

## **Mapping the mind**

New England Complex Systems Institute  
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Supervisor: Prof. Yaneer Bar-Yam

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## Mapping the mind

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Mainstream social and psychological sciences has traditionally disregarded individual differences with respect to perception. While studies on perception have been performed on individuals, the differences in their perception were discarded and only the “average” perception consensus reported. Only in recent years, have perceptual systems been thought of in dynamical sense (Freeman 1995; Kelso 1999). In this study we attempt to investigate the visual perceptual system of individuals with respect to a specific object. In particular we are trying to probe what is it that an individual sees when he/she is looking at something? For many investigators the quandary of perception resides in how properties of the world come to be represented in the mind of the perceiver. In our project, however, we are less concerned with the *contents* of perception and more interested with the *dynamics of perceiving*.

Touching, looking, listening and smelling are obviously dynamical processes. But what is the nature of the dynamics? If we describe our concept spectrum as an ever changing energy landscape where each concept is a basin of attraction, then describing the dynamics of the basin implies mapping its size in concept space and its slopes in every direction in continuous time. The dimensionality of our concept space is extremely large – the number of different concepts that we know. More concretely, if we examine a specific concept, i.e. –chair, then how an individual perceives a chair can be described as having the consensus chair be the bottom of the basin, and differences in criteria, such as comfort, utility and aesthetics be dimensions in our infinite concept space, describing the slopes of the basin. Chairs less similar than the ideal consensus chair could be mapped

along the slopes of the chair basin. Obviously, in every individual the basin for each concept would be shaped differently.

This study is a first attempt to explore individual concept space at a specific point of time, and contrast it with the concept space of other individuals. To achieve this goal, we constructed a survey which attempts to explore the space for a specific concept.

## **Methods**

**Data Collection:** We constructed a questionnaire containing two parts: the first with general questions about respondents' interests, the second – containing the questions targeting our analysis, with the task to classify 11 images as how they fit a specific concept (i.e. chair) according to four criteria (utility/functionality, comfort, aesthetics and price). Fitness to the classification concepts was done by ranking the different images for each one of the criteria. For utility/functionality, comfort, aesthetics ranking was done by using a numbering system between 1 and 11, while for the price criteria, participants were asked to name a price in US dollars they would be willing to purchase the item in the image provided. Questionnaires were filled out by all participants at the same time independently of one another. The respondents were 43 participants in an intensive complex systems course given by the New England Complex Systems Institute. See appendix A for questionnaire.

**Data Analysis:** Data from questionnaire was entered into a spreadsheet. Pricing ranking was converted to sequential discrete number ranking between 1-11. Complete linkage analysis was used to cluster the participants according to each criteria as well as all the criteria together. The number of clusters for each criteria was decided upon by manual observation of branch lengths in the linkage dendrogram and the data. Clustering was performed by using the public domain Cluster package and visualized using TreeView. Spearman's rank correlation was used to try and detect if any correlation existed between each of the first three criteria and the price criteria. Any criteria that was missing a data point in the form was disregarded and all correlation analysis between that criteria and others was not done. Participants answers for the general questions section of the

questionnaire was reviewed by the authors. The data in those answers was deemed to be too diverse to include in the study.

## Results

**Clustering participants by category:** Linkage analysis and manual cluster cutoff yielded 4 utility clusters, 3 comfort clusters and four aesthetic clusters. Table 1 displays the clusters per criteria category as well as the commonalties in the answers of the participants of each clusters.

**Table 1:** Clusters of participants' rankings by criteria. Bold font in the commonalties column indicates the top and bottom picks of each clusters.

Category	Cluster Number	Number of Participants	Commonalties
Utility	1	3	Ranked on the highest levels the objects: <b>C, D</b> , E and on the lowest levels the objects: <b>A, J, H, K</b> .
	2	13	Ranked on the highest levels the objects: <b>A, C, F, J</b> and on the lowest levels the objects: <b>G, B, H, I</b> .
	3	21	Ranked on the highest levels the objects: <b>A, F</b> and on the lowest levels the objects: <b>E, J, H, G</b> .
	4	6	Ranked on the highest levels the objects: <b>B, K, F</b> and on the lowest levels the objects: <b>C, H, J</b> .
Comfort	1	1	Ranked on the highest levels the objects: <b>G, F, E</b> and on the lowest levels the objects: <b>A, J, B</b> .
	2	23	Ranked on the highest levels the object <b>D</b> and on the lowest levels the objects: <b>G, J, H</b> .
	3	19	ranked on the highest levels the objects: <b>A, F, D</b> and on the lowest levels the objects: <b>J, H</b>
aesthetics	1	13	Ranked on the highest levels the object <b>H</b> and on the lowest levels the objects: <b>C, A</b> .
	2	15	Ranked on the highest levels the objects: <b>I, D</b> and on the lowest levels the object <b>H</b> .
	3	6	Ranked on the highest levels the objects: <b>D</b> and on the lowest levels the objects: <b>K, G</b> .

	4	9	Ranked on the highest levels the objects: <b>I</b> , <b>H</b> and on the lowest levels the objects: <b>A</b> , <b>K</b> .
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**Utility and function:** the variability among the clusters is relatively low, which could relate this with the fact that the functionality of casual objects like a chair is perceived as a well defined category. A special mention should be made concerning the wheel chair, which assessment of utility varies very much from person to person. Averaging these clusters over all people, we

Please answer these questions. **Do not consult others.**

1. What is your primary professional interest?

\_\_\_\_\_

2. What is your secondary professional interest?

\_\_\_\_\_

3. Please list your hobbies

\_\_\_\_\_  
\_\_\_\_\_

4. Why did you decide to take this course?

\_\_\_\_\_  
\_\_\_\_\_

5. Think of the objects on the next page as chairs. Classify them concerning the following criteria.

Rank	Utility/functionality	Comfort	Aesthetics
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			

6. How much would you pay for each of the objects A-K? Please write down your assessed values in US\$ under the images of the objects.

predictable result: the most functional is perceived to be the object F – a classical chair and the less functional is perceived to be object H – a rock.

**Comfort:** The variability among the clusters is the lowest one, and we could relate this with the fact that the comfort of casual objects is the less affected by personal biases.

Averaging these clusters, we obtained that the most comfortable is perceived to be D – a “banana” chair and the less comfortable is perceived to be J – a unicycle.

**Aesthetics:** The variability among these clusters is relatively high, and it is difficult to conclude specific information from it, except to say that individuals have a very different aesthetics slope from one another. Averaging these clusters, we obtained that the preferred object is D – a “banana” chair and the less aesthetic is perceived to be A – a wheelchair.

**Clustering of participants by all three criteria simultaneously:** Though meaningful clusters of participants are obtained by per-criteria linkage analysis, this is not the case for the clustering by all three criteria, no clusters result and much diversity is displayed.

**Correlation between different criteria:** Using Spearman’s ranked correlation we compared the ranking of a specific individual for different criteria. We performed this analysis both between the first three criteria as well as between them and the price criteria, in the hopes of finding which correlation influenced pricing. Table 2 displays the results. Quite a few people display a consistency in ranking two of the criteria. However, the average of the complete population was not with a particularly large positive correlation, most people seem to assign similar rankings to the utility and the comfort criteria (0.4). However, the measure that is the best estimate of how much an individual will be willing to pay for the item in the image, is aesthetics. This implies that people prefer a good looking chair to a functional one.

**Table 2:** Results of a Spearman's ranked variation study between criteria. Values are correlation values between -1 (fully anti-correlated) and 1 (fully correlated).

Person	Utility & comfort	Utility & aesthetics	Comfort & aesthetics	Utility & price	Comfort & price	Aesthetics & price
1	0.309091	-0.2	-0.02727	-0.39545	-0.34091	-0.06818
2	0.154545	-0.14545	0.1	0.436364	0.2	0.327273
3	0.363636	0.713636	0.686364	0.481818	0.818182	0.577273
4	0.509091	0.213636	0.495455	0.222727	0.55	0.945455
5	0.181818	0.127273	0.2	0.568182	0.440909	0.386364
6	0.290909	0.127273	-0.05455	0.213636	-0.12273	0.240909
7	0.390909	0.436364	0.127273	0.640909	0.668182	0.340909
8	0.536364	0.472727	0.572727	0.436364	0.509091	0.345455
9	0.454545	-0.05455	0.3	0.295455	0.25	0.077273
10	0.190909	-0.18182	0.190909	0.368182	0.377273	0.322727
11	0.263636	-0.71818	0.009091	-0.29091	-0.38182	0.418182
12	0.154545	-0.26364	-0.03636	0.209091	0.145455	0.209091
13	-0.05455	0.490909	0.172727	0.777273	0.222727	0.522727
14	0.154545	0.281818	-0.33636	0.327273	0.272727	0.436364
15	0.863636	-0.6	-0.44545	-0.00909	0.127273	0.209091
16	0.6	0.4	0.281818	0.409091	0.4	0.345455
17	0.3	0.163636	-0.21818	0.222727	0.004545	0.568182
18	0.336364	-0.23636	0.272727	0.486364	0.195455	0.286364
19	0.890909	0.209091	0.190909	na	na	na
20	0.645455	-0.09091	0.372727	-0.01364	0.068182	0.368182
21	0.090909	0.013636	0.422727	0.354545	0.490909	0.686364
22	0.754545	-0.43636	-0.43636	-0.03182	0.122727	0.368182
23	0.518182	-0.30909	0.181818	na	na	na
24	0.390909	-0.46364	0.127273	0.163636	-0.14545	0.154545
25	0.336364	-0.20909	0.363636	-0.32727	0.436364	0.709091
26	0.463636	0.245455	0.736364	0.813636	0.595455	0.204545
27	0.527273	0.236364	0.245455	0.318182	0.354545	0.145455
28	0.463636	0.045455	0.681818	na	na	na
29	0.381818	0.090909	-0.00909	0.318182	-0.13636	0.3
30	-0.29091	-0.23636	0.463636	0.231818	-0.04091	0.404545
31	0.7	-0.56364	-0.30909	0.095455	-0.05909	-0.55
32	0.554545	-0.48182	-0.05455	-0.00909	0.3	0.209091
33	-0.2	0.3	0.409091	0.468182	0.068182	0.586364
34	0.363636	0.154545	0.518182	na	na	na
35	0.936364	0.572727	0.372727	0.490909	0.590909	0.418182
36	0.145455	-0.45455	0.536364	-0.05	-0.10455	0.222727
37	0.972727	0.972727	1	0.35	0.322727	0.322727
38	0.481818	0.536364	0.545455	0.704545	0.713636	0.522727
39	0.627273	-0.19091	-0.1	0.436364	0.327273	0.409091
40	1	0.354545	0.354545	na	na	na
41	-0.29545	-0.91364	-0.14545	na	na	na
42	0.236364	0.072727	-0.18182	0.059091	0.186364	0.504545
43	0.854545	0.272727	0.409091	0.681818	0.736364	0.390909
<b>average</b>	0.40814	0.017548	0.208985	0.282555	0.247666	0.347789

## Discussion

This study attempts to try and map a small section of the concept space section in various individuals. A second objective of the study was to use these gained maps as a means of contrasting different individuals concept space. Finally, we hoped that we could leverage the general information queried for in the survey to define general rules of thumb on the relation of background similarities to individual concept space basin. By challenging participants to “force” peculiar objects into their pre-existing concept basin we have managed to map individual differences in perception of external objects, or their internal conception. The correlation studies performed allow to map the relation of different concepts to one another (i.e. orthogonal or parallel) in an individual. Comparing these to the average correlations attained for the complete sample allows to place a figure on how different a particular person’s conception is to the “norm”. The preliminary statistical analysis that we performed here allows to map the relation of one person to another using linkage analysis. The low level of these correlations shows that there is high dispersion among options in ranking properties. The fact that clustering was achieved only on a per-criteria level and not on the complete set of criteria tells us of the complex shape of the basin and how it differs from one person to another. While two people may be very similar in their conception of the term “comfort”, they can have very different views of the concept of aesthetics. Due to an ill constructed section of the survey, the latter tertiary objective was not achieved. The questions in the general section of the survey were designed as open ended questions and in addition, were not clear enough (many participants were baffled by the questions “what is your professional interest”).

Future work on the topic should include following the same work in a larger sample of people, mapping a concept basin over time and observing the changes occurring in it, or mapping more concept basin. It would be interesting to try and expand the current methodology and develop it to encompass non-physical concepts. This would allow a complementary study of how the participants perceive concepts such as aesthetic and comfort for all physical objects and not just a particular one.

From this, we conclude that whatever the reason shaping the internal representation, people show patterns in associating properties to objects. What is perceived is a particular *function*, a role that is tied inextricably to *context*. Consequently, we can safely claim that *perception is a creative process* rather than just an accumulation of imprinted images or data.

### **Bibliography**

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Kelso, J. A. S. (1999). Dynamic Patterns: The self-organization of brain and behavior, MIT Press.

Images of various objects used in the survey were downloaded from the web.

Please answer these questions. **Do not consult others.**

1. What is your primary professional interest?

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A \$ \_\_\_\_\_



B \$ \_\_\_\_\_



C \$ \_\_\_\_\_



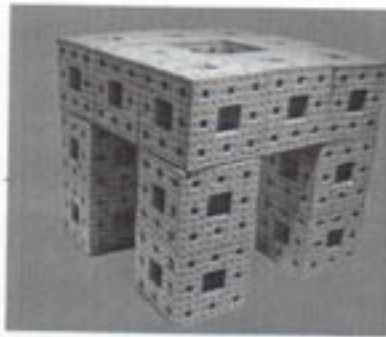
D \$ \_\_\_\_\_



E \$ \_\_\_\_\_



F \$ \_\_\_\_\_



G \$ \_\_\_\_\_



H \$ \_\_\_\_\_

