chapter 10

practical: I'm trying to concentrate!

Have you ever had someone talking to you when you've been attempting to do something that required you to concentrate? In this practical we look at how you might go about investigating what constitutes 'distraction' and what kind of tasks you might use when investigating whether distractions can cause problems for different work practices, such as navigating, finding information, or working on a document or presentation. This will let us look at a few issues of design that you need to know about.

Topics covered: Variables, independent samples, standardized instructions, practice effects, independent variable, dependent variable, repeated measures design.

You will need: a sample of people, a maze printed on some paper, a pencil, something to record sound on and play it back with (a computer is ideal) and some headphones.

Background

Governments appear to be waking up to the idea that doing more than one task at once can be a problem for people. For instance, having a conversation on a hand-held telephone while driving is now illegal in many countries. This is because there is a belief that not having both hands on the wheel is dangerous. It could, of course, be that it is the conversation itself that is the problem. Common sense suggests that completing a task, even a relatively simple one, can be made significantly more difficult with the intervention of a friend

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intent on describing the plot of a movie they went to the night before, or, even worse, attempting to reproduce the jokes of a comedian who they obviously found hilarious.

The implications of research like this are rather wide-ranging. Let's think about the telephones in cars problem for a moment. Next time you are a passenger in a car, watch the driver for a few minutes. Do they really keep both hands planted firmly on the wheel? Usually it depends on how long ago it was that they received their driving licence! A few weeks of freedom from an instructor telling them what to do and you'll soon find that one hand strays to the controls of the stereo, or an elbow finds its way onto the sill of an opened window. So what is the issue with people using a hand-held telephone? Well, it might be that having a conversation is distracting them from their ability to concentrate on the road. If that were the case, then perhaps all conversations in cars should be banned? Passengers would be banned from 'speaking to the driver' as they are on many buses around the world. Or it might not just be speaking: it could be that having any kind of distraction is a problem. If that was the case, listening to music or the radio while driving should be banned as well.

How about another example that those of us who work in offices are becoming more aware of? The larger institutions get, the more staff they employ, and these have to be put somewhere. Offices are expensive places to buy or rent, and heat, and so more desks are crammed into smaller and smaller places to accommodate the increasing workforce. Eventually, there is no more room for desks, and managers try and come up with solutions to the problem. One glance around a busy office will usually reveal an empty desk or two, vacated briefly by a colleague at a meeting or symposium out of town perhaps, or someone unfortunate enough to be sick and unable to attend work. 'Aha!' says the manager, 'I spy a solution!' and so 'hot-desking' is born – a (some would say) elegant solution to a busy open-office environment. However, is it? Does a 'different' environment alter the way we work? If it does, and people work better, longer and more efficiently in familiar surroundings, then the concept of the 'hot desk' is not really the good idea people thought it was.

Let's go one step further since we're on the subject of offices. Many of us now work in open offices, separated by low walls into workspaces where we are allowed to bring personal items such as photographs and sometimes plants to make the space our own. Open environments like these are extremely busy and often quite noisy places. Workers there are carrying out their tasks while bombarded with information from screens and their surroundings. It could be that the level of distraction is damaging their concentration and their ability to do their task. There is research showing memory can be significantly influenced by different types of sounds (Beaman and Jones,

1998), and so any task that involves dealing with information may also be affected by a noisy office. If this really is the case, then open office spaces (even though a suitably inexpensive way to accommodate many workers) may not be the best way to achieve high standards of work.

How about anther example? Have you ever had to learn information for a test or an examination? Of course you have! Have you ever had to run through an important presentation for a seminar, conference or meeting? How annoying is it when your careful preparations are interrupted by the family pet, or the television or radio in another room? Many of our students tell us that they revise with a personal stereo on, or, worse, the television! Whereas it may well be true that some lucky people can indeed develop an understanding of information under very distracting conditions, the majority of us, alas, cannot. Or can we? Perhaps you could think about how you might go about finding out?

You see? We're thinking here about relatively big and important questions. What kind of office environment is best, what kind of legislation to pass ensure the safety of your car-driving population, and how best to learn material in order to get the job at interview, or pass your examinations.

Method

Design

The *keep it simple* rule is in play, as usual, so have a think about how you might best begin to answer the question of whether being distracted influences your ability to do a task. We'd like you to develop your own plan for this project, but you should be aiming to test a hypothesis something like:

'Performance on a task will be affected by the level of simultaneous distraction that is experienced.'

It's pretty clear, then, that *level of distraction* will be the thing that you vary. That's the **independent variable** and *performance on the task* will be the **dependent variable** you will measure. The next thing for you to decide is exactly how you will operationalize these dependent and independent variables.

What constitutes 'distraction' depends at least in part on the person being distracted. Our example of studying for a test in front of the TV or while listening to music shows that rather neatly. However, for the purpose of your investigation you need to decide on something you can sensibly identify as a 'distraction'. A word of warning here...

There will be a temptation here to complicate the design of your study to investigate whether one thing is more distracting than another. That's not really the question, though, and, whereas it is an interesting problem to try and solve, there are issues you will have to consider in the design that would be best left until you have addressed the more basic matter of whether distraction matters at all. We recommend you at least think your way through a very simple design first before complicating it with more questions. Keep it simple, remember?

So have a think about things that people might find distracting, and write them down. We've just done the same and have come up with a few options. Our list includes the following: *Conversations, television, noises like car-horns, flashing lights, cats sitting on keyboards, crying children, music in the room next door, the sound of a kitchen appliance rumbling away downstairs, barking dogs, the ringing of an unanswered telephone.*

With the need to keep things simple we can choose two conditions, one with 'no distraction' and one with 'distraction'. The distraction condition will involve listening to one of these noises; the no-distraction condition will involve silence.

The next thing to decide upon is the study's design. The choice of independent measures or repeated measures is central again, and each brings with it its own positive and negative aspects. It's worth talking through the two possibilities here as this practical is rather a good one for showing up the various issues in this particular design choice.

What if I choose an independent-samples design?

If you choose an independent-samples design you'll have two groups of people doing your task. One group will do the task under distracting conditions; the other will do the task in silence. The issue you now have is the people in each group. A suitably ridiculous example will highlight the major problem here. Let's say you choose 'listening to a recorded conversation' as your distracting stimulus, and 'watching out for red cars in a film of a busy road' as your task. As a good researcher you fill up your two groups, in two trips to the park, approaching people to help you with your carefully designed project. Your results, though, gathered over several days of testing, seem a little odd. Some investigation reveals that Monday is the day that the local colour-blindness support group take their weekly stroll in the park, and Tuesday is when the local deaf football team train. You have, inadvertently, filled one group with people who have problems seeing colours, and the other group with people who have difficulty hearing. Your procedure has been confounded by a very significant extraneous variable.

We know the odds of this kind of thing happening are rather slim, but the point is, an independent-samples design is prone to the influence of individual differences. If there are more highly vigilant people in one group than another then your results will be misleading. Similarly, if there are more people with uncorrected visual problems in one group than another then their ability to spot red cars will be influenced by that as well as the variation of distracting stimuli.

If you do choose an independent-samples design, the best way to deal with these individual differences is to have large groups. This is not so much avoiding the effect of individual differences, as minimizing or limiting their effect. With a very large group, each individual should find a similar person in the other group, just by chance. How large do the groups need to be, you ask? As large as possible really. A group of 20 people in each group is good, a group of 100 in each group is better. Either way, you'll need plenty of people for this type of design.

What if I choose a repeated-measures design?

If you decide on a repeated-measures design, each of your participants takes part in the whole project, providing you with data for the 'no distraction' condition as well as the 'distraction' condition. If you were to choose this type of design you would be removing any effects of individual differences because if any participants have weak eyesight, or slightly damaged hearing, this will be just the same in each of your conditions. As such, you don't need to choose quite as many participants to limit the influence of individual differences as in an independent-samples design.

Of course, the price you pay is that you now have to deal with order effects. Since each participant will be doing the task in both conditions they may get systematically better at it the second time they do it. This is a practice effect. Similarly, if you choose a task that takes a while, or that involves quite a lot of concentration, when they do it for the second time they may be tired, and not perform as well. This is a fatigue effect. You can control for order effects by counterbalancing your procedure.

Design checklist

- Think about which is best: a repeated-measures design or an independent-samples design.
- Rough out the pros and cons of each design, and run through a 'thought' version of each procedure to see if that illuminates any problems.
- Either decide on how you will put participants into groups (for an independent-samples design) or identify how you will counterbalance the procedure (for a repeated-measures design).

Participants

We will assume we are using a repeated-measures design for the rest of this practical, so we need to locate some participants. Where you locate your participants will depend on where you are. A conveniently placed poster requesting that participants volunteer to help you, perhaps, for the reward of coffee and cake. In some university departments at which we have worked, students are obliged to help researchers with their studies and receive credit for participating. These students form a 'participant pool' upon which you may be able to draw. You may work for a company or organization which has a budget available for research. Whichever way you get people, it is likely that you will engage in opportunity sampling of some kind, so be aware of sampling bias. It is possible that people who sign up to help with research have a more 'helpful' personality than those who do not. If this is likely to be a factor in your research, or if you think that it may be, then you should consider it when locating your participants.

How many participants do I need for a repeated-measures design?

That's the beauty of a repeated-measures design: you need fewer participants than in an independent-samples design because you do not have to limit the influence of individual differences. Because each participant provides data in each condition they are 'matched' to themselves. They are their own 'control'. Obviously, you need more than one participant, but you don't need too many. In this example we have two conditions, and so there are two ways in which the different conditions can be presented. For this reason you would need to use multiples of two participants (4, 6, 8, 10, 12, etc.), although, as usual, the more the better. The reason for this is that the **power** of the experiment increases quite significantly with sample size: if there really is something going on in your investigation, and if distraction really does have an influence on performance of a task, then you are more likely to see it with more participants, even if the effect is relatively small. For now, however, let's choose 24 participants. That seems like a sensible number.

How will we distract the participants?

You'll have come up with the same kind of things. For argument's sake, let's choose barking dogs as an example of a distraction. This is a handy one for us to choose and we have at hand a decent microphone, a laptop computer, a squeaky toy and (importantly) a handy dog. While one of us winds Baxter up into a frenzy of barking the other can record a suitable amount of 'barking sound' onto the computer for use in our project. Our independent variable is whether

people are distracted or not and we have operationalized the distraction as hearing a recording of a dog barking (distraction condition) or hearing no noise (control condition).

What task shall we use?

There are countless tasks that you might use. One could be completing simple mathematical problems involving adding and subtracting numbers. Another possibility is a simple task where participants read a page of text and are required to identify all incidences of the letter 'e' with a highlighting pen. The task that worked best for us when we were trying out all these practicals was a maze completion task.

Find yourself a simple pen-and-paper maze and print it out onto paper. If you can't find one you can use the one we used when we tried this out, and we've included it in the electronic resources for the book. The task is simple enough to understand: you measure how many mistakes a person makes as they complete the maze. We did it by measuring how many times either of us touched the edges of the maze. Our dependent variable (the thing that depends on our independent variable) is the participant's ability to complete the task, and we have operationalized it as the number of times their pencil touches the edges in a maze completion task.

The next thing you need to do is decide on some standardized instructions. This helps you to avoid any bias that you may inadvertently introduce into the procedure by using different instructions with different participants. Your instructions may look something like this:

Thank you for agreeing to participate in this procedure. In front of you there is a sheet of paper and a pencil. When I say 'go' please turn the paper over. You will see a maze. Using the pencil, please solve the maze doing your best not to touch the sides. You will be required to do the task twice, once while listening to some sounds over headphones and once in silence.[1] On this occasion you will be presented with sounds / working in silence (delete as appropriate).

Make sure that each time you give a participant a maze to complete you write on it the participant number and whether it was completed in silence or with sounds.

Collecting and collating your data

After your participants are finished, take their completed mazes and work out how many mistakes they made by counting up how many

[1] Even though the person is not listening to any sounds, you must still have them wear headphones. This ensures that the only thing you are varying is whether they are listening to distracting sounds. Keeping the headphones on maintains the 'feeling' of wearing headphones.

times they touched the edges while completing the task. Draw yourself a table, and fill it in. You should end up with something that looks like the one we have shown here. We've only given the results of four participants here; you will have 24 in total if you have followed the procedure we have decided upon.

Participant number	Silence	Distraction
1	4	9
2	2	7
3	8	8
4	6	10

Procedure checklist

- Decide on how many participants you will need and locate participants.
- Counterbalance, if you are using a repeated-measures design. Decide on the order in which each participant will complete the procedure (distracting sound first or second).
- Operationalize your variables (decide on a task and how you will distract people).
- Read out standardized instructions to each participant, or give written instruction for them to read.
- Have participants complete the task.
- Collate and tabulate your data.

Results

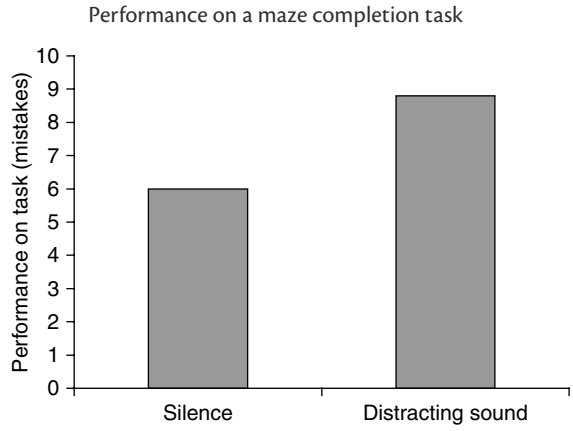
Looking at your data

First of all, calculate some descriptive statistics to help you decide what your data are telling you. You'll need a mean value for the number of mistakes made in each condition, which will tell you whether, overall, distracting sounds affected people's performance. You'll also need a measure of dispersion for the data to show you how people's scores tended to vary. A standard deviation will do nicely. Put your descriptive statistics in a table for your own reference. You'll hopefully end up with something that looks a bit like this:

	Silence	Distraction
Mean	6	8.8
Standard deviation	2.6	2.3

Draw a graph to help yourself and others see as clearly as possible what you have found. A single graph will do. Two conditions,

and one data point for each, lends itself to a barchart of the type shown here:



The graph really helps us see what appears to be going on in our version of the procedure. From the mean performance it would suggest that people make more errors when distracted than when they are allowed to complete the task in silence. Of course, that's not the end of the story at all. We now need to see if the results of your small sample can be said to appropriately reflect the behaviour of the population from which it was drawn, so we'll need to do some analysis.

Statistical thinking

What we want to know at the end of this study is whether the number of mistakes in the 'silence' column of our results sheet is reliably different from (smaller than) the numbers in the 'distracting sound' column – is the difference in our graph large and consistent enough that we can attribute it to the effect of distraction rather than chance? The analysis we would use for this is of a very common type, where we want to compare two mean scores to see if they differ. There are several tests for this, depending on whether you are using a repeated-measures or an independent-samples design, and depending on whether your data meet certain assumptions. In this case, where we used a repeated-measures design, we would test the effect of distraction using a repeated-measures *t*-test or, if the assumptions for this test were not met, with a Wilcoxon[2] test.

After we ran this study we used a repeated-measures *t*-test which provided us with a *t*-statistic, from which we could calculate a *p*-value. In our data, the *p*-value was .006. This tells us there is only a .006 chance – a 0.6% chance – that the effect in our graph just

[2] A Wilcoxon matched-pairs signed-ranks test, to give it its rather grand full name.

arose by chance, and so means nothing. This is a nice small *p*-value, well below the usual criterion level (α) of .05. As such, with this low *p*-value we would reject our null hypothesis: these results almost certainly didn't arise by chance, and this is what we will conclude – they almost certainly arose because distraction affected people.

Discussion

This practical has used an extremely simple design that can be manipulated and added to to suit your needs. It rather nicely illustrates a point in research design that never ceases to surprise those new to the art. That is, even the simplest of designs with very few conditions and manipulations can become very seriously complicated unless you are methodical and careful about your choices.

When you are thinking about reporting your findings and discussing your results you should always have a think about how your procedure might have been improved. Use part of your write-up's discussion to be reflective and self-critical. That is not to say you should spend all your time saying how awful your ideas were and how much better they might have been if someone who was any good at research design had done the work for you[3], but there is a place for some sensible and carefully placed comments on your own work that will have occurred to you while you were carrying out the procedure.

For instance, has it occurred to you that the way in which we decided to measure an 'error' might have been a little misleading? Just because you touch the edge of a path on a maze does not mean that you have made an error on a maze completion task, really, does it? It just means that you are a little clumsy. It could be that more errors were made in the distracting sound condition because the sound simply made people more clumsy for some reason. The other problem we spotted with our error measure is that it does not take into account different strategies people might use. Some might try to complete the maze as quickly as possible, and so touch the edges often, whereas others might be extremely cautious, never touching the edges but also taking 20 minutes to complete each maze! If we repeated the procedure we would probably include a measure of how long people took, or at least give them a time limit, and this insight is something we would mention in our write-up.

[3] Yes, odd as it may sound, we have both read discussion sections that spend nearly all their time indicating how much better it would have been to test more participants or how a completely different design would have been more appropriate. It rather makes us want to write 'Well WHY didn't you test more participants then, and why didn't you use the better design?!'

The choice of maze completion task may also have been a little peculiar. We rather liked it because it was convenient and simple, but is it an appropriate task? Does it sensibly operationalize your dependent variable? In the 'alternative versions' section of this practical, below, we describe some ideas for other tasks you might consider that might suit your needs a little better. It all rather depends on why you are investigating the problem. Those of you working in an office may be more interested in using a task that better reflects their line of work, so you might choose a task that suits your particular needs better. Those of you who are students might choose to look at the ability to study material whilst being distracted, to investigate the sorts of task you face regularly.

It is entirely possible that you will have found completely different results from ours, and you should be prepared for that. We often hear the phrase 'My research project didn't work' from students who found unexpected results, or no effect at all. This is disappointing to the student, who has slaved away as carefully as possible just to be faced with either very confusing or extremely dull graphs and results. They usually perk up a little when we explain to them that it is not really the result that matters, it is knowing that you have designed the procedure properly and carried it out carefully. If you have done that, then, whatever the result is, this is absolutely acceptable. More than that, an unusual result can be more interesting than an expected one as it allows you to refute evidence provided by other researchers in the field. This can lead to a very lively discussion section indeed.

Alternative versions

Think about the type of task you have used to operationalize your dependent variable. We used maze completion, but you may like to use something else that is more relevant to your line of work or enquiry. 'Proof reading' might be a good one. Reading a document for errors is a regular task in a busy office environment, and you could deliberately insert a number of mistakes into a series of documents and use this as a means of calculating how a means of distraction influences performance of a task.

You might also like to think about how you could vary the means of distraction. We have used the sound of a dog barking, as it is something that annoys us when we are trying to work. You might like to engage in a less serious investigation, perhaps as a pilot procedure. We did think about 'tickling' as a means of distraction, but you'd need to be sure that you were amongst friends to try this one out. Again, the method you employ to operationalize your independent variable of distraction might depend on your environment and the

focus of your investigation. You might like to investigate whether people listening to music are more distracted than those who are not, directly investigating the claim of many people who say that they are completely unable to work in silence.

Further investigations of whether people's performance on a task is influenced by some sort of distraction may take the form of a direct comparison of the types of distractions used. For instance, what is worse, a person speaking directly to you over a telephone, a person speaking directly to you whole sitting next to you, or some sort of speech-based radio show? This kind of procedure relates to the issue of the use of telephones in cars and might be of interest to you.

Test yourself

1. What are order effects and how do you avoid them?
2. In an independent-samples design, individual differences can be a real problem. How can their influence be minimized?

Reference

Beaman, C. P. and Jones, D. M. (1998). Irrelevant sound disrupts order information in free recall as in serial recall. *Quarterly Journal of Experimental Psychology, 51A*, 615–636.