Chapter 13: Developing a Research Proposal

For our hands-on approach to learning experimental research methods, an important part of the learning experience is to develop, propose, carry out and write up a small project using experimental methods. Given the constraints of class, this necessarily is a very constrained process with limited scope. These projects can be carried out with generally good adherence to experimental design principles but cannot be considered formal, publishable research. Should a class project identify something that looks like a novel and interesting research finding, it is recommended that interested students seek out a laboratory group working in that area.

# Developing a research hypothesis

## Start with intuition

It’s very common to start the research process with a statement that begins “I wonder what would happen if…” These ideas are usually more exploratory in nature and not initially expressed in the form of a testable hypothesis. You can turn these ideas into a testable hypothesis by not stopping with the exploratory statement. Make a prediction about what would happen and then argue for your prediction. Now you have a testable hypothesis.

Keep in mind that your hypothesis may very well be wrong at this point. One reason why it is often more comfortable at this stage of idea development is that you might not be very confident that your hypothesis is correct. A highly effective hypothesis for driving a research idea needs to be specific and testable, but it does not have to be correct. Often the most interesting research ideas are where the outcome is difficult to predict, or if there are two different theoretical approaches that make different predictions.

A useful heuristic for research proposals: *it is better to be wrong than to be vague*.

## Preliminary background research

The original idea can come from background research, or it might come from a textbook or even more purely from intuition. Developing the idea requires examining the relevant published research around the question in the subdomain of interest. Google Scholar is the currently best recommended search engine for scientific work. It works through a familiar search term interface and covers all available published research across psychology and broader scientific fields. The amount of research included is vast enough that it is important to identify the correct key terminology, the right search terms, to find the related published work.

Many subfields of psychology have specific technical terms or jargon that are precisely defined and identifying these is very important to being able to do thorough background research. Many areas of science have jargon as shorthand, but this is a particular feature of psychological science because we are often studying concepts that have familiar names. For example, a concept like “depression” is one that most people have an idea of but not everybody’s idea may actually be the same. Research in this area will tend to cluster around the term “mood disorder” which is a less common but more precisely defined construct. Similarly, the idea of “altruism” is often done as part of research on “pro-social behavior.” Getting started on background research is often a matter of first learning the best keywords for searching.

Once you have found the terms that lead you to the prior work in the area, you can start reviewing the methodologies that are commonly used. As an aside, if you cannot find prior published work, it is much more likely that you have not found the right search terms than nobody has ever thought to do research in this area before. Most research areas will have reported findings using a variety of methodological approaches. Many of these approaches may not be suitable for your proposal. They might require expertise in a complex or demanding technique requiring specific training. They might require access to a special population, or a very large number of participants to be adequately powered.

When a tractable methodological approach has been identified, the next step is to incorporate the original ideas behind an experimental hypothesis into that methodology. That requires constructing the operational definitions of the key constructs, identifying what can be manipulated and how and what the key dependent measure will be.

## Operational Definitions

As noted previously in our approach to basic experimental design, we first need to come up with operational definitions of the constructs embedded in our hypothesis. Existing published research is the best place to start with ways to implement complex psychological ideas with tractable methodology. Examine the methodologies used in published work and consider how effective they are with respect to face validity, that is, how obviously the capture the idea. Where they seem imperfect, there may be necessary compromises made to make experimentation possible. Or it can be the case that the idea is so complex that there are many different ways to reconceptualize the idea for a research paradigm. Making adjustments to the methodology can improve the design, especially if the published work might have been constrained by technology of the time in which the research was accomplished.

In general, the process of setting up the operational definitions is the same as described earlier. Identify the key independent variable(s) and the level across each that can be controlled (for experimental designs) or measured (for non-experimental factors such as participant variables). The dependent variable needs to be a measured operational definition that can be collected and exhibits a roughly normal (gaussian) distribution. The main issues to assess for the dependent variable are that participant scores will not tend to cluster at floor, the lowest possible value, or ceiling (perfect performance).

Operational definitions will often require defining the stimuli that will be used in the research. Any surveys to be used for measurement or words, images, pictures to be shown to the participants should be characterized. The published work may provide exact examples of the stimuli and instruments used or may give a broad overall description. Many published studies are accompanied on the journal’s website by Supplementary Materials that may contain the exact stimuli or questionnaires used in the research. In other cases, it is necessary to go and obtain exact stimuli to be used in the research protocol. This should be done early in the research development process to be sure that the stimuli are obtainable and any surveys that are planned to be sued are available. Some research depends on research instruments that are held under copyright and may not be openly available to other researchers. In some cases, authors indicate that the stimuli used are “available upon request” but are not as responsive as would be desired. Before committing to the research plan, the availability of the key research elements needs to be assured. In addition, evaluation of the specific operational definitions used helps guide the analysis of possible extraneous variables to consider.

## Extraneous Variables

For planning the experimental procedure, it is necessary to identify as many possible extraneous variables as possible. There is no guaranteed approach to figure out all of these in advance, unfortunately. Looking at the detailed procedure from prior published work will provide a lot of insight into known factors that influence the DV. General knowledge of the research area is the other main source of ideas. Once the known extraneous variables are identified, the tools to manage these are the same as we have seen before: constancy and counterbalancing. Across the manipulated levels of your design, keep as much constant as possible. Anything you cannot keep constant, counterbalance across groups to keep this variable from confounding your research. This process will give you a detailed structure for your research protocol. It is often a good idea to fully script out the research procedure as it helps maintain constancy across multiple participants and especially when research is done by a collaborative team of experimenters (who should all try to administer the task exactly the same way).

## Recruiting Plan

Once the procedure is known, the nest step is to develop a recruiting plan. The two key questions to answer are (1) how many participants will be included in the study? and (2) how will these participants be found? Since all research participation is voluntary, the plan involves outreach to the population of interest with the opportunity to participate. If a specific subpopulation is the focus of research, a plan for finding and recruiting participants is necessary. The number of participants can be technically accurately estimated via the use of a power analysis (from Chapter 12). In many research projects based on convenience sampling, the main constraint is how many people can be recruited making the answer to this question “as many as you can.” A good rule of thumb is 15-20 participants per manipulated condition, i.e., 40 for a two-group design and 80 for a fully between-participants 2x2 factorial design.

In formal research, an important aspect of the recruiting plan is developing a fair compensation plan for participants who volunteer. In some cases, this is based on class credit and therefore the experimental protocol is generally highly constrained in length (e.g., 30 m or 1 hr). The length of time needed to carry out the experimental protocol is important for this step as both financial compensation and credit are generally scaled on an hourly basis.

## Analysis Plan

Best practice for experimental design is to have a formally written analysis plan for the DV as a function of the IV’s before starting data collection. This can be as simple as noting that the analysis will depend on independent samples t-tests or a factorial ANOVA. It can also require more complex analysis approaches planned in advance. However, in a lot of research cases where a novel set of ideas are being tested against each other, unexpected findings will inspire additional analytic ideas in the course of the research process. As a rule of thumb, if the analysis plan is significantly different than originally planned, the research should most likely be further explored with additional studies. Those studies can be planned with a more accurate understanding of the analytic needs. Using very creative and flexible analytic strategies runs the risk of research being bias by “p-hacking” as will be discussed in Chapter 19 (Responsible Conduct of Research).

## IRB approval

Once the entire research plan is complete, the protocol is submitted for review to the Institutional Review Board for approval and/or revision. No systematic data collection from human participants intended for broad distribution should ever be carried out without review. Classroom research by not being intended for broad distribution is typically seen as not under the purview of the IRB. However, it is still important that class projects be carried out under the general principles of ethical research: Respect for Persons, Beneficence and Justice.

# Practical Guidelines for Class Research

The most important first step for planning a psychological science project that can be completed in a classroom is to find a published report in a peer-reviewed journal to work from. You may start from intuition, interesting results you have seen in other classes or elsewhere, but it is extremely valuable to have a closely related publication for reference. The reason for this is that the operational definition process in psychological science is often a lengthy one with false starts, mistakes and gradual improvements. Most published research implicitly relies on a series of pilot studies that guided the design through a variety of pitfalls. In a new subdomain, the first paper could easily reflect several years of preliminary research developing the methodological tools to test the hypothesis. Those often do not get included in the final publication – making science often look a lot easier than it is – but for classwork there is not time to do this methodological exploration. A published report will contain information on a set of definitions that worked, which is a good place to start.

As noted above, Google Scholar is the tool to use to find this first background publication. Be aware that it may take some exploration to identify the key technical terms used in your area of interest to find the published work. Also be aware that Google Scholar indexes outside of psychology. Pay attention to the journal the work is published in to identify if your search has drifted into related areas that are more physiological in nature (e.g., neuroscience, health) that may be impractical for class. Try to verify that the journal is peer-reviewed if the name is unfamiliar by checking if the publication is cited in recognizable outlets (use the Cited By link) and avoid publications with “Proceedings” in the name as these are conference proceedings which may not robust findings.

Once you have the first paper, you should look for something new to add to their approach. Even for class projects, we should approach research with the idea of extending findings to something novel and not just simply replicating a famous finding. The new idea to add can come from intuition, from the authors discussion of future research in their Discussion section, or from another related publication in the field. Blending two papers together often works well to create a 2x2 design from two publications that each had contrasts between two groups. Note that even if the two published papers used more complex designs, you may be able to take their main effect findings as evidence that a two-group study would work and use this as a factor in your design. Check the interaction terms in their work, of course, to ensure that these are not indicating critical extraneous variables that you need to plan for.

For classroom work, you will prepare a 2x2 design with at least one manipulated variable. If you are combining published papers, you may come up with a design plan that is more complex. If you find that the design that best captures the previous work is a 3x2 or a 2x2x2 design, you will want to simplify down to 2x2 even if it weakens the scientific impact of your potential findings. Anything more complex than a 2x2 adds too much difficulty to be plausibly carried out in a classroom context. They require too much data, extending the time needed to recruit and test participants. The analysis is also necessarily much more complex and will significantly slow both the analysis and interpretation of the data when writing up the results later.

As discussed previously, there are a variety of ways to design a factorial study with 2x2 complexity. In general, for the manipulated variable, it is best to try to follow a published successful study as much as possible. The second factor can be a participant variable that is measured or recruited for instead of manipulated. However, avoid the temptation to lazily use men versus women as the second variable. This is an area where intuitions are often not at all grounded in a theory that can be articulated to motivate the study. To make the case that this is an important question to ask in your study, you must find research that shows your manipulated variable is explicitly affected by gender. Even so, be aware that modern understanding of gender does not reduce this variable to a simple choice of two options which will make this factor not suitable for a 2x2 unless you restrict recruiting.

With good sources, most of your work establishing the operational definitions can be taken from those publications. Use existing surveys, stimuli, or other materials from those papers as much as possible. If you need to create something new, keep it as simple as possible and maximize face validity, e.g., 1-10 scales asking participants to subjectively rate their current state.

Once you have the basic design and materials, you need a plan for carrying out the procedure. It is very popular to collect data using online tools such as Qualtrics. Many aspects of experimental control can be implemented within these robust systems. Simpler systems such as Google Forms may also work. Be careful of fees associated with systems not affiliated with the university. Systems with university site licenses often provide access to a great deal of technical documentation to help set up the design and will have local experts to can answer questions (e.g., Northwestern University has a site license with Qualtrics and it is very effective for this purpose).

If you are not doing data collection online, write out a script for how participants will carry out the design procedures. The script helps maintain consistency in interactions with participants through the 40-80 repetitions of the process needed to accumulate the data. It also helps maintain consistency across a collaborative group where 4 people might each be responsible for portions of the data collection.

The recruiting plan should also be specified in advance as part of the research proposal. It may be as simple as social media posts or emails to a locally available convenience sample. If your research plans to recruit from specific populations such as athletes or engineers, be sure to plan how that group will be reached.

Once all the pieces are in place, the entire research protocol is written and provided to class instructors for review. This must include all stimuli that will be used in the planned research. That is, you should not at this point say, “we will collect images of famous celebrities from the internet.” You should collect the images you will use and include those in your protocol submission.

Given time constraints, there is generally not time for a formal IRB review of these research plans and the instructor and teaching assistant will act as an informal IRB. As a result, all research should be absolutely minimal risk. All aspects of deception or any issues with privacy should be minimized or eliminated as much as possible. This may render some very interesting and motivated scientific research unable to be carried out in the classroom environment, but this should not be surprising given how important adherence to ethical research is in science.

Data collection can not start until the entire protocol is reviewed and explicitly approved by classroom instructors. This is necessary for ethical research but has the risk of delaying projects and placing classroom researchers under severe time constraints. Prepare your proposal early and expect feedback about adjustments and revisions to your plan. Make those and resubmit the proposal as quickly as possible. Data collection can take significant time and there is a lot of work still to do after collecting data. The results need to be organized, analyzed and then then the writeup of the results needs to be prepared. It is very ambitious to try to carry out an independent project in the scope of a month. It is possible but requires good time management throughout the process.

## Grant proposals to funding agencies

The process of preparing a research proposal bears some resemblance to the process of writing grant applications that is an important part of the operation of major research laboratories. This process is somewhat more focused on obtaining funds to support these research projects. Many of the staff in most large research labs are not supported by the institution or university housing the lab but are entirely paid through outside funding to the lab. Research funds also support more expensive methodologies and participant compensation to carry out a series of studies organized around a core theoretical framework.

These proposals often look like research papers to some degree, although written in future tense rather than past tense. They will typically include a fair amount of “preliminary data” that has already been collected but not yet published that indicates that the research plan is feasible. The research plan will detail a series of experiments over a time frame that can vary from less than a year up to five years. These proposals have three major components: the collaborative team (led by a Principal Investigator, PI), a budget (cost/year) and a specific scientific research plan. The format of these sections varies very widely across funding agencies. Research staff supporting grant applications spend a lot of time reading detailed formatting requirements and necessary levels of detailed information. The research plan is generally reviewed by a committee of scientific peers in a competitive fashion. Grants are reviewed on an annual cycle and depending on availability of funds to the funding agency only the top 5%-15% of proposals may be awarded funding.

Ideas for research proposals to granting agencies virtually never start with intuitive ideas and background research. Agencies tend to award grants to established experts in a field, so most grants build on the prior work of the collaborative team and PI. This does have some known issues in potentially creating a barrier to entry for researchers to become established or to move into a new area. At the same time, much of the money available for research funding comes from governmental sources which have a requirement to obtain some value from those funds. It is very hard to tell in proposal review which projects are going to have the largest scientific impact. Practically speaking, experts with robust track records in an area are most likely to produce scientific advances.

Within the USA, two major institutions that fund psychological science are the National Science Foundation (NSF) and the National Institute of Health (NIH). Within NSF, most psychological research is in the broad category of Social, Behavioral, Economic Sciences (SBE) which is then further subdivided into Behavioral and Cognitive Sciences and Social and Economic Sciences. The NIH is much larger in size and budget than NSF and houses 21 divisions across a very wide range of health-related research areas. Examples of programs that fund psychological science research include National Institute of Mental Health (NIMH), National Eye Institute (NEI), National Institute of Child Health and Human Development (NICHD), National Institute of Aging (NIA), National Institute of Deafness and Other Communication Disorders (NICHD), National Institute of Neurological Disorders and Stroke (NINDS).

There are also research projects funded through scientific divisions within the Department of Defense (DoD). These include a collection of laboratories such as the Air Force Research Laboratory (AFRL) and Army Research Laboratories (ARL). The Office of Naval Research (ONR) acts as a funding agency similar to NSF but with research aimed at application at military personnel. Most DoD research is aimed at more immediate application of findings rather than long-term scientific understanding. However, it should be noted that these projects can be aimed at psychological questions across the large range of both active and retired (veteran) military personnel, making this sample fairly similar to the overall population. There are also specialty agencies within the DoD such as the Defense Advanced Research Projects Administration (DARPA) which fund very basic science aimed at extremely novel ideas (which has, unfortunately, led historically to support of ideas with little credible scientific support).

There are also private foundations that support psychological science that often have specific areas of interest. Many of these foundations approach scientific support with the same goal of highly rigorous, robust and internally valid research. However, there are some foundations that look for work that advances an agenda regardless of the robustness of science. Most universities or large research institutions have a Development office that provides guidance on private funding sources that support high quality psychological and other science.

Most of this information is not immediately relevant to undergraduate researchers but if you have the opportunity to work in a university laboratory, you may encounter some work aimed at seeking external funding. Some universities have some internal funds set aside to support undergraduate research and if you have the opportunity to apply for these, you will find yourself working through the same process as the lab PI. For example, Northwestern University has undergraduate research funding available for projects done over the summer as well as during the academic year. These can be a great opportunity to do formal, high quality research within a professional laboratory context.