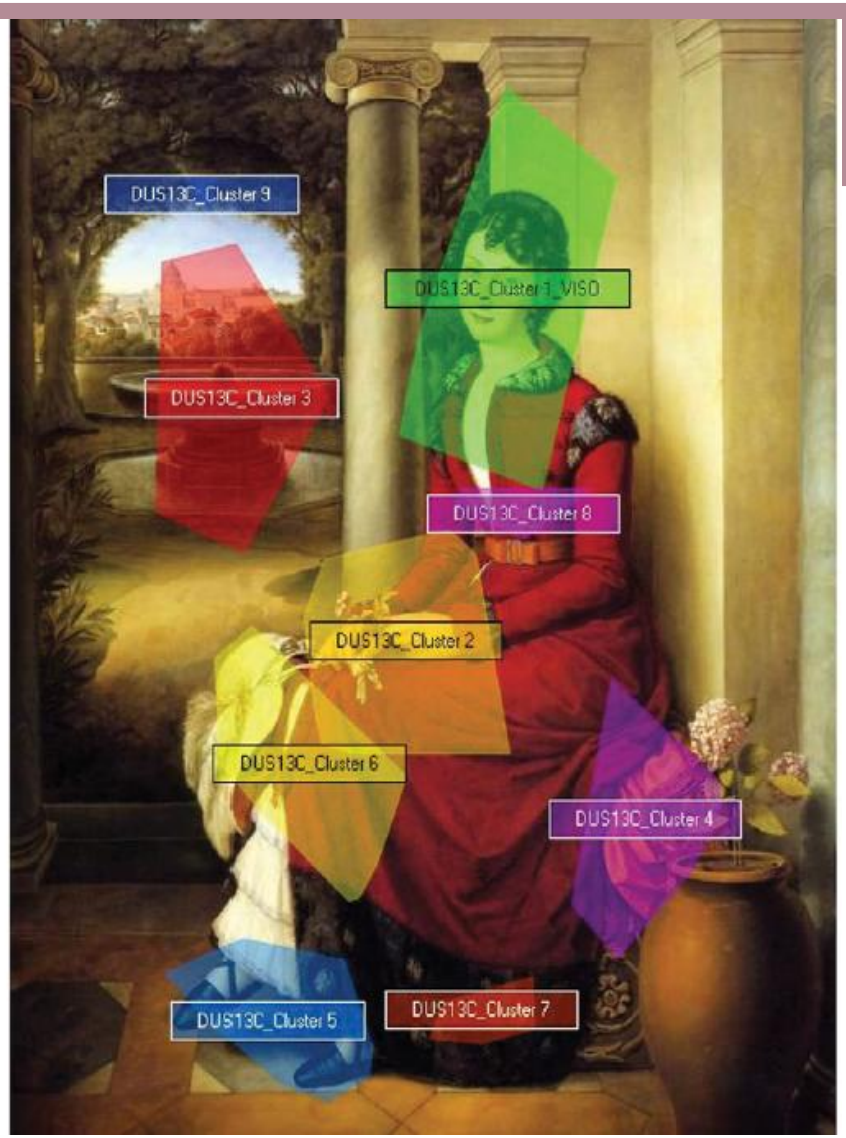

DUS13C_Cluster 9
DUS13C_Cluster 1_VISO
DUS13C_Cluster 3
DUS13C_Cluster 8
DUS13C_Cluster 2
DUS13C_Cluster 6
DUS13C_Cluster 4
DUS13C_Cluster 5
DUS13C_Cluster 7

Figure 7. Heat map visualization of the gaze behavior for human color images. On the left is a dynamic image, on the right is a static image. The red gradient indicates portions of the image observed by the totality of the sample.
doi:10.1371/journal.pone.0037285.g007

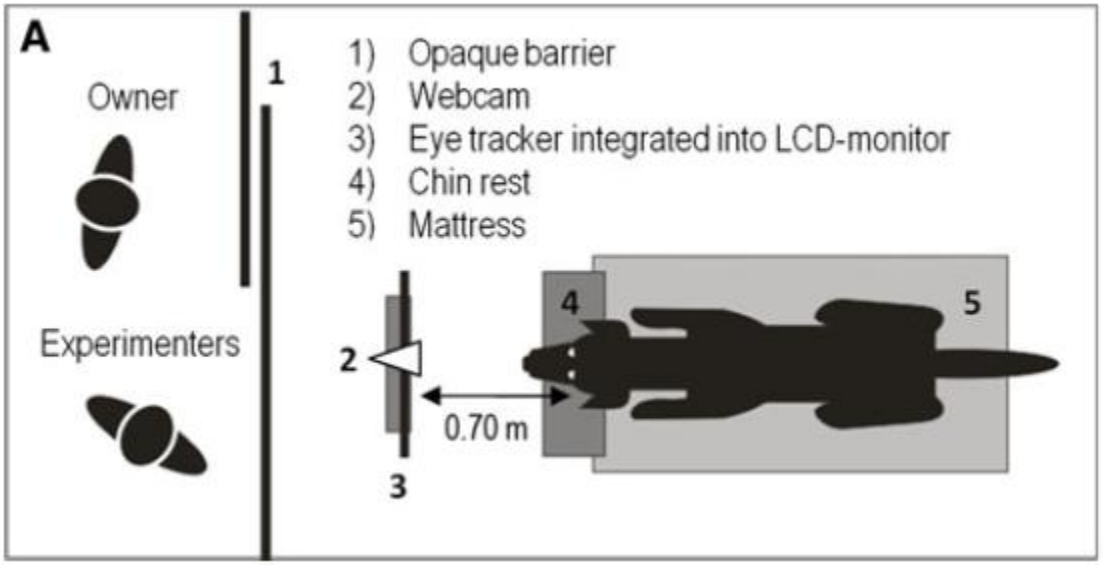
2012 Eye-tracking For Dogs

Anim Cogn (2012) 15:163–174
DOI 10.1007/s10071-011-0442-1

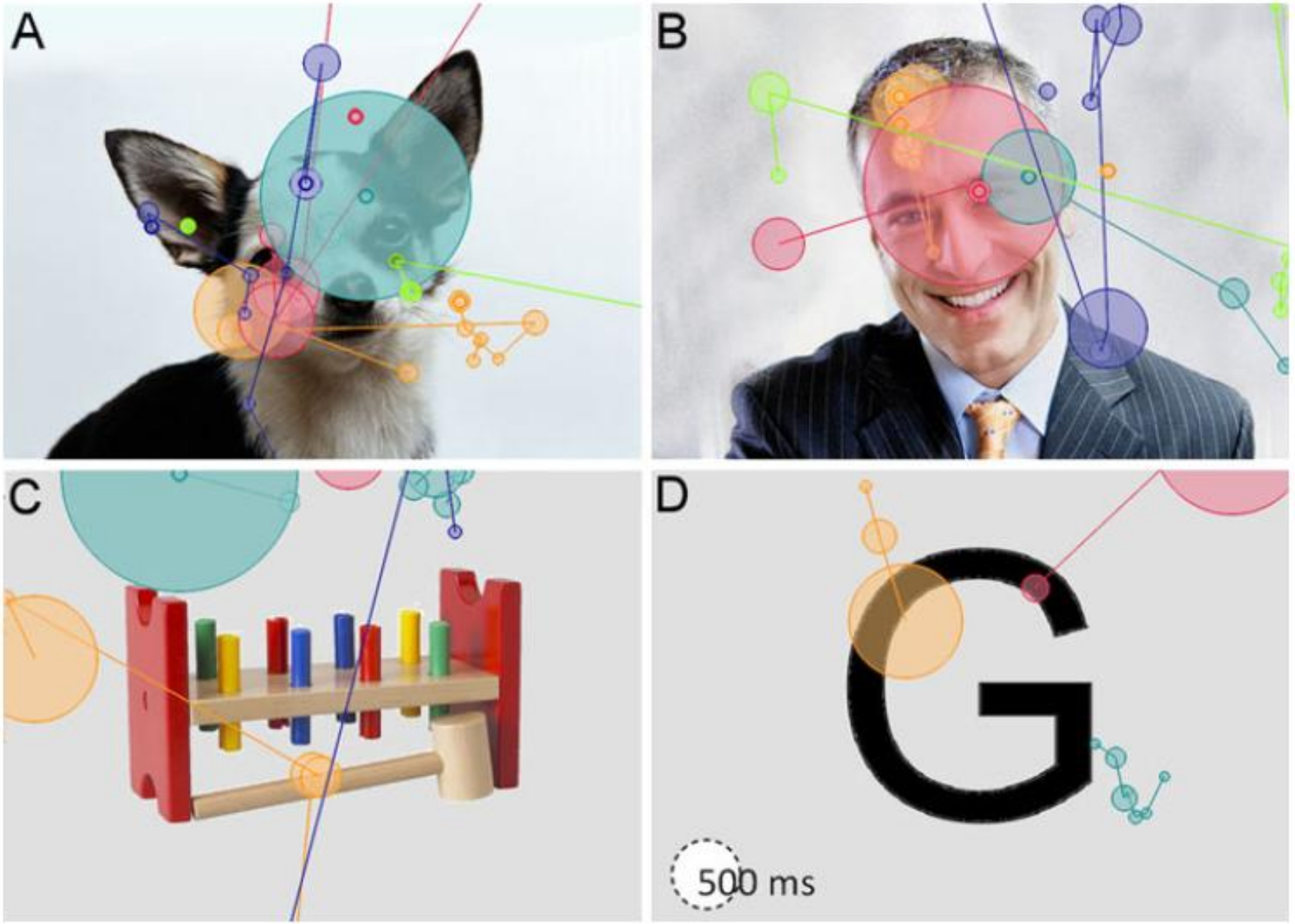
Dogs do look at images: eye tracking in canine cognition research

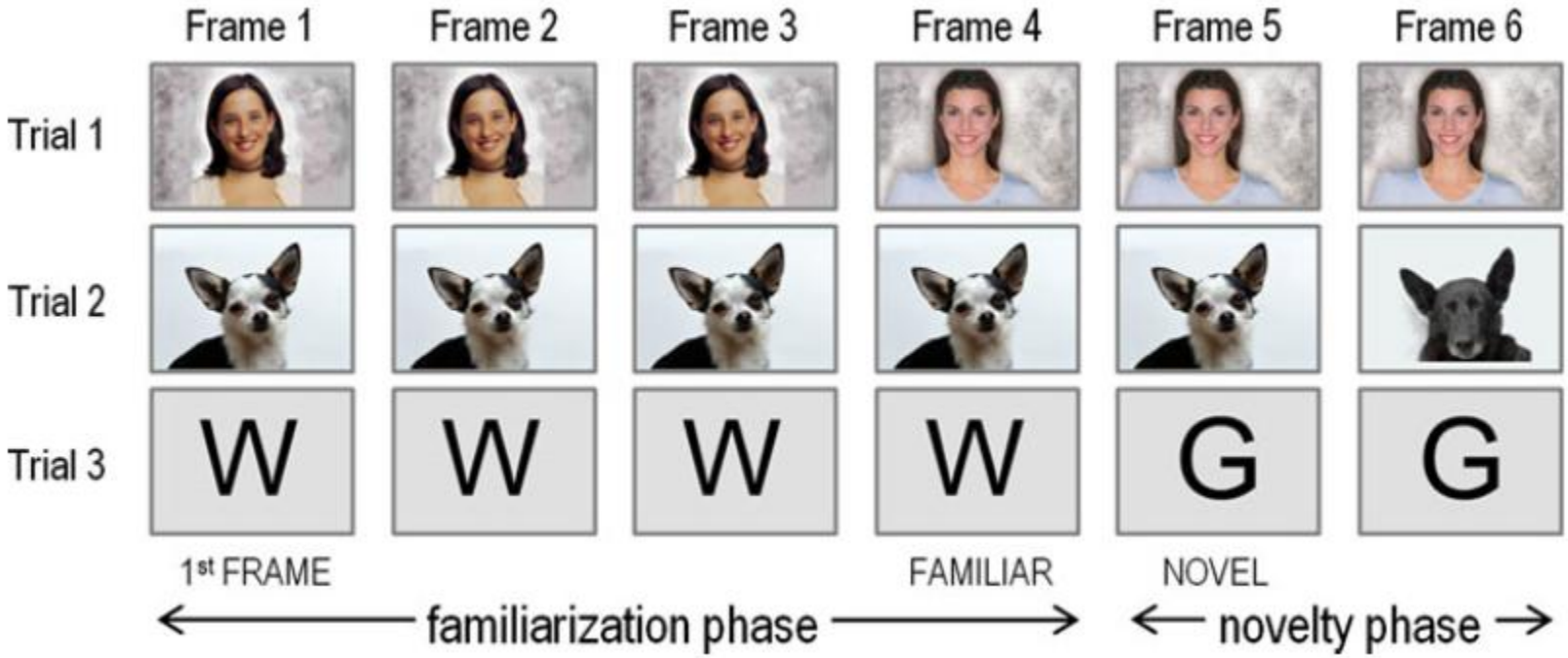
Sanni Somppi · Heini Törnqvist · Laura Hänninen ·
Christina Krause · Outi Vainio

Received: 11 February 2011 / Revised: 6 July 2011 / Accepted: 1 August 2011 / Published online: 23 August 2011


A
Owner
Experimenters
1
1) Opaque barrier
2) Webcam
3) Eye tracker integrated into LCD-monitor
4) Chin rest
5) Mattress
2
3
4
5
0.70 m


B


A
B
C
D
500 ms


Frame 1
Frame 2
Frame 3
Frame 4
Frame 5
Frame 6
Trial 1
Trial 2
Trial 3
W
W
W
W
G
G
1st FRAME
FAMILIAR
NOVEL
familiarization phase
novelty phase

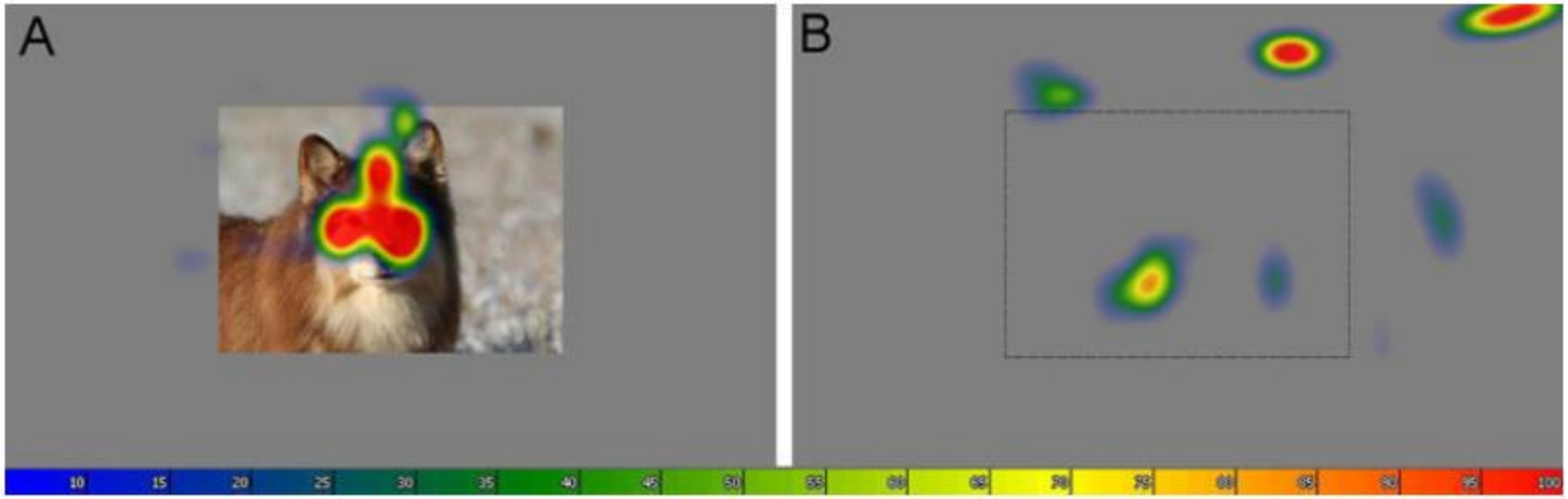

A
B
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100

Fig. 1. The eye tracking equipment in place on the dog showing scene camera (1) eye camera (2) head strap (3) mirror support rod (4) mirror clamp (5) dichroic mirror (6) muzzle (7) and mirror frame (8).

Fig. 2. The calibration cross in place on the head gear showing cross mount (1) and calibration cross (2).

2010 Eye Tracking For Rats USA Harvard Univ.

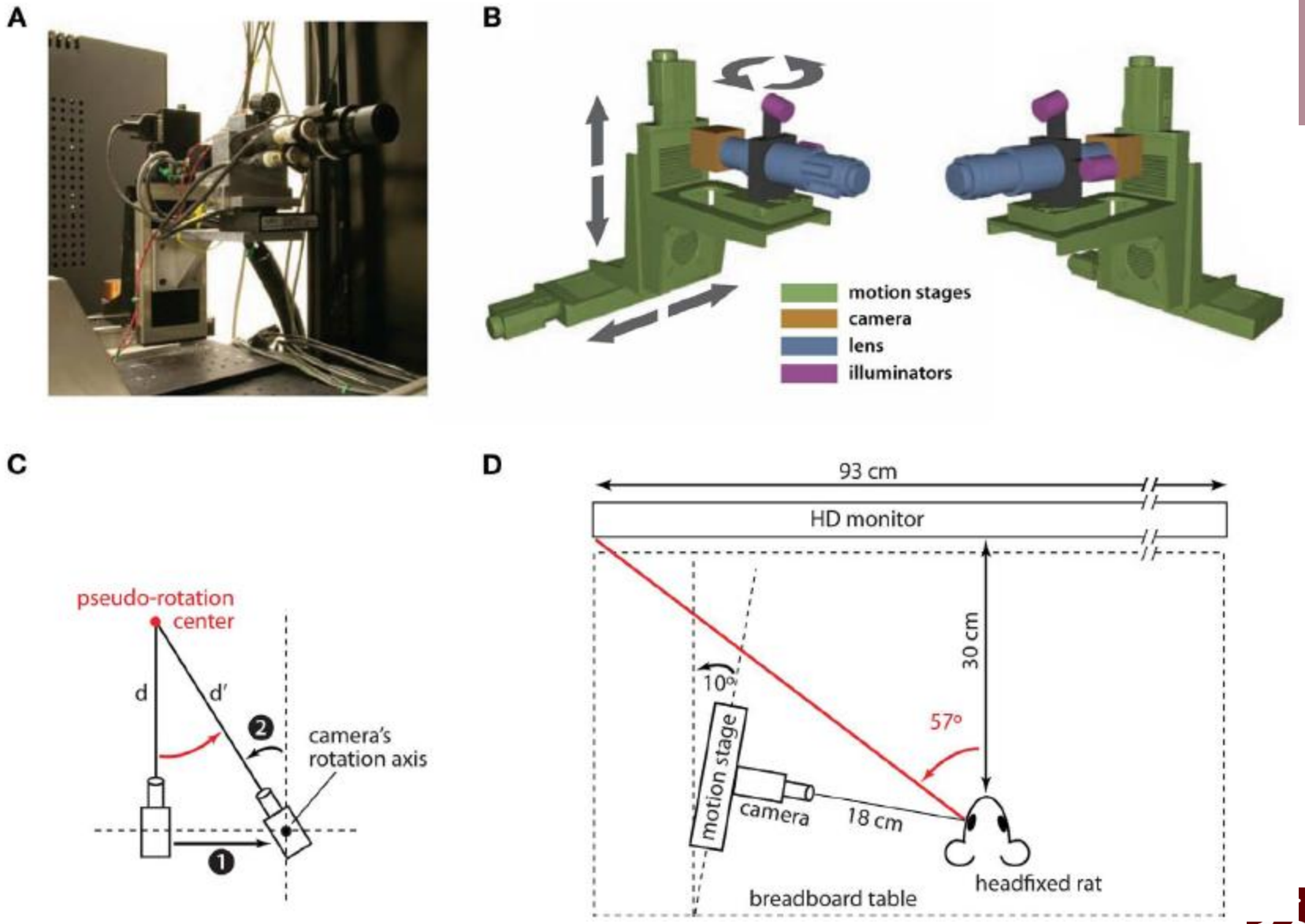
frontiers in NEUROSCIENCE

METHODS ARTICLE
published: 29 November 2010
doi: 10.3389/fnins.2010.00193

A self-calibrating, camera-based eye tracker for the recording of rodent eye movements

Davide Zoccolan[1,2]*, Brett J. Graham[1] and David D. Cox[1]*

[1] *The Rowland Institute at Harvard, Harvard University, Cambridge, MA, USA*
[2] *Neurobiology and Cognitive Neuroscience Sectors, International School for Advanced Studies (SISSA), Trieste, Italy*


A
B
motion stages
camera
lens
illuminators
C
pseudo-rotation center
d
d′
2
camera's rotation axis
1
D
93 cm
HD monitor
30 cm
10°
57°
motion stage
camera
18 cm
headfixed rat
breadboard table

2001 Group Conversation

CHI 2001 • 31 MARCH – 5 APRIL Papers

Eye Gaze Patterns in Conversations: There is More to Conversational Agents Than Meets the Eyes

Roel Vertegaal
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Canada
roel@acm.org

Robert Slagter
Telematics Institute
The Netherlands
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Gerrit van der Veer
Vrije Universiteit
The Netherlands
gerrit@acm.org

Anton Nijholt
Twente University
The Netherlands
anijholt@cs.utwente.nl

Figure 1. *Conversational partners as seen from a camera located above the subject's head.*

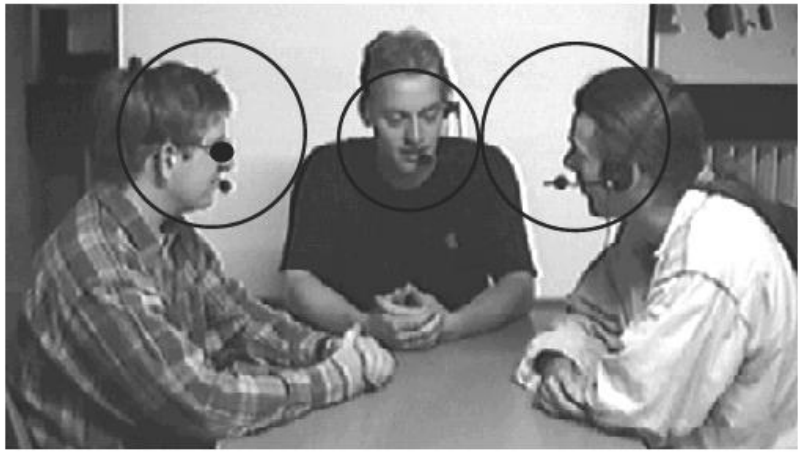

Figure 2. *When subject fixations (the black dot) hit one of the circles, gaze was registered for that person.*

2007 Sex Difference

ELSEVIER

Available online at www.sciencedirect.com
ScienceDirect

Hormones and Behavior 51 (2007) 524–533

Hormones and Behavior

www.elsevier.com/locate/yhbeh

Sex differences in viewing sexual stimuli: An eye-tracking study in men and women

Heather A. Rupp [a,b,*], Kim Wallen [a]

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[b] *The Kinsey Institute for Research in Sex, Gender and Reproduction, Indiana University, Morrison Hall 313, Bloomington, IN 47405, USA*

Received 14 October 2006; revised 27 January 2007; accepted 30 January 2007
Available online 12 February 2007

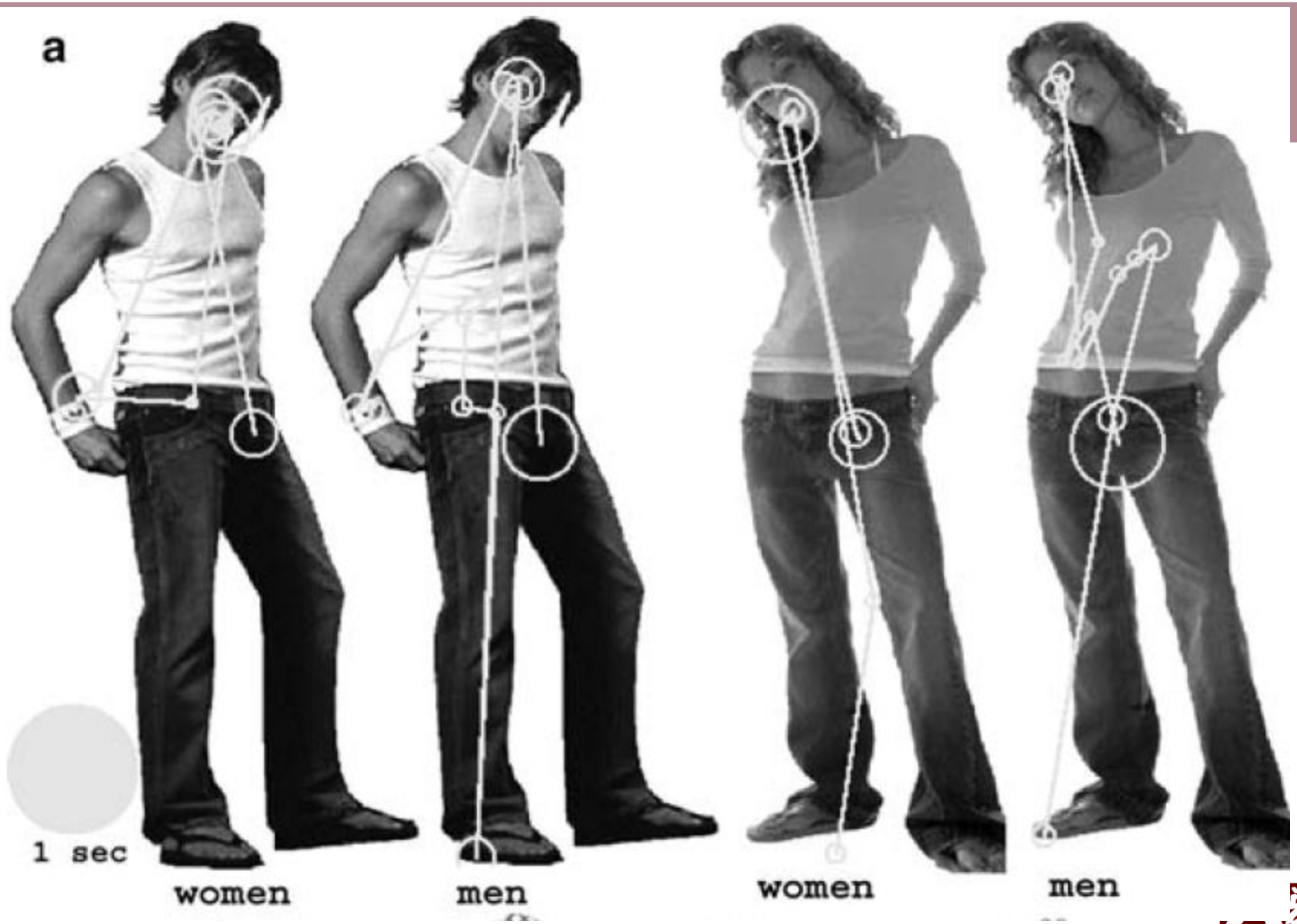
2008 Non Verbal Behavior-German Research

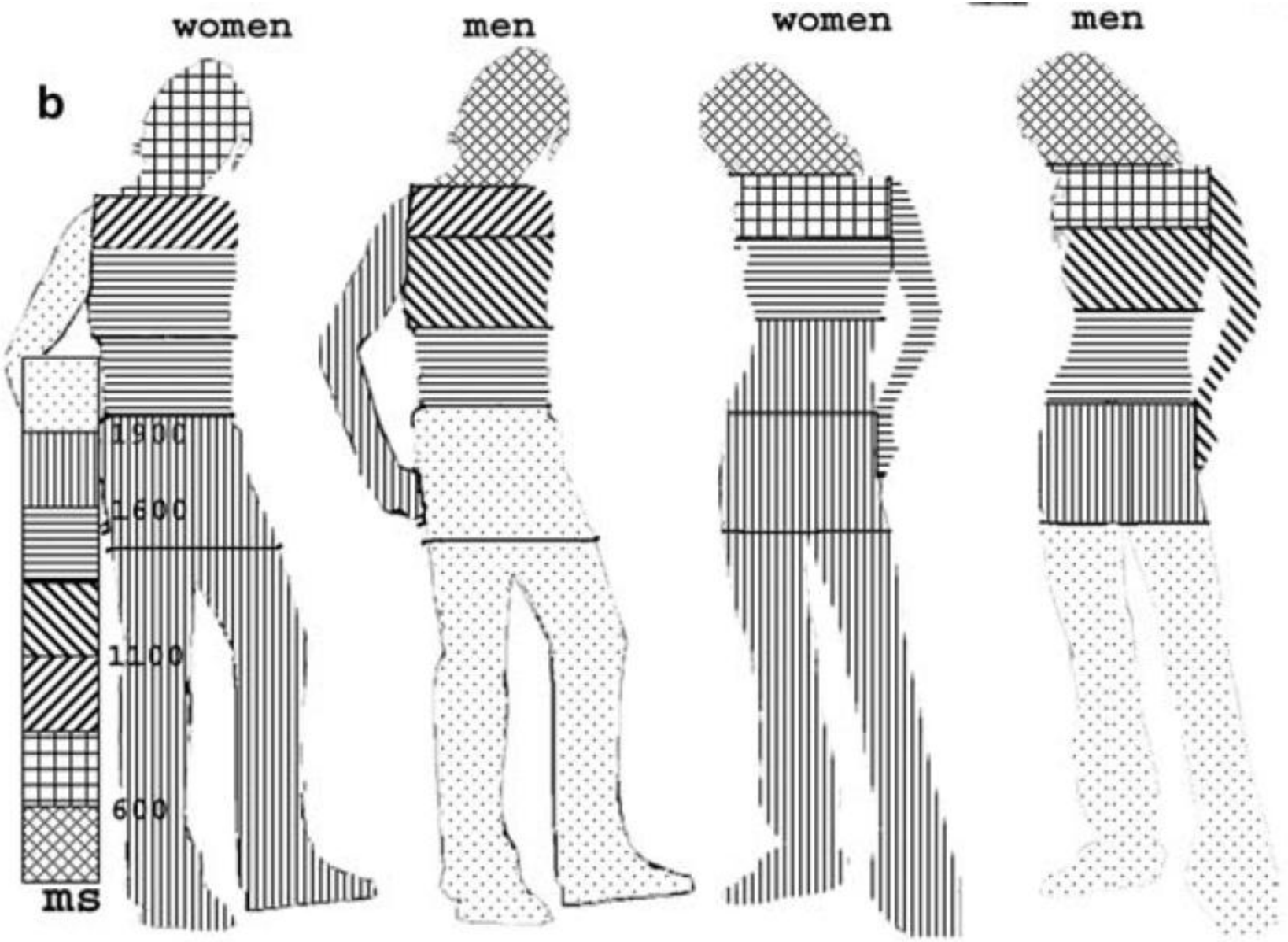
J Nonverbal Behav (2008) 32:67–78
DOI 10.1007/s10919-007-0043-5

ORIGINAL PAPER

Gender Differences for Specific Body Regions When Looking at Men and Women

Johannes Hewig · Ralf H. Trippe · Holger Hecht · Thomas Straube · Wolfgang H. R. Miltner


a
1 sec
women
men
women
men


women
men
women
men
b
1900
1600
1100
600
ms

2009 Human Behavior

ELSEVIER

Evolution and Human Behavior 30 (2009) 417–428

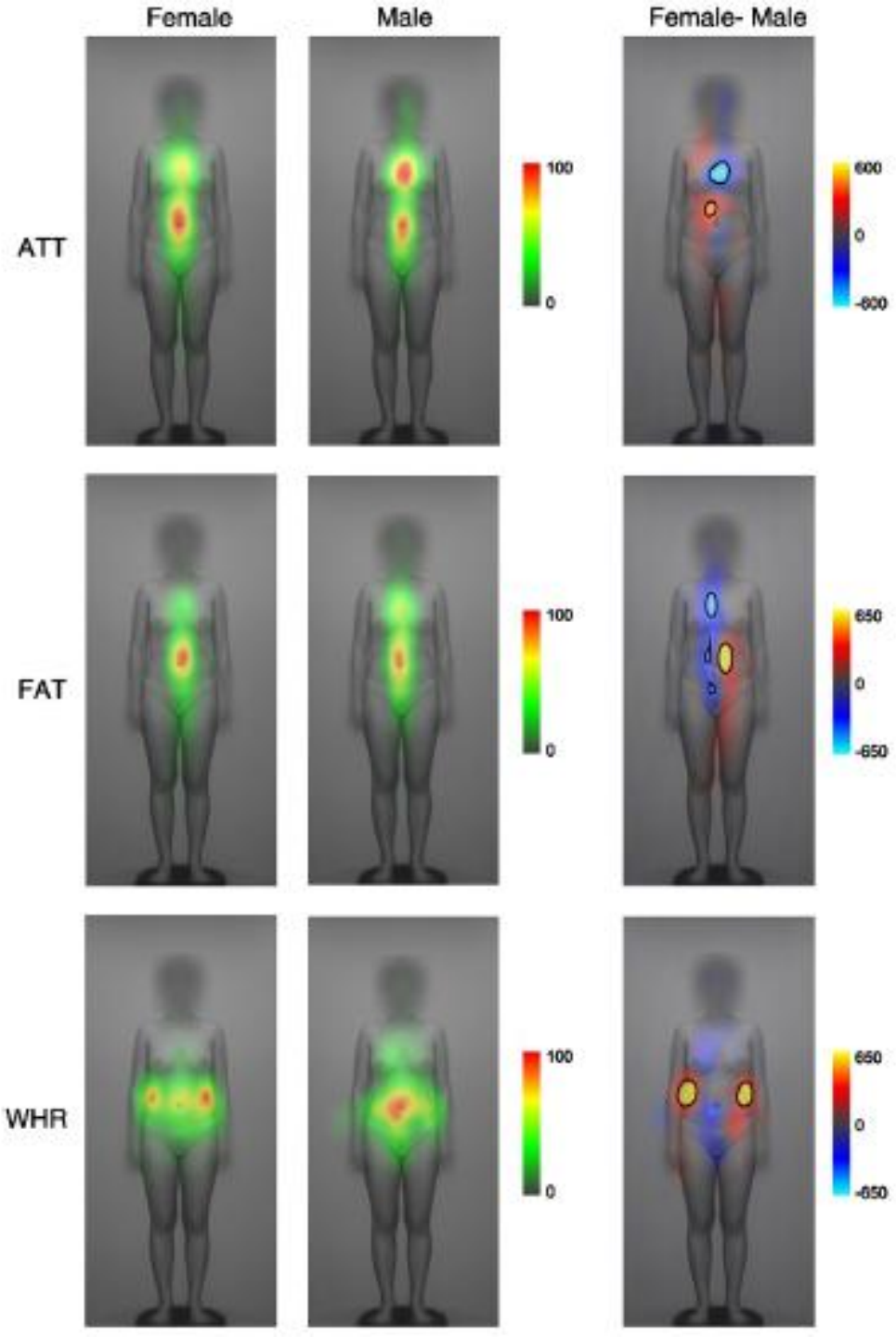
Evolution and Human Behavior

Patterns of eye movements when male and female observers judge female attractiveness, body fat and waist-to-hip ratio

Piers L. Cornelissen[a], Peter J.B. Hancock[b], Vesa Kiviniemi[c], Hannah R. George[d], Martin J. Tovée[d,*]

[a]*Department of Psychology, University of York, YO10 5DD York, UK*
[b]*School of Psychology, Stirling University, Stirling, FK9 4LA Scotland, UK*
[c]*Department of Statistics, University of Kuopio, FIN-70211 Kuopio, Finland*
[d]*Institute of Neouroscience, Newcastle University, NE2 4HH Newcastle Upon Tyne, UK*

Initial receipt 4 September 2008; final revision received 26 April 2009


Female
Male
Female- Male
ATT
FAT
WHR
100
0
600
0
-600
100
0
650
0
-650
100
0
650
0
-650

2010 Arch Sex Behavior

Arch Sex Behav (2010) 39:1055–1062
DOI 10.1007/s10508-009-9482-x

ORIGINAL PAPER

Gazing Behavior During Mixed-Sex Interactions: Sex and Attractiveness Effects

Ischa van Straaten · Rob W. Holland ·
Catrin Finkenauer · Tom Hollenstein ·
Rutger C. M. E. Engels

2011-New Zealand Research

Arch Sex Behav (2011) 40:51–58
DOI 10.1007/s10508-010-9601-8

ORIGINAL PAPER

Eye Tracking of Men's Preferences for Female Breast Size and Areola Pigmentation

Barnaby J. Dixson · Gina M. Grimshaw · Wayne L. Linklater · Alan F. Dixson

Research Material

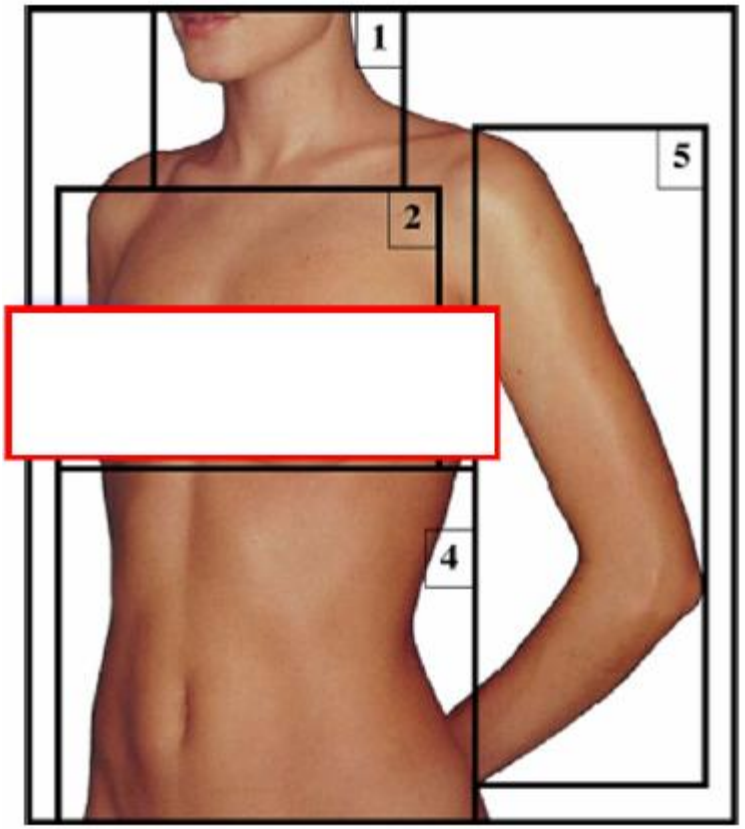


Fig. 1 Female stimulus images were divided into five anatomical regions in order to analyze male visual attention during eye-tracking. 1 = neck and jaw; 2 = breasts; 3 = nipples and areolae; 4 = midriff; 5 = arm

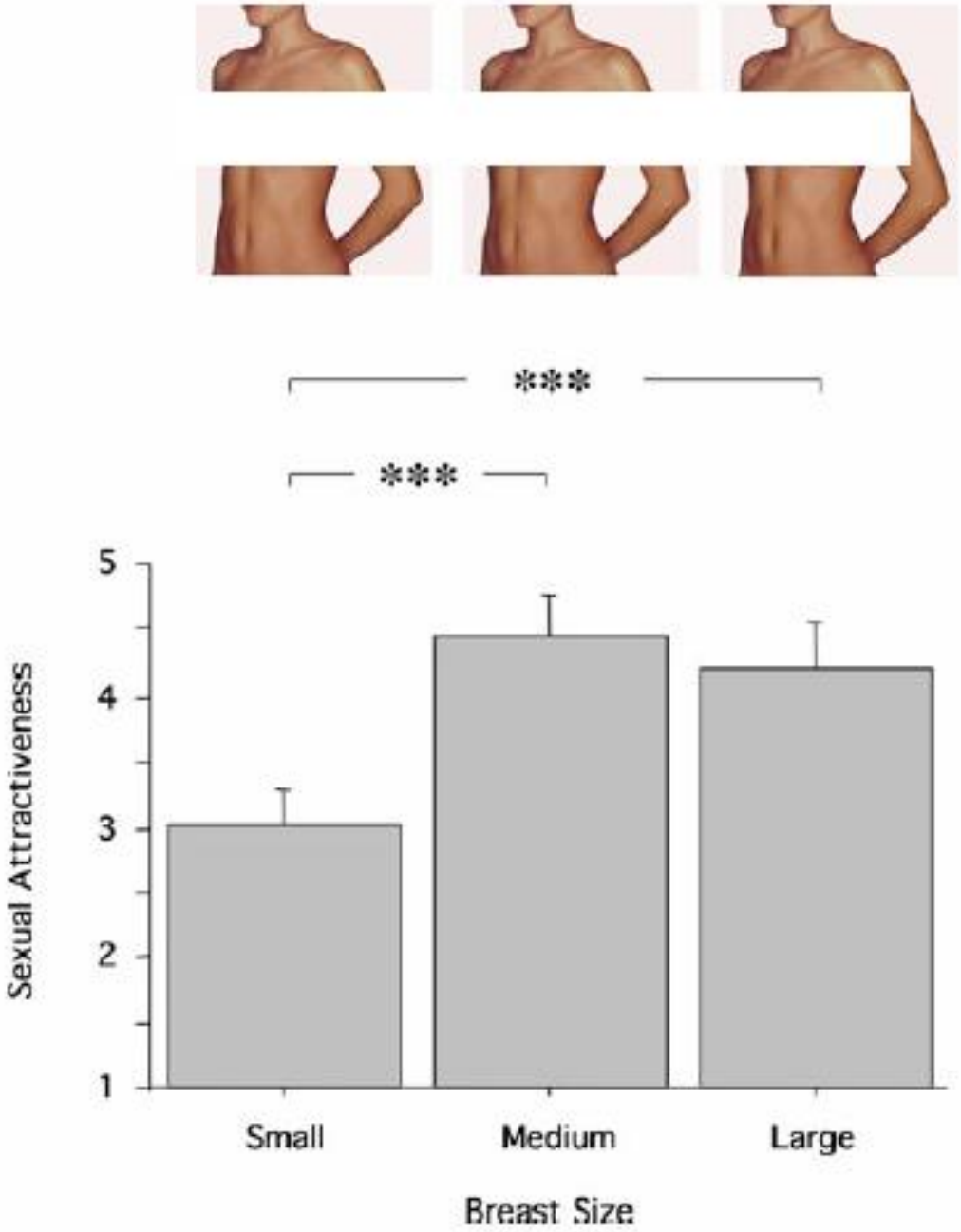


Fig. 2 Mean ratings (+SD) of sexual attractiveness for three female torsos varying in breast size (small, medium or large). ***$p < .001$

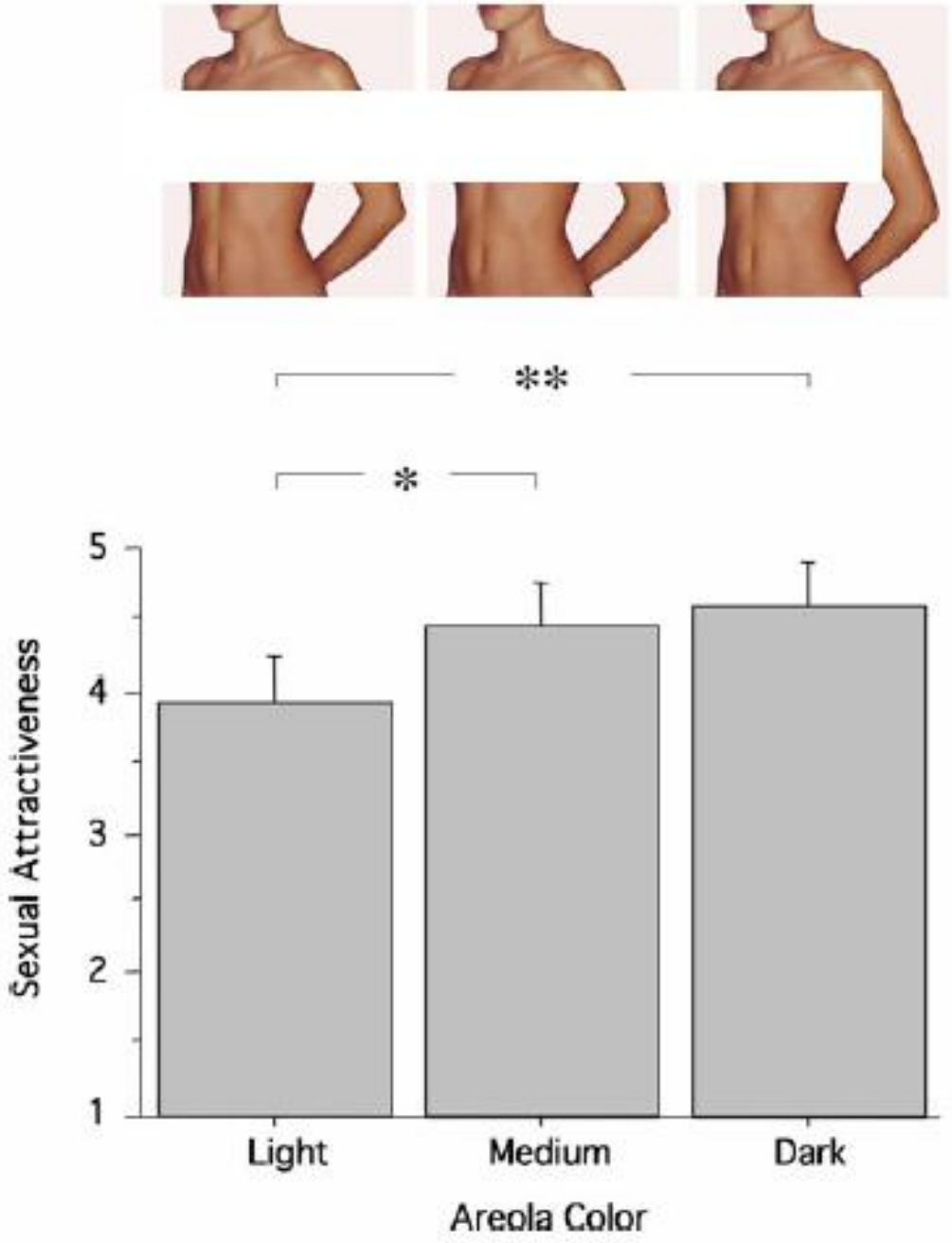


Fig. 3 Mean ratings (+SD) of sexual attractiveness for three female torsos varying in areola color (light, medium or dark). * $p < .05$, ** $p < .01$

2006 Medical Education-Tissue Biopsy

Human Pathology (2006) 37, 1543–1556

ELSEVIER

Human PATHOLOGY

www.elsevier.com/locate/humpath

Original contribution

Eye-movement study and human performance using telepathology virtual slides. Implications for medical education and differences with experience☆

Elizabeth A Krupinski PhD[a,c], Allison A. Tillack MA[b], Lynne Richter MT (ASCP)[b,c], Jeffrey T. Henderson MD[b], Achyut K. Bhattacharyya MD[b], Katherine M. Scott MD[b], Anna R. Graham MD[b], Michael R. Descour PhD[d], John R. Davis MD[b], Ronald S. Weinstein MD[b,c,*]

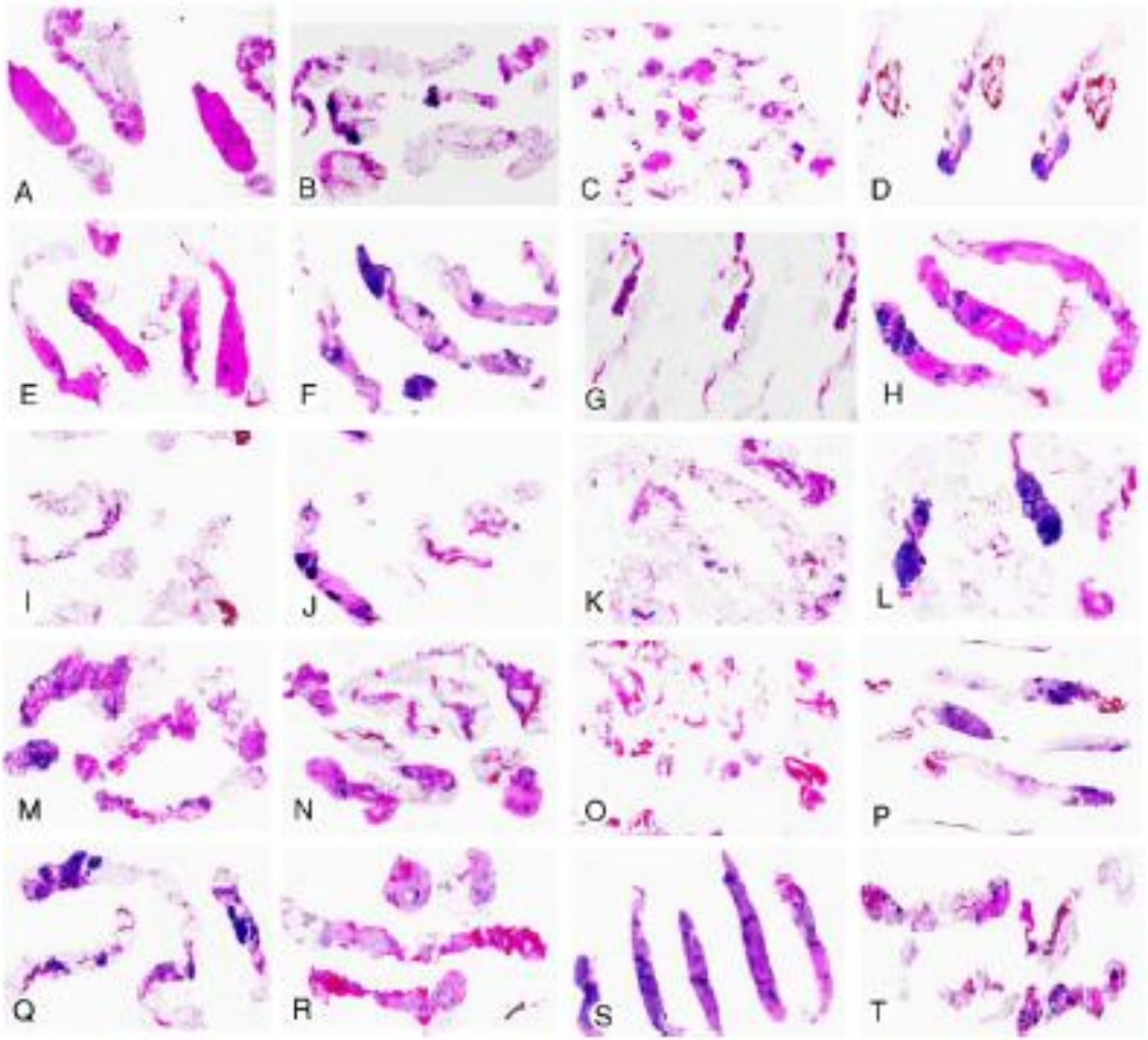
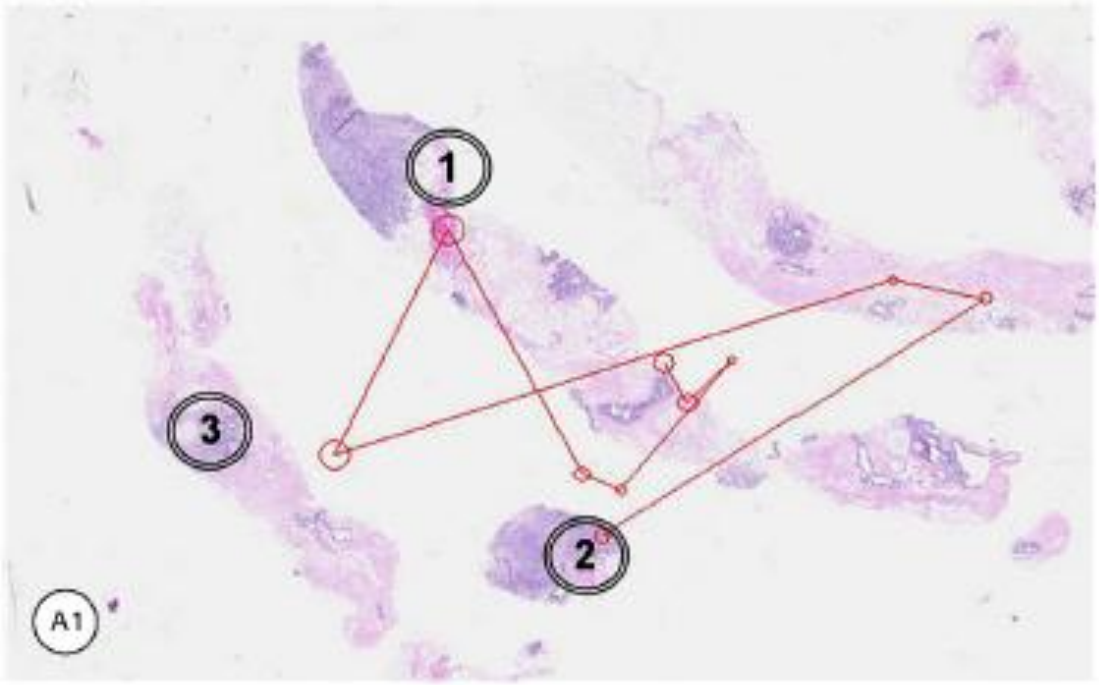
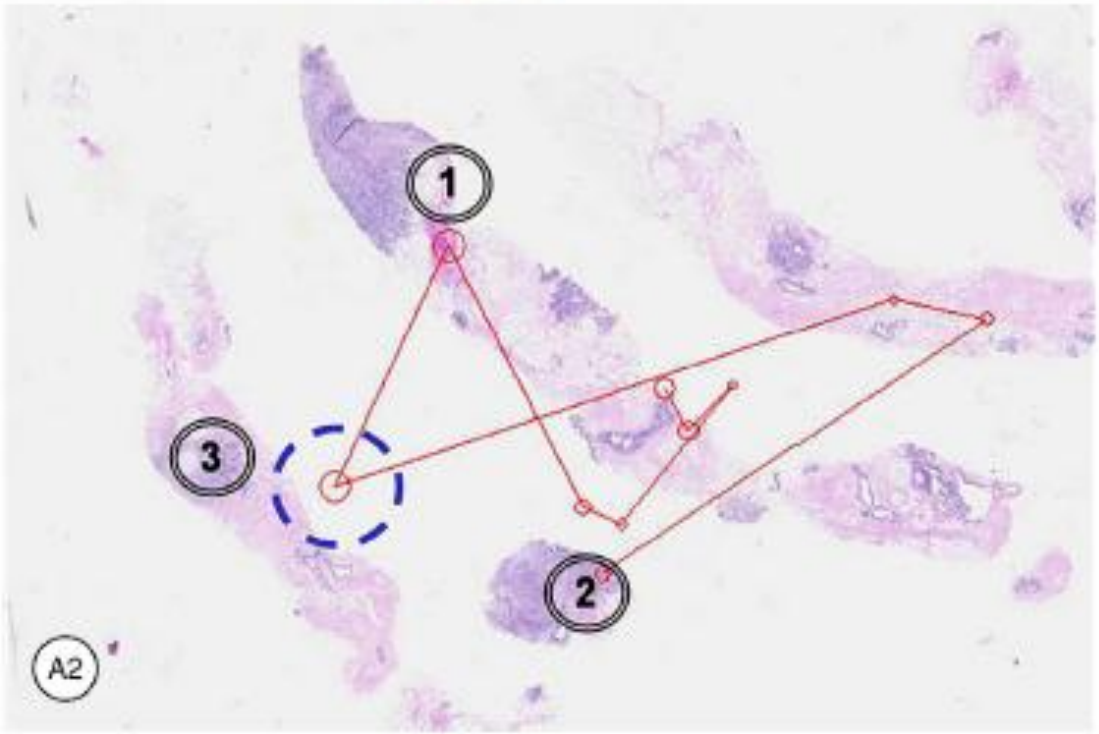
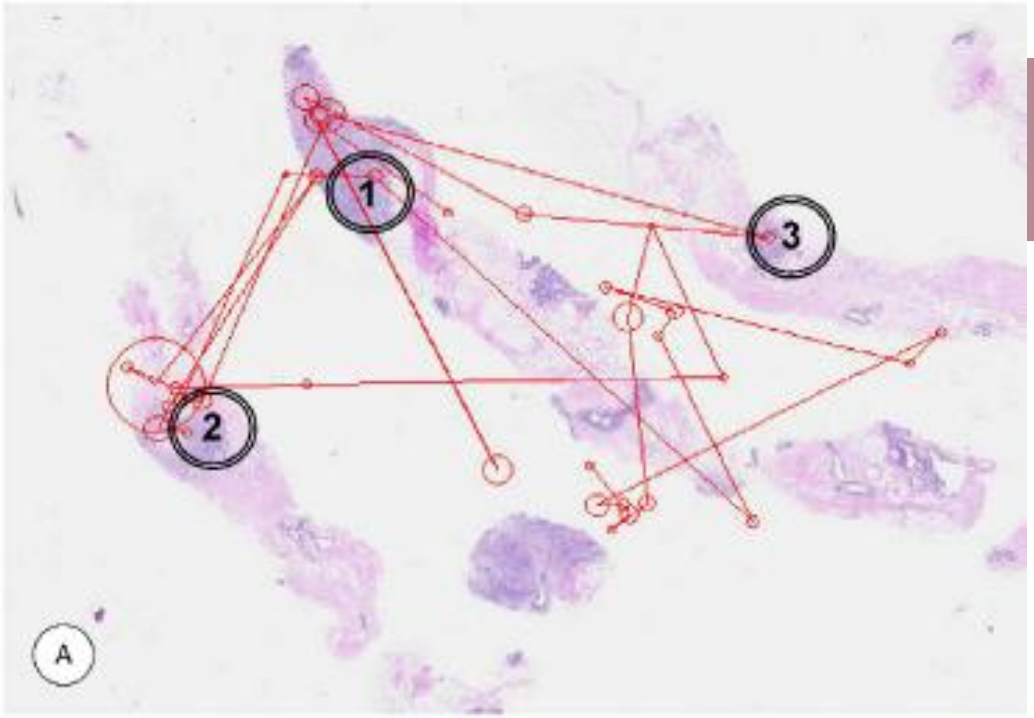
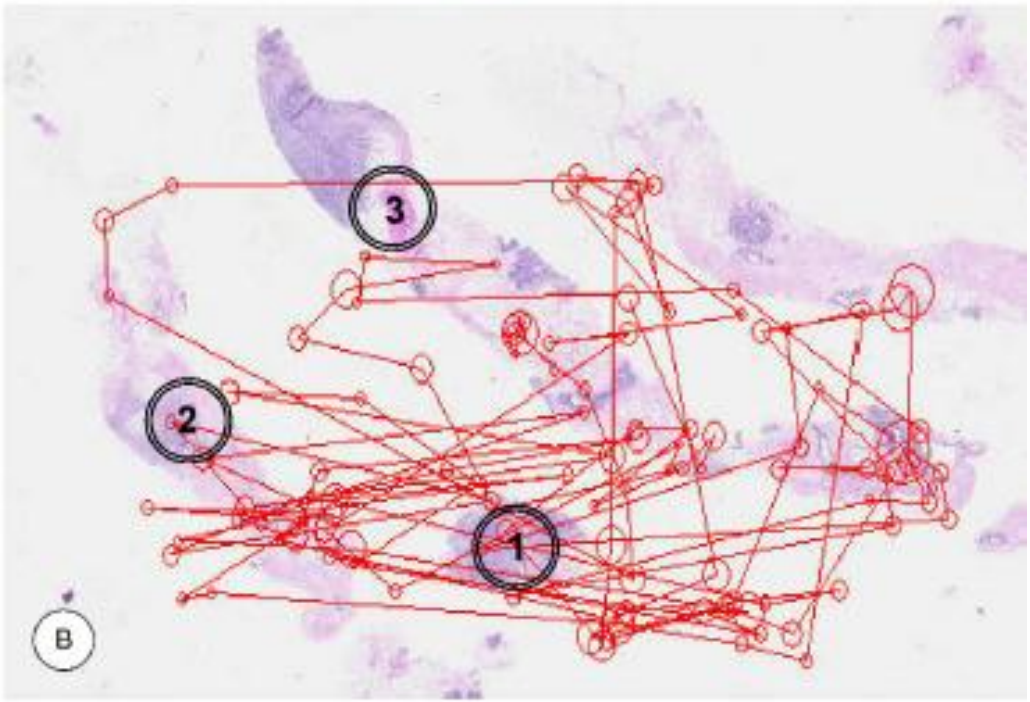


Fig. 4 Gallery of thumbnail images of the 20 breast core biopsy DMetrix virtual slides (A-T) viewed by the slide readers. Each virtual slide was viewed individually at low magnification on the monitor. Typically, slides have tissue sections of 3 or more breast core biopsies.


1
3
2
A1


1
3
2
A2


1
3
2
A


3
2
1
B

2010 Medicine Surgical Training-England

Surg Endosc (2010) 24:2458–2464
DOI 10.1007/s00464-010-0986-1

Psychomotor control in a virtual laparoscopic surgery training environment: gaze control parameters differentiate novices from experts

Mark Wilson · John McGrath · Samuel Vine · James Brewer · David Defriend · Richard Masters

Facility

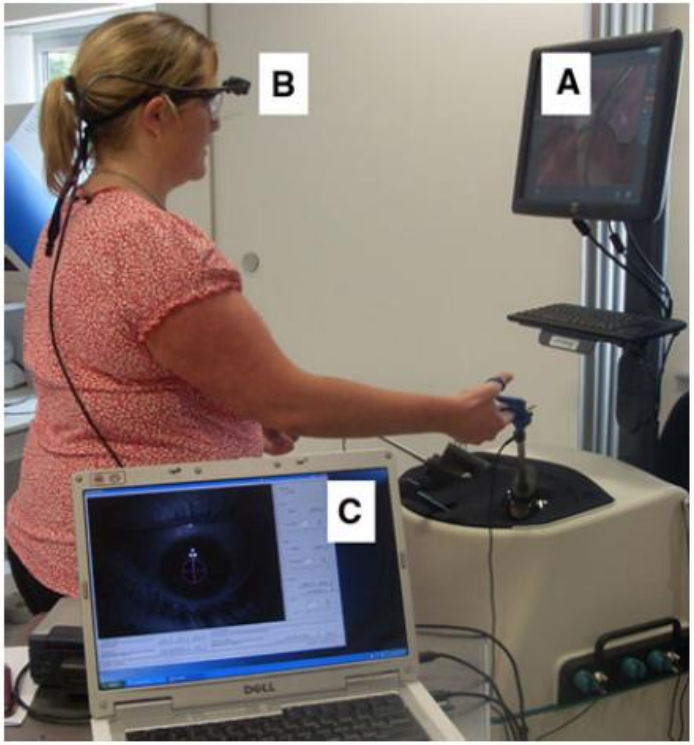


Fig. 1 The testing environment demonstrating the LAP Mentor virtual reality simulator (**A**), the lightweight optics unit (**B**), and the supporting software running on the laptop (**C**)

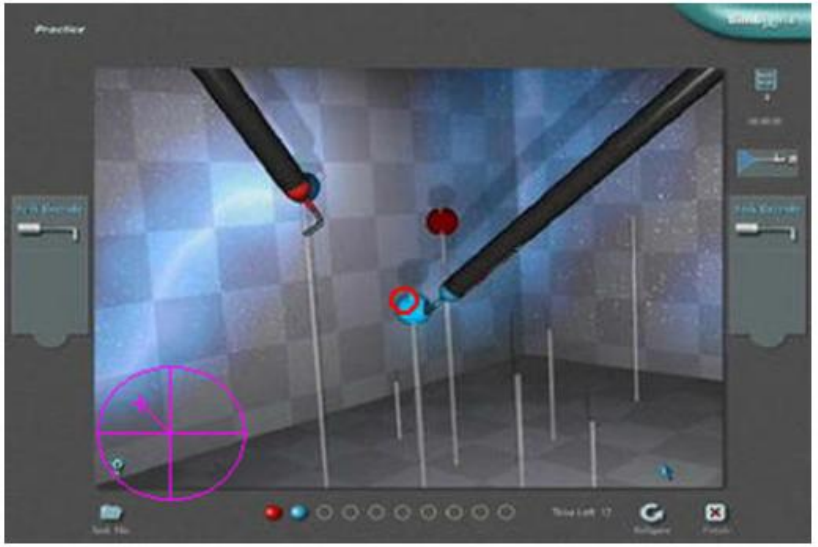


Fig. 3 The eye-hand coordination task showing the target balls, the "virtual" instruments, the gaze cursor (on the central flashing ball), and the vector angle calculation (*bottom left* of screen)

Tool、Result

Fig. 2 An image from the eye camera in the Eyevision software environment showing the *corneal reflection* from the LEDs (three white dots); the *pupil center* (midpoint of the magenta circle) and the *vector* line between the pupil centre and the corneal reflection

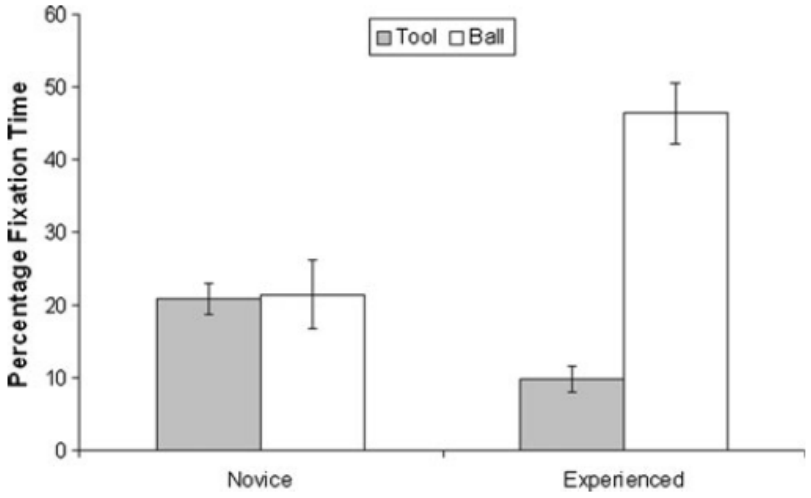


Fig. 4 The percentage of total fixation duration to each of the two relevant locations for novice and experienced surgeons (±SEM)

2012 Medical Training-England

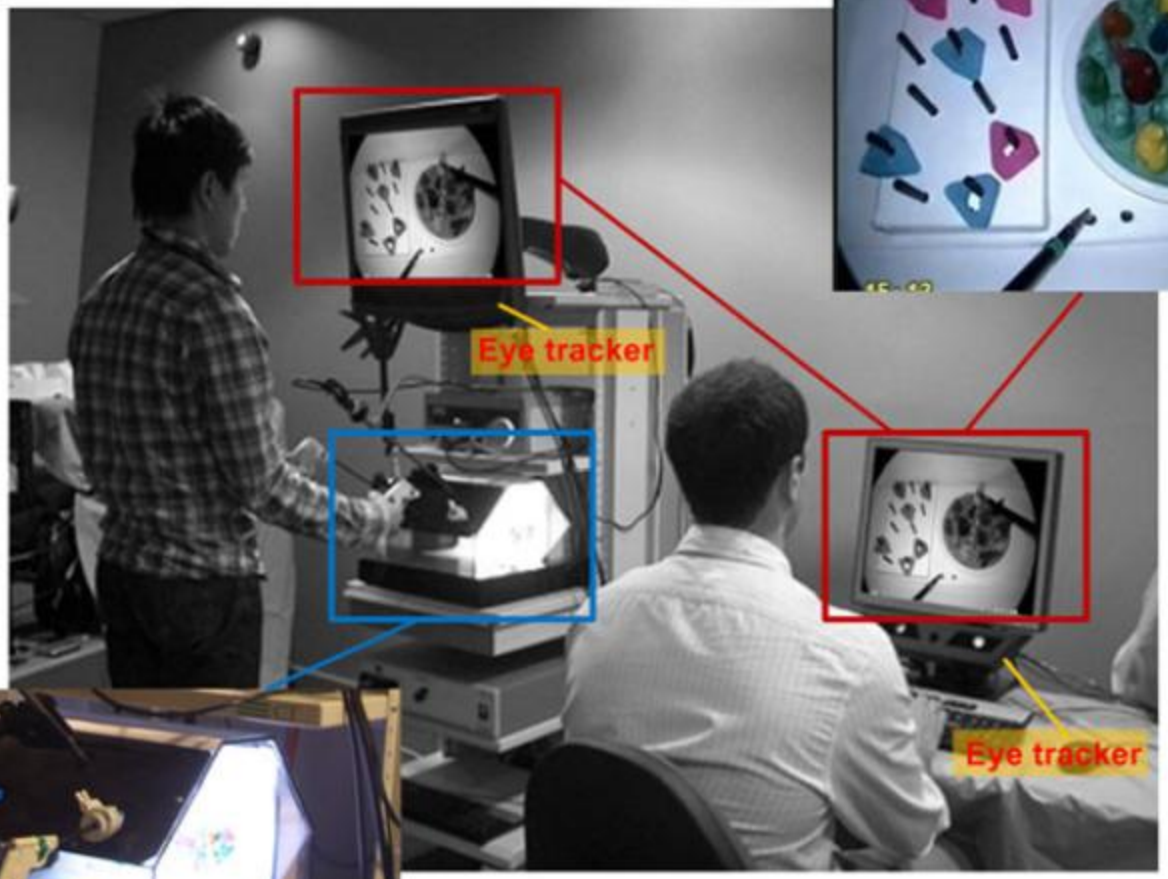
Surg Endosc
DOI 10.1007/s00464-011-2143-x

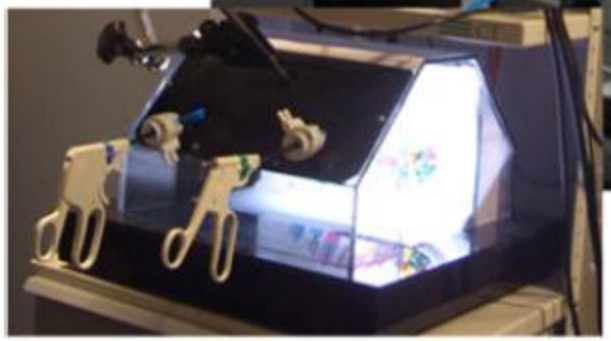
Collaborative eye tracking: a potential training tool in laparoscopic surgery

Andrew S. A. Chetwood · Ka-Wai Kwok · Loi-Wah Sun · George P. Mylonas · James Clark · Ara Darzi · Guang-Zhong Yang

Received: 24 August 2011 / Accepted: 15 December 2011

Two screens in same content showing the surgical task, both the eye trackers built-in under the two screens





Laparoscopic simulator comprised of surgical environment, two Maryland laparoscopic graspers and 0 degree camera

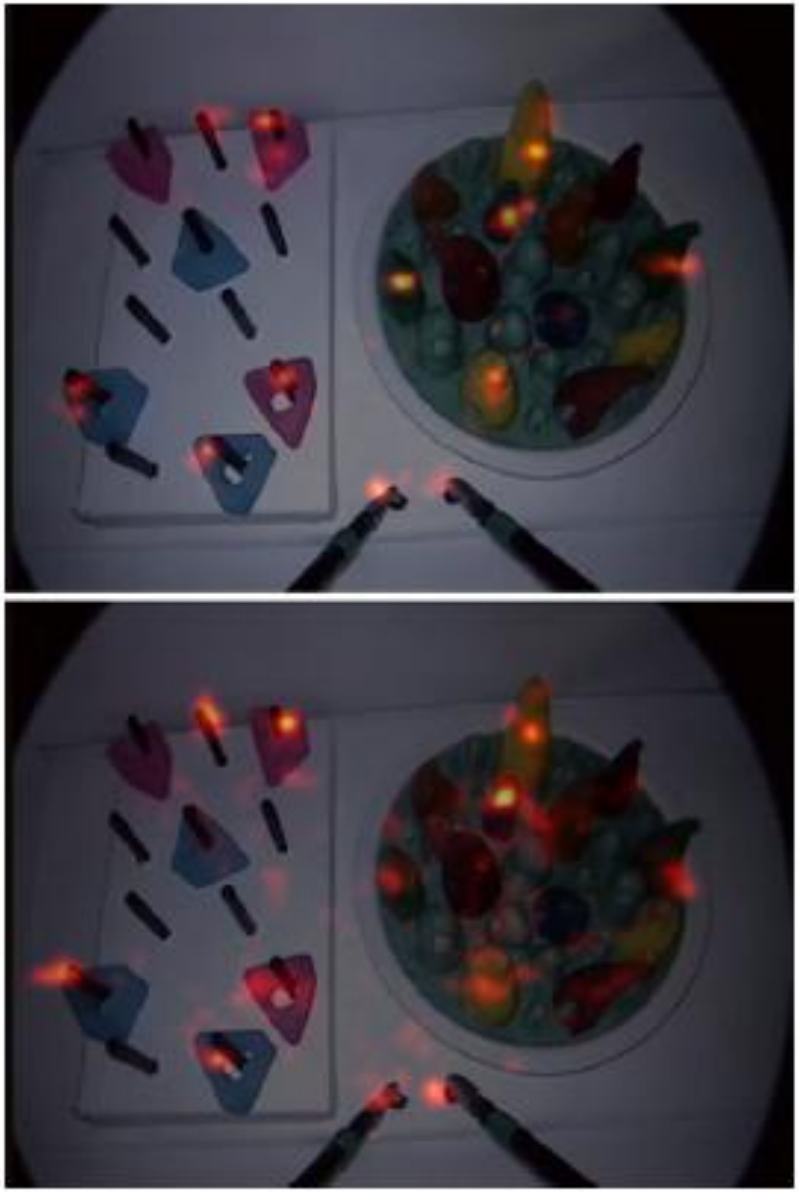
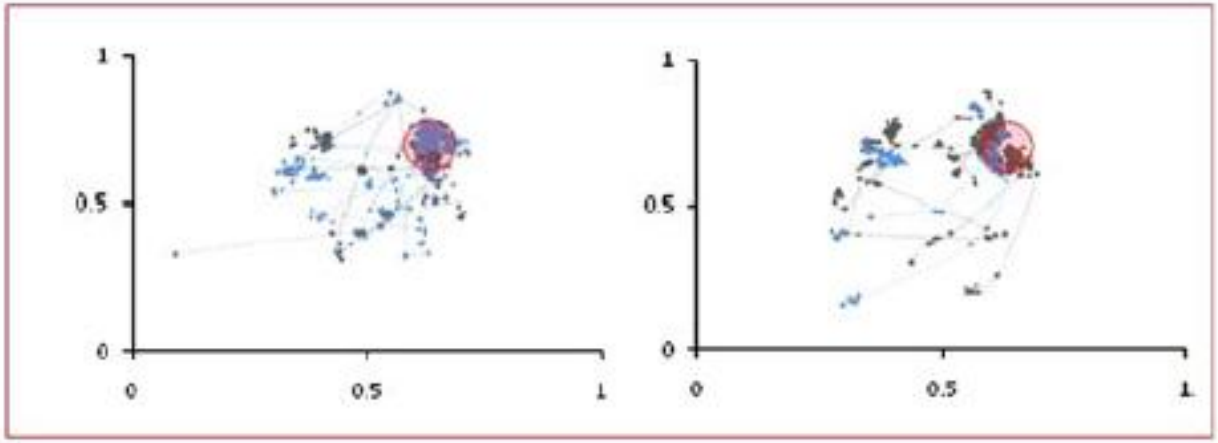


Fig. 2 Pictorial representation of subjects' point-of-regard. More precise areas of focus ("hotspots") are visible in the top image which represents (verbal plus eye) VE guidance. By comparison, the verbal guidance shows numerous areas of focus away from the target image reflecting scanning of the object field in an attempt to follow the spoken instruction (Color figure online)

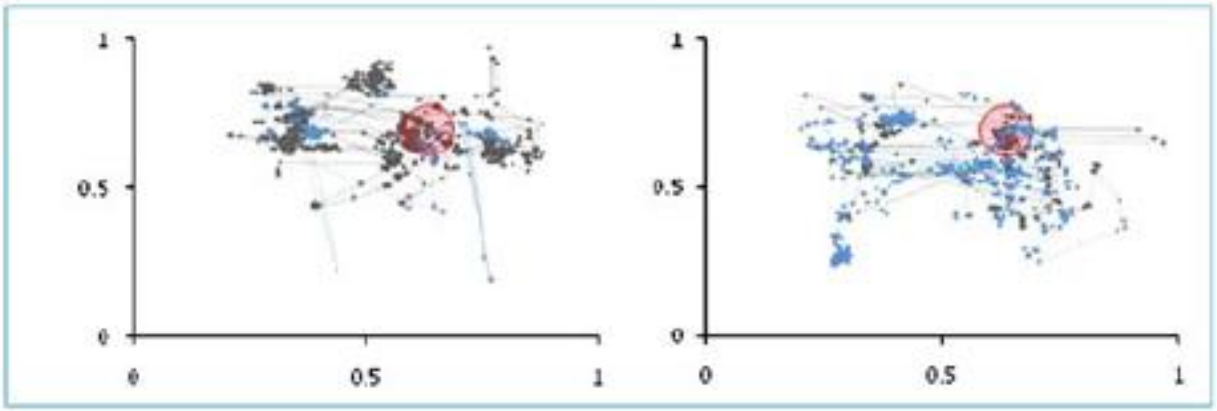
English as first-language

English not as first-language

When only Eye guidance used (E)



When Verbal guidance used (V)



2012 Skin Lesion Examination

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Differences in examination characteristics of pigmented skin lesions: Results of an eye tracking study

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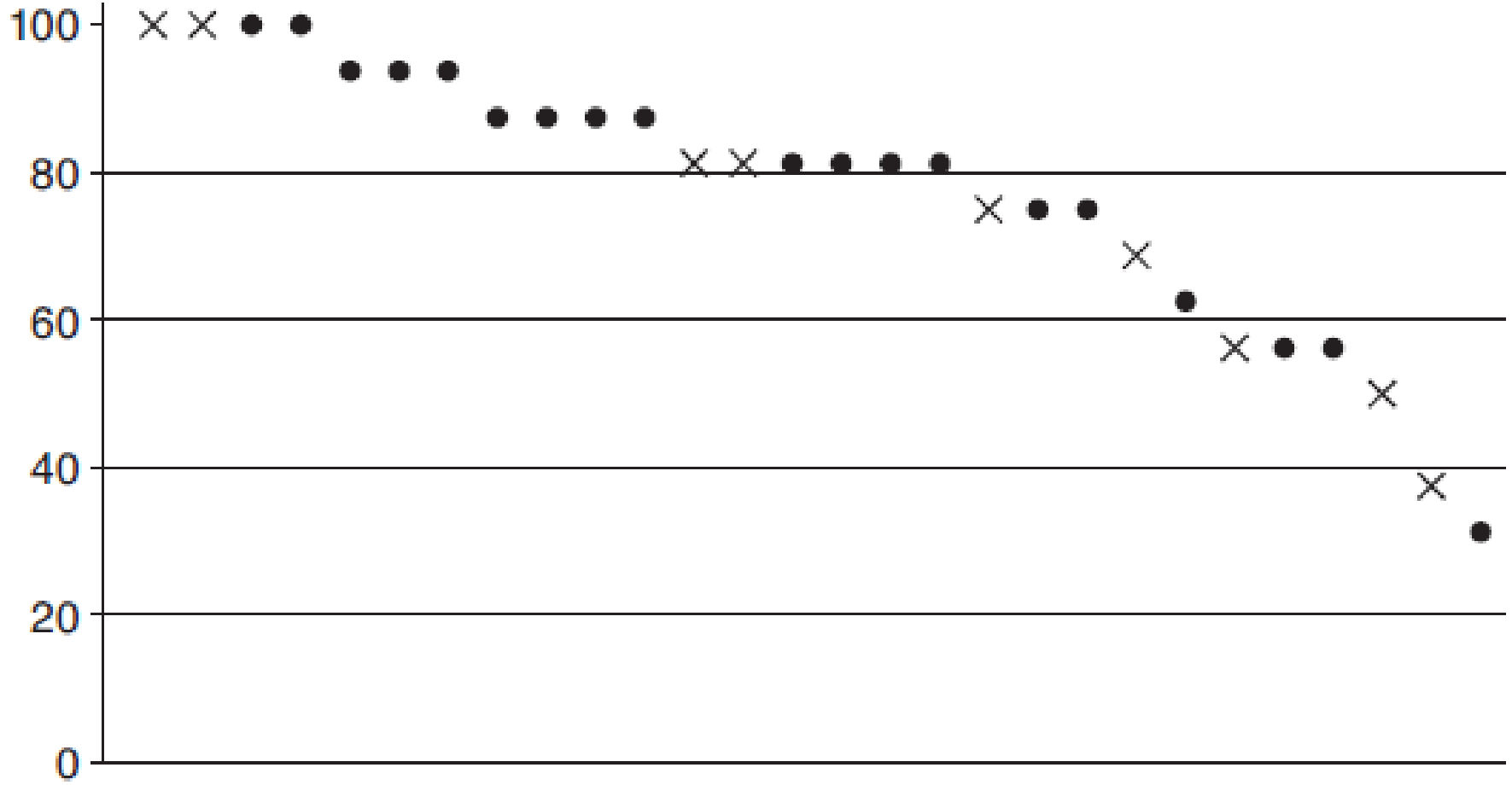

Fig. 1. Distribution of lesion difficulty, shown as percentage of correct diagnoses (*y*-axis) for each of the 28 lesions (*x*-axis). Lesions were sorted by decreasing ease of diagnosis, with benign lesions marked by a dot, and malignant lesions marked by a cross.

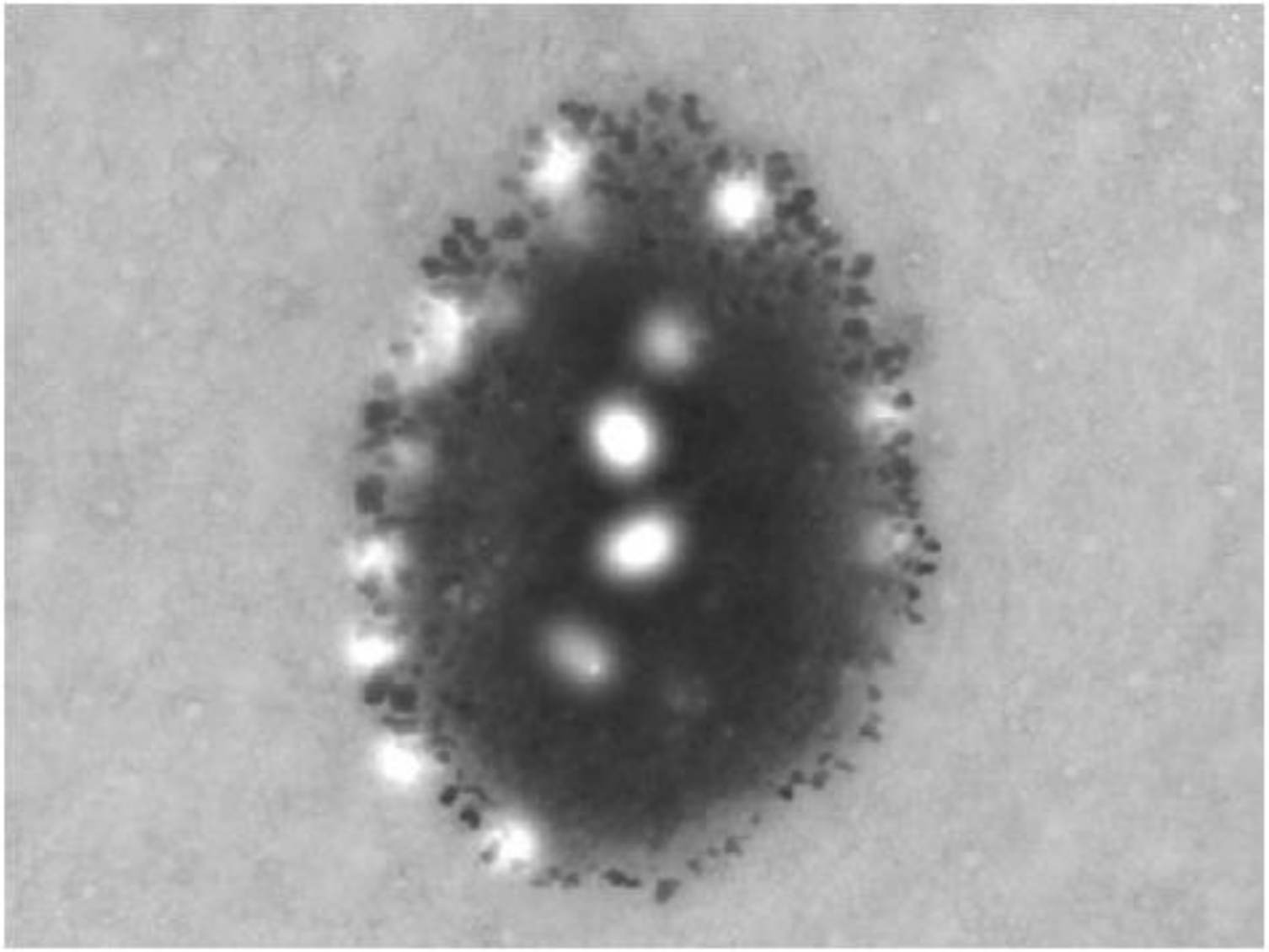

Fig. 2. Graphical representation of gaze hot spots for a lesion image. Brighter spots indicate longer fixation times.

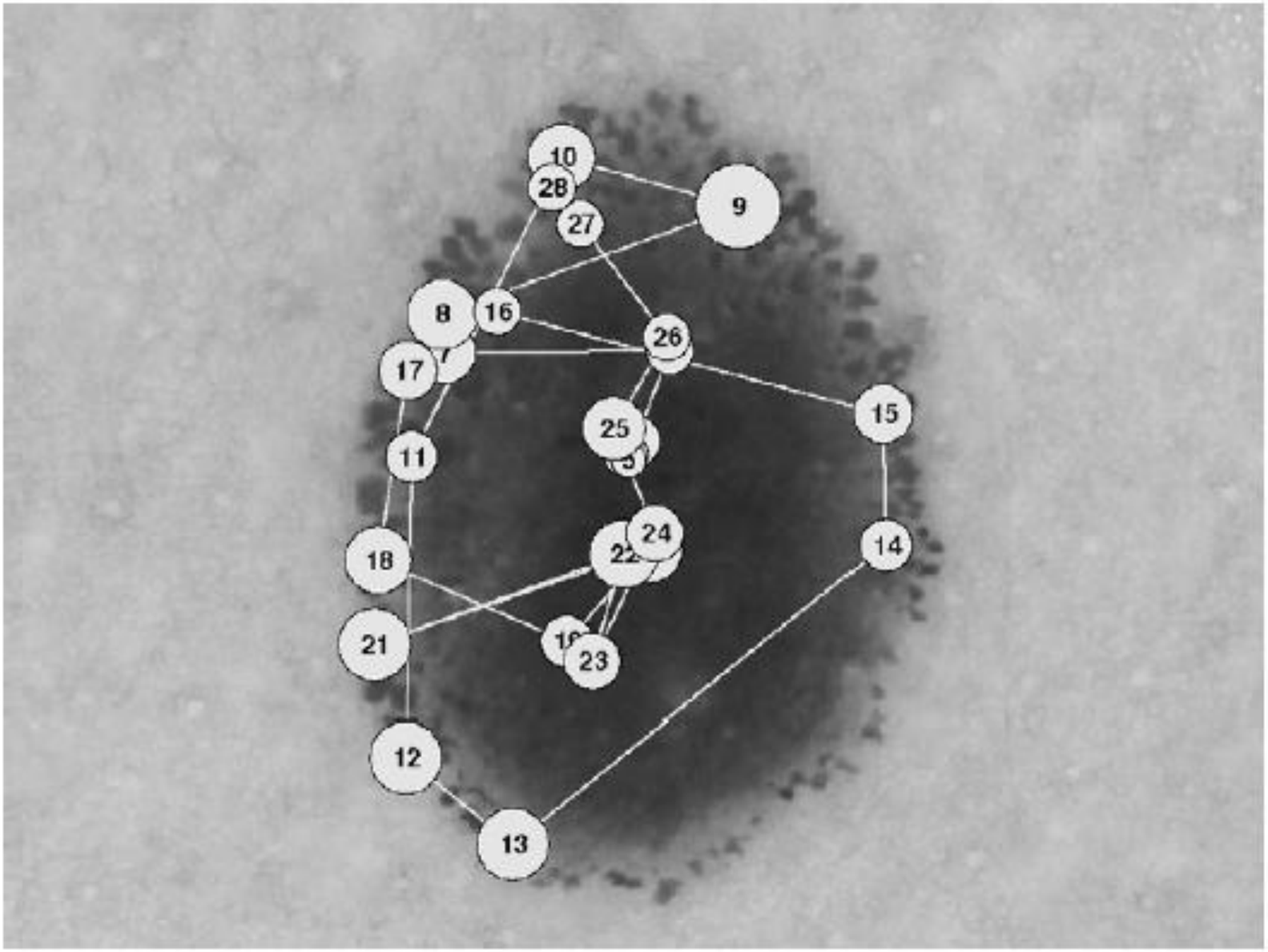

Fig. 3. Graphical representation of the gaze track recorded during a lesion examination.

2012 Surgical Performance

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ORIGINAL ARTICLE

Eye-tracking analysis of skilled performance in clinical extracorporeal circulation

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Satoshi Suzuki · Toru Matayoshi · Ryohei Yozu

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Observation Timeline

Fig. 1 Example of observation timeline (perfusionist 1)

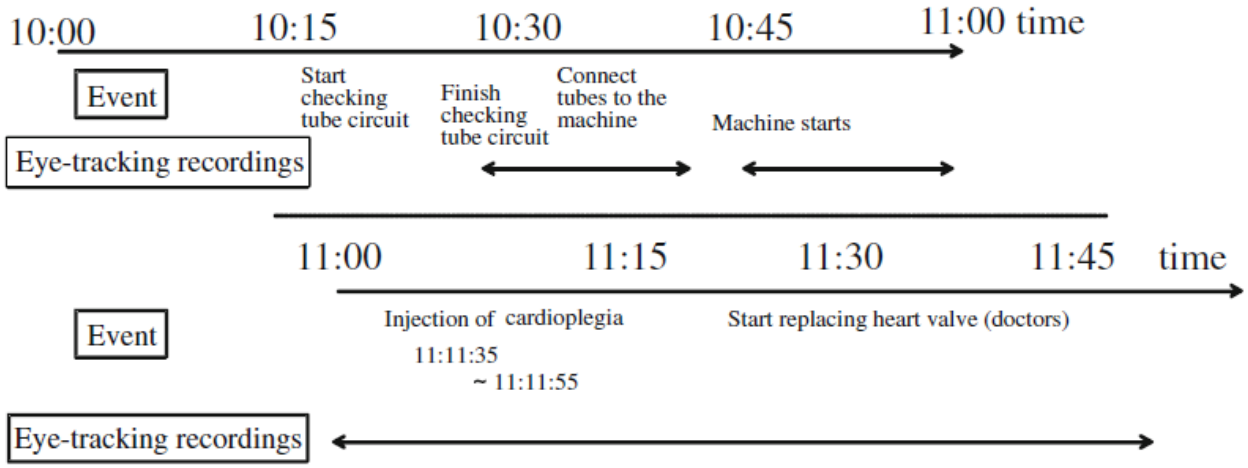


Fig. 2 Eye-tracking device worn by perfusionist during real cardiac surgery in the operating room (perfusionist 1)

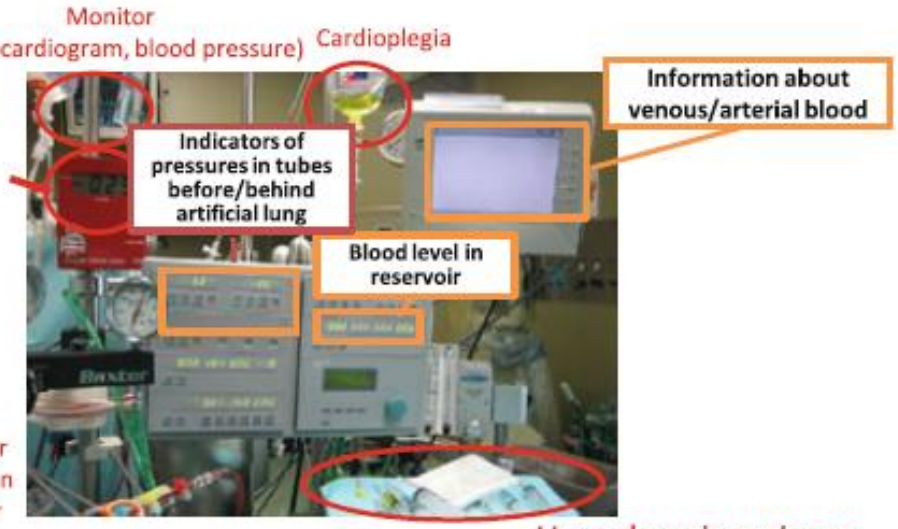
Fig. 3 Example of video-recorded eye-tracking data. *Blue circle* area at which the perfusionist is gazing

Info Groups & Aois

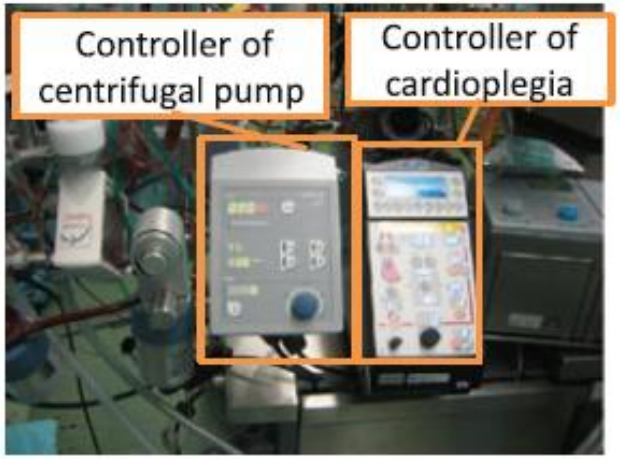
Blood reservoir

Too much buffer: hazardous to patient's body

Too little buffer: dangerous when unpredicted events occur



Hypodermic syringes
(vasodilator, heparin, etc.)



Aim for the Top University Project

Thank you
and
Welcome for collaborative research