

Perception of Statistical Presentations - Investigated by Means of Internet Experiments

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Abstract

A main responsibility of a national statistical office is to disseminate statistical information about the state and development of the country to its citizens. In statistical presentation, it has been assumed that statistical tables are particularly useful and required for precise analysis and research, charts are suitable for fast visual orientation of the main trends within the area on which information is requested, and that textual or vocal presentations are best suited for mass media presentation, such as in newspapers, television, or Internet news services. To date, there have been few studies of how the general public recipient perceives information in these various formats.

The primary objective has been to investigate how these three presentation forms for statistical facts are perceived and interpreted by general public readers of statistical information. A second purpose has been to study the utilization of a Web based experiment built on statistical design principles.

1. Project justification

A national statistical office fulfills its primary mission to disseminate statistical information about the state and development of its country through response to requests for statistical publications, tabulations, or through general information distribution in such mass media as newspapers, radio, television, or Internet publication. The information disseminated may be in the form of text, table, chart, vocal, and/or even animated presentations depending on the topic and the public to which the presentation is aimed. It has been assumed that statistical tables are particularly useful for precise analysis and research, charts are suitable for fast visual orientation of the trends and/or highlights within a

topic area, while textual and vocal types are suited for newspapers and broadcasting, respectively [Tufté, 1990].

While it is generally assumed that graphical presentation improves comprehension, studies have shown that graphic displays, showing relationships between objects, are not easily understood. A study of the errors made by young students (12-14 years), asked to interpret Cartesian graphs, found that half of the error types were caused by graphic presentation characteristics, such as: domain specification, language wording, graph appearance, graph concepts, and/or graphic syntax [Preece, 1983]. Only 21% of young adults (21-25 years) were found to be proficient at locating and using information contained in maps, tables, or charts [Gillespie, 1993]. A comparison between textual and graphical presentations of three-level nested program structures concluded that graphic presentations were not necessarily more accessible, comprehensible, or memorable than textual presentations. Particularly, novice readers have problems locating and focusing on essential parts of the graph [Petre, 1995]. A comparison of graphic models of different styles found that graphic syntax affected model comprehension [Nordbotten, 1999]. These studies indicate that comprehension of graphic models is a skill that requires learning.

Considerable resources are spent to disseminate statistics from the national statistical offices to inform the citizens about their environment and prepare them for more informed decisions. What are the best ways to present information on social facts for the public? Can the dissemination of statistical information to the public be improved and how?

One objective of this project is *to investigate how different types of presentations of statistical facts are perceived.* The scenario is the general public receiving statistical news by different news media such as newspapers, radio, television, or Internet information providers. These passive 'statistical users' do not request any particular information and may have limited interest in the statistical

fact presented. A study of Web presentations has shown that these users also spend little time viewing presentations [Nordbotten, 1997]. None the less, users still observe, digest, and store information from presentations provided by the media.

A second objective of the project has been to develop and test a Web based experimental environment. We believe that the unique characteristics of the Web are well suited for both experimental design and recruitment of participants.

In the following, section 2 presents the design and implementation of the Web based experiment, while section 3 reports our experience and preliminary results from the initial execution of the experiment, carried out in the spring term of year 2000.

2. Experiment Design

The project includes the specification of a perception model, development of an experimental framework, collection of suitable facts, creation of a gallery of different representations of the facts, programming the execution of the experiment, recruiting participants, running and analyzing the recorded data.

A prototype system was developed first and tested by several interested colleagues. The final system includes modifications based on the experience from the prototype. A set of real statistical facts was collected from different official sources and presented in verbal, tabular and graphical representations, and the system was tested again. Finally, participants were recruited for the experiment reported in this paper.

The experiment can be run using the keyword = "visitor" at: <http://nordbotten.com/perception/welcome.cfm>. Figures 1-4, placed at the end of this article, show examples from the experiment Web pages. These are discussed in the following sections.

2.1 Fact selection and presentation

The experiment was based on a selection of 25 statistical facts from the socio-economic sectors. A list of the facts used and their sources is given in Table 1. The target facts were collected from the web pages of national and international statistical offices and recorded in a standard format.

Statistics Denmark, July'98	Environmental expenditures
Statistics Finland, July '98	Industrial output
INSSE, France, July '98	Research and development Expenditures
INSEE, France, July '98.	Living standards
INSEE, France, July '98	Tourism trade balance
Federal Statistical Office, Germany, July '97	Severely handicapped persons
Federal Statistical Office, Germany, July '97	Land area use
Federal Statistical Office, Germany, July '97	1996 vintage
Hagstofa Islands, July '98	Key figures
Ireland Central Statistical Office, July '96	Population
Statistics Norway, July '98	Camping
Statistics Norway, July '98	Crude oil price
Statistics Norway, July '98	Consumer prices
Statistics Sweden, July '98	Economic activity
Statistics Sweden, July '98	Population growth
UK National Statistical Office, July '98	National accounts
UK National Statistical Office, July '92	Leisure and entertainment
UK National Statistical Office, July '96	Climate
Australian Statistical Bureau, July '98	Literacy
Statistics Canada; July '98	Forrest
EUROSTAT, July '98	Birth rates
OECD, July '98	Economic development
UN Statistical division, July '98	Life expectancy
Bureau of the Census, July '98	Population

Each fact was transformed to verbal, tabular and graphical representations. The resulting 75 presentations were assembled in a gallery with each presentation identified by a unique name, and associated with fact and representation type identifications. Figure 1 illustrates the presentation of fact #4 in text, tabular, and graphical form.

Table 1: Facts and Their Sources

<i>Source</i>	<i>Subject</i>
Statistics Denmark, July'98	Election to the parliament (Folketing)

2.2 Measuring perception

For this study, perception is measured by the participant's ability to identify the presentation variables for the fact. We have used the following 4 variables:

1. the *domain* of the topic of the fact, such as demographics, education, employment, production, research, entertainment, environment, or government.
2. the *unit measurement* used, such as numeric values, percentages, or time.
3. if single or multiple points or periods were shown.
4. if single or multiple categories, such as gender, age, area were used.

Figure 2 shows the report form used to collect the participants perception of each fact. The Report Form has been designed for response as a choice from a menu of options.

2.3 The experiment framework

A participant in the experiment will be shown up to 53 HTML pages: an introductory page, a demographic request form, 25 randomly selected fact presentations, 25 perception report forms, and a concluding page. The introductory page, shown in Figure 3, gives general information about the experiment.

The 2nd page presented is the *Demographic Form* shown in Figure 4, which contains questions about the participant's gender, age group, type of occupation/studies, and country of residence to be used as background data for the analysis.

The main part of the experiment is controlled by an experimental system that generates a random number, in the range 1 to 75, for selection of a fact from the presentation gallery. Before proceeding, the system checks that the selected fact has not previously been displayed to the participant. If it has been used, a new random number is generated, checked and, if necessary rejected, until an unused fact is identified, or all of the 25 facts have been presented. Each fact presentation is displayed for a limited time between 10 and 20 seconds determined randomly by the experimental system. Presentation time is recorded to permit the investigation of a possible impact on the perception of the presentations.

Following the fact presentation, a Report Form, Figure 2 above, is displayed. The form requests information from the participant about the displayed fact. There are no time restrictions for completing the form. However, the participant is not permitted to see the presentation again using the *back button*. If he tries to back up, the experimental system gives a warning. The participant always has the option to continue or terminate his participation. If he decides to continue, the system stores the data and then selects a new fact for presentation.

A participant's exact start time is used as the internal unique identification for the whole experiment session. This session identification is attached to all recorded information about which facts and presentations were displayed for the participant, as well as all information fed back into the system. In this way, all perception data can be related to the demographic data for the respective participant.

The experiment completes after 25 facts have been presented. Upon completion, a *Thank you* page is shown inviting participants to contribute with their comments before exiting the experiment.

2.4 Implementation technology

The experiments were carried out using Web technology. Figure 5 gives the general structure of the experimental system. The core of the system is the *host server*, which hosts the *web server*, the *experiment system*, and a *database* containing the presentation gallery, participant responses and process data stored during the sessions. The *clients* are computers operated by the participants through a Web browser, linked to the host via Internet. Each client is assumed to be equipped with a web browser for communicating with the host. The host web server passes on the data received from the clients to the experimental system that controls communication to and from the database, as well as the responses to the client.

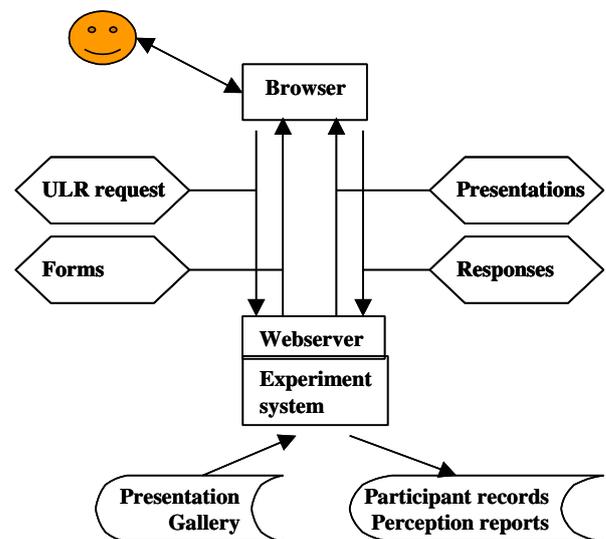


Figure 5: Outline of the experimental system

The experimental system has been designed and implemented using ColdFusion 4.0 from the Allaire Corporation to control and individually respond to the clients' requests as well as for the communication with the database. The system data, including the presentation gallery and the data provided by the participants are stored in an Access97 database. The system is remotely implemented and managed on a commercial ISP system.

3. Preliminary Results

The following reports the results from the data collected using the Web experiment from January to April 2000.

3.1 Participants

Ideally, we want to investigate the perception of statistical presentations by the general public. In our experiment, the participants were recruited from students in university classes. Students are only one of the groups the statistical information services try to reach. Participation was online by Internet. No information about the identity of the participants was collected.

The participants were students from 3 different classes at The University of Hawaii, USA (UH) and 2 classes at The University of Bergen, Norway (UiB). All classes were from computer and information science departments. A few visitors from outside the classes also participated. Each participant was given an entrance keyword indicating the class to which they belonged, providing a simple mechanism to keep track of their origin. Table 2 shows the number of participants by participating group.

Table 2: Participation

<i>Group</i>	<i>Completed Demographic Form</i>	<i>Completed 1 or more Report Forms</i>
UH (1)	13	12
UH (2)	6	5
UH (3)	6	6
UiB (1)	17	13
UiB (2)	13	10
Visitors	6	4
Total	61	50

Only those who completed at least 1 Report Form have been included in the perception analysis. Of the 50 participants, 35 were males and 15 females. Distributed by age, 30 were 20-24, 7 were 25-29, 10 were 30-49 and 3 were 50 or above.

The participants were asked about their university background or profession. About 1/3 gave *Social sciences and business* as their background, a second 1/3 *Natural*

sciences, while the last third of the participants answered *Other*.

The recruited sample is not representative for the general public and neither for a typical university population, which should be born in mind when interpreting the figures.

3.2 Perception

In total, 847 fact presentations were viewed. Each participant could view 25 fact presentations, but could end the session at any time. Fact presentations viewed per session by age averaged 15, 20, 18, and 25 for age groups 20-24, 25-29, 30-49, and 50+, respectively. The numbers probably reflect motivation for participation in the experiment.

Perception of a fact presentation was measured by the number of errors in the Report form compared to the predetermined values for each of the 4 perception variables. The number of errors for any given representation can vary from 0 to 4 with an expected value of 2 for random responses to a presentation. Of the 3788 fact presentation variables recorded, 1143 were incorrect, corresponding to an average value of 1,3 errors per presentation. Perception errors by variable are displayed in the rows of Table 3.

The facts were displayed in 3 different formats, by *text*, *table* or *chart*. Since the presentation type was determined randomly with equal probabilities for selection, the number of presentations for each type to the participants was about 280 presentations of each type. The columns of Table 3 show the errors by type of presentation.

Table 3: Errors by Presentation Type and Variable

<i>Presentation type</i>	Text	Table	Chart	Total
<i>-----</i>				
<i>Variable type</i>				
<i>Domain</i>	84	90	85	259
<i>Measure</i>	70	85	100	255
<i>Time periods</i>	97	94	92	283
<i>Number of categories</i>	127	109	110	346
Total errors	378	378	387	1143

The total errors in perception by type of presentation are surprisingly equal. As shown in Table 3, the participants had most problems perceiving the 'category' aspect of the presentations. In more than 40% of the presentations, the participants responded to the question about single/multiple categories incorrectly. The table indicates also that the *unit of measurement* is most difficult to identify in chart presentations, while perception of *categories* appears to be most difficult in text presentations.

Each presentation was displayed for a randomly determined time between 10 and 20 seconds. To study possible effects of the display time on perception, the report

records were divided into two groups by display time equal to or less than 15 seconds and more than 15 seconds. This partitioning of the collected data resulted in 464 records in the first group and 383 in the second group. Table 4 gives support to the hypothesis that display time has an effect on perception. Perception reports for presentations displayed for more than 15 seconds contained the fewest errors.

Table 4: Number of Errors per Record by Display Time and Variable.

<i>Group</i>	<i>Display <=15 sec.</i>	<i>Display >15 sec.</i>
<i>Domain</i>	0.31	0.30
<i>Measure</i>	0.35	0.24
<i>Time</i>	0.34	0.32
<i>Categories</i>	0.42	0.39
<i>Total</i>	1.42	1.25

A hypothesis frequently referred to in experiments of this type is that the participants learn during participation in an experiment and thus give better answers during the latter part of the experiment. To investigate if this was the case in our experiment, the reports were partitioned into 5 groups. The first group contains the reports for the 5 first presentations displayed in all sessions, the second group contained the reports for presentations displayed as number 6 to 10 in the sessions, and so on. Table 5 summarizes the errors for the 5 groups by measurement variable.

Table 5: Errors per Presentation by Sequence Order and Variables

<i>Presentation set</i>	<i>1-5</i>	<i>6-10</i>	<i>11-15</i>	<i>16-20</i>	<i>21-25</i>
<i># participants</i>	216	179	160	147	145
<i>Domain</i>	0.35	0.30	0.28	0.32	0.26
<i>Measure</i>	0.32	0.30	0.31	0.24	0.32
<i>Time</i>	0.40	0.39	0.28	0.24	0.32
<i>Categories</i>	0.45	0.41	0.44	0.35	0.35
<i>Total</i>	1.52	1.40	1.31	1.15	1.25

An obvious reduction in perception errors can be observed when moving from the first to the last presentation of a session. However, in the very last group there is a general increase in perception errors. One explanation may be that the participants at this stage were getting tired of the experiment, but being so near the end they wanted to finish the 25 facts.

4. Some final remarks.

Two import reservations should be kept in mind when interpreting the results from this experiment. First, it should be observed that this type of experiment does not generate any random sample of participants. The experimenter may have access to certain populations, resulting in participation from these, but not from other important populations. Further, the participants may not even be representative for their population since the experimenter can not control the selection of participants. This self-selection can easily generate biased samples.

Second, the theoretical concept of perception is difficult to operationalize. The 4 variables used in this experiment could be supplemented and/or substituted with other variables, giving other, possibly more interesting results.

In our opinion, the most valuable experience from the experiment was that it demonstrated that the Web is an important medium for executing experiments with a design of randomized components that are difficult to implement by such traditional means as mail surveys and interviews.

5. Acknowledgements

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6. References

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Figure 1: Fact Presentation

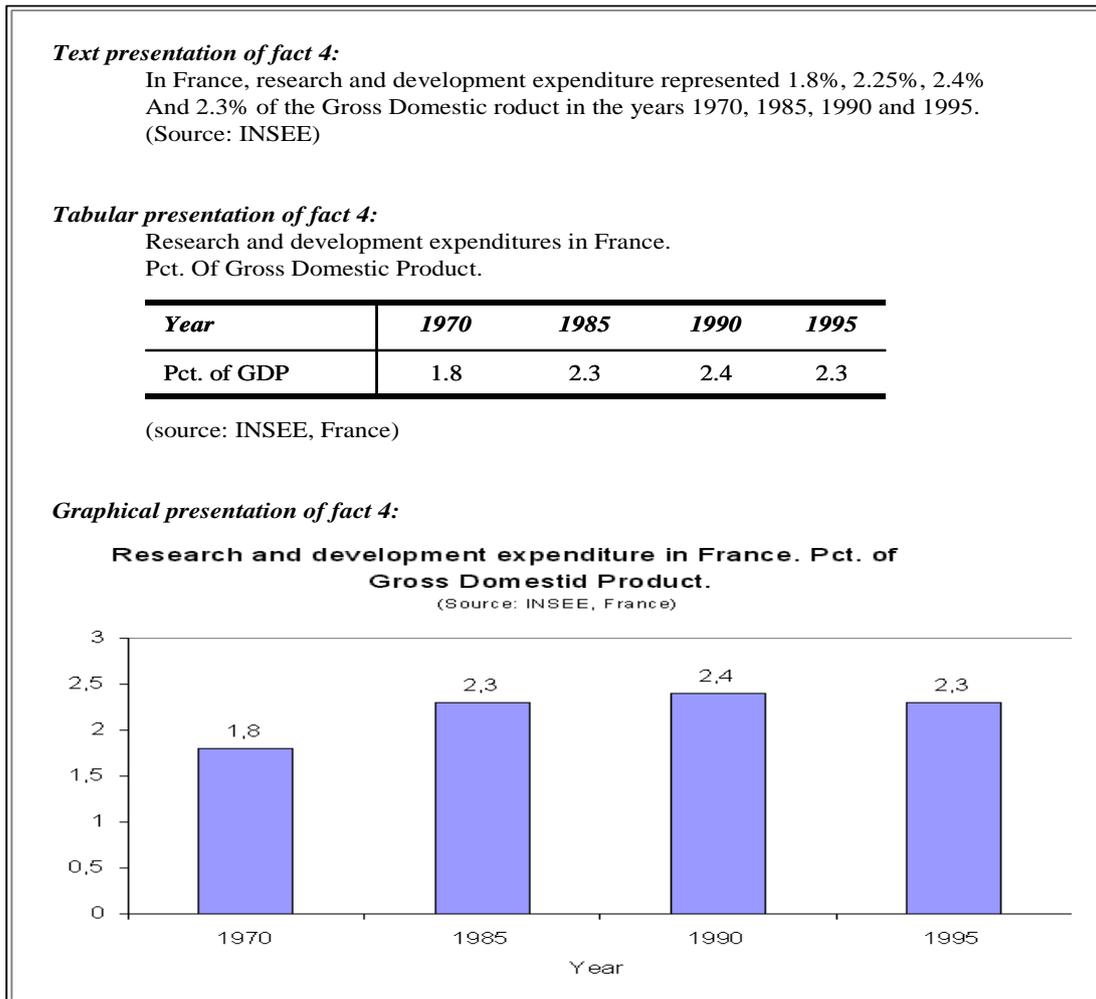


Figure 2: Perception Report Form

Untitled - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Refresh Home Search Favorites History Mail Print Edit

Address <http://localhost/perception/form2.cfm> Go

Report Form

Please do not get tempted to use your Back button, it may ruin your participation.

This is your report on the presentation which was displayed for you. Some presentations are intentionally displayed for only a short period in order to test for how long time such a presentation should be displayed, f.ex. on TV. It is not expected that you always can give answers to all questions. If the presentation was not displayed, leave the form blank.

Click at the arrow symbol at the right hand side of each reply box to get the reply options displayed and make your selection. Please take the time you need to complete the report.

Was the *topic* of the presentation within the domain of:

In which *measure* the presented fact expressed by:

Were the facts related to a *single* or *multiple* point(s)/period(s) of time:

Were the facts presented in a *single* or *multiple* categories:

Thank you so far!

If you want to continue, click the button . (please be patient while the display is compiled), else go to the URL you prefer.

Figure 3: The Introductory Page.

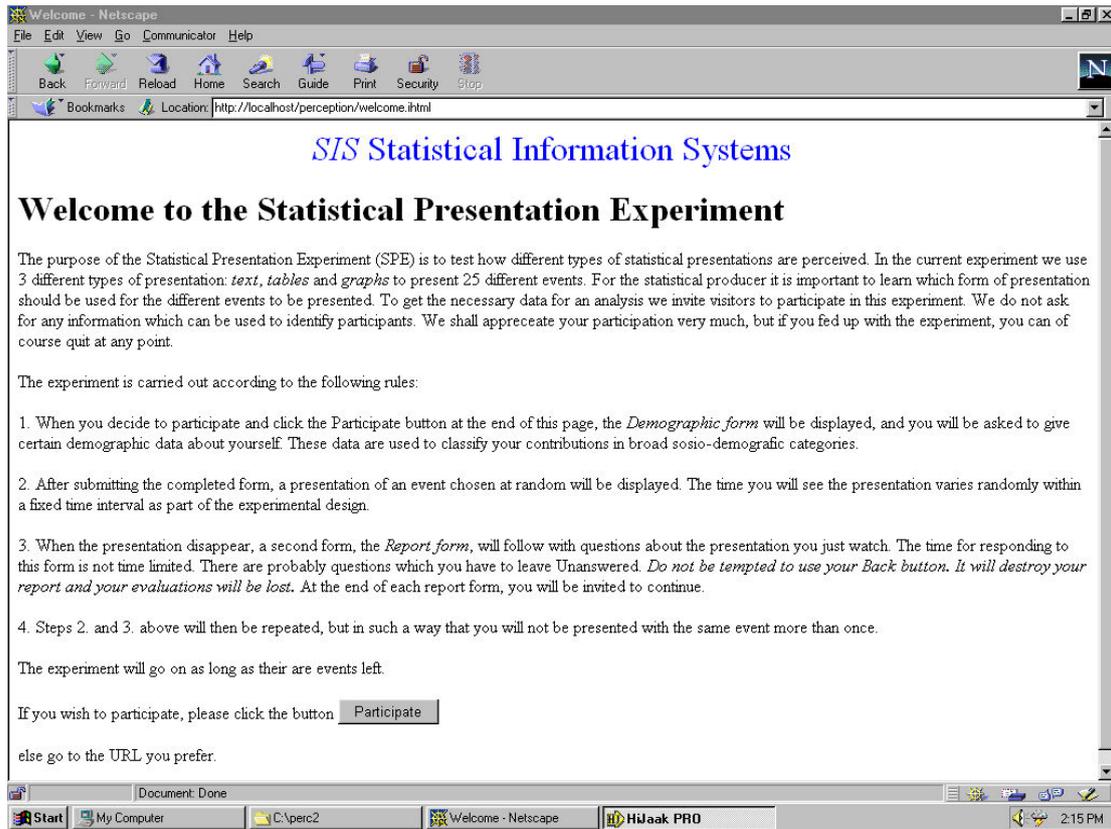


Figure 4: Demographic Form

