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7 Online experiments

Researchers undertaking online experiments draw on a rich and long-standing methodological tradition that has been reworked and reformat- ted for a new environment. As with other online methods, a key question for the proponents of online experiments is how they compare to onsite experiments. In general, there is considerable evidence that suggests that the two return similar, if not identical, results and that online experiments offer a valuable tool which social science researchers may wish to utilize (Krantz and Dalal 2000).

Gosling *et al.* found that internet samples are relatively diverse with respect to gender, socio-economic status, geographic region and age; that findings were not adversely affected by non-serious or repeat responders; that findings are consistent with those from traditional methods (Gosling, Vazire, Srivastava and John 2004). Similarly, Meyerson and Tryon conducted a study to evaluate the psychometric equivalence of online research, and concluded that data gathered was reliable, valid and reasonably representative, as well as noting that the process of gathering data was cost effective and efficient (Meyerson and Tryon 2003). However, there are comparisons which have shown differences. Dandurand, Shultz and Onishi found that online participants were less accurate in their performance of tasks than lab-based participants (Dandurand, Shultz and Onishi 2008). Buchanan reviewed the literature on equivalence, and concluded that where there were (usually small) differences between the results of online and offline personality tests it was unclear as to why (Buchanan 2007). Alongside a call for further research, he speculates that the presentation of the instrument, the perception of online anonymity and computer anxiety may all play a role.

So although it is possible to see online experiments as equally as valid and reliable as lab-based experiments, this does not mean that they are identical. Online experiments require the development of an experimental approach that recognizes some of the particular challenges and

opportunities that the environment offers. This chapter focuses on exploring when, where and how to most effectively use online experiments for social research.

Experimental methods in the social sciences

Experimental methods are well-established in areas such as psychology and behavioural economics, but can also be found in a range of different social science disciplines including sociology, political science and anthropology, as well as in inter-disciplinary areas, particularly those that cross over with technical or behavioural areas.

For further information about designing social science experiments, researchers may wish to consult *Laboratory Experiments in the Social Sciences* (Webster and Sell 2007) or *Social Experiments* (Orr 1998). Economists may also be interested in Levitt and List's article on experimental methods in economics (Levitt and List 2009), and psychologists in *Research Methods in Psychology* (Elmes, Kantowitz and Roediger 1999).

case study

Using Amazon Mechanical Turk

Suri and Watts undertook experimental research looking at the nature of co-operative behaviour (Suri and Watts 2011). Participants were recruited using an online labour market called Amazon Mechanical Turk (AMT) in exchange for micro-payments. This approach has been developed across a number of studies using AMT as a practical and effective method of recruitment. The typical interaction on AMT pays workers a small amount (less than \$1) for conducting a short task. AMT recruits workers globally, although Rand notes that the majority are from either the US or India (Rand 2011). Rand also found that for the cost of less than \$1 per person it was possible to collect data from over 1000 subjects in only one or two days. Paolacci, Chandler and Ipeirotis have also undertaken research using AMT, and argue that participants recruited from the site are 'at least as representative of the US population as traditional subject pools' (Paolacci, Chandler and Ipeirotis 2010: 411).

Following recruitment, Suri and Watts moved participants into a waiting room until they had collected a sufficient number to run the

experiment. Their experiment dealt with co-operation, and required participants to interact synchronously. This in turn led to the need to corral them in a waiting room whilst a cohort was built. An initial design was tried which would have created groups of twenty-four; however, it was found that participants abandoned the waiting room before sufficient numbers had been recruited. An alternative approach was then developed in which four participants were recruited at a time for an initial task. Their details were then held to create a standing panel from which larger groups of participants could be recruited, with advance notice about the time of the experiment.

Suri and Watts conducted 113 experiments exploring how participants co-operated whilst taking part in an investment game. Participants were able to see the behaviour of a sub-set of the other participants, and asked to make investment decisions over the course of ten rounds. Participants had the choice to co-operate, not to co-operate, or to split their investments between a co-operative and non-co-operative position. Suri and Watts then used automated stooges to explore whether co-operative behaviour was contagious and to investigate other issues related to co-operation.

Suri and Watts argue that their research highlights the speed, flexibility and cost-effectiveness of web-based experiments over those conducted in physical labs. However, the process of conducting experiments online has the potential to offer researchers a range of opportunities beyond merely being cheap and convenient. For example, Suri and Watts were easily able to manipulate the experiment through the use of automated stooges without raising the suspicion of the participants. This would have been more expensive and complex to organize in a lab-based experiment. In their experiments in AMT, Paolacci, Chandler and Ipeirotis identify a similar benefit in the opportunity to reduce experimenter bias and participant crosstalk, noting that 'Mechanical Turk workers can complete experiments without interacting with experimenters, possibly without even knowing that they are in an experiment' (Paolacci, Chandler and Ipeirotis 2010: 415). Rand also notes that if you can gain access to the IP addresses of participants, it is possible to access information about them, their demographics and the areas from which they are accessing the internet (Rand 2011).

Some of these additional benefits of online experiments raise ethical questions that researchers may want to consider. In particular, issues around the appropriateness of payment for participation, particularly when combined with elements of deception or surveillance, merit consideration and may raise questions in some ethics approval processes. However, many of these issues are not specifically associated with online experiments, although in some cases they are made easier by the move online.

Advantages and disadvantages of experimenting online

As with other online methods, online experiments have a number of advantages over onsite experiments. These are summarized by Reips (Reips 2002a) as:

- Faster speed.
- Lower cost.
- Greater external validity.
- The ability to experiment around the clock.
- High degree of automation of the experiment leading to low maintenance costs and limited experimenter effects.
- Wider samples.

Reips therefore argues that the internet is likely to become the setting of choice for many experiments.

Online experiments also suffer from many of the disadvantages already discussed for other online research methods. They can offer researchers less control over the environment in which the participant encounters the experiment, and the way in which the participant engages with it. So when Dandurand, Shultz and Onishi found that online participants completed their task less accurately than their lab-based participants, they attributed it to the possibility that online participants may have been simultaneously working on other things or have been distracted while completing the task (Dandurand, Shultz and Onishi 2008). There are also challenges around the verification of identity and the skewing of samples towards those who are digitally literate, or at least connected. The section on sampling in chapter 4 is worth looking at in relation to online experiments.

Table 7.1 (derived in part from Reips) examines some of the key disadvantages and challenges experienced in the use of online experiments, and suggests some ways in which these have been addressed.

Table 7.1 Addressing the challenges experienced in online experiments

Disadvantages/ Challenges	Solutions and examples
Possible multiple submissions	Multiple submissions can be avoided or controlled by collecting personal identification items, by checking internal consistency as well as date and time consistency of answers (Schmidt 1997), and by using techniques such as <i>sub-sampling</i> , <i>participant pools</i> or handing out <i>passwords</i> (Reips 1999; Reips 2000; Reips 2000). There is also evidence that multiple submissions are rare in web experiments (Reips 1997).
Researchers have less control over the experimental conditions	It is arguable that participants will be in conditions that are more typical than those encountered in a lab. Keller <i>et al.</i> noted that technical issues relating to the range of connection speeds, browsers and operating systems from which participants access experiments can reduce the reliability of an experiment in ways that are very difficult to track or adjust for (Keller, Gunasekharan, Mayo and Corley 2009: 1). However, some of these issues can be identified and avoided through testing, piloting and utilizing feedback. However it is also important to recognize that for some research questions lab-based experiments remain optimal.
Self-selection of participants and demographically limited samples	As has already been discussed in this book (chapters 1 and 4), the demographics of internet use are continuing to broaden. The sample can be broadened by recruiting participants from a range of sites. Much experimental work has relied on the use of undergraduates (Peterson 2001), so web -based samples can provide a broader sample.
Dropout and participant motivation	When and where people dropout whilst participating in online experiments can be used as a source of data about motivation and engagement. Dropout can be reduced by implementing a number of measures, such as promising immediate feedback, giving financial incentives and personalization (Frick, Bächtiger and Reips 2001).

Disadvantages/ Challenges	Solutions and examples
Reduced interaction with participants may lead to instructions being misunderstood.	This can be addressed to some extent by piloting the materials and by allowing participants the opportunity to feedback.

Many of the advantages and disadvantages associated with online experiments are closely related to those that have already been discussed in relation to other online methods. Furthermore, as Honing and Reips argue, there is considerable continuity in the challenges faced by the online researcher to those experienced by the onsite researcher (Honing and Reips 2008). For example, issues around identity verification or participant engagement are not new issues, even if they are reframed somewhat by the online environment. However, there are a number of features that are more specific to online experiments, which are worth exploring in more depth – in particular, the issues of automation, enhanced precision in observation, and the opportunity to undertake very large-scale experiments.

The ability to automate experimental procedures accounts for much of the reduction in costs by reducing the need to have an individual available to supervise participants and manage the experiments. However, Reips argues that this process of automation also increases the uniformity of the procedure and minimizes the impact of the researcher on participants (Reips 2002a). It is therefore arguable that the fact of automation can enhance the quality of the research as well as its efficiency.

The fact that all online experiments are mediated through a computer also offers an enhanced level of observation – for example, the ability to record reaction times without the participant being aware that they are being recorded (Kelso and Barchard 2005). Keller *et al.* also note the importance of this ability to record reaction time in some studies, and conclude that despite some of the technical difficulties in measuring reaction times, this is ‘a very promising line of research’ (Keller, Gunasekharan, Mayo and Corley 2009).

Perhaps most excitingly, online experiments open up the potential for very large studies. Salganik and Watts begin their article on the social

dynamics of cultural markets with reference to Zelditch's question, 'Can you really study an army in the laboratory?' (Salganik and Watts 2009; Zelditch 1969). They note that entirely new kinds of experiments are now possible given the 'vast increase in computing power' and 'the almost limitless pool of participants now available via the internet'. It is now possible, they argue to move beyond the study of small groups towards the study of large groups, 'involving thousands, or even millions, of participants' (Salganik and Watts 2009: 440).

Deciding when an online experiment is appropriate

While there are good reasons to be positive about the value of online experiments, the online environment is clearly not appropriate for all research questions. Chapter 4 discussed this issue in relation to online surveys, and many of the limitations are similar in the case of online experiments. Researchers will want to consider whether the use of the internet is appropriate as they develop an approach to a research theme or question. Online experiments may not offer the most appropriate approach where identity verification, access to populations with low digital literacy or digital access, physical interaction with people or materials or a high level of control over the environment are important. However, as has already been argued, this is not to say that all of those issues are solved by conducting the research in a face-to-face environment.

An important area to consider during the development of methodologies is whether online and onsite experiments can be combined. Wiersma notes that there are a number of places where the distinction between online and onsite experiments becomes blurred, such as lab experiments preceded by an online survey, lab experiments validated over a number of sites, or the use of email as a stimulus for field experiments (Wiersma n.d). An example of an online/onsite combination is found in Burger, Charness and Lynham, who conducted related online and field experiments to explore students' self-control in relation to study behaviour (Burger, Charness and Lynham 2011). The field component enabled the researchers to examine students' actual behaviour, while the online element allowed a greater amount of control over the experience of the participants, a larger sample size and more rapid execution of the experiment. Taken together, the two experiments provided Burger, Charness and Lynham with more data which could inform their analysis.

Types of online experiment

As with other kinds of online research, there is a range of different types of online experiment. In a similar way to online interviews and focus groups, it might be possible to plot a matrix with synchronous and asynchronous on one axis and text-based and multi-media on the other (see chapter 5). Wiersma creates a similar typology, which examines the relationship between the technological and methodological approach that is taken in online experiments (see Table 7.2).

Table 7.2 Wiersma’s typology of online experiments

	Lab	Field
Web-based	web	web-field
Virtual reality	virtual lab	virtual world

On one axis Wiersma counterposes web-based experiments with experiments that use virtual reality approaches. Web-based experiments use websites as their medium and draw on the tradition of lab-based experiments, often using similar elements (images, checkboxes and data fields). Virtual reality experiments provide an immersive environment where participants’ behaviour is directly measured. Wiersma uses the examples of Second Life and World of Warcraft to describe his vision of virtual reality; however, it might be possible to broaden this definition out to include other kinds of interactive environment such as Suri and Watts’ market simulations (Suri and Watts 2011).

Research which has looked at how people conduct themselves within virtual environments has often noted its utility for social research. For example, Kozlov and Johansen argue that virtual reality spaces offer experimenters an ideal space because they seem to offer a way to exercise a high level of experimental control, whilst offering a situation that is less contrived (Kozlov and Johansen 2010). They note that their participants exhibited similar behaviours in virtual reality environments to those that have been observed in lab- and field-based studies. However, they also note that the stronger the social presence of other participants in the virtual reality environment (the more they are perceived to be real human beings), the more participants treat them like human beings. The virtual reprise of the Milgram obedience experiments by Slater *et al.* also reported participants exhibiting similar behaviours in virtual environments to onsite

environments (Slater, Antley, Davison, Swapp, Guger, Barker, Pistrang and Sanchez-Vives 2006).

Wiersma's other axis focuses on the methodological approach within which the experiment is situated. Is the experiment seeking to intervene in the actual online behaviour of individuals (the field), perhaps by bringing about a behaviour change in their use of a particular online tool or environment, or is it about bringing participants into a private or closed space (equivalent to a lab) in a way that does not interact with their daily lives and online activities?

Considering both the technical and methodological elements of an online experiment is key to designing the experiment. The nature of online research, and the methodological approaches that are used in it, are forged out of the conversations and compromises that are made between the technical possibilities and methodological approaches. This will be discussed further in the next section looking at designing online experiments.

Designing experiments

As has already been suggested, online experiments are not a methodology in themselves, but rather a particular mode through which experimental research can be conducted. Researchers are therefore advised to begin from their research questions or themes, and to develop a methodological approach in response to this. In some cases, this methodological consideration will lead towards an online approach, whilst in others it will lead to conventional lab or field approaches or to some kind of blend or hybrid.

For a general introduction to designing experiments in the social sciences, see Field and Hole or Webster and Sell (Field and Hole 2003; Webster and Sell 2007). More specific advice is also available for psychologists (Harris 2008), behavioural scientists (Open University 2006) and economists (Friedman and Sunder 1994; Hagel and Roth 1997). There are also a number of texts which provide specific advice in the design of online experiments such as Birnbaum, Reips and Gosling and Johnson (Birnbaum 2000; Reips 2007; Gosling and Johnson 2010). Some of these texts will be discussed in more detail in this section.

Once it has been determined that an online approach is appropriate, there are a number of key issues that researchers will need to work through.

These include:

- Experimental context.
- Considering what tools to use.
- Managing recruitment and avoiding dropout.

Experimental context

The context within which the experiment is conducted is a key decision that researchers need to make. The online space that is chosen enables or constrains both the functionality that the research is able to use (which will be covered in the next section on tools) and the social and cultural context within which the experiment is encountered. There is clearly a difference between completing an experiment within a university website, Facebook, the website of a supermarket or the website of a terrorist group. Each of these contexts is likely to impact on whether participants decide to participate, as well as the nature of their participation.

One useful way to conceptualize this would be to make the distinction between the online lab and the online field as potential sites for the experiment. So the study by Cosley *et al.* provided Wikipedia users with a stimulus (SuggestBot), and examined how user behaviour changed in response to exposure to SuggestBot (Cosley, Frankowski, Terveen and Riedl 2007). This kind of study might be described as a field experiment in comparison to Greiner, Jacobsen and Schmidt's 'virtual laboratory infrastructure for online economic experiments', which created a controlled environment for conducting economics experiments (Greiner, Jacobsen and Schmidt 2002).

Where experiments are conducted in the field, researchers need to attend to all of the ethical issues that they would in conventional field research. For example, if an experiment is conducted within Facebook, it may be being conducted in full view of participants' friends, colleagues and family, and an awareness of this public and open context needs to be built into the experiment design.

Contextual and environmental elements also have a role to play in online experiments within the lab paradigm. Kozlov and Johansen's decision to use a popular 'shoot 'em up' game as the site for their virtual lab may have created some contextual confusion for those participants already familiar with the environment in its usual form (Kozlov and Johansen 2010). As with physical environments, online environments are

replete with factors and signifiers that may shape or influence participants' behaviours. Researchers therefore need to attend to these environmental factors during experimental design.

Considering what tools to use

The tools which are used to undertake online experiments are closely related to the issue of context. In many cases, the site that is chosen as the context will also form the experimental tools. So, for example, an experiment may offer a participant a virtual maze to explore (context), but the researcher will choose a site that enables the accurate recording of participants' behaviour, thus transforming the context into a research tool. In many cases the ability to manipulate the context to suit the needs of the online experiment will be a key tool required by the researcher. Konstan and Chen argue that the level of control offered by the website is crucial in deciding where to conduct the experiment, and that the best approach is to own the site (Konstan and Chen 2007).

This desire for a highly tailored and controllable experimental environment led Dandurand, Shultz and Onishi to craft their experiment using Java and Perl scripts (Dandurand, Shultz and Onishi 2008). Similarly, Kelso and Barchard discuss how 'easy' it is to hand-code web pages or use a What You See is What you Get (WYSIWYG) web-editor (Kelso and Barchard 2005). More recently, the growth of easy to use, web-based and often free tools has offered researchers a far wider range of opportunities to ensure that they have a high degree of control over the experiment. So while there are still going to be circumstances when researchers will want to build their own environment from scratch, as technology has moved on, the need to use scripting or mark-up languages has thankfully diminished.

Increasingly, it is possible to find highly configurable environments without needing to buy or purpose-build a site. Being a careful consumer of others' products is probably a more useful skill for the online experimenter than being a programmer. When creating online experiments, researchers are typically looking for a tool that offers some or all of the following functionality:

- Adaptable: the site needs to offer researchers sufficient flexibility and control to ensure that they can shape it to the experiments needs.

- Visible: researchers need to be able to see what goes on in their online environment.
- Enclosable: some experiments may require that researchers can control who has access to the environment and when people have access to it.
- Recordable: most research requires that what takes place in the online environment can be recorded in some way.
- Analysable: the online experiment needs to produce data in a format that it is possible for the researcher to analyse.

There are a number of purpose-built tools that researchers can use for online experiments. Reips offers a useful list on his 'tools for internet-based data collection' web page (Reips n.d). An alternative list is held by the Online Psychology Research website (Online Psychology Research UK 2011). It is difficult to recommend a particular tool, both because technology is dynamic and the tools continue to be born, develop and die in extremely rapid cycles, but also because every researcher and every experiment is different. The construction of methods needs to be done with an awareness of technological possibility, but not be driven by it.

Increasingly, researchers are finding that it is possible to adapt online tools that are designed for non-research purposes. So Koslov and Johansen's use of the game Half-Life 2 to provide a virtual reality environment for a replication of the Good Samaritan study by Darley and Batson provides one such example (Koslov and Johansen 2010; Darley and Batson, 1973). The case-study also showed how economists had used AMT for their research, and Schnoebelen and Kuperman also found it to be useful for linguistic research (Schnoebelen and Kuperman 2009). The growth of free tools is one of the phenomena of the contemporary web, and online researchers are likely to continue to find ways to use and re-purpose these for research. Tools like Google docs, various wikis and the range of tools available through the Digital Research Tools Wiki (DiRT) all merit a mention.

Managing recruitment and avoiding dropout

A key challenge in experimental design is creating an experiment that you will actually be able to get people to undertake and complete. The challenge of recruitment has already been discussed in chapters 4 and 5,

and much of the learning can be transferred over to the area of online experiments. In particular, Madge *et al*'s checklist for online surveys can be easily re-purposed for online experiments (Madge, O'Connor, Wellens, Hooley and Shaw 2006).

Recruiting participants is challenging in all experimental studies. In some ways the online experiment is more challenging than its onsite equivalent, as engagement can be more difficult and the identification of a finite population from which to recruit is extremely challenging. On the other hand, the vast size of the online pool of participants offers some clear advantages. It is possible to advertise an online study from a wide range of places, such as Facebook, email lists, blogs, websites, discussion boards and so on. Reips argues that the quality of the participant pool can be enhanced by recruiting from multiple sites (Reips 2007).

There is also a range of web portals that exists specifically to recruit participants for online experiments. Some of these are listed below.

Table 7.3 Online portals for recruitment of participants

Krantz	Psychological research on the net	http://psych.hanover.edu/research/exponnet.html	A list of current online psychology experiments
Reips	Web Experiment List	http://www.wexlist.net	Intended to be the world's most comprehensive list of online experiments (both past and present)
Social Psychology Network	Online Social Psychology Studies	http://www.socialpsychology.org/expts.htm	A list of online social psychology studies (including many online experiments)
Gardiner	Online Psychological Research	http://www.onlinepsychresearch.co.uk/	A list of online psychology experiments
Weijers and Richmond	The Inquisitive Mind	http://beta.in-mind.org/online-research	A list of online studies

Most of the online recruitment portals are focused in the area of psychology. It is also unclear how effective they are in recruiting participants, and what kind of participants they tend to recruit. However, they

provide a useful resource for researchers who are interested in examining other researchers' approaches, and who wish to experience an experiment from the perspective of a participant.

An alternative approach is to use some kind of payment or incentive to engage participants in an experiment. The case-study by Suri and Watts discussed the use of an online labour market and micro-payments as one way to recruit participants (Suri and Watts 2011). Alternatives include the use of participant pools and (paid or unpaid) online panels (Goritz 2007). While payment organized through an online labour market or a panel can incentivize participation and prevent drop-out, the evidence is more contested around the offer of lottery/prize draw type incentives. So while Frick, Bachtiger and Reips found that incentives did mitigate against drop-out, Goritz found no significant difference in relation to either recruitment or drop-out (Frick, Bachtiger and Reips 2001; Goritz 2006).

Closely allied to the issue of recruitment is that of dropout. An instructive example is found in Dandurand, Shultz and Onishi, who kept their online experiment open to all for 7.5 months (Dandurand, Shultz and Onishi 2008: 431). During that time the experiment received a total of 600 visitors. 62.7% of the 600 did not even start the experiment. An additional 16.3% were unable to complete the experiment due to technical reasons. Only 21% of those who looked at the online experiment started it and only 4.5% completed it. While it is difficult to generalize about dropout rates, it is clear that in most cases researchers can anticipate that a large number of those who start the experiment will not complete it.

Various approaches have been proposed to minimize or manage dropout. Reips recommends using warm-up tasks that are not part of the experiment in order to get dropout to happen before the experiment begins (Reips 2000). Other researchers have explored how the structure of an experiment can facilitate or limit dropout. O'Neil, Penrod and Bornstein found that placing requests for personal information at the start of the experiment heightened dropout, as did the use of over complex or poorly designed materials within the experiment (O'Neil, Penrod and Bornstein 2003). An alternative and ethically preferable approach is to think about the participants in a more positive way and to try to design, as Salganik and Watts claim they have done, 'experiments that are intrinsically rewarding for participants' (Salganik and Watts 2009: 461). Attending to the experience of the participant is an essential part of both experimental design and management. Kraut *et al.* note that 'researchers get less direct

feedback from subjects than they do in other settings', and argue that this fact necessitates a greater attention to pre-testing and piloting of all elements of online experiments (Kraut, Olson, Banaji, Bruckman, Cohen and Couper 2004).

In summary

As with other online research methods, online experiments offer researchers considerable advantages. The decision to situate an experiment within the online environment is one that must be taken carefully and for sound methodological reasons. However, there is a wide range of advantages in terms of cost, time and improved quality. Perhaps even more exciting is the way in which online experiments open up the possibility for new kinds of studies, in terms of improving the quality of observations, the potential scale of experiments, and of course the ability to explore a range of topics directly related to the online environment.

As with all experiments, online experiments need to be designed carefully and to attend particularly to the nature of the online space within which the experiment is taking place. The idea of the online lab and the online field has been suggested as one way in which the nature of these online spaces can be conceptualized. How this is implemented through the use of a variety of purpose-built and adapted tools is also a critical question for the researcher to consider. Finally, this chapter has suggested that the online researcher should be highly aware of the experience of the participant. There are obviously key ethical reasons why this is important, but the reality of dropout in online experiments means that ensuring a positive experience is also essential for intensely practical reasons.

Further reading

There are a number of useful texts that can provide an introduction to the area of online experiments, in particular *Psychological Experiments on the Internet* (Birnbau 2000). More recent additions to the field include *Oxford Handbook of Internet Psychology* (Joinson, McKenna, Postmes and Reips 2007), and *Advanced Methods for Conducting Online Behavioral Research* (Gosling and Johnson 2010).

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