Collaborative and Distributed E-Research:

Innovations in Technologies, Strategies and Applications

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Cover Design:	Nick Newcomer, Lisandro Gonzalez

Published in the United States of America by
Information Science Reference (an imprint of IGI Global)
701 E. Chocolate Avenue
Hershey PA 17033
Tel: 717-533-8845
Fax: 717-533-8661
E-mail: cust@igi-global.com
Web site: http://www.igi-global.com

Library of Congress Cataloging-in-Publication Data

Collaborative and distributed e-research: innovations in technologies, strategies, and applications / Angel A. Juan ... [et al.], editors.
p. cm.
Includes bibliographical references and index.
Summary: “This book offers insight into practical and methodological issues related to collaborative e-research and furthers readers understanding of current and future trends in online research and the types of technologies involved”--Provided by publisher.
ISBN 978-1-4666-0125-3 (hardcover) -- ISBN 978-1-4666-0127-7 (print & perpetual access) 1. Internet research. 2. Group work in research. I. Juan, Angel A., 1972-
ZA4228.C65 2012
001.4’202854678--dc23
2011039614

British Cataloguing in Publication Data
A Cataloguing in Publication record for this book is available from the British Library.

All work contributed to this book is new, previously-unpublished material. The views expressed in this book are those of the authors, but not necessarily of the publisher.

Chapter 2
The Web as a Platform for E-Research in the Social and Behavioral Sciences

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ABSTRACT

As a consequence of the joint and rapid evolution of the Internet and the social and behavioral sciences during the last two decades, the Internet is becoming one of the best possible psychological laboratories and is being used by scientists from all over the world in more and more productive and interesting ways each day. This chapter uses examples from psychology, while reviewing the most recent Web paradigms, like the Social Web, Semantic Web, and Cloud Computing, and their implications for e-research in the social and behavioral sciences, and tries to anticipate the possibilities offered to social science researchers by future Internet proposals. The most recent advancements in the architecture of the Web, both from the server and the client-side, are also discussed in relation to behavioral e-research. Given the increasing social nature of the Web, both social scientists and engineers should benefit from knowledge on how the most recent and future Web developments can provide new and creative ways to advance the understanding of the human nature.

DOI: 10.4018/978-1-4666-0125-3.ch002

WEB-BASED RESEARCH IN PSYCHOLOGY: TWO DECADES OF JOINT EVOLUTION

Cognitive psychology has traditionally kept a special relationship with computer science. In fact, the "cognitive revolution" usually refers to the joint developments that took place in the mid 1950's and 1960's in computer science and psychology, together with those of other cognitive sciences (linguistics, philosophy, anthropology, and neuroscience). Initially, psychologists were interested in computers mainly because they provided a novel and interesting model on how the brain might work (Gardner, 1985). Behaviorists had complained that cognitive concepts were difficult to apprehend in mechanistic and reductionist terms and that they should, therefore, always be avoided in scientific psychology. However, computer science showed for the first time that simple, mechanic devices were also able to process information and perform many cognitive tasks that had sometimes been assumed to remain beyond the realm of science. Soon, psychologists proposed that the human brain was just a peculiar type of computer and that the mind was a kind of software running on this "hardware." Moreover, cognitive scientists started to describe cognitive processes in a program-like manner and even tried to simulate these processes in standard computers (Newell & Simon, 1972).

For a long time, this was the main role played by computers in cognitive psychology. However, during the 1980's, when computers became cheaper and the recently developed high-level programming languages made their use more accessible, psychologists started to use computers with a new purpose in mind. Instead of just using them as an abstract model of how the mind works, psychologists began to use computers as an additional tool in their experiments. Computers simplified the presentation of stimuli to participants and the registration of many types of responses to those stimuli. In fact, any researcher with rudimentary programming skills could easily conduct classical laboratory experiments with only the help of a desktop computer. The old laboratory in which a different apparatus had to be used for each different experiment was soon substituted by laboratories in which computers were used to run all types of experiments, including tasks as different as: a) spatial navigation through different types of mazes, b) memory tasks with different lists of words, or with images or sounds, c) reading comprehension studies using different types of stories and distracting stimulation, d) reaction-time studies, e) subliminal perception involving words or images or sounds presented so rapidly that they could not be consciously processed, f) Pavlovian and operant conditioning including visual or auditory stimuli as well as different types of responses (from keyboard to mouse to vocalizations), g) divided attention, h) social dilemmas, or any other interesting research question a psychologist could think of. Thus, by the time the World Wide Web was created, in the early 1990's, most experimental psychologists were already used to having computers in their labs and using them extensively in their experiments. It was only a matter of time before some researchers made the first steps towards taking advantage of the new opportunities offered by the Internet as a multipurpose and world-wide psychology laboratory. There is no doubt that this world-wide laboratory is also of great value to other social and behavioural sciences interested in human behaviour, beliefs, attitudes, and social relations. These include education, economics, marketing, anthropology, sociology, and politics, but this list is certainly not complete. Indeed, any scientific discipline interested in how people reason, learn, relate to each other, process information, and respond to it, should benefit from using the Web as a platform for e-research. Although focusing on examples from our own field of expertise, experimental psychology, the present chapter should become a useful guide for other social sciences as well.

From its very beginning at the Conseil Européen pour la Recherche Nucléaire (CERN) in the early 1990's, the World Wide Web has been closely linked to the academic world. During the past two decades, we have witnessed its technological evolution and how social science researchers have been taking advantage from its capability to engage participants around the whole world to perform larger, more insightful, and valid experiments. The advantages of conducting psychological research over the Internet soon became clear. Probably the most remarkable one is that the Internet made it relatively easy to access extraordinarily large samples, something that is usually beyond the possibilities of the traditional psychological laboratory. In fact, this is still the main reason many researchers decide to conduct experiments over the Internet (e.g., Nosek, 2005). This feature of Internet-based experiments becomes especially relevant when researchers are interested in determining whether a nonsignificant statistical result reflects a genuine absence of effects or a simple lack of statistical power (Bar-Anan, De Houwer, & Nosek, 2010; Ratliff & Nosek, 2010). Moreover, this methodology does not only allow the recruitment of many participants but also can be used to target very peculiar populations which would otherwise remain inaccessible (Mangan & Reips, 2007; Vernberg, Snyder, & Schuh, 2005).

However, in spite of these and other advantages, Internet-based research methods also pose important methodological problems. In general, researchers have little control over the conditions in which online participants conduct the experimental task. They cannot even make sure of whether the participants have been paying attention to the task or of whether they have correctly understood the instructions. Moreover, the participant can enter the Web site of the experiment several times and submit data repeatedly. Although there are some technical measures that can be used to avoid or reduce the negative impact of these and related methodological problems (Birnbaum, 2004; Reips, 2002), many of these solutions pose their own problems as well. It is not surprising that the pioneers of Internet-based research usually had to face a high level of scepticism in the evaluation of their studies.

In this situation, the first step that had to be made before Internet-based methods could be trusted was to carefully assess the impact of conducting a study over the Internet, in relation to the traditional laboratory. Therefore, many researchers started to replicate well-known effects over the Internet or to conduct studies simultaneously in the laboratory and over the Internet, so that the results of both methodologies could be contrasted. This work was done both to assess the validity of online questionnaires and surveys (Buchanan & Smith, 1999; Schmidt, 1997a), on the one hand, and the validity of experimental procedures, on the other (Birnbaum, 1999; Birnbaum & Wakcher, 2002; Dandurand, Shultz, & Onishi, 2008; Matute, Vadillo, & Bárcena, 2007; Matute, Vegas & Pineño, 2002; Steyvers, Tenenbaum, Wagenmakers, & Blum, 2003; Vadillo, Bárcena, & Matute, 2006; Vadillo & Matute, 2009, 2011). It was particularly important to show that effects could be replicated over the Internet even when delicate dependent measures, such as reaction times, were used (McGraw, Tew, & Williams, 2000). In general, the main result of this research was that, with very minor exceptions, online methods could be trusted and that the drawbacks of this methodology were clearly compensated by its many advantages.

A second step towards the generalization of e-research in psychology was the development of experimental software that could be easily used by researcher to develop their own experimental applications. Although most cognitive psychologists were used to having to learn some programming languages in order to design their experiments, during the '90's and even today, few of them have the necessary skills to adapt these experiments to the Internet environment.

Therefore, many researchers started to develop simple design tools that could be used to generate survey forms (Birnbaum, 2000; Schmidt, 1997b) or more complicated experimental tasks (Reips & Neuhaus, 2002) without much technical knowledge of Internet-based programming.

After two decades of joint evolution, the Internet has become a highly valuable research tool for many experimental psychologists. They do not only regularly use the Internet to conduct experiments and large correlational studies. They are also using it to gather other types of information such as, for instance, psycholinguistic data about the frequency of words in several languages (Lahl, Göritz, Pietrowsky, & Rosenberg, 2009), or the susceptibility of people to cognitive illusions and biases such as the illusion of control (Matute, Vadillo, Vegas, & Blanco, 2007). Moreover, the increasing access of the general population to the Internet is also providing psychologists with new research topics that need to be explored (e.g., Internet abuse, cyberbullying) and with novel ways of delivering psychological interventions to the population (e.g., Botella et al., 2008a, 2008b, 2009). As we will show below, the recent developments in the Web 2.0 and the future Semantic Web bring new and yet unexplored possibilities for e-research in social sciences.

THE NEW WEB PARADIGMS AND THEIR IMPLICATIONS FOR E-RESEARCH IN THE SOCIAL SCIENCES

The Future of the Web is yet unclear, but some approaches like Social Web, Semantic Web, and Cloud Computing have been used widely and can still be substantially improved. In this section we will describe the new scenarios enabled by them in terms of e-research in the social and behavioral sciences, and we will also glimpse at the possibilities offered to social scientists by future Internet proposals.

The Social Web

Despite of the fact that even from its first stages of development at the early 1990's the World Wide Web (WWW) had a flexible and collaborative design that allowed users to create new links and content, it was not until the beginning of the 21st century that this possibility became true by virtue of the technological and methodological evolution popularly known as the Web 2.0 (DiNucci, 1999; O'Reilly, 2005) or the Social Web (Hoschka, 1998).

For the last two decades, Web users have moved forward from simply carrying out hypertextual data transfers to the socialization of many aspects of their lives. The Web has evolved towards the "Read/Write Web," achieving one of the goals initially proposed by its designers (Berners-Lee & Cailliau, 1990). Describing this new stage of the Web as the "Social Web" seems more appropriate, since the adoption of the new technologies and methodologies involved has not been as abrupt or revolutionary as the term "Web 2.0" might suggest, but through a progressive process of socialization. There may be differences between both terms when explaining the origin of the change, but there is no such discrepancy when considering its effects. O'Reilly (2005) defines Web 2.0 applications as services that get better the more people that use them. Over the last 15 years, the Web has grown from an information-centered network (i.e., "information superhighways") into a people-centered social media in which user-generated content is crucial. This trend is likely to continue further, considering that Future Internet aims at favoring user-empowerment (i.e., two users making the same search with the same keywords being at different locations and having different web profiles will obtain different search results).

Two are the foundations of this Social Web: users and data. Users generate content with different levels of implication (from merely being part of a social media site to publishing and editing multimedia content, rating or tagging it, or providing recommendations and reviews), attract more users, and reshape platforms and Web services in terms of content (e.g., fixing errors) and purpose (e.g. creating new ways of using them, not defined by their designers). Data is the fuel that drives social media, regardless of whether it is generated by users or by other online services. Instead of conforming vast repositories of unrelated information, the Social Web's data is available in several standard formats, ready to be remixed, completed or updated by third-party services. As stated by Engeström (2009), people do not just connect to each other using social media. They connect through "shared objects," and good online services (e.g. Youtube, Flickr, Delicious) allow people to create social objects that add value to the rest of the users, and subsequently to the whole social media.

Both these aspects of the Social Web can enhance e-research in social and behavioral sciences in two different ways. On the one hand, the Social Web allows using methodological approaches that would be unfeasible otherwise, providing cheap and effective ways to engage people in participating in experiments, or taking advantage from the sharing features of social media to distribute and process experimental data. On the other hand, the success of the Social Web has significant consequences from a psychological point of view, in terms of new or implicit behaviors in social media. Thus, the Social Web can be a good means for improving research methodology and, at the same time, an object of e-research in psychology.

Improving Research Methodology through the Social Web

Many authors agree that the popularization of computational technology provides a new way to do science. Wolfram (2002) remarks the power of using computers when facing complex problems, even through simple programs, delegating the tedious calculations to machines. According to Shneiderman (2008), new kinds of science are needed to study the integrated interdisciplinary problems at the heart of socio-technical systems. This Science 2.0 combines the methods of traditional science (i.e., hypothesis testing, predictive models, and the need for validity, replicability, and generalizability) with the opportunities offered by the Social Web to collect and process real-time empirical data. E-research in the social sciences is also involved in this evolution. In addition to academic social networks (e.g., Academia.edu, Mendeley, ResearchID, SciLink), general purpose social networks (e.g., Facebook, Twitter, MySpace) can be used to spread scientific findings or even to discuss them. The idea of achieving insightful conclusions through open debates in social media is still very controversial for many reasons (e.g., irrelevant or non-accurate contributions, reputation, non-disclosure agreements). Nevertheless, there is no such debate about using the social media as a way to recruit participants for experiments. Many social science experiments can take advantage from the wide range of ways to push information provided by the Social Web. It is easy to publish information regarding the experiment or to recruit potential participants using tags, categories, recommendations, groups, or fan-pages, without annoying other people with unsolicited notifications that could be considered as spam. Due to all the hints provided by user-generated content, the Social Web is able to hit very specific targets and avoid general and ineffective ways of promotion (Anderson, 2006). Thus, e-researchers in social sciences can reach very specific participants in studies that would be extremely difficult or even unfeasible without the social features of the Web.

Apart from the increase in the number and prevalence of participants in social sciences experiments, the Social Web provides several techniques to analyze and exploit user-generated content. Virtually all social media services allow interacting with their data through Application Programming Interfaces (APIs). APIs allow consuming a Web service without using a browser to browse through service's Website (e.g., using a mobile phone application) contents. Features derived from APIs are often underestimated by non-programmers. Using a real-life comparison, APIs can be shown as "delivery services" of a restaurant. If a family does not want to prepare dinner, they can either go to a restaurant or call to a delivery service. There are also mixed alternatives, like going to a restaurant and order a take-away meal, or even pay for a catering service at home. Coming back to Web services, the meal is the content that users need, and the delivery service is the API. There are some restaurants without delivery service that force customers to go to their place for a meal, as API-less Web applications do; and there are some other restaurants which provide both alternatives (local or delivery), and customers can decide whether it is worth going to the restaurant or it is better to have dinner at home.

Moreover, by using APIs, third-party developers can aggregate social services to create new ones, called "mash-ups" (e.g., an application that mixes cartographic information provided by Google Maps with beautiful pictures of nearby places gathered from Flickr, with no need to have an explicit agreement between the providers of those APIs [Google and Yahoo!]). Another interesting feature of social media APIs is that they allow to access, collect, and analyze huge amounts of useful information. Older methodologies, like traditional offline experimentation or even online experimentation with no use of social media, can handle tens, hundreds, or thousands of participants. But using the APIs provided by social media, millions of interactions can be handled in real time. Eventually, the range provided by the API is able to cover the whole target population of the study, but it can sometimes be more limited in wide-range studies due to technical and economic reasons. Nevertheless, going from thousands to millions of interactions is a significant leap in e-research. For instance, Twitter's public APIs allow to access to the 1% of all real-time 'tweets'—messages sent via Twitter—to third-party applications. The third-party applications using Twitter APIs can apply to be whitelisted, which allows upgrading their quota and access to the 10% of all Twitter content. This means a huge number of 2 to 20 million tweets per day for regular and whitelisted applications, respectively.

Providing ways to build a third-party applications' ecosystem is at the core of all successful social media platforms. The case of Facebook is particularly remarkable because it enables the creation of successful business models within the social network (e.g., Zynga, the social videogame company behind FarmVille, got over $1 million in revenue a day during 2010 thanks to Facebook), boosts the use of the Facebook fan-pages by companies, and provides several interfaces to publish outside-generated content in Facebook, or vice versa, Facebook content in third-party platforms. If Facebook's benefits from interconnectivity are considerable, Twitter's are outstanding. Although it is still unclear whether Twitter can be considered a social network like Facebook or not (Kwak, Lee, Park, & Moon, 2010), Twitter describes itself as an "information network" where users find, curate, and deliver content, rather than socialize. Twitter users focus less on their social graph and more on information broadcasting. Paradoxically, Twitter's limitations are its biggest strengths: Its home page is extremely simple compared with other social media, text-based content and 140-character limitations encourage focusing on crucial information and the subscription-based social graph allows asymmetric relationships between users. Contrary to Facebook's symmetric relationships, where "friendship" is always bi-directional, a Twitter user can follow another user (i.e., subscribe to other user's tweets), while not being followed by her. The simplicity of Twitter's Web interface contrasts with the large set of rich clients that extend the capabilities of the platform through an intensive API usage. Metaphorically, we can see Twitter as a government that builds highways (i.e., Twitter servers and network bandwidth), sets the regulations to use them (i.e., APIs descriptions), and provides standard and simple vehicles (i.e., Twitter Web page). Users can choose to drive these standard vehicles or get others more adapted to their needs (e.g., motorbikes, trucks, etc.; or their equivalents in mobile Twitter clients, blogging Twitter publishing buttons, etc.), as long as they fulfil the regulations. This is a standard feature of most social media platforms, but it is more evident in Twitter because of the extreme simplicity of its Web interface and the myriad of third-party clients. As Cheng and Evans (2009) found, in 2009 TweetDeck was the most popular non-Twitter.com publishing tool with a 19.7% market share, and more than half of Twitter users (55%) used something other than Twitter.com. In 2010, as stated by Twitter's CEO (Williams, 2010), just 25 percent of the content is generated from Twitter.com. That is, 75 percent of traffic comes from outside Twitter.com through the ecosystem provided by public APIs.

Twitter is a good example of the success that public APIs can reach, but the rest of social media (e.g., Facebook, Youtube, Flickr) are also seizing the opportunity to offer content outside their platforms and enabling mixing their contents: Facebook users can share Youtube videos in their fan-pages or walls, blog editors can embed slideshows from Flickr and add social media links at the end of each post to share it across the Social Web, LinkedIn (a business-oriented social network) users can include Slideshare presentations in their resumes. Using APIs is not exclusive for social media, though. Wherever a dynamic map is needed, Google is providing it through Google Maps API.

Social sciences e-researchers must take into account the fact that most of the Social Web's data is being heavily used and reused. Accounting reused information should be done carefully. On the one hand, researchers should avoid populating their local databases with multiple copies of the same information. On the other hand, information reusage may imply relevance, and should be analyzed on its own. Suh, Hong, Pirolli, and Chi (2010) studied the variables that predict Twitter content reusage ("retweetability," the ability of being retweeted—forwarded—when posting content). Agichtein, Castillo, Donato, Gionis, and Mishne (2008) question the simple metrics used when analyzing social media, and introduce a general classification framework for combining the evidence coming from different sources of information, that can be tuned automatically for a given social media type and quality definition.

The Social Web's public APIs are not the panacea to all problems related to content. Sometimes they are inadequate, insufficient or too complex to use. In those cases, e-researchers should look for third-party APIs with extra functionality or a wider range of provided information formats. GNIP.com is probably the best example of a third-party API provider, as it supplies its own APIs for more than 30 different social media (e.g., Facebook, Twitter, Youtube, Flicrk, Worpdress). For instance, GNIP.com provides several Twitter-related APIs with interesting extra features ("GNIP Premium Twitter feeds"), like access to the 50 percent of all Twitter content, delivered in real time (GNIP Twitter Halfhose), a stream of all Twitter statuses containing URLs, delivered in real time too (GNIP Twitter Link Stream), or statuses that mention any given user (GNIP Twitter User Mention Stream). The main drawback of this kind of services is its price, not suitable for low-budget research initiatives. Even so, there are academic institutions that offer third-party social media APIs for free, but under some restrictions (e.g., limited date ranges, sample sizes, storage quotas) due to the costs involved in maintaining the service (Gaffney, Pearce, Darham, & Nanis, 2010).

Finally, when no API is provided to access relevant information from service providers, e-researchers still have some alternatives. The first one is to take advantage from "Web feeds" (also known as "Web syndication"), if they are available. Web applications use web feeds to publish updated content in a standard way (i.e., using XML-based formats like RSS or Atom). Newspapers are probably the best example to illustrate the Web feed concept. In a newspaper's Web site, information is arranged by relevance and topicality. If someone wants to be informed, she should periodically access that Web site and look for new content. As this can be very difficult for some news, newspapers offer a publicly available time-ordered news list as a Web feed. Gathering the new content of a Web site is extremely easy when Web feeds are available. The main difference between API-based queries and Web feeds is that using the former allows advanced queries, whereas the later is limited to the last updates. Coming back to the previous comparison between APIs and pizza deliveries, a Web feed would be like a delivery where customers cannot order the pizza they want, but the last pizza that came out from the oven. The second alternative when no API is provided is a technique called "Web scraping." Using Web scraping techniques, a researcher can convert human-readable data provided by a web site and defined in HyperText Markup Language (HTML) into raw data defined in an XML dialect or other data formats, and subsequently store and process it by means of a content analyzer. There are many problems related to Web scraping: (a) The HTML code of some Web sites is not easy to parse to extract valuable data, (b) Small changes in Web site's HTML code have large impact in the gathering process, and (c) Extracting data from Web sites and using it in third-party services can sometimes violate Terms of Use and content license of the service provider.

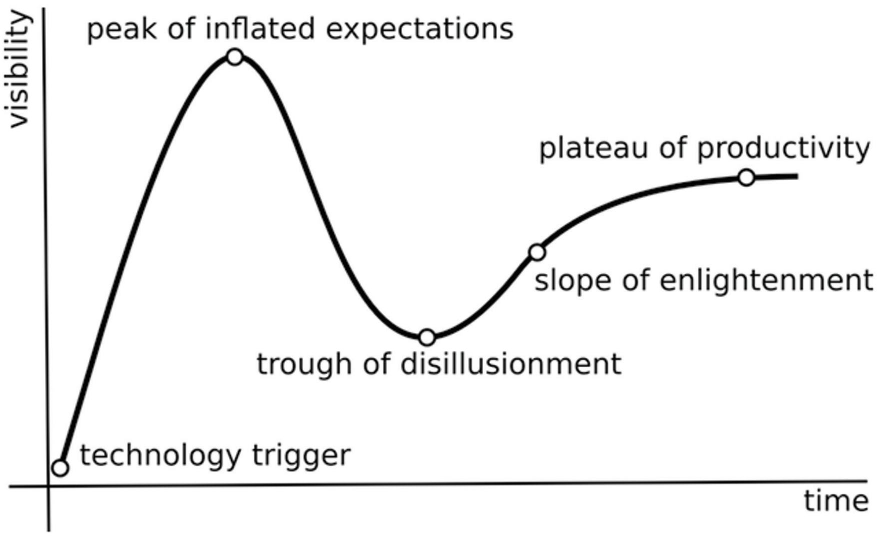
In conclusion, there are many interesting features of the Social Web that can be very useful for e-research. Firstly, the Social Web is an excellent platform to promote ongoing experiments and to disclose findings, encouraging discussions about them and reaching a large-scale pool of people interested in participating in experiments. Secondly, the Social Web's stress on data reuse allows researchers to collect and process huge amounts of original information, using social media public APIs, third-party APIs, or even more complex techniques like Web feeds or web scraping.

The Social Web as the Object of E-Research in Psychology

Over the last decade, the Social Web has gone through various stages (i.e., blogs, wikis, social networks, location-based social networks). The social component of the Web is a key factor to understand why so many technologies are now considered obsolete, and why the findings of research studies conducted a few years ago no longer apply to the current situation. Linden and Fenn (2003) created a graphic representation of the maturity, adoption and social application of specific technologies to characterize the over-enthusiasm or "hype" and subsequent disappointment that typically happens with the introduction of new technologies. As shown in Figure 1, a typical "hype cycle" consists of five phases:

1. "Technology Trigger": The new technology is presented to the public with a proof of concept, trying to achieve media coverage.
2. "Peak of Inflated Expectations": Everyone wants to use the new technology. Media organisations show it as the solution to every problem. There may be some successful applications of a technology, but there are typically more failures.
3. "Trough of Disillusionment": Over-enthusiasm vanishes and technology fails to be successful in all proposed scenarios. Media usually abandons the topic and the technology.
4. "Slope of Enlightenment": The technology is improved and adapted to those specific situations where it was successful (less than expected during the "Peak of Inflated Expectations," but more than discarded during the "Trough of Disillusionment").
5. "Plateau of Productivity": The benefits of using the technology are widely demonstrated and accepted. The technology becomes increasingly stable and evolves in second and third generations.

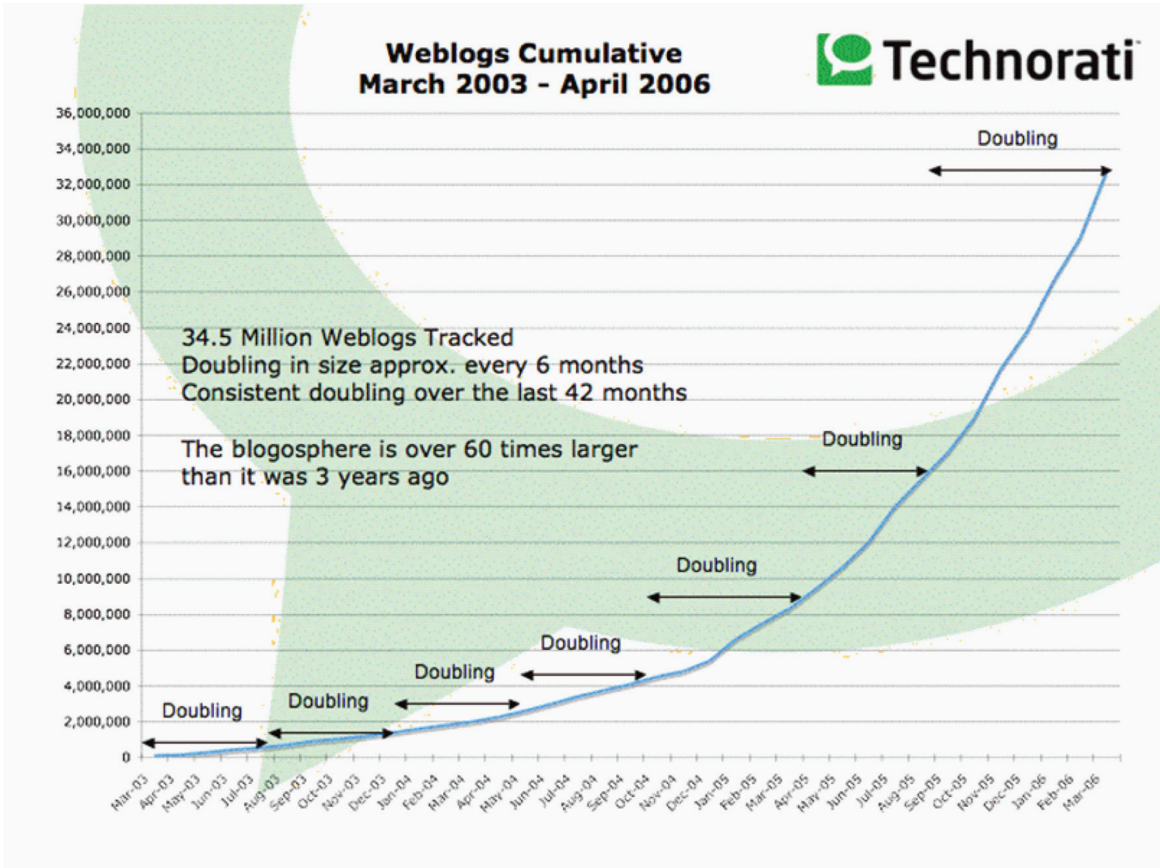
Figure 1. Gartner's hype cycle phases (adapted from Linden & Fenn, 2003)



Blogging, like all technologies related to the Social Web, passed through the different phases of adoption, very similar to this "hype cycle." The number of blogs was consistently doubled every 6 months from 2003 until 2006 (see Figure 2), but needed 320 days to double in 2007 (Sifry, 2007). In 2008, there were 600,000 blog posts per day, less than in 2007 (Winn, 2009). Did blogging reach the "Peak of Inflated Expectations" at the end of 2006? It is very likely that the success of Facebook and Twitter influenced in this decrease of blogging usage, but this can also be related to the fact that blogs were presented as the solution to all Web needs during the period from 2003 and 2007 (e.g., comercial promotion, e-learning, research, multimedia portfolios). The over-enthusiasm was answered with the creation of companies focused in blog analysis (e.g., Technorati, BlogPulse, Google Blog Search), but some of them changed their target when blogging became less popular. Nowadays, blogs are close to the "Slope of Enlightenment," as they are being used for the specific purpose they were created for. This crazy growth of expectations around the Social Web was described by Engeström (2009) as "butterfly flights," as they fly higher and higher, and suddenly descend to the floor. The same happens with social media adoption when they lose the users' interest (e.g., Six Degrees, Friendster, MySpace). Thus, exponential growth rates (Fisch, 2006) should be considered cautiously in the Social Web, because they can be a sign of being at the "Peak of Inflated Expectations."

E-research in psychology has dealt with blogging by studying the causes and consequences of being a blogger. Even though there are diverse motivations for blogging (Nardi, Schiano, Gumbrecht, & Swartz, 2004), some authors suggest that it can be predicted from the big five personality traits (Digman, 1990): People who score high in openness to new experience and high in neuroticism too are more likely to be bloggers (Guadagno, Okdie, & Eno, 2007). Similarly, Hsu and Lin (2008) proposed a model based in the Theory of Reasoned Action (TRA) where ease of use, enjoyment, and knowledge sharing (i.e., altruism and reputation) explain 78 percent of the variance of being a blogger; and social factors (e.g. community identification) and attitude toward blogging explain 83 percent of the variance

Figure 2. Weblogs cumulative (March 2003 - April 2006). Weblogs reached the "Peak of Inflated Expectations" at the end of 2006 (© 2007, Technorati.com. Used with permission).



of continuing to blog. In relation to the consequences of being a blogger, Baker and Moore (2008) found that intending bloggers were more psychologically distressed and more likely to use venting and self-blame to cope with their stress than non-bloggers. Intending bloggers also scored lower on measures of social provisions and were less satisfied with their number of online and offline friends when compared to non-bloggers. Consistent with the similarities between blogging and writing a diary, many of the benefits related to writing a diary (Smyth, 1998) have been found to also be present in blogging.

Despite the fact that wikis did not attract the attention of many e-researchers in psychology, Amichai–Hamburger, Lamdan, Madiel, and Hayat (2008) studied personality characteristics of Wikipedia members (i.e., "wikipedians"), and found that Wikipedia members locate their real me on the Internet more frequently than non-Wikipedia members. They also found significant differences in agreeableness, openness, and conscientiousness, which were lower for the Wikipedia members, and an interaction between Wikipedia membership and gender: Introverted women were more likely to be Wikipedia members as compared with extroverted women.

There is no doubt that online social networks have been hot topics for e-research in psychology. MySpace was the first online social network to reach an audience of more than 100 million people (Adest, 2006), creating huge expectations for this new way to socialize. Thelwall (2008) studied the motivation of MySpace members, finding significant differences between male and female. Female members tended to be more interested in friendship and males more interested in dating. As expected, female and younger members had more friends than others, and both genders seemed to prefer female friends, with this tendency more marked in females for their closest friends. Regarding privacy, females were more likely to maintain private profiles. Due to the extensive use of slang (i.e., not only related to the age of the members, but also for being online and using a social network with its own rules) there are difficulties in parsing the messages shared on MySpace (Thelwall, 2009). However, Thelwall, Wilkinson, and Uppal (2010) found that two thirds of the comments expressed positive emotion, and that just a minority (20%) contained negative emotion. Perhaps unsurprisingly, females were more likely to give and receive positive comments than males, but there was no difference for negative comments. Torkjazi, Rejaie, and Willinger (2009) remarked the "hype cycle" of MySpace analyzing the number of members. The growth of allocated user IDs in MySpace was exponential until 2007 (i.e., "Peak of Inflated Expectations") followed by a sudden and significant slow-down in 2008 (i.e., "Trough of Disillusionment") motivated by an increase in the popularity of Facebook. Hargittai (2007) verified the struggle for new members between Facebook and MySpace and found significant differences according to their socio-economic situation. Students whose parents had lower levels of schooling were more likely to be MySpace members, whereas students whose parents had higher levels of education were more likely to be Facebook members.

Facebook offers a reasonable trade-off between standardization and customization for members' profiles. Both characteristics are interesting from a researcher perspective: Having standard features makes profiles easily comparable, and customizations can be correlated with many other variables (e.g., personality traits, mental disorders). Zhao, Grasmuck, and Martin (2008) found differences between anonymous online environments (e.g., Massively Multiplayer Online Role-Playing Games, chat rooms, forums) and social networks like Facebook, where most members use their real identity. Facebook members claim their identities implicitly (i.e., showing group and consumer identities) rather than explicitly (i.e. talking about themselves). Other studies agree that Facebook profiles reflect actual personality rather than self-idealization, and can be used to predict owner's personality, especially for extraversion, but not so accurately for emotional stability (Gosling, Gaddis, & Vazire, 2007; Back, et al., 2010; Correa, Hinsley, & Gil de Zúñiga, 2010). Rosen (2007) studied the tendency to publicly trumpet one's online friendships, and characterized it as a narcissistic quest for social status. Several authors came to a similar conclusion. For example, Buffardi and Campbell (2008) found that higher levels of social activity and self-promoting content in Facebook can be predicted through narcissistic personality self-reports. Ellison, Steinfield, and Lampe (2007) found a strong connection between Facebook use and perceived social capital. Social networks help to maintain relationships as people move from one offline community to another (e.g., when students graduate from high school or college). Such connections could have strong payoffs in terms of jobs, internships, and other opportunities, even in online environments. Lerman and Galstyan (2008) found evidence of it analyzing the impact of the "social graph" in social news Websites (e.g., Digg, Reddit, StumbleUpon): Users tend to like stories submitted by friends and stories their friends read and liked.

Another important issue related to Facebook is privacy. There is a tendency for social media users to value privacy, security, and trust, but there are still inconsistent concerns about them. For instance, Acquisti and Gross (2006) found that social networks users are mildly concerned about who can access their personal information and how it can be used, but not concerned about the information itself, mostly because they are the publishers of the content shared on the social network, and because they believe to have some control on its access. Moreover, there are many social motivators against privacy when using social networks, like having fun or allowing the social network to be a useful tool by sharing enough information. Fogel and Nehmad (2009) concluded that general privacy and identity information disclosure concerns are more salient to female than male (e.g., greater percentages of male than female display their phone numbers and home addresses on social media). Social media around "social objects" (Engeström, 2009) offers a wider range of alternatives to deal with privacy. Lange (2007) analyzed social relationships among youth on Youtube, identifying various degrees of "publicness" in video sharing. Considering the anonymity and the access restriction as factors, four combinations could happen (i.e., public account with unrestricted content, anonymous account with unrestricted content, public account with restricted content, and anonymous account with restricted content). Lange remarked the use of two strategies to leverage anonymity while sharing content: (a) "publicly private," in which video maker's identities were revealed, but content was relatively private because it was not widely accessed, and (b) "privately public," where content was widely accessible, but detailed information about video maker's identities was limited. However, anonymity and privacy are not the same thing, and social media users should realize that both are important.

As mentioned before, Twitter is not really a social network, but an information network. Perhaps the most interesting issue regarding Twitter is related to the fact that users reshaped the network, creating new ways of using it: (a) When users needed a short way to answer a message, they added an "@" to the username to mean it; (b) "RT" or "retweet" was unofficially created to express that the content is not original, but forwarded from other user; and (c) as there was no tagging system on Twitter, users started to prepend a "#" to words to be considered as tags by other users. Months later Twitter administrators realized that these new codes were "de facto" standards among the users and implemented them as official features. Taking into account its fast evolution in less than 5 years, studies published in the last years should be considered within its context, as their conclusions are not likely to apply to current Twitter activity. For instance, Java and Song (2007) concluded that the most common use of Twitter was talk about daily routine. This could be true in 2007, but nowadays people use Twitter with other purposes. Moreover, other particular characteristics of Twitter, like its text-based only content, asymmetric relationships (e.g., @aplusk, Ashton Kutcher user on Twitter follows less than a thousand users, but is followed by more than 6 million users), or similar functionality for mobile users, make Twitter a great platform for e-research in social sciences. Cha, Haddadi, Benevenuto, and Gummadi (2010) analyzed influence in Twitter and found that popular users who have a large number of followers are not necessarily influential in terms of spawning retweets or mentions (e.g., a tweet from Ashton Kutcher is not more likely to be forwarded or mentioned just because the extraordinary number of followers). Furthermore, a concerted effort (e.g., limiting tweets to a single topic) seems to be the best way to gain influence in Twitter. Conversely Suh, Hong, Pirolli, and Chi (2010) found that the number of followers and "following" (i.e., followees), as well as the age of the account, seem to affect influence in Twitter in terms of "retweetability," while, interestingly, the number of past tweets does not predict retweetability of a user's tweet. It is also interesting the fact that URLs and hashtags have strong relationships with retweetability, confirming the shift of typical Twitter activity from daily routine to information sharing. Perhaps some of the controversial issues can be explained examining the topology of the social graphs. Mislove, Marcon, Gummadi, Druschel, and Bhattacharjee (2007) stated that online social networks have structures that differ from other networks, in particular the Web. Social networks have a much higher fraction of symmetric links and also exhibit much higher levels of local clustering.

Location Based Social Networks (LBSN) go further in the real-time social media mobility (e.g., FourSquare, Gowall, Whirl). As LBSN users tend to be Twitter members, all of them are tightly connected with it, providing multiple ways to automatically publish their content on Twitter. This can be also problematic. Humphreys, Krishnamurthy, and Gill (2010) found that about a quarter of tweets included information regarding when people are engaging in activities and where they are. Educating users about the ways in which personal information can be used for alternative purposes (i.e., related to user's privacy, security or even safety) is an important step in media literacy.

Given the aforementioned privacy and security issues in social networking, several radical approaches for social media are being tested. For example, Diaspora is a distributed social network that provides a decentralized alternative to services like Facebook. The project is currently under development by Grippi, Salzberg, Sofaer, and Zhitomirskiy (2010), and works by letting users set up their own server of the social network, or by using a server of a trusted organization. Diaspora servers interact to share status updates and other social data. Being open source software, it can be audited by security experts and checked for backdoors or other privacy leaks. With a decentralized schema, the members of an institution concerned about privacy, security, and trust (e.g., the Department of Defence of the United States of America) can use the Diaspora server set up by their own IT department, and still socialize with the rest of the social network with no risk. Path.com offers another new concept: The personal network. Each path member creates her own personal network limited to her 50 closest friends (Morin, 2011). This limit is based on the "Dunbar's number," a theoretical cognitive limit to the number of people with whom one can maintain stable social relationships (Dunbar, 1992). Although, Dunbar's research suggested 150 as the maximum number of social relationships, the network expands in factors of roughly 3 (i.e., ~5 closest friends, ~20 people with regular contact, ~50 people considered within the personal network, and ~150 stable social relationships). It is still too soon to assess such revolutionary approaches, but all of them suggest that there is much work to do in the Social Web in terms of privacy, security, and trust.

The Semantic Web

When Berners-Lee, designer of the World Wide Web, described the Semantic Web with Hendler and Lassilla (Berners-Lee, Hendler, & Lassila, 2001), the evolution of the Web appeared to be targeted towards a machine-readable World Wide Web (i.e., using metadata to describe meaningfully the content of the Web), and not through the socialization of the technologies involved (i.e., the Social Web). Initially, Berners-Lee underestimated the Web 2.0 phenomenon (Lanningham, 2006), considering that most of the alleged new features were already present in his original World Wide Web design (i.e., the "Read/Write Web"). He dreamed about a new Web where machines would be able to understand and work with the data transferred on interactions between people or other machines (i.e., textual or multimedia content, web links, user interactions), and prevent people from tedious and repetitive procedures that could be accomplished through machines talking to other machines (Berners-Lee & Fischetti, 1999). If so much data is already published on the Web, why do we still need to compare or aggregate it manually? For instance, a Semantic Web approach of "buying the cheapest flight from one place to another" would provide the automatic mechanisms to gather all the information from diverse sources, understand and integrate it into a semantic reasoner, and get the best offer among all processed ones.

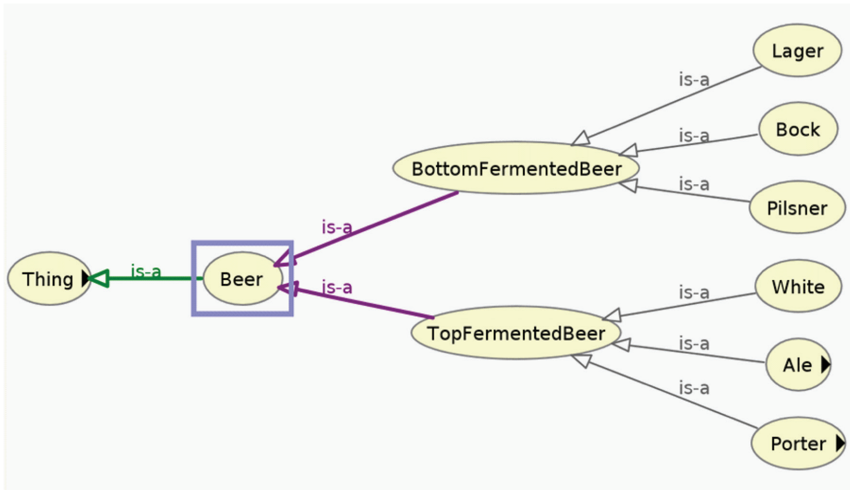
Although the Semantic Web is a much bigger step compared with the Social Web, its current development status is promising but limited. The main reason is technological. Adapting a Web designed for humans (i.e., full of ambiguous and incomplete information, multimedia content without textual transcription, or broken links) to a machine-readable one is not a trivial task. The Social Web is the Web of people. Social media users generate, consume and share content. The Semantic Web is the Web of data. Semantic data provide enough meta-data to allow for automatic processing. Old hyper-text formats are too limited for this purpose, so new formats are needed. Semantic web formats should be able to describe data, define data properties, relationships among data, data classes or models, and logic rules to process data without human help. The World Wide Web Consortium (W3C) launched the Semantic Web Activity, where a big number of Working Groups are developing and adapting the Semantic Web standards (e.g., RDF Working Group to define Resource Description Framework, RDF format, SPARQL Working Group to define SPARQL Protocol and RDF Query Language, SPARQL format, and so forth).

Designing the standard formats to build the Semantic Web is very important, but more actions have to be taken towards achieving a machine-readable World Wide Web. The next step should be to start describing Web data using semantic formats, creating ontologies that explain and describe relationships between concepts (Chandrasekaran, Josephson, & Benjamins, 1999). Under the field of the Semantic Web, an ontology is a formal representation of knowledge about a specific domain. Within an ontology, concept properties and relationships between them are explicitly described using a restricted vocabulary that allows automatic reasoning about them. Thus, defining and using ontologies are key factors for the Semantic Web's success, but it is not an easy task and experts are needed to supervise and correct the ontology defining process. Besides, in most of the cases experts cannot formally describe their domain of expertise and the formalization process may lead to a loss of accuracy.

Ontologies are valuable tools used to process large amounts of data. They are often confused with taxonomies—hierarchical, experts-made—or even folksonomies (Vander Wal, 2004)—non-hierarchical, amateurs-made. Both taxonomies and ontologies need experts to be precisely defined, but while taxonomies are focused on classifying, ontologies provide enough semantic metadata to enable automatic reasoning about the data. Perhaps, recurring to a widely-used example is the easiest way to understand ontologies better. There are different versions of the beer ontology, but regardless the semantic format used to describe it, all of them are very similar. Figure 3 shows a beer ontology (http://www.purl.org/net/ontology/beer.owl) that describes almost everything related to beer: Types of beer, ingredients, regions where beer is produced, awards and associations related to beer brewery, beer festivals, and so on. Expert knowledge about beer brewery is needed to create the beer ontology, because it has to be able to accurately describe every concept related to beer. Combining the beer ontology with a semantic reasoner and other Web services, a Semantic Web service would be able to fulfil complex queries like "show me the closest bars serving a pale ale beer with caramel, ordered by distance and beer price."

Considering that data is the raw material of scientific research, the Semantic Web (i.e., the Web of data) is tightly related to e-research. Indeed, Engelbrecht and Dror (2009) suggest that cognitive psychology can contribute to the development of ontologies for semantic technologies and the Semantic Web in two different ways: (a) The efficiency with which activities that involve domain experts (e.g. knowledge elicitation and ontology authoring) are carried out and the utility of the resulting ontologies can be improved by considering human information processing and its limitations, and (b) the human cognitive system, in general, and human knowledge representation,

Figure 3. Partial view of a beer ontology (http://www.purl.org/net/ontology/ beer.owl)



in particular, can act as a model for the structure of ontologies.

While it is essential to take into account the cognitive abilities of experts to create ontologies, it is also important to consider the opportunities that the Semantic Web could provide. Bairoch (2009) pictured the current situation: "It is quite depressive to think that we are spending millions in grants for people to perform experiments, produce new knowledge, hide this knowledge in an often badly written text and then spend some more millions trying to second guess what the authors really did and found." If all scientific knowledge published in thousands of peer-reviewed journals were stored using semantic formats, automatic reasoning could be used to infer vast amounts of new implicit knowledge, refuting established models, completing preliminary studies, or foreseeing new fields of research. W3C's Scientific Publishing Task Force was created with this goal. Actually, Aleman-Meza et al. (2006) went further in reanalyzing published data when they proposed a Semantic Web application that detects Conflict of Interest (COI) relationships among potential reviewers and authors of scientific papers.

W3C decided to encourage the use of Semantic Web technologies for Health Care and Life Sciences (with focus on biological science and translational medicine), for many reasons: (a) these domains have to process huge amounts of complex (and not simplifiable) data, (b) there is a high level of interaction in managed data (e.g., interactions between molecules through well-known processes generate new molecules with different effects), (c) data sources are very heterogeneous and diverse, (d) the benefits are crucial for humanity. However, there are still some bad practices related to "in silico" (i.e., computer-based) experiments. Good and Wilkinson (2006) criticized researchers that prefer to develop their own and lesser-quality technological solutions in order to increase the number of publications and citations, which is precisely the opposite of the main goal of the Semantic Web. Having more and better applications using Life Science Identifier systems (LSID), Resource Description Framework (RDF), Web Ontology Language (OWL), and Semantic Web Services should discourage the use of non-standard technologies.

What would be the psychological equivalent of large genomic databases? There is no direct equivalent, but as explained before, the Social Web generates millions of single interactions among social media users that could be semantically analyzed to extract opinions, emotions and feelings and to infer new knowledge from them. Opinion Mining (computer science) or Sentiment Analysis (computational linguistics) are two promising fields of research specialized on content analysis (Pang & Lee, 2008). Some Web-focused companies are currently developing semantic parsers for social media content (e.g., Semiocast provides semantic APIs for Facebook and Twitter content), and many researchers are applying data mining techniques to information shared in social media. In two similar studies, Mislove and colleagues (Mislove, et al., 2010; Mislove, et al., 2010) created cartograms (i.e., maps where geometry or space is distorted in order to convey the information of a variable) based on the evolution of political topics on Twitter through time. Sakaki, Okazaki, and Matsuo (2010) proposed an algorithm to detect earthquakes in real time by social sensors (i.e., social media activity). In a similar way, Asur and Huberman (2010) found significant correlations between box-office revenues of movies and social media activity prior to their public release. Finally, many other authors (Specia & Motta, 2007; Van Damme, Hepp, & Siorpaes, 2007) have worked on the integration of the Social Web and the Semantic Web, trying to take advantage of the best features of both approaches.

Despite being so promising, the Semantic Web will not be widely available within the next few years, due to the technological and human resources involved. However, "Linked Data" (Berners-Lee, 2006) is an attempt to progress towards a more realistic application of Semantic Web, where a cut-down data model empowered by the rich expressivity of new semantic standards (especially a combination of RDF and OWL, termed as RDFS++) is used to define vocabularies and instance data which are interlinked. Thus, a global knowledge graph (see Figure 4) is being enabled under the auspices of Linking Open Data initiative (Bizer, Heath & Berners-Lee, 2009), linking and bringing together concepts and relationships about different knowledge domains. An interdisciplinary and global science could arise from Open Data (Uhlir & Schroeder, 2007).

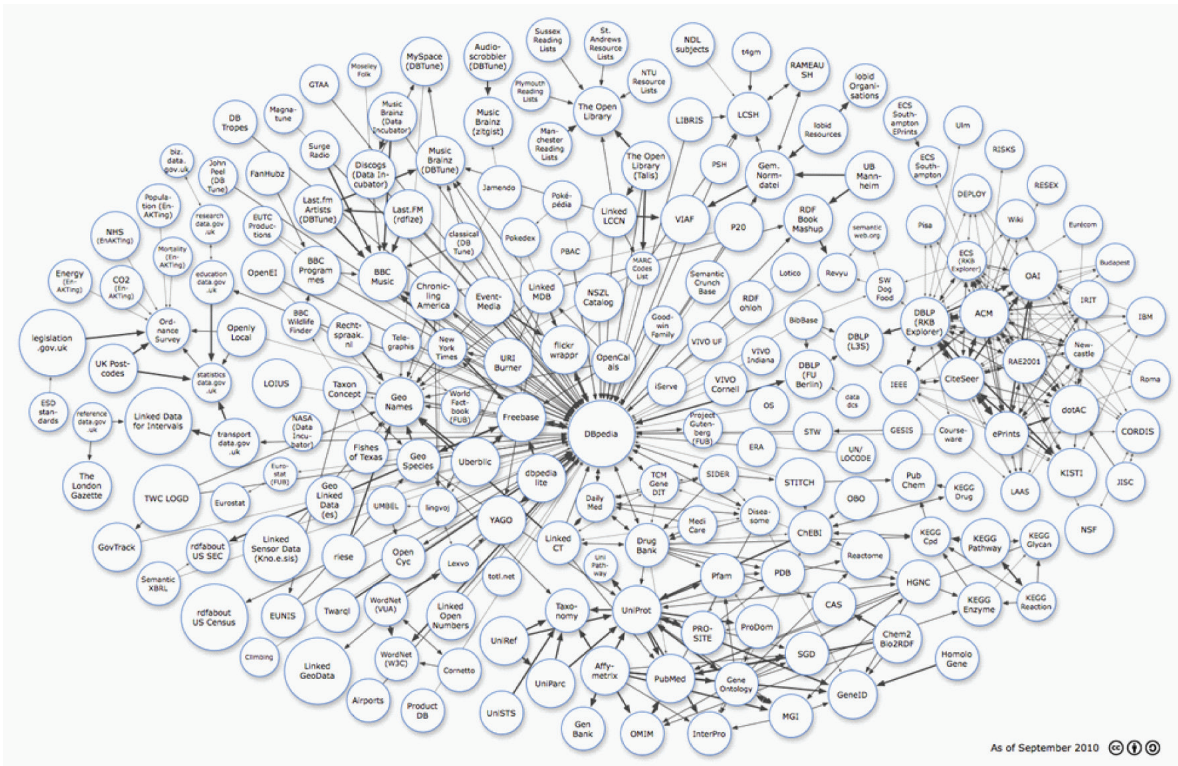
In the meantime, less ambitious approaches, like microformats or "lowercase semantic web"—also known as "decaffeinated Semantic-Web" or "lower-s semantic web"—(Khare, 2006), can provide semantic features to the Web through simple semantic annotations (e.g., a non-semantic Web service can offer semantic features using microformats to express the language of each Web page with a simple "lang" property: <html lang="es">). These annotations are often invisible to users but enable valuable third-party web applications and e-research initiatives. For example, each message or "tweet" transferred via Twitter contains not only the 140 characters sent by the user to the social network, but also tens of metadata fields regarding dates, location, user preferences, scope of the message and so forth (indeed, the text of the message only represents the 5-10% of the whole tweet, depending on the personal settings of the sender). Reips and Garaizar (2011) used geo-location related metadata of millions of Twitter messages to create iScience Maps (http://maps.iscience.deusto.es), a service that allows researchers to assess via Twitter the effect of specific events in different places as they are happening and to make comparisons between cities, regions, or countries and their evolution in the course of an event.

Web-based research should be aware of this kind of solutions and apply them, when available.

New Paradigm Addressed by Future Internet

The current Internet, with billions of users worldwide is a great success in terms of connecting people and communities, but it was designed in the 1970s for purposes quite different from today's heterogeneous needs and expectations. The current Internet has grown beyond its original expectations and beyond its original design

Figure 4. Linking open data cloud diagram (© 2011, Richard Cyganiak and Anja Jentzsch: http://lod-cloud.net/. Used with permission)

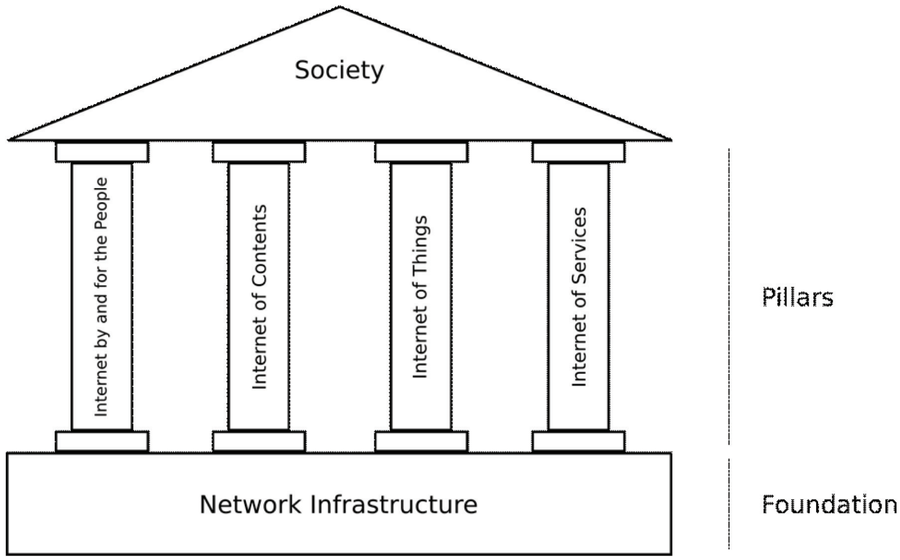


objectives. Many partial solutions have been progressively developed and deployed to allow the Internet to cope with the increasing demands in terms of user connectivity and capacity. There is a growing consensus among the scientific and technical community that the methodology of continuously "patching" the Internet technology will not be able to sustain its continuous growth, and to cope with it at an acceptable cost and speed. The current Internet architecture is progressively reaching a saturation point in meeting increasing user's expectations and behaviors, as well as progressively showing inability to efficiently respond to new technological challenges (i.e., in terms of security, scalability, mobility, availability, and manageability, but also of socio-economical challenges).

Future Internet is a new term which summarizes the efforts made by international associations (e.g., GENI, AKARI, Future Internet) to progress towards a better Internet, either through (a) small, incremental evolutionary steps, or (b) complete redesigns (clean slate) and architecture principles. It should offer all users a secure, efficient, trusted, and reliable environment, that allows open, dynamic, and decentralized access to the network and adapt its performance to the users' needs and context.

Figure 5 illustrates how the 4 pillars of Future Internet rely on the Future Internet networking infrastructure foundation: (a) Internet by and for people, (b) Internet of contents and knowledge, (c) Internet of services, and (d) Internet of things (Gershenfeld, Krikorian, & Cohen, 2004; Papadimitriou, 2009). All the elements of the Future Internet (foundation and pillars) need each other and are mutually dependent. New services and applications are a prerequisite for investments in

Figure 5. Future Internet foundation and pillars (adapted from Gershenfeld, Krikorian, & Cohen, 2004)



new infrastructure, since Infrastructure without necessary capabilities cannot support new services and applications (i.e., technology pull). New infrastructure technologies open new opportunities for new services and applications (i.e., technology push). Therefore, cooperation between all stakeholders is required for a successful Future Internet.

Considering how all of these new approaches redefine the relationship between users and technology, their implications for e-research in Social Sciences are clear: Not only because of the methodological changes that will come, but also because of the wide range of new scenarios and their psychological and social implications.

THE WEB AS A PLATFORM

The most recent advances in the architecture of the Web allow using it as an excellent platform to deploy social science experiments over the Internet. In this section we will discuss the specific implications for e-research in social sciences of those improvements, both on the server and the client-side.

Server-Side Technology: WOA, REST, Cloud Computing

The Web as a platform defines its services using Web Oriented Architecture (WOA), a design and modelling methodology that extends Service Oriented Architecture (SOA) to web applications. WOA represents information as resources that will be handled by user-agents (browsers) and Web servers through a simple Representational State Transfer (REST) mechanism. In other words, simple interfaces using XML and Hyper-Text Transfer Protocol (HTTP). Regarding the infrastructure, Cloud Computing provides a platform to develop and deploy Web applications offered as services that can be consumed without knowledge about its use and the implementation of its resources.

This set of technologies and design methodologies fosters the vision of the Web as a platform to develop and deploy all kind of applications, including social science e-research ones, empowering them with distributed, scalable (i.e., capable of not degrading the service upon increasing demand), and underlying technology agnostic services.

Although Web 2.0 has more commonly been known as the Social Web, some researchers have also highlighted another important facet of it: It transforms the Web into an application platform. This is explained by the fact that there are numerous services or functions published on the web as proven by the site programmableweb.com, where thousands of services, mainly offering easy to consume Representational State Transfer (REST) interfaces—a well-know approach to export functionality through the HTTP protocol—and smart combinations and aggregations of them in the form of Web mash-ups are published. Learning this publicly available (most often free) web-accessible functionality is very easy at first, developers only need to understand the methods, parameters and results returned by its Application Programming Interfaces (APIs). Therefore, they have given place to remarkable innovation in mash-up creation from the active Web developer community.

Furthermore, the emergence of a new computing paradigm, namely Cloud Computing, where data and services lie in highly scalable data centers which can be ubiquitously accessed from any Internet-connected device, is addressing two key aspects for reliably pushing (migrating) application functionality to the Internet: scalability and ease of deployment. Cloud Computing can be defined as a pool of abstracted, highly scalable, and managed (supervised and controlled) compute infrastructure capable of hosting (running) end-customer applications and billed by consumption. Interestingly, Cloud Computing makes available a service hosting infrastructure for Web application server-side deployment through easily consumed REST interfaces. Remarkably, Cloud Computing is designed to make more computing and storage resources available in a dynamic manner as the demand for the consumption of a given Web application grows in time. Big companies such as Google, Microsoft, and Amazon offer compelling Cloud Computing solutions on top of which e-research applications could be easily and scalably hosted.

Client-Side Technology: From Browsers to Web Application Players

Thanks to the last decade's technological and social developments, the Web is progressively becoming something that cannot only be browsed, but also used for specific purposes. At present, it is becoming less and less frequent to use a Website just to have a look at news or to "jump" from one site to another, with no particular purpose in mind. Instead, many traditional desktop applications are being replaced by equivalent programs offered as Web services (e.g., Gmail instead of the traditional email client, Youtube instead of the multimedia player, Google Docs instead of the classical word processors) that can be accessed by Web user-agents (i.e., web-browsers), now more similar to "application players" than to simple Internet browsers.

As we have already discussed, part of this evolution from static websites to current Web applications can be seen as the result of the natural development of the technologies that support the Web (i.e., Cloud Computing, WOA). However, the evolution of web user-agents has played an important role too, providing an execution environment increasingly similar to that of the traditional desktop applications. Many of these improvements have been made possible by the Hypertext Application Technology Working Group (WHATWG), an initiative of the developers of the main web user-agents (i.e., Apple, Mozilla, and Opera) aimed at extending and updating the hypertext definition language used to design Web sites (i.e., HTML) so that it can support the main functionalities of most applications, such as local storage, exchanging messages between documents, drag-and-drop features, browsing history management, or 2D immediate sketching, among others. The efforts made by the WHATWG, with the support of the W3C, gave rise to the specification of HTML5, which includes many of these improvements (Hickson, 2011).

Let's analyze in detail the most important implications of HTML5 for e-research in social sciences. First, the "canvas" object for 2D sketching, the drag-and-drop events or the timed multimedia playing allows social science researchers to design experiments that, until this very moment, could only be conducted with desktop applications. Given that the Web is increasingly being accessed from mobile devices, one can achieve several goals by being able to drag-and-drop elements directly with the fingers or by synchronizing the interaction with multimedia elements: (a) the development of more attractive experiments, (b) the possibility of interacting with the experiment almost anywhere and in any circumstances, thanks to the use of Web standards, and, most importantly, (c) the study of psychological processes that can hardly be explored with the limited interactivity of traditional PCs. HTML5 also offers interesting possibilities for Internet-based surveys, as it provides a new API for web forms that allows to edit documents, send data from one form to another, or even manage browsing history. Both types of studies, either interactive or form-based, can benefit from the local-storage functions offered by HTML5, so that experiments do not depend on the users' connectivity, which can facilitate longitudinal studies and also naturalistic experiments conducted outside the laboratory. An additional contribution of these standards to the new Semantic Web is their support for microdata management, brief semantic labels that can help to make inferences about the type of experiment being conducted, its published results or the relationship between that experiment and similar ones conducted by the same research team or related people.

In spite of these new possibilities, both WHATWG and W3C continue working on new specifications that allow Web user-agents to better compete with desktop applications. For instance, Web workers have been designed to accomplish background tasks (e.g., complex calculations). Similarly, Web storage, Web sockets, and server-sent events can be used for a better integration of Web applications. The Geolocation API allows to place on a given map any web interaction in an automatic manner. Finally, other data formats can be imported to HTML by means of SVG (vectorial graphs) or MathML (mathematical equations). The implications of all these tools for e-research are promising, not only because of the specific contributions made by each of them, but also because of the more general transition from an hypertext- and form-based Web to a different Web in which almost everything in a desktop is possible and the Web user-agents provide all the necessary functions to simplify this task.

CONCLUSION

Throughout this chapter, the different approaches of the Web as a platform for the development of social science experiments have been fully considered, from simple standalone web experiments to Cloud Computing based services accessed by Web application players. Researchers cannot only run their traditional experiments on the Internet to get larger and more representative data, as has become usual during the last decade, but they can also benefit from the new Web technologies and the increasingly social character of the Web.

The Social Web can be used as a research platform to collect data that can be used to contrast psychological or sociological theories on how people interact, reason and feel in different settings. Likewise, the recent developments in Cloud Computing and in the design of Web-user agents will allow conducting more interactive and realistic experiments on the Internet. Moreover, the way people interact and behave on the Internet may not be a mere reproduction of the offline social behaviour. The peculiarities of this medium and the impact it might have on behaviour, as well as the personal factors that influence their use, are becoming important issues in current social science research. Psychological research can also make an important contribution by endowing people with the cognitive skills necessary to grasp knowledge in this vast universe of information, while protecting their privacy.

Although our discussion has focused mainly on our own area of expertise, experimental psychology, other social sciences, such as marketing, sociology, politics, economics, education, or anthropology, should benefit to a similar extent from these new technologies. During the next years, the combined efforts of these disciplines and computer scientists will surely provide new and intriguing insights on human behaviour.

ACKNOWLEDGMENT

Support for this research was provided by Grants IT363-10 and IT458-10 from the Education, Universities, and Research Department of the Basque Government.

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KEY TERMS AND DEFINITIONS

API: Application Programming Interface, a layer or interface between different software programs aimed to facilitate their uncoupled interaction.

Cloud Computing: Provides a platform to develop and deploy web applications offered as services that can be consumed without knowledge about its use and the implementation of its resources.

Future Internet: The efforts made by international associations to progress towards a better Internet that should offer all users a secure, efficient, trusted, and reliable environment to enable open, dynamic, and decentralized access to the network and adapt its performance to the users' needs and context.

HTML5: The Fifth revision of the HTML standard, a language for structuring and presenting content for the World Wide Web.

Linked Data: An attempt to progress towards a more realistic application of Semantic Web, where a cut-down data model empowered by the rich expressivity of new semantic standards (especially a combination of RDF and OWL, termed as RDFS++) is used to define vocabularies and instance data which are interlinked.

SaaS: Software as a Service, a software delivery model in which software and its associated data are provided as services hosted in Cloud Computing based servers.

Semantic Web: A machine-readable World Wide Web using metadata to describe meaningfully the content of the web.

Social Web: A new approach of the Web, also known as Web 2.0, that emphasizes user-generated content and user interactions in web applications.