

**PERCEPTION OF STATISTICAL PRESENTATIONS
INVESTIGATED
BY MEANS OF INTERNET EXPERIMENTS¹**

**Svein Nordbotten
P.O. Box 309 Paradis
5856 Bergen, Norway
svein@nordbotten.com**

ABSTRACT

One of the main responsibilities of a national statistical office is to disseminate statistical information about the state and development of the country to its citizens. It has been assumed that statistical tables are particularly useful and needed for precise analysis and research, charts are suitable for fast visual orientation of the mainlines within the area on which information is requested while textual and vocal types are suited for newspapers and broadcasting.

One purpose of this paper is to investigate how different types of presentations of statistical facts are perceived, interpreted and remembered. The focus is on the passive users receiving statistical news by different media such as newspapers, television and other mass media. A second purpose is to study how the former purpose can be carried out by a Web based experiment based on statistical design principles.

In this paper, the design of an experiment is discussed. The design was implemented an experiment was carried out in the spring term of year 2000. Experience from the experiments and some analytical results are reported.

This experiments is part of the project SIS - Statistical Information Systems. For further information about SIS: <http://nordbotten.com/sis/>.

The URL for this experiments is: <http://nordbotten.com/perception/welcome.cfm>

1. Project justification

One of the main responsibilities of a national statistical office is to disseminate statistical information about the state and development of its country. The information may be in response to requests for statistical publications, tabulations or for general distribution in newspapers, radio, television, etc, as part of the obligation to feed the public with information about the state and development of the society to which they belong. The information disseminated may be in the form of texts, tables, charts, vocal or even animated presentations depending on the topic and the public at which the presentation are aimed.

It has been assumed that statistical tables are particularly useful and needed for precise analysis and research, charts are suitable for fast visual orientation of the mainlines within the area on which information is requested while textual and vocal types are suited for newspapers and broadcasting [Tufté 1990]. The objective of this project is *to investigate how different types of presentations of statistical facts are perceived, interpreted and remembered*. The focus is on the general public receiving statistical news by different news media such as newspapers, radio, television and other mass media. These passive ‘statistical users’ do not request any particular information and may have limited interest in the statistical fact presented. They may still observe, digest and store the information from presentations provided by media.

The justification for the project is that *considerable resources are spent to disseminate statistics from the national statistical bureaus to inform the citizens about their environment and prepare them for more informed decisions*. What are the best ways to present information on different facts for the public? Can the dissemination of statistical information to the public be improved and how?

2. Project overview

The investigation of this project includes the following tasks:

1. Specify the problem as a perception model.
2. Specify an experimental framework.
3. Identify a set of representative facts suitable for an experiment.
4. Design a gallery of alternative statistical presentations for the set of facts.
5. Develop a system for displaying the statistical presentations.
6. Design a tool for recording participants' perceptions of the presentations.
7. Recruit a sample of participants.
8. Run the experiment with the participants.
9. Test the data recorded from the experiment.
10. Conclude the experiment.

It was envisaged that the project had to be implemented and carried out in several stages. In the first stage, a prototype system with a limited set of facts and limited alternative types of presentations was developed to test the functionality of the system and the experiment by means of recruited participants expected to give useful feedback for improving the experimental design.

In the second stage, a set of real life investigations based on a limited set of statistical facts presented in verbal, tabular and graphical representations are currently being carried out with participants from specific subgroups of the general public.

Several full-blown experiments are anticipated to obtain as much as possible of representative information about the public's perception and interpretation of statistical facts. In addition to cover a wider set of participants, vocal and animated representations will also be included.

3. Theory and model definition

3.1 Outline of a cognitive model

Consider a population of N individuals, indexed by i , and a set of M facts, indexed by j . Assume a target description of each fact, denoted by the variable X_j , associated with the fact j . A target description is the original description of a fact limited to a few general characteristics. Each fact is represented by K different types of presentations which include *text*, *chart*, and *table* representations, indexed by $1, 2, 3$. The perception by individual i of the fact j of the presentation of type k , is denoted by the variable Y_{ijk} . The perception variable is described in such a way that it can be compared with the target perception of the corresponding fact. The distance $|Y_{ijk} - X_j|$ between a recorded perception and the target is assumed to be explained by the individual's personal perceptual characteristics, the fact exposed and the representational type:

$$Y_{ijk} = F(A_i, B_j, C_k).$$

where F is a mapping representing the dependence of Y_{ijk} on the arguments individual characteristics A_i , fact related characteristics B_j , and the representational type C_k .

We measure how well a presentation of type k conveys fact j to individuals is expressed by the distance $|Y_{.jk} - X_j|$ where $.jk$ refers to the average recorded perceptions of fact j represented by representation k . Similarly, the presentations of different types could also be ordered according to the lengths of the time the presentations were exposed and permit the study of exposure time effects on perceptions. It may also be possible to delay randomly the measurement of the perceptions of presentations in order to be able to study

variation over time in recollection of the perceived facts. These aspects will be investigated in future experiments.

3.2 Statistical model

To investigate the assumed perceptive relations discussed in the previous paragraph, the variables of the above theoretical model were substituted by operational variables which can be observed and measured at the same time as they are acceptable indicators of the theoretical variables.

In the following sections, we discuss the experiment performed, specify the background variables used to characterize the individuals participating in the experiment, a set of facts to included and operational variables used for describing the facts, the types of presentations used to represent each fact, how the experiment was performed, and finally, how the recorded data were organized and analyzed.

4. Experiments

4.1 Outline of the experimental framework

The experiment was based on a selection of 25 statistical facts. The target facts were collected from the Web pages of national and international statistical offices and recorded in a standard format. Each fact was given a unique identification number, and then reproduced in verbal, tabular and graphical representations. The resulting 75 presentations were assembled in a gallery identified by a unique name, and described by the associated fact and presentation type numbers.

Ideally, we wanted to investigate the perception of statistical presentations by the general public in a representative sample of the population. In the current experiments, the participants were recruited from university classes assuming that they were representative for one of the groups the statistical information services try to reach. In future experiments, the participation will be extended to more general groups of the public and made as representative as possible. Participation in the experiments was by Internet and no informations about the identity of the participants were asked for.

The recruited participants from the different population were given entering addresses depending on the population to which they belonged. This provided a simple mechanism to keep track of the origin of participants. When calling the first page, see Figure 1, visitors were presented with general information about the experiment, that participation

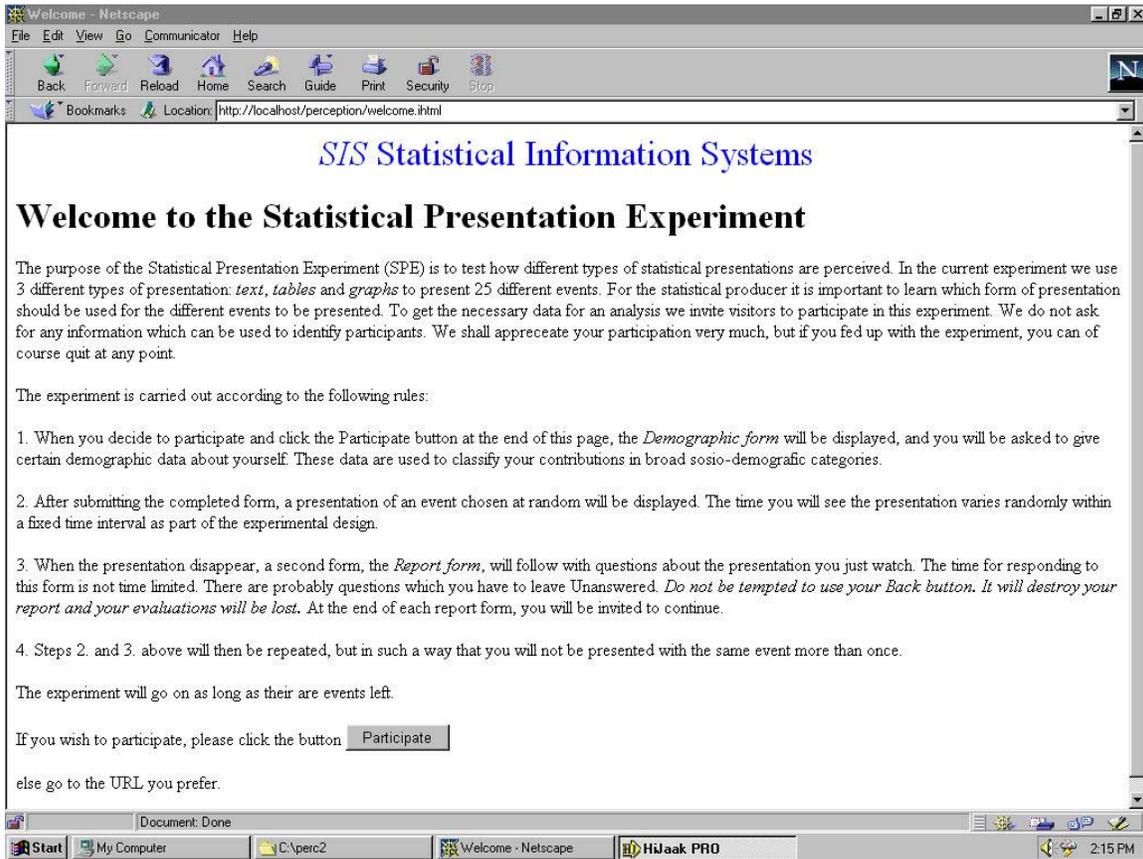


Figure 1: The introductory page.

was anonymous and voluntary and could be left at any point. The visit was time-stamped and used as the unique identification for the participant. This id number was attached to any information provided during the participation by this person.

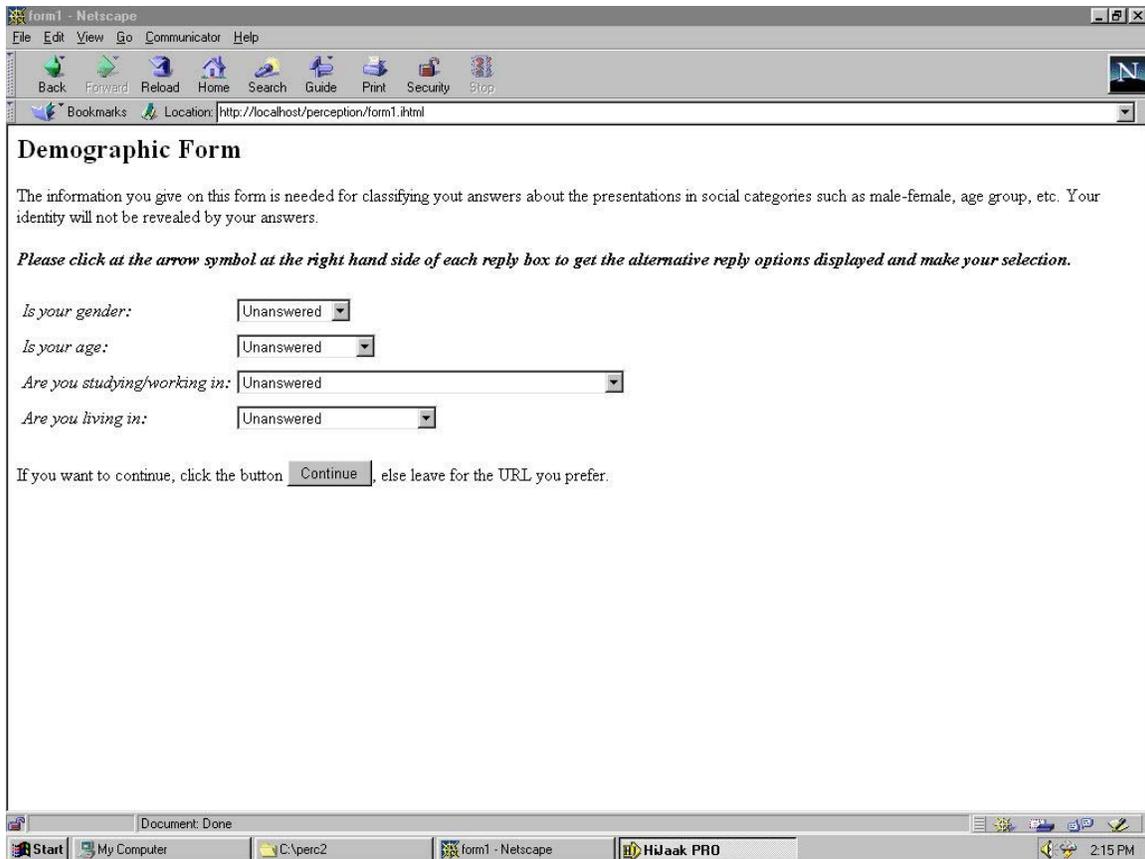


Figure 2: Demographic form

After the person had chosen to participate, he was presented with the *Demographic Form* as shown in Figure 2 with a questions about the participant's gender, age group, and type of occupation/studies and country of living to be used as background data in the analysis. The form was designed for easy response by clicking the mouse.

Next, the experimental system generated a random number in the range 1 to 75 for selecting a presentation from the gallery. Before proceeding, it checked that the associated fact has not previously been displayed to the participant in one of the three alternative types. If so, a new random numbers was generated, checked and, if necessary rejected, until a fact not already presented was identified, or all 25 facts were exhausted.

The selected presentation was displayed for a limited time between 20 and 30 seconds determined randomly by the experimental system. Figure 3 exhibits a fact presented in tabular form.

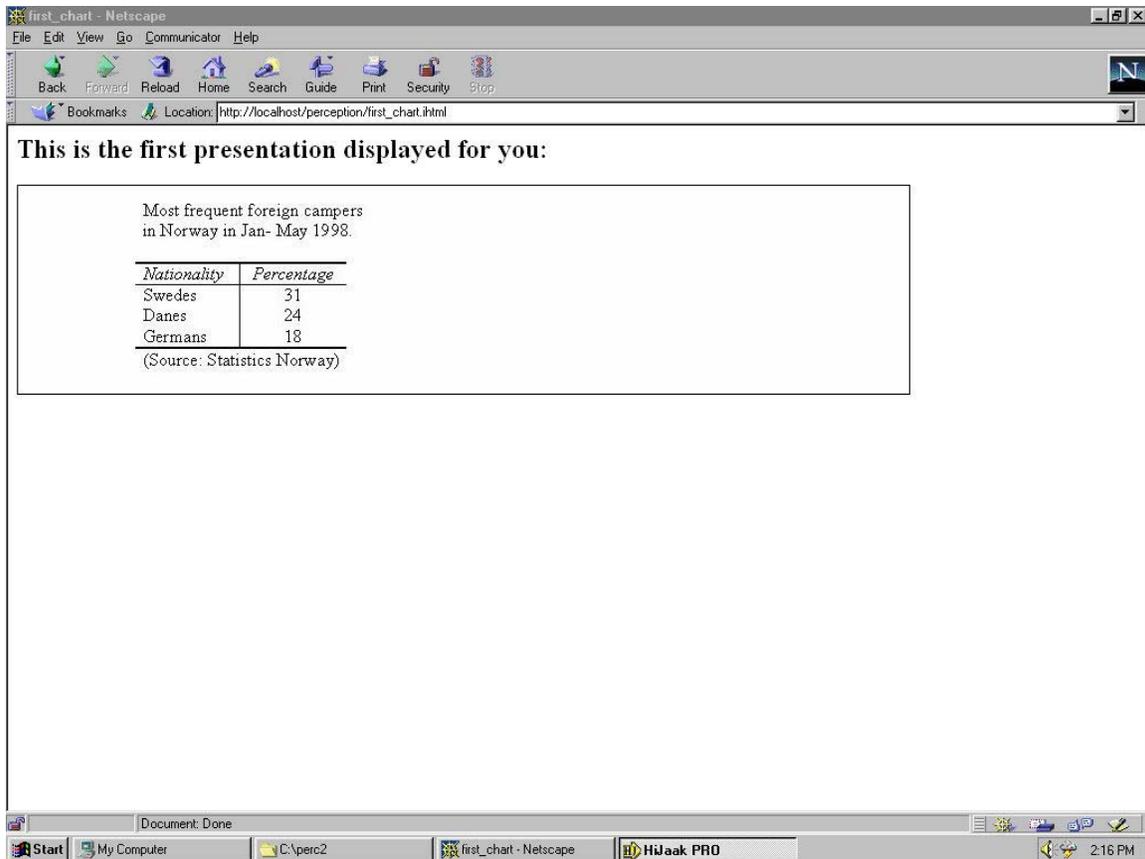


Figure 3: A fact displayed as a tabular presentation

terminated presentation, a *Report Form* was displayed for the participant. The form, shown in Figure 4, requested information from the participant about the last displayed presentation. There were no time restrictions for completing the form. However, the participant was not permitted to see the presentation again using the back button. If he tried to back up, the experimental system would give a warning that if he did not continue to complete the report form, the system would terminate his participation.

As the Demographic Form, the Report Form was designed for easy response by clicking the mouse. When received, the host server copied the time-stamp to the report form answers, which were stored in a database. The participant got the option to continue or terminate his participation. If he decided to continue, a new presentation was randomly selected and the process repeated subject to the condition that no fact should be presented more than once.

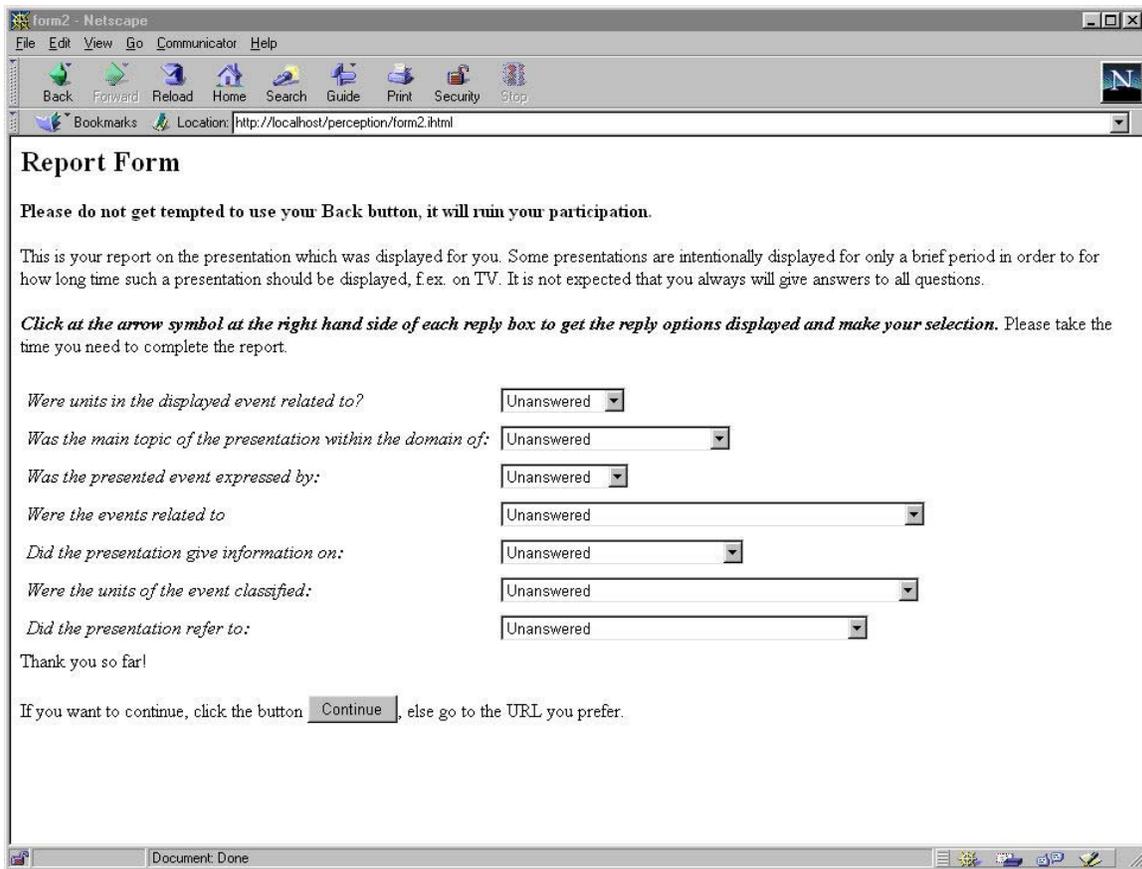


Figure 4: The Report Form

The time for which each presentation was displayed was also recorded to permit the investigation of a possible impact on the perception of the presentations. Following each

When completed, a *Thank you* page as shown in Figure 5 was finally presented at which the participants were invited to contribute with their comments ended the experiment.

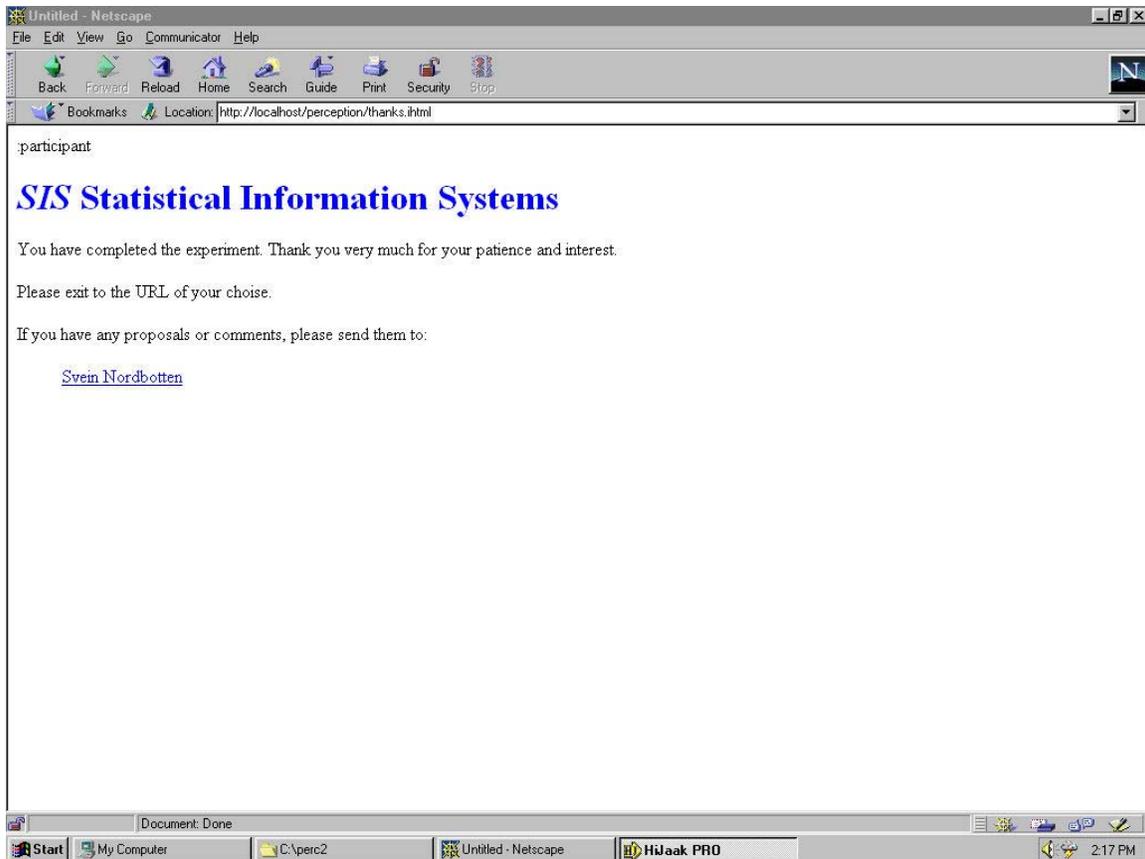


Figure 5: The final page

4.2 Demographic variables

The experiments focused on the perception of statistical information presented in different types. As a background description of the individual participant, the variables gender, age group, area of study, and location were assumed to be among the most relevant. These variables were included in the experiments with preset, mutually exclusive values as options for the participants to choose:

gender

Male
Female

age

<20 years
20 -24 years
25-29 years
30-49 years

50+ years

area of study/profession

Humanities
Social sciences
Life sciences
Natural sciences
Agriculture, fisheries, industry
Business
Services
Central and local government
Other

country of living

Denmark
Finland
Norway
Sweden
Other European country
USA
Other country

The variables and their values reflect the populations from which we recruited participants.

4.3 Fact attributes

Facts observed by national and international statistical offices were used as facts in the experiments. Each fact was precisely described by means of a predetermined set of variables. These variables with their respective permitted values were used:

topic of fact:

Demography
Social conditions and health conditions
Education
Religion
Work, profession
Economy
Culture and art
Entertainment
Other

measurement unit:*Integers**Value**Percentage**Other***single/ multiple points of time:***Single time**Multiple times***Categories:***Not categorized**Non-valued categories**Valued categories*

The population described by the fact was usually indicated in the title of the presentation. In complex facts there might be multiple populations and/or times displayed

The purpose of describing the fact in the above detail is to have a precise benchmark to which we can relate the participants' responses and which will help us to interpret the responses.

4.4 Definition of presentation types.

The presentations of the facts included three types: text, table, and graphical presentation.

There were several types of graphical presentations which could have described each recorded fact and a number of rules for selecting good charts have been established [Tufté 1983, Wallgren 1996]. In the experiments reported, only bar charts were used, while other types of charts will be included in later stages of the experiment.

4.5 Design of the experimental system

The experiments were carried out using Internet technology. Figure 6 gives a general view of the system.

The core of the system is the *host server*. The server hosts the *web server*, the *experimental system* and the *database* including the presentation gallery, participant responses and process data stored during the sessions. The *clients* are operated by the participants and linked to the host via Internet.

The clients are assumed to be equipped with browsers for communicating with the host. The host web server is passing on the data received from the clients to the experimental system which controls the communication to and from the database, and the responses to the client. Four html pages denoted as welcome, form1, form2 and thanks as seen by the participants take care of the communication with the database. These pages also include template parts invisible to the client which together two separate invisible script templates, *first_page* and *next_page*, are controlling and managing the experiment.

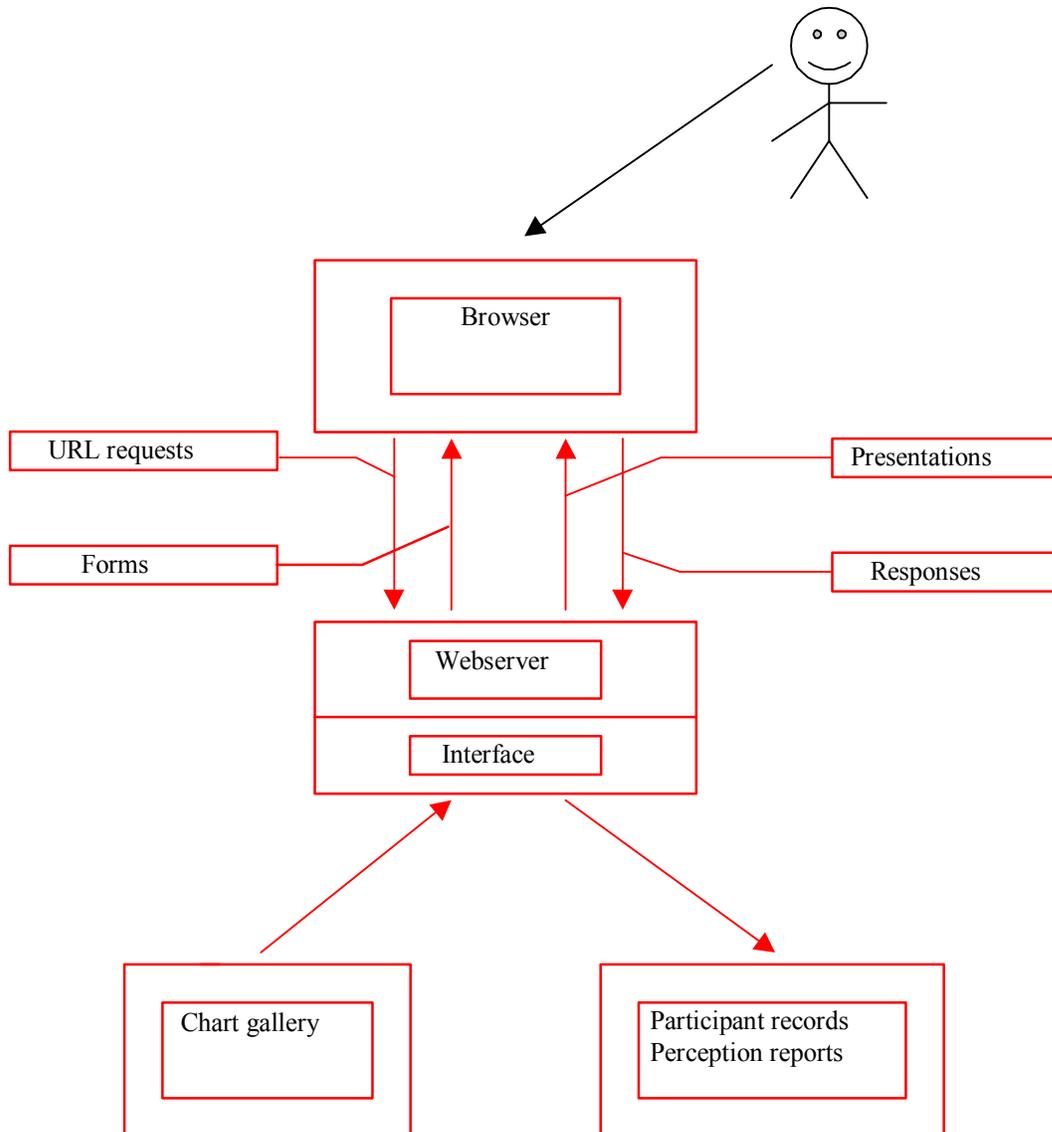


Figure 6: Outline of the experimental system

The prototype experiment host was a PC with an Intel processor run by a Microsoft *WINDOWS NT 4.0* operating system. The web server used was the O'Reilly *WebSite Professional 2.0*, and the scripting tool was *iHTML* from INLINE. Part of the browser was controlled by *JavaScript*, requiring the use of browsers able to handle *JavaScript*.

The system was later redesigned by means of *Cold Fusion 4.0* from the Allaire Corporation, and is currently run on a larger server provided by a commercial provider, *Webstream.net*.

4.7 Selection of facts and a gallery of statistical charts for perception test.

The descriptions of the set of facts were kept in a *fact file* outside the experimental system, and used in the data analysis together with the results from the experiments. A list of the facts used in can be inspected from Figure 2. These facts were based on statistics published by national and international statistical agencies responsible for official statistics.

Source	Subject
Danmark Statistik, July 1998	Election to the Folketing
Danmark statistik, July 1998	Environment expenditure
Statistics Finland, July 1998	Industrial output
INSSE, France, July 1998	Research and dev. Expenditure
INSEE, France, July 1998.	Living standards
INSEE, France, July 1998	Tourism trade balance
Federal Statistical Office, Germany, July - 97	Severly handicapped persons
Federal Statistical Office, Germany, July - 97	Land area use
Federal Statistical Office, Germany, July - 97	1996 vintage
Hagstofa Islands, July 1998	Key figures
Ireland Central Statistical Office, July 1996	Population
Statistics Norway, July 1998	Camping
Statistics Norway, July 1998	Crude oil price
Statistics Norway, July 1998	Consumer prices
Statistics Sweden, July 1998	Economic activity
Statistics Sweden, July 1998	Population growth
UK National Statistical Office, July 1998	National accounts
UK National Statistical Office, July 1992	Leisure and entertainment
UK National Statistical Office, July 1996	Climate
Australian Statistical Bureau, July 1998	Literacy
Statistics Canada; July 1998	Forrest

Source	Subject
EUROSTAT, July 1998	Babies
OECD, July 1998	Economic development
UN Statistical division, July 1998	Life expectancy
Bureau of the Census, July 1998	Population

.

Figure 7: List of facts used in experiments

5. Executing the experiments

Following the experiment with the prototype, the list of facts and types of presentation as well as the operation of the system were adjusted. The experiment reported was based on groups of recruited participants, students from University of Hawaii, USA, and University of Bergen in Norway.

The experiment was run in a private website, nordbotten.com, and by a commercial provider of host services, Webstream.net.

6. Analysis

The general goals of the project were to contribute to:

- 1) the understanding of the effectiveness of alternative presentations types, and
- 2) how an Internet collection of data can increase the knowledge about statistical presentation.

More specific, we wanted to investigate if any conclusions could be obtained about

- 3) the perception of statistical facts presented in alternative ways.

We also wanted to be able to study the average number of displays in participation sessions counted by the number of presentations requested by the participants. The randomized display time could finally permit analysis of exposition time effect on perception.

The data collected on the demographic and the report forms during the experiments were systematically stored in a Microsoft *Access* database consisting of relations. An outline of the data model on which the database is implemented is shown in **Figure 8**.

Three of the relations were pre-specified with data on the *facts*, the *types* of presentation and the *exhibits* of the gallery presentation. A fourth relation, *calls*, was used for keeping

track of the facts each participant have been presented with to avoid duplication. They were deleted, when 24 hours had passed since the participant entered the experiment.

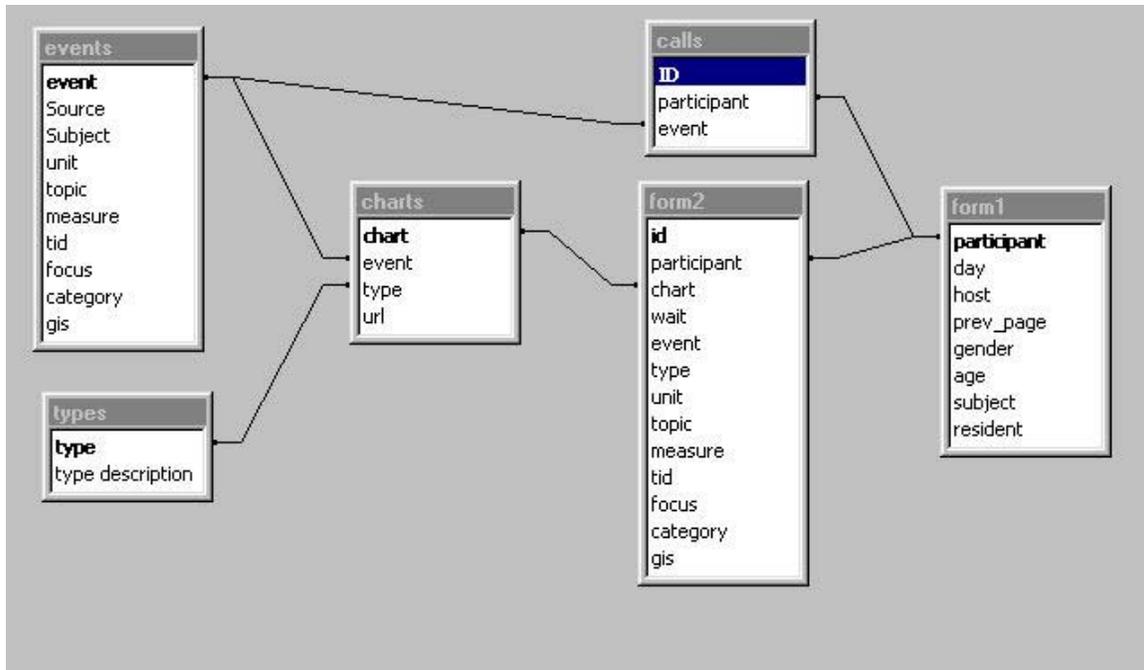


Figure 8: The experiment database.

The data collected from the participants by means of the *Demographic* and the *Report Forms* were recorded in the data base relations *form1* and *form2*. For each participant a single row was recorded in relation *form1* while in relation *form2* each participant generated one row for each submitted *Report Form*.

As discussed above, each participant was assigned a unique, but confidential identification by means of the time-stamp she got when entering the experiment. This was replicated in both the *form 1* and *form2* relations. In the latter, the unique identifications of fact and type of presentation related to each presentation were also copied.

A number of possible records could be retrieved from the database about the participants' reaction to different facts and types of presentation can be investigated.

The *form1* row permitted the data for each participant to be classified in categories according to her demographic characteristics while data from *form2* were comparable with the data from the *fact* relation and expressing the degree of perception of the respective presentation.

(number of participants distributed by demographic variables. Form1)

(basic description of each participation. Form2)

(analysis of perception. Form2 and Charts)

(explanation of perception. Form2, Charts and Form1)

7. Summary and conclusions.

The results from the experiments and analyses are of relevance in three professional fields, *official statistics*, *applied Internet technologies*, and *cognitive science*.

Reports relevant for the practical implications of the results will be prepared for interested users in the statistical community. This will be the primary goal of the experiments and the reports. In addition to observations about the dissemination of statistics by means of statistical charts in mass media, it is expected that some experience in collecting data/opinions by means of Internet may also be of interest to this profession.

The technological interest is mainly associated with the sampling process of the interface between the web server and the updating and retrieval from the data files. As far as we know, this kind of experimental design has not yet been implemented in an Internet environment.

Finally, it is hoped that the experiment will offer some empirical contributions to the general knowledge about how people react to, perceive and interpret images representing different types of facts, which may be of interest for cognitive scientists.

8. References

Nordbotten, J.C. and Nordbotten, S. (1997): A Study of Reactions to WWW Presentations. Department of Information Science, Bergen.

Tufte, E.R. (1983): *The Visual Display of Quantitative Information*. Graphic Press. Cheshire. Conn.

Tufte, E.R. (1990): *Envisioning Information*. Graphic Press. Cheshire, Conn.

Wallgren, A., Wallgren, B., Persson, R., Jorner, U. and Haaland, J. -A. (1996): *Graphing Statistics & Data*, Sage Publications, Inc., Newbury Park, California.

