TABLE of CRITICAL VALUES for STUDENT'S *t* DISTRIBUTIONS

Column headings denote probabilities (α) ***above*** tabulated values.

d.f.	0.40	0.25	0.10	0.05	0.04	0.025	0.02	0.01	0.005	0.0025	0.001	0.0005
1	0.325	1.000	3.078	6.314	7.916	12.706	15.894	31.821	63.656	27.321	318.289	636.578
2	0.289	0.816	1.886	2.920	3.320	4.303	4.849	6.965	9.925	14.089	22.328	31.600
3	0.277	0.765	1.638	2.353	2.605	3.182	3.482	4.541	5.841	7.453	10.214	12.924
4	0.271	0.741	1.533	2.132	2.333	2.776	2.999	3.747	4.604	5.598	7.173	8.610
5	0.267	0.727	1.476	2.015	2.191	2.571	2.757	3.365	4.032	4.773	5.894	6.869
6	0.265	0.718	1.440	1.943	2.104	2.447	2.612	3.143	3.707	4.317	5.208	5.959
7	0.263	0.711	1.415	1.895	2.046	2.365	2.517	2.998	3.499	4.029	4.785	5.408
8	0.262	0.706	1.397	1.860	2.004	2.306	2.449	2.896	3.355	3.833	4.501	5.041
9	0.261	0.703	1.383	1.833	1.973	2.262	2.398	2.821	3.250	3.690	4.297	4.781
10	0.260	0.700	1.372	1.812	1.948	2.228	2.359	2.764	3.169	3.581	4.144	4.587
11	0.260	0.697	1.363	1.796	1.928	2.201	2.328	2.718	3.106	3.497	4.025	4.437
12	0.259	0.695	1.356	1.782	1.912	2.179	2.303	2.681	3.055	3.428	3.930	4.318
13	0.259	0.694	1.350	1.771	1.899	2.160	2.282	2.650	3.012	3.372	3.852	4.221
14	0.258	0.692	1.345	1.761	1.887	2.145	2.264	2.624	2.977	3.326	3.787	4.140
15	0.258	0.691	1.341	1.753	1.878	2.131	2.249	2.602	2.947	3.286	3.733	4.073
16	0.258	0.690	1.337	1.746	1.869	2.120	2.235	2.583	2.921	3.252	3.686	4.015
17	0.257	0.689	1.333	1.740	1.862	2.110	2.224	2.567	2.898	3.222	3.646	3.965
18	0.257	0.688	1.330	1.734	1.855	2.101	2.214	2.552	2.878	3.197	3.610	3.922
19	0.257	0.688	1.328	1.729	1.850	2.093	2.205	2.539	2.861	3.174	3.579	3.883
20	0.257	0.687	1.325	1.725	1.844	2.086	2.197	2.528	2.845	3.153	3.552	3.850
21	0.257	0.686	1.323	1.721	1.840	2.080	2.189	2.518	2.831	3.135	3.527	3.819
22	0.256	0.686	1.321	1.717	1.835	2.074	2.183	2.508	2.819	3.119	3.505	3.792
23	0.256	0.685	1.319	1.714	1.832	2.069	2.177	2.500	2.807	3.104	3.485	3.768
24	0.256	0.685	1.318	1.711	1.828	2.064	2.172	2.492	2.797	3.091	3.467	3.745
25	0.256	0.684	1.316	1.708	1.825	2.060	2.167	2.485	2.787	3.078	3.450	3.725
26	0.256	0.684	1.315	1.706	1.822	2.056	2.162	2.479	2.779	3.067	3.435	3.707
27	0.256	0.684	1.314	1.703	1.819	2.052	2.158	2.473	2.771	3.057	3.421	3.689
28	0.256	0.683	1.313	1.701	1.817	2.048	2.154	2.467	2.763	3.047	3.408	3.674
29	0.256	0.683	1.311	1.699	1.814	2.045	2.150	2.462	2.756	3.038	3.396	3.659
30	0.256	0.683	1.310	1.697	1.812	2.042	2.147	2.457	2.750	3.030	3.385	3.646
31	0.256	0.682	1.309	1.696	1.810	2.040	2.144	2.453	2.744	3.022	3.375	3.633
32	0.255	0.682	1.309	1.694	1.808	2.037	2.141	2.449	2.738	3.015	3.365	3.622
33	0.255	0.682	1.308	1.692	1.806	2.035	2.138	2.445	2.733	3.008	3.356	3.611
34	0.255	0.682	1.307	1.691	1.805	2.032	2.136	2.441	2.728	3.002	3.348	3.601
35	0.255	0.682	1.306	1.690	1.803	2.030	2.133	2.438	2.724	2.996	3.340	3.591
36	0.255	0.681	1.306	1.688	1.802	2.028	2.131	2.434	2.719	2.990	3.333	3.582
37	0.255	0.681	1.305	1.687	1.800	2.026	2.129	2.431	2.715	2.985	3.326	3.574
38	0.255	0.681	1.304	1.686	1.799	2.024	2.127	2.429	2.712	2.980	3.319	3.566
39	0.255	0.681	1.304	1.685	1.798	2.023	2.125	2.426	2.708	2.976	3.313	3.558
40	0.255	0.681	1.303	1.684	1.796	2.021	2.123	2.423	2.704	2.971	3.307	3.551
60	0.254	0.679	1.296	1.671	1.781	2.000	2.099	2.390	2.660	2.915	3.232	3.460
80	0.254	0.678	1.292	1.664	1.773	1.990	2.088	2.374	2.639	2.887	3.195	3.416
100	0.254	0.677	1.290	1.660	1.769	1.984	2.081	2.364	2.626	2.871	3.174	3.390
120	0.254	0.677	1.289	1.658	1.766	1.980	2.076	2.358	2.617	2.860	3.160	3.373
140	0.254	0.676	1.288	1.656	1.763	1.977	2.073	2.353	2.611	2.852	3.149	3.361
160	0.254	0.676	1.287	1.654	1.762	1.975	2.071	2.350	2.607	2.847	3.142	3.352
180	0.254	0.676	1.286	1.653	1.761	1.973	2.069	2.347	2.603	2.842	3.136	3.345
200	0.254	0.676	1.286	1.653	1.760	1.972	2.067	2.345	2.601	2.838	3.131	3.340
250	0.254	0.675	1.285	1.651	1.758	1.969	2.065	2.341	2.596	2.832	3.123	3.330
inf	0.253	0.674	1.282	1.645	1.751	1.960	2.054	2.326	2.576	2.807	3.090	3.290

More Measures!

Irene Rae
Computer Sciences

CS-570 Introduction to Human-computer Interaction

Today and Thursday

What measures should you use to gather data?

How do you analyze the data?

How do you present your findings?

Beyond people perform
and what they say

Behavioral Measures

What People Do

Clickstream measures

Where they click, what they type

How much time they spend on dialogs, screens

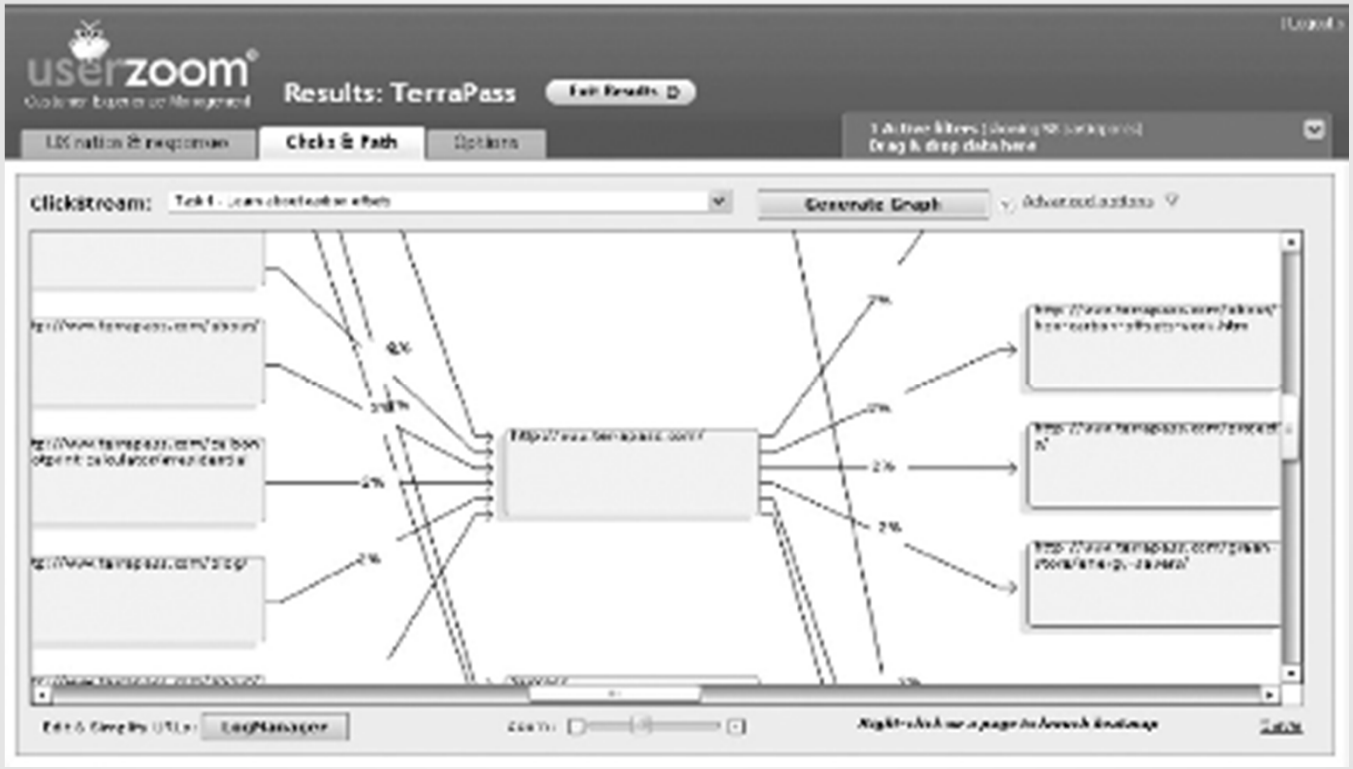
Verbal behaviors

What people say

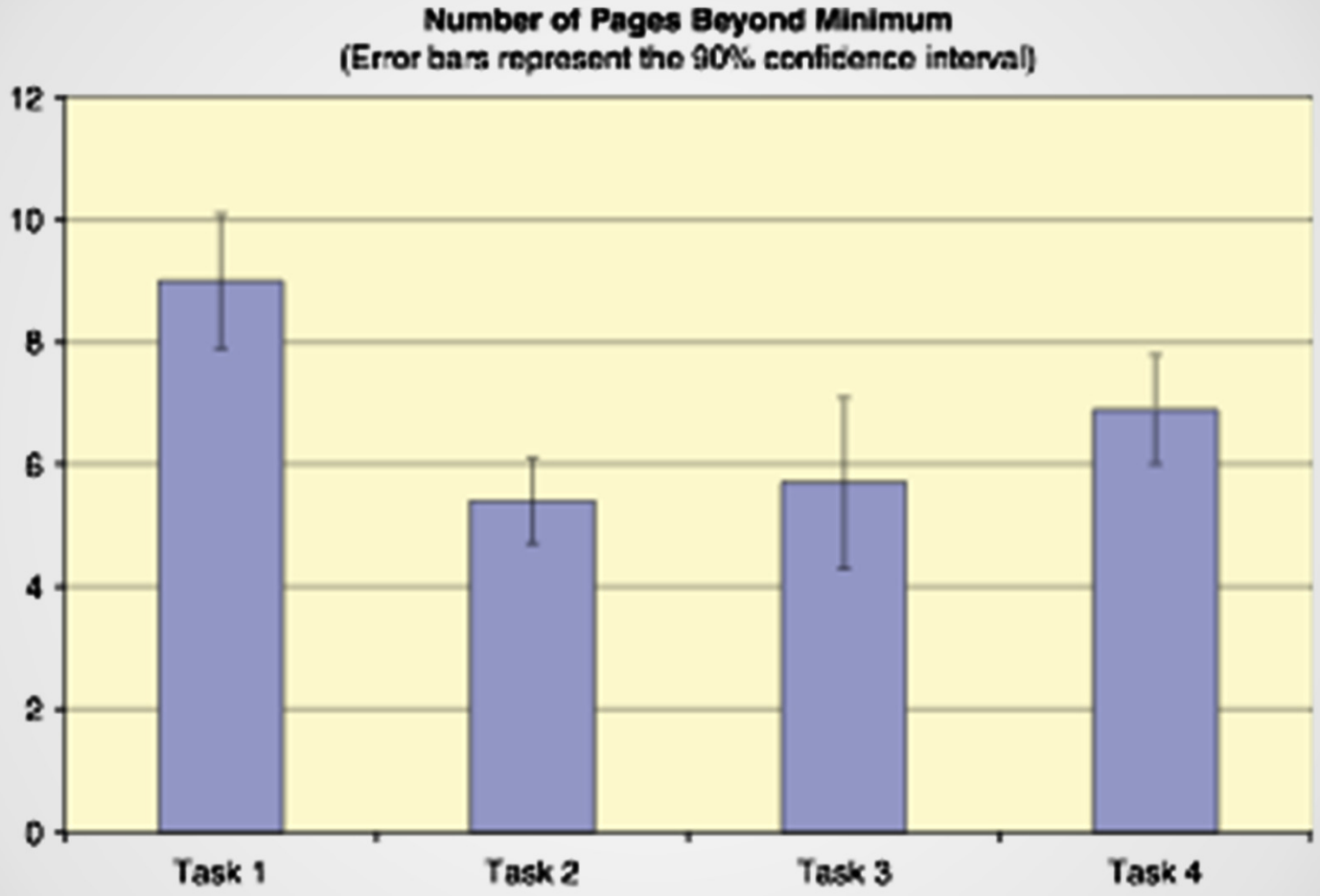
Nonverbal behaviors

How people behave

Click Paths


userzoom
Results: TerraPass
Clicks & Path
Clickstream:
Generate Graph

Number of Pages Visited



# of pages visited beyond the minimum necessary to complete the task

Verbal Behaviors

Verbal behaviors provide valuable insight into people's emotional and mental state

Examples: (Tullis & Albert)

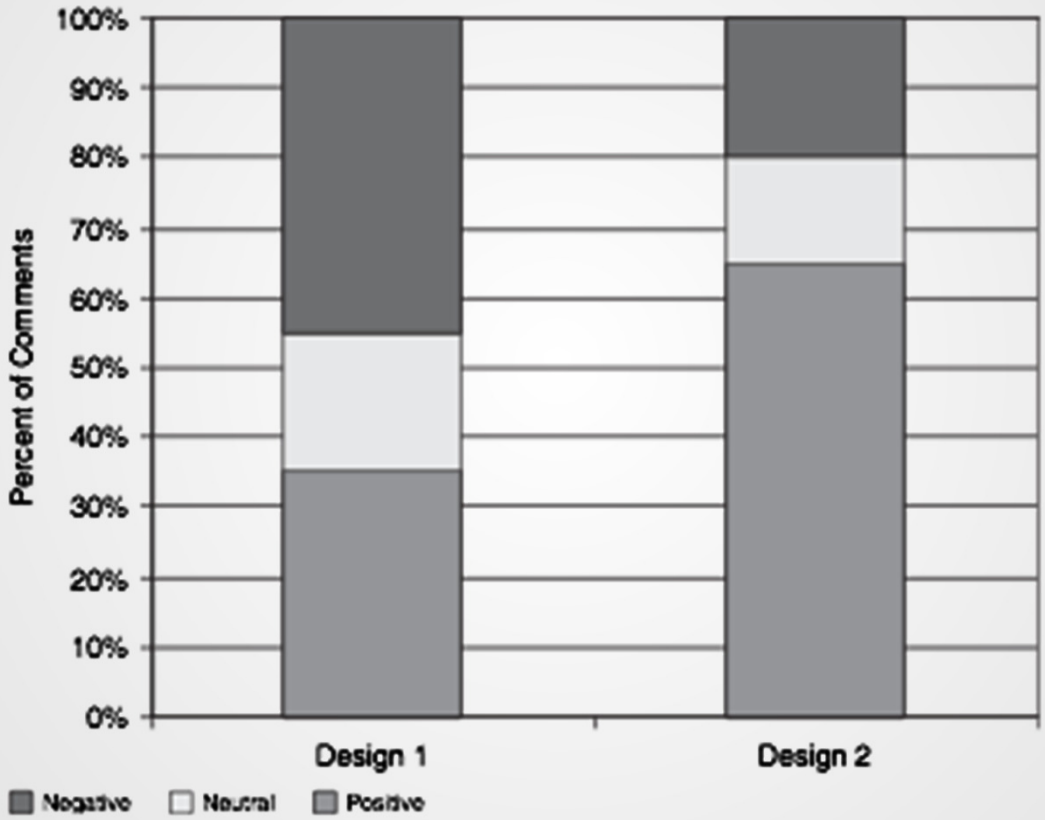
"This is terrific!"

"This website is terrible!"

"This isn't what I was expecting…"

"How does this work?"

Verbal Responses



Verbal Responses

Nonverbal Behaviors

Provides somatic information on emotional and mental states

Facial expressions (frowning, smiling, looking surprised, having a furrowed brow)

Body language (fidgeting, posture, gestures)

Facial Expressions

Coding Behaviors

Usability Test Observation Coding Form

Date: _____ Participant #: _____ Task #: _____

Start Time: _____ End Time: _____

Verbal Behaviors **Notes**

- ☐☐☐ Strongly positive comment
- ☐☐☐ Other positive comment
- ☐☐☐ Strongly negative comment
- ☐☐☐ Other negative comment
- ☐☐☐ Suggestion for improvement
- ☐☐☐ Question
- ☐☐☐ Variation from expectation
- ☐☐☐ Stated confusion
- ☐☐☐ Stated frustration

Other: _____

Nonverbal Behaviors **Notes**

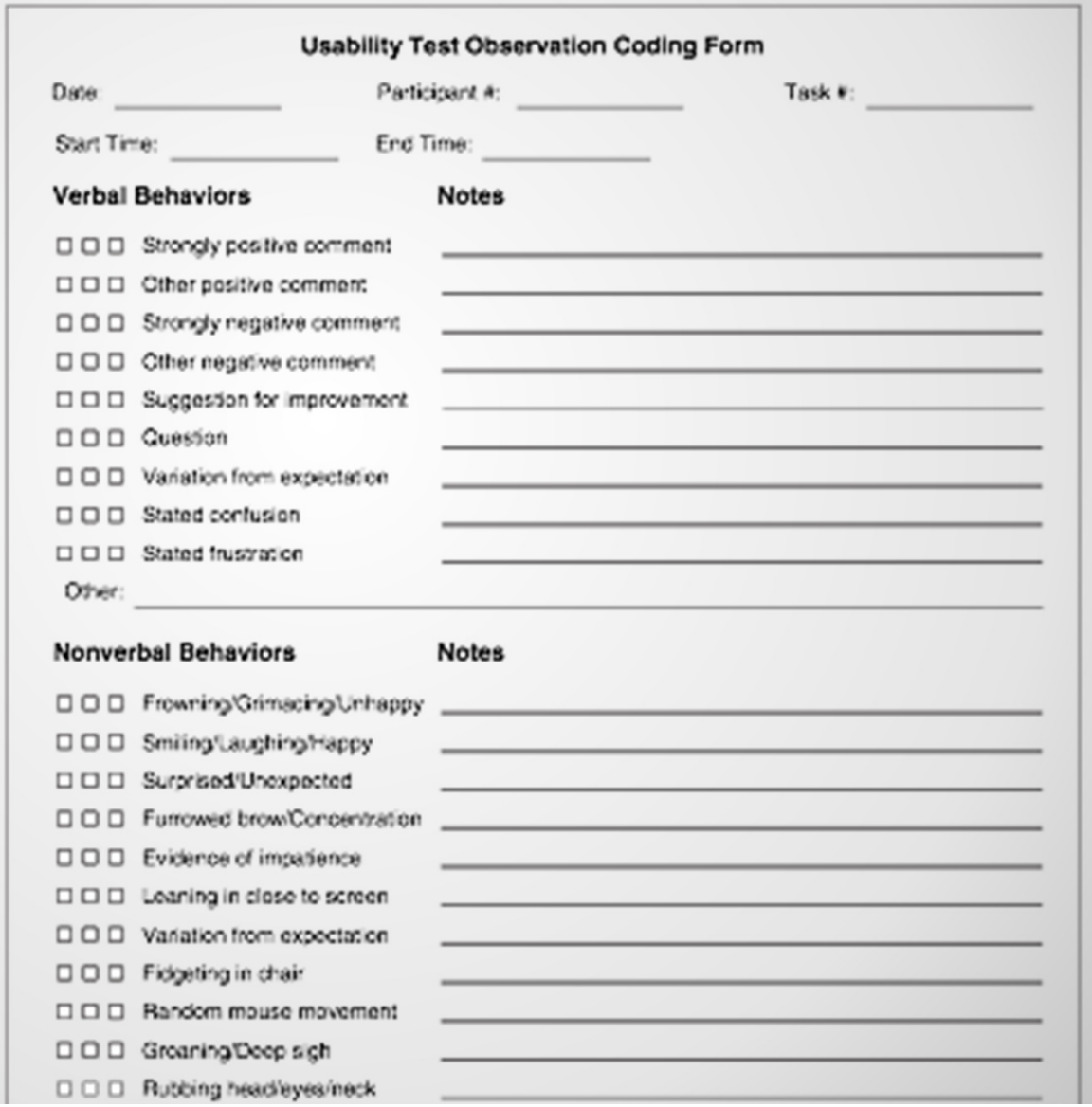
- ☐☐☐ Frowning/Grimacing/Unhappy
- ☐☐☐ Smiling/Laughing/Happy
- ☐☐☐ Surprised/Unexpected
- ☐☐☐ Furrowed brow/Concentration
- ☐☐☐ Evidence of impatience
- ☐☐☐ Leaning in close to screen
- ☐☐☐ Variation from expectation
- ☐☐☐ Fidgeting in chair
- ☐☐☐ Random mouse movement
- ☐☐☐ Groaning/Deep sigh
- ☐☐☐ Rubbing head/eyes/neck

Other: _____

Task Completion Status Notes:

Incomplete:
- ☐ Participant gave up
- ☐ Task "called" by moderator
- ☐ Thought complete, but not

Complete:
- ☐ Fully complete
- ☐ Complete with assistance
- ☐ Partial completion



Usability Test Observation Coding Form

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- ☐☐☐ Suggestion for improvement
- ☐☐☐ Question
- ☐☐☐ Variation from expectation
- ☐☐☐ Stated confusion
- ☐☐☐ Stated frustration

Other: _____

Nonverbal Behaviors **Notes**

- ☐☐☐ Frowning\Grimacing\Unhappy
- ☐☐☐ Smiling\Laughing\Happy
- ☐☐☐ Surprised\Unexpected
- ☐☐☐ Furrowed brow\Concentration
- ☐☐☐ Evidence of impatience
- ☐☐☐ Leaning in close to screen
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- ☐☐☐ Fidgeting in chair
- ☐☐☐ Random mouse movement
- ☐☐☐ Groaning\Deep sigh
- ☐☐☐ Rubbing head/eyes/neck

Questions?

Physiological Measures

Eye tracking

Pupil dilation

Galvanic skin response (GSR)

Muscle movements (GSR)

Muscle Activity — Electromyogram (EMG)

Brain activity

Electroencephalogram (EEG)

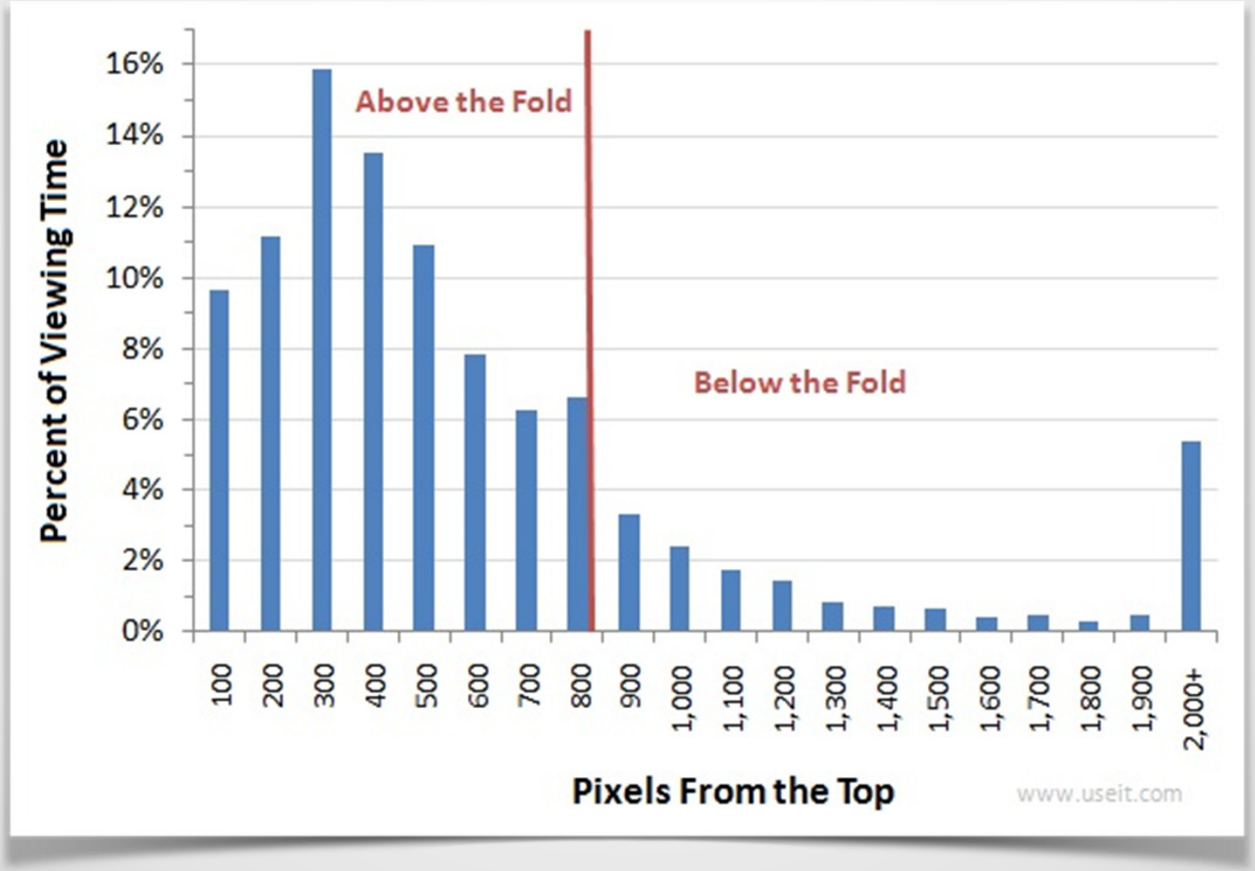
Functional Magnetic Resonance Imaging (fMRI)

Eye Tracking

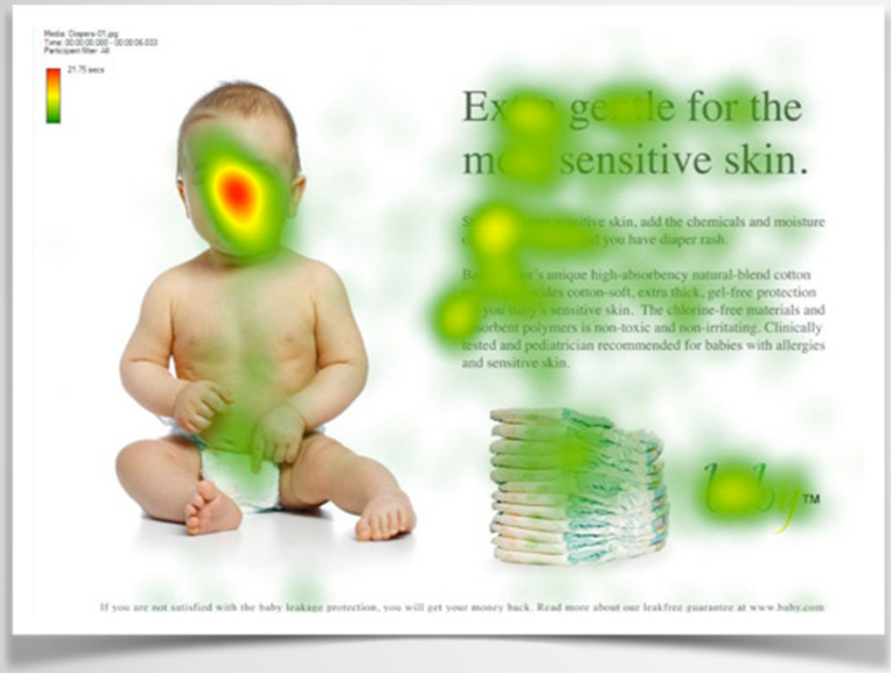
Eye movement might indicate the amount of cognitive processing a display requires

Head or desk-mounted equipment tracks eye position

Fixations: Eye maintains a stable position. Number and duration indicate level of difficulty with display



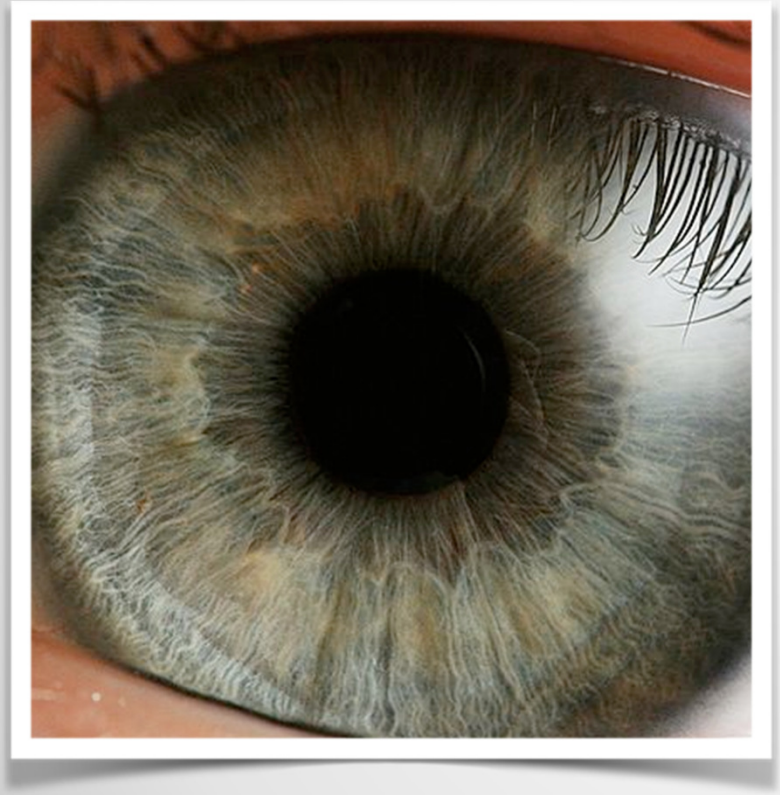
Scan paths: Moving straight to a target with a short fixation at the target is optimal



Before

After

Pupil Dilation

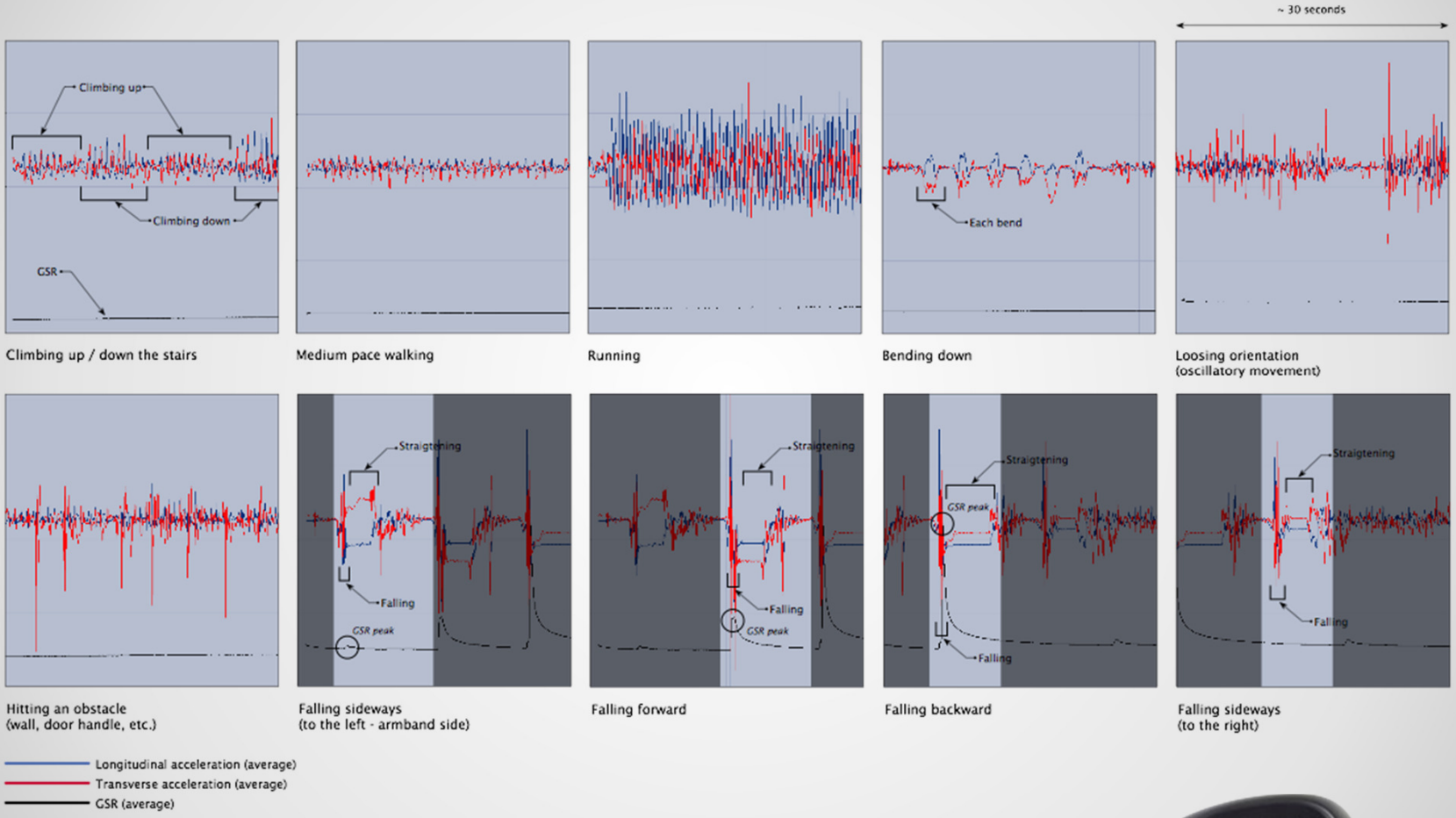


Pupils dilate in response to:

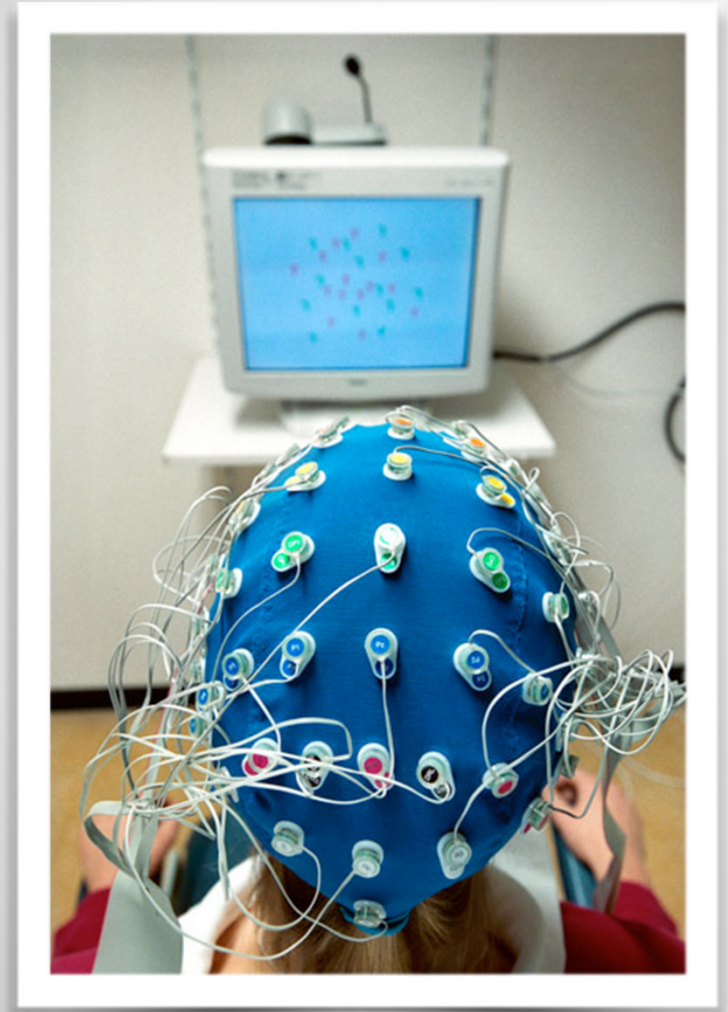
Extreme emotional situations (fear, pain, contact with nerves)

Loads on working memory, increased attention, sensory discriminations, cognitive load

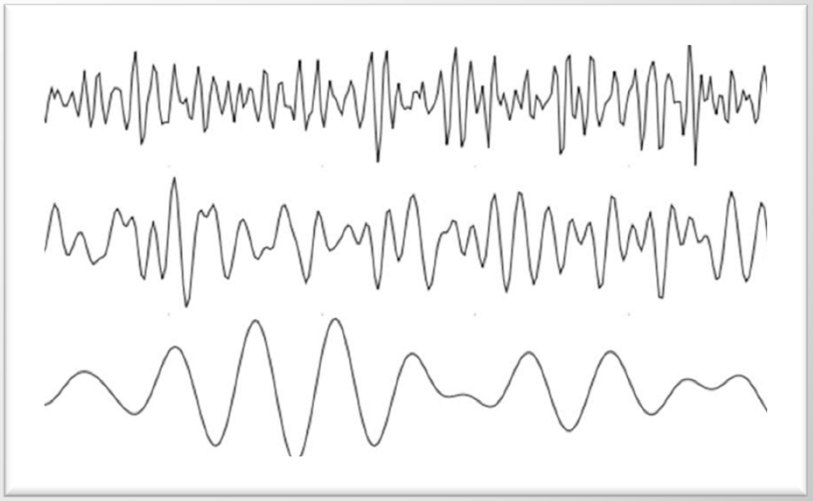
Galvanic Skin Response (GSR)



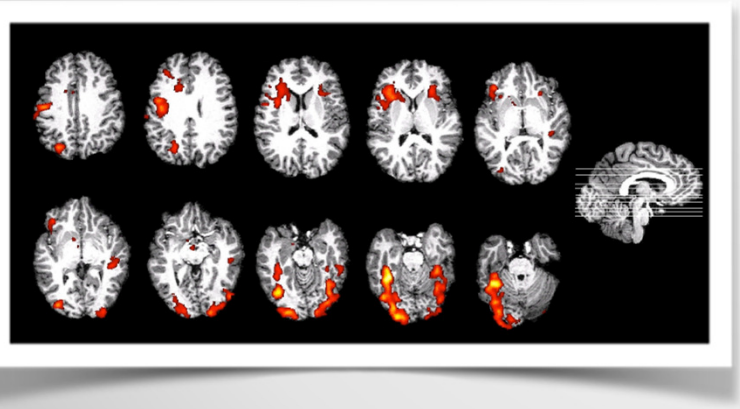
Electroencephalography (EEG)



- Measures large groups of neurons
- Low spatial resolution
- High temporal accuracy



Magnetic Resonance Imaging (fMRI)

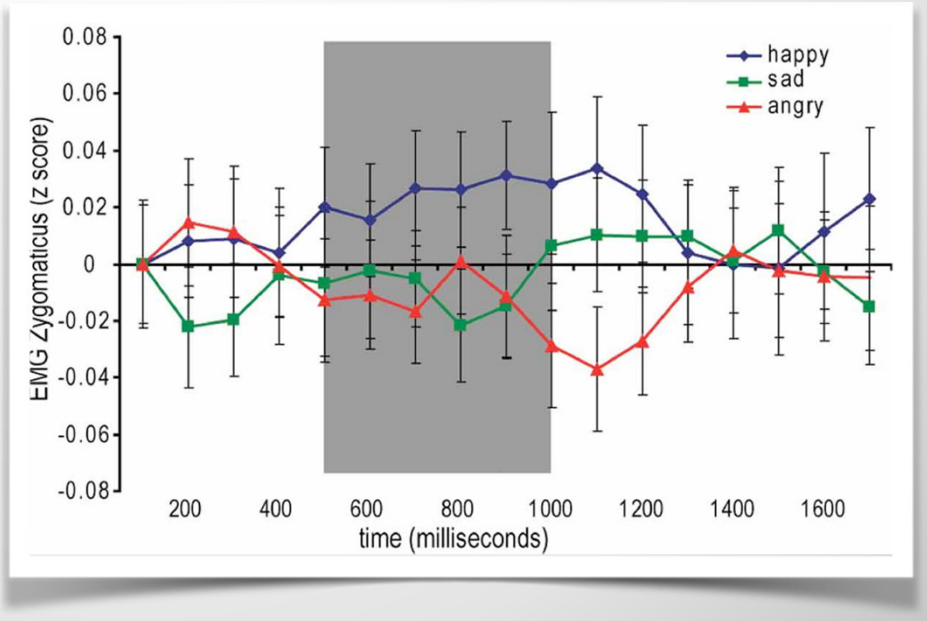


- Measures changes in blood flow related to neural activity
- High spatial resolution
- Low temporal accuracy

Electromyography (EMG)

Measures electrical activity in muscles

Example: facial expressions



Enabling Always-Available Input With Muscle-Computer Interfaces

T. Scott Saponas[1,2], Desney S. Tan[1], Dan Morris[1],
Ravin Balakrishnan[1,3], Jim Turner[4], James A. Landay[2]

[1]Microsoft Research
[2]University of Washington
[3]University of Toronto
[4]Microsoft Corporation

ACM UIST 2009

Questions?

Presenting your findings

Key Things To Consider

What are you trying to get across?

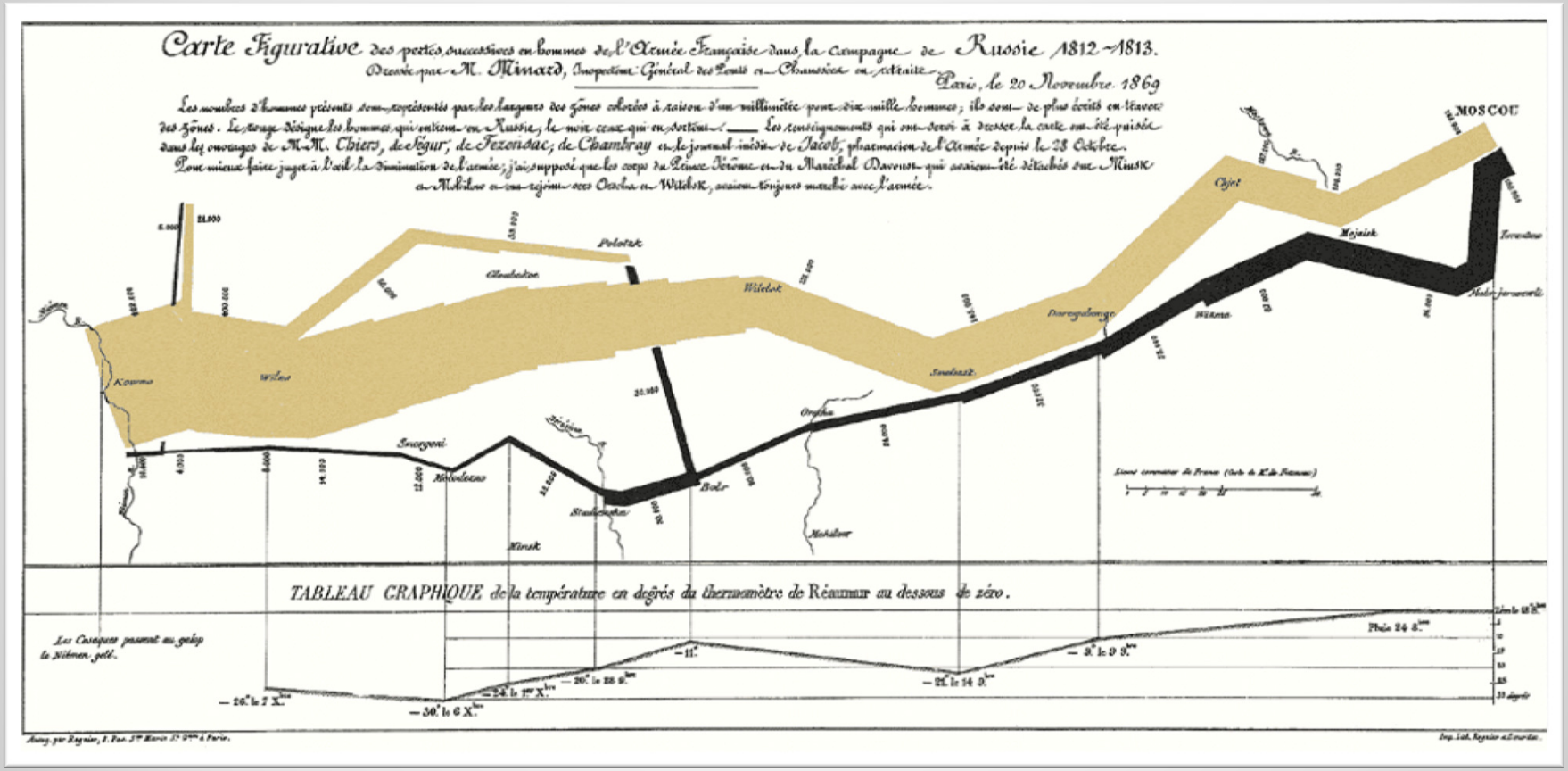
Who is your target audience?

What context will it be looked at in?

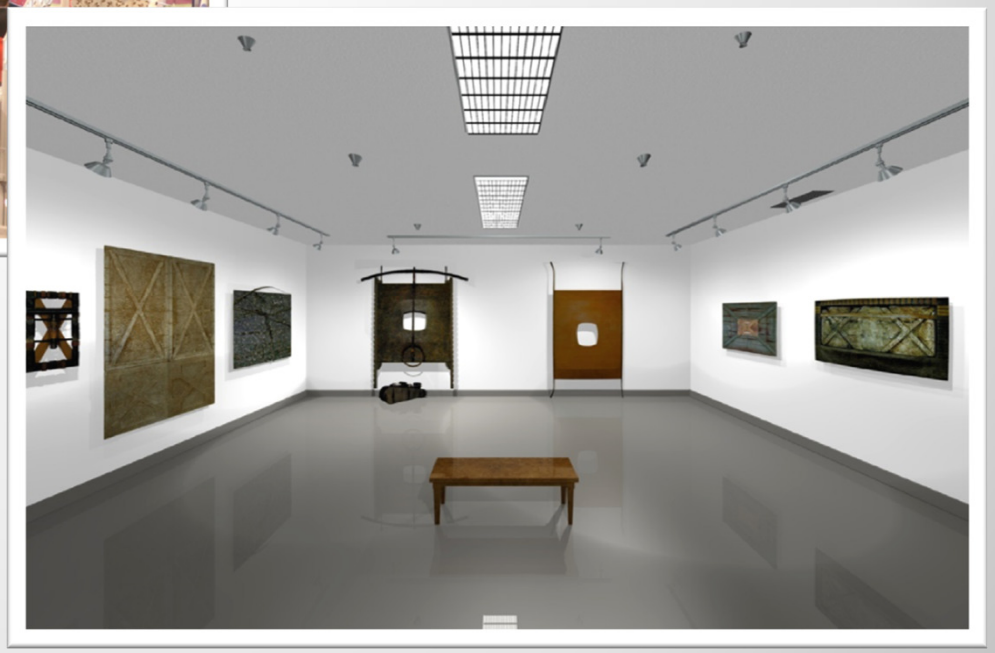
How many dimensions is your data?

How is each dimension encoded?

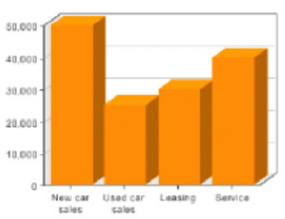
Who is your audience?



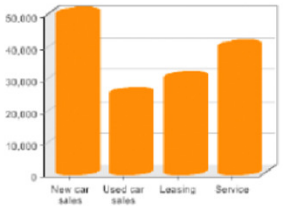
What is the context?



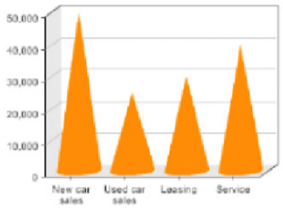
Common Options



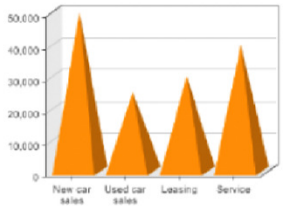
bar



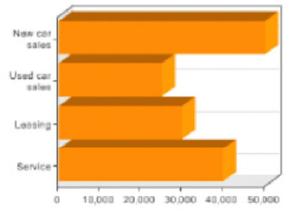
cylinder



cone



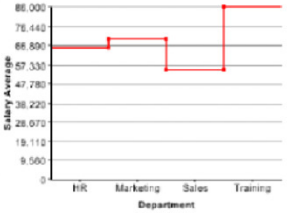
pyramid



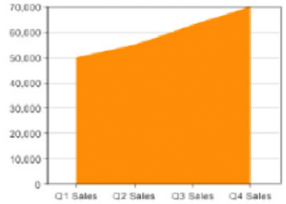
horizontal bar

line

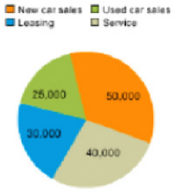
curve



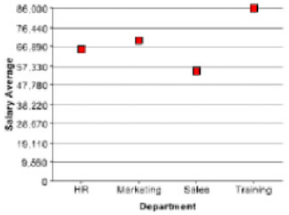
step



area

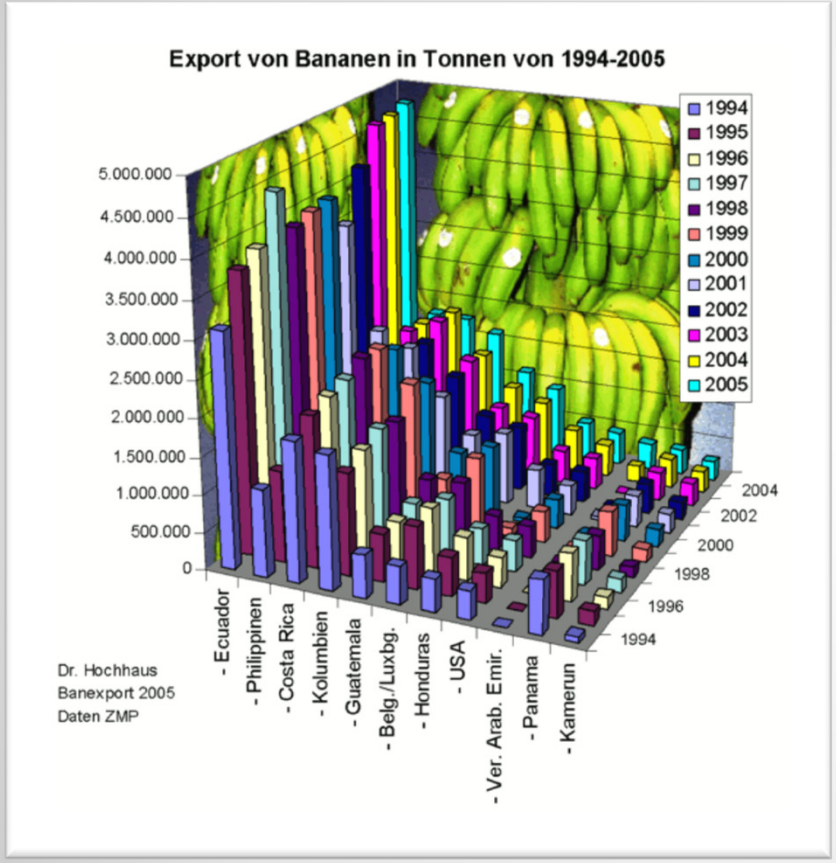


pie



scatter

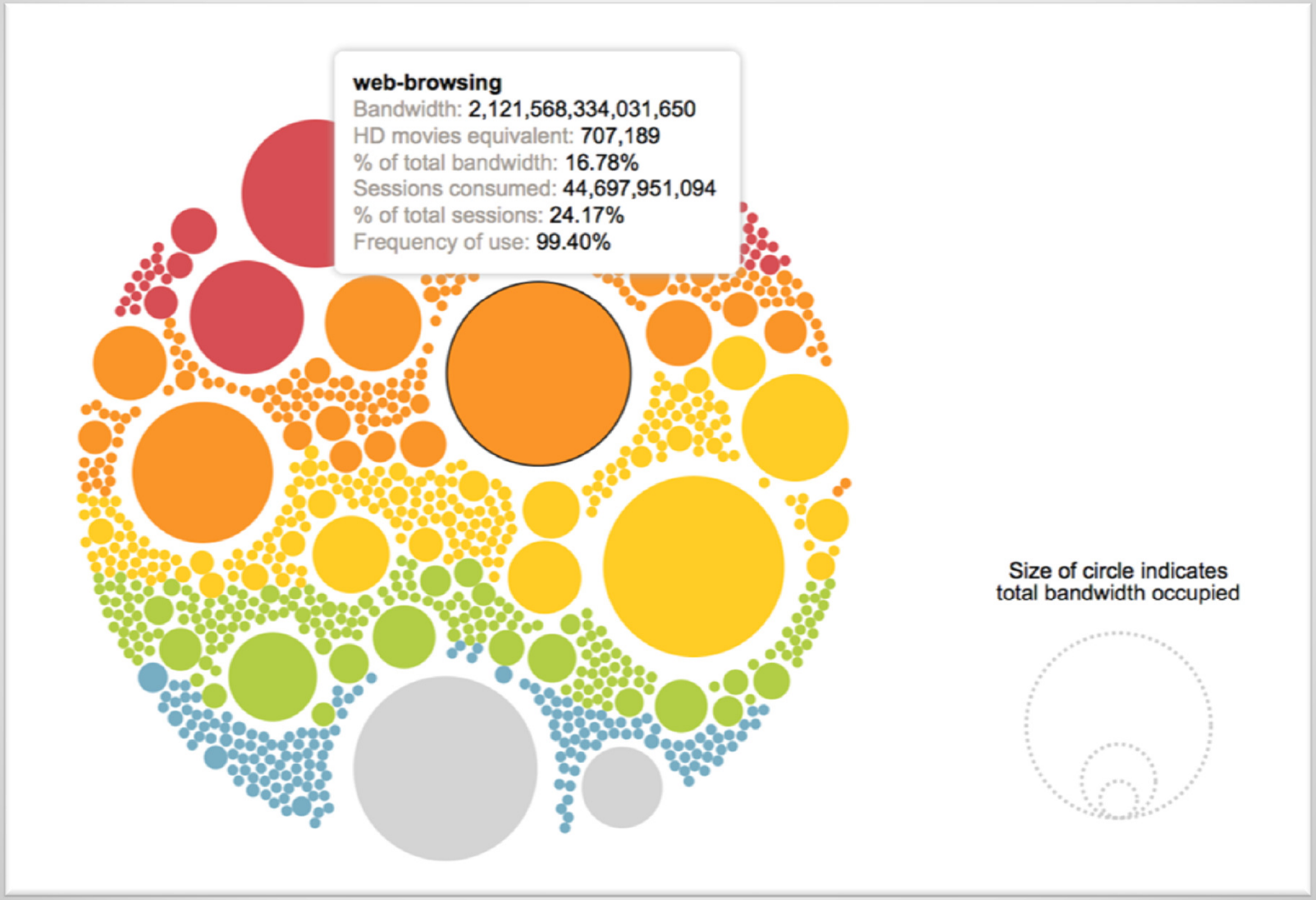
Dimensions



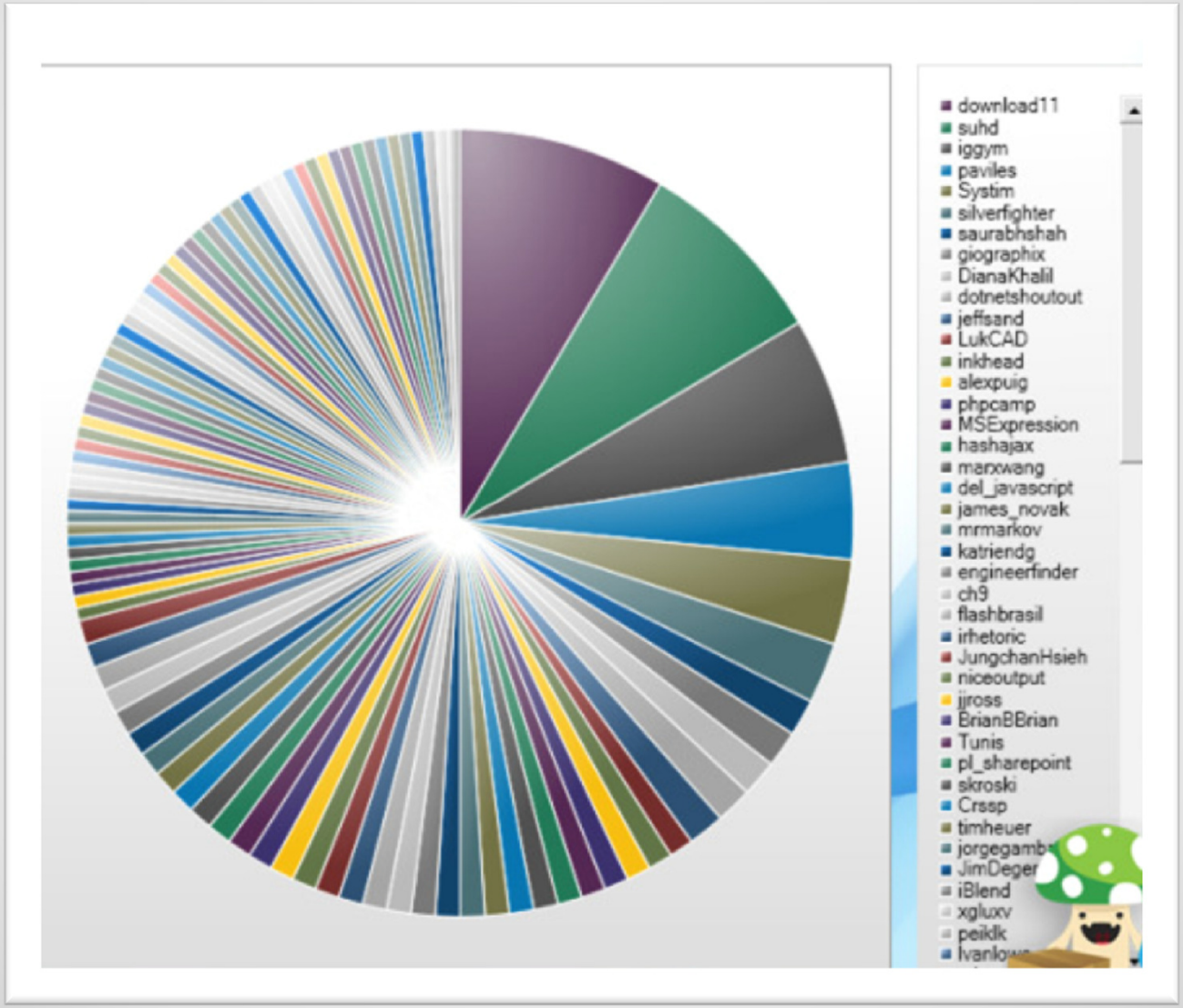
Each dimension is a piece of data that you want to present

How many dimensions is this graph?

Encoding


web-browsing
Bandwidth: 2,121,568,334,031,650
HD movies equivalent: 707,189
% of total bandwidth: 16.78%
Sessions consumed: 44,697,951,094
% of total sessions: 24.17%
Frequency of use: 99.40%
Size of circle indicates
total bandwidth occupied

Encoding & Readability



Questions?