Task 1:

Formulate your research problem

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	Hand in your Research Problem worksheet.		26
	Hand in a list of at least 10 references, in APA-format, to empirical articles related to your research problem. See **Task 2** for more information about finding and formatting your references.		
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Overview

One of the requirements for this course is that you do your own research project – plan it, collect the data, analyze it, and present everything – on a topic that interests you and is related to your professional activities, *i.e.*, something that you may find useful to know in the future. In addition, you will have to carry out this research project in collaboration with a partner: teamwork is essential in research. Your first task together is to decide on what exactly you will study: you have to formulate your research problem. This Task Package will walk you through the steps to formulating a focused, researchable problem. There is a section on each of several questions that you should answer to explain what your specific research problem is.

Remember that for Task 1, you'll develop a preliminary, draft version of your research problem that you'll rethink and revise afterwards. Call this your "working version" of the research problem. In Task 2, by looking at published research on the same problem, you'll be able to revise, improve, and sometimes even abandon your research problem. Similarly, in Task 3 you'll work out the methododogical details of your experiment and that will help you revise and improve the way you understand your research problem.

To do this task step by step – to formulate your research problem –, you will need to answer several questions, even if for now you only provide a guess. The later sections of this task package go into these topics in more detail. For starters, you may want to browse through the sample research problems in Appendix A, if only to get an idea of where this task will lead you.

approach - The collection of assumptions, techniques and background knowledge that guides a researcher's choices in what to study and how to study it.

empirical research - Systematic learning through studying data. *Experimental research* is one kind of empirical research that uses experimental methods.

Here's a brief breakdown of the information you'll need to gather to formulate your research problem:

1. Which approach will you use? This course emphasizes the scientific approach: empirical research based on experimentation. You might also do scholarship, descriptive research, industrial research or use other approaches. When you choose to work within a discipline (such as Psychology) or area (such as Cognitive Psychology), you usually adopt the preferred approach of that area. [See approach]

2. What are the parts of a research problem? You need to define different pieces of information to describe a research problem. [See parts]

3. Who will you work with? You need to choose a partner. [See collaboration]

4. What *process* are you studying? What *sub*-process or *part* of the process will you focus on? [See process]

5. What factors affect this sub-process? [See factors] Different things can make the sub-process more frequent or more error prone or more variable. There may be several of these factors. You will only study two, but it is good to identify others.

process, sub-process - One of the psychological activities that underlie

factor(s) - Some characteristic(s) that the researcher suspects can causes changes in the sub-process. The factors correspond to the *independent variables*.

6. Who do you want to observe carrying out this sub-process? [See participants] Maybe you want to compare two different groups of people: which groups and why?

7. What kind of effects will your factors have? The factors should make the process or its outcomes different. Which differences do you think you will find? [See effects]

8. Why bother studying this? The people who read about your research need to understand why this problem is important and who should care about it. [See importance]

effects - Researchers predict that changes in a factor will have certain measurable *effects* on a process. The effects correspond to the *dependent variables*.

Choose an approach for your research problem

This textbook is about doing empirical research with experiments, so your general approach to research has already been chosen by your professor. It's important for you to know about other options and to continuously ask about their advantages and disadvantages.

The way that you chose and formulate problems for study is influenced by the general approach that you take to finding out information. The approach that you choose will determine where you will look for information, what kinds of data (if any) you will consider, who is likely to read your results, etc. Three approaches are described here: scholarship, theoretical research, and empirical research.

You choose an approach in the first place by choosing a major or discipline. Different disciplines will use different approaches to study the same thing. For example, linguists, cognitive psychologists, computer scientists, neurologists, language teachers, and sociologists might all study language, but they'll use quite different approaches. Linguists, language teachers, and sociologists rarely do experiments, and computer scientists rarely do experiments with human participants. Neurologists do more case studies and focus on people with pathological conditions. Cognitive psychologists usually focus on normal adults and use experimental methods. When you choose a discipline, like Psychology, and a field within that discipline, like Cognitive Psychology, you usually adopt the preferences of the other researchers in that field. Still, regardless of the differences in approach, researchers in all of these

fields are still studying language. The way you formulate your research problem will lead you to more specific choices and make your approach more precise.

Most of what is done under the name of "research" in high school and other classes is what is more technically called "scholarship". *Scholarship* focuses on finding, documenting, and organizing other people's information. If you follow this approach, you will formulate your problem in terms of existing information about topics that other people have studied and you will use their data. Scholarship adds value to existing information by organizing and evaluating it to make it easier for others to understand and use.

Research is different because it focuses on having you generate new information of your own, often about a problem that other people have not yet studied.

Theoretical research emphasizes generating new information by thinking about existing data in new ways. If you do this kind of research, you will formulate your research problem in terms of evaluating how coherent and reliable different ways of thinking (*i.e.*, hypotheses or theories) are, given existing data. One problem with this kind of research is that very often the existing data are only indirectly related to the research problem that you want to solve. In this case, you often cannot draw very strong or very reliable conclusions.

Empirical research, on the other hand, emphasizes collecting new data about what happens in the world (*empirical* comes from the Greek word for personal experience), data that is specifically chosen to help evaluate specific ways of thinking (*i.e.*, hypotheses or theories). The big advantage of this kind of research is that the data is custom tailored to be as relevant and reliable as possible for testing a given hypothesis. This means that you can draw much stronger and more reliable conclusions with this approach. It also means that you are not limited to studying problems that other people have investigated: you can develop your own ways of producing data for whatever problem you choose.

Experimental research is one kind of empirical research – the kind that uses a particular, more rigorous procedure for data collection called an *experiment*. See **Task 4** for more information about what makes experiments different.

> **Your research project this semester will be a piece of empirical research that you will plan, collect data for, and report on.**

Science. Notice that we defined all of the approaches above in terms of how ways of thinking (hypotheses, theories, organization) are related to observable data. This mix of theory and data is one of the key characteristics of what we call *science*. But why is that the case? Why do we need both?

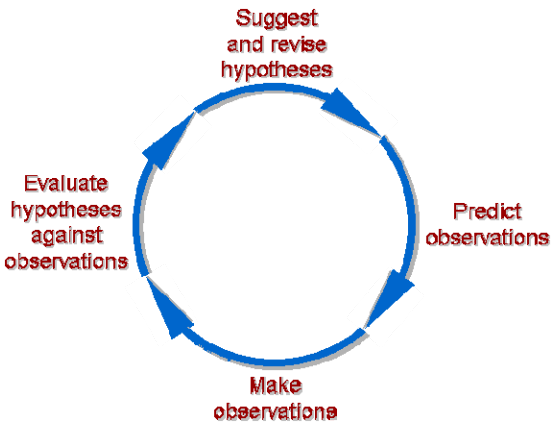
Science – or scientific research – is the most highly refined way we have of learning about what we observe, that is, of building reliable mental models for observable phenomena. One way of looking

at the general principles of learning in science (we call these principles "the scientific method") is by thinking that they derive from the very simple observation that **the individual researcher has finite (and in fact, quite limited) capacities of sensation, perception, reasoning, and memory**. Hundreds of studies in cognitive psychology have confirmed these limitations and teased out many of the qualitative and quantitative details, including the fact that the specific limitations are very variable from individual to individual.

So, there are kinds of information and rates of information flow that scientists simply cannot deal with: however wonderful the human cognitive apparatus is, it has very clear limits. Besides this, the existence of distractions, illusions, and hallucinations shows that our cognitive ability is also limited in reliability. In addition, reports of memory and subjective experience show that our ability is often unreliable in unpredictable ways. Finally, the concept of selective attention shows that not all of the information available from the environment is in fact used or even perceived. The inevitable conclusion is this:

> The fundamental tools that scientists have for producing knowledge – sensation, perception, reason, and memory – are both imperfect and severely limited.

This means that obtaining reliable knowledge about a very complex world requires scientists to develop special strategies for getting around these limitations. The main strategy that scientists have developed is mixing thinking and data: in a nutshell, checking theories against observable data helps compensate for the limitations of how people think. And thinking about the same data with different theories helps compensate for the limitations of how people observe the world. In other words, how we understand something (our reasoning) guides our observation of it and what we in fact see modifies how we understand it. In other words, theorization in effect directs observation and observation restricts theorization.



When we combine observations and thinking, we generate a view of scientific investigation as a virtuous circle: a cycle of activities that mutually feed, stimulate, and constrain each other (See the figure, based on Bunge, 1967). Note that new theories don't actually *break* this cycle: they lead researchers to do the same things in different ways. A new theory will suggest different hypotheses about existing data, predict novel observations, encourage researchers to observe different phenomena, and suggest different was of evaluating hypotheses.

The modern view of scientific research, then, is the systematic search for explanations of observable phenomena. Part of the "magic" of science is the discovery that neither observation nor thinking alone are enough, but the synthesis of the two has turned out to be the best strategy for producing reliable knowledge.

> In today's science, neither theory alone nor observation are sufficient to constitute research; research is the *synthesis* of the processes of observation and theorization.
>
> data + theory = reliable knowledge

To be considered reliable, new research has to have clear links to existing research (this is one reason why the literature review is so important) to show how other people have thought about (part of) your problem before. Scientists would say that you want to choose a research problem that is *grounded* in previous research. This means that you have to choose a problem for which some research has already been done. In empirical research, to add something of your own, you need to collect your own data. This means that you have to choose a problem that you can actually collect data for.

Your research results will be based both on your view of existing explanations (the information that you find for your literature review) and the observations that you will get through your own data collection.

Focus on a very specific problem. You may have started a project with a topic or theme at some time. You probably found it a difficult starting point: a topic like "Memory" or "the Civil War" is just too vague to work with. If you go to the library or do a database search, you will find literally thousands of things to read. Then you are left with no idea of which ones are important and which ones to read first. This is a frustrating and unproductive approach.

Researchers do not start with this kind of topic. They start with something much more specific: a question that usually asks about the influence of something on the process that they are interested in. In fact, it is most efficient to ask yes/no questions like:

"Is there an effect of gender on reading ability in fourth-grade students?" or

"Does gender affect reading ability in fourth-grade students?"

The question that you ask formulates a hunch or hypothesis that you have (or have read about or observed). Novice researchers often find it hard to come up with such a specific problem, so the rest of this Task Package will step you through the process: it is just a case of adding details one by one.

Researchers use these more specific problems because experience shows that smaller, more specific problems lead to clearer, more reliable experiments. For example, "How does vision work?" is much harder to answer with data than a problem like "How do six-year-olds see unfamiliar letters in low lighting?".

Focusing your research problem on a very specific situation is essential for successful research.

Nobel Prize-winner François Jacob (1982, p. 362-3) makes this same observation in an interesting way:

> "Whether mythic or scientific, the view of the world that man builds is always largely a product of his imagination. For, in contrast to what is frequently believed, the scientific process does not consist merely in observing, in collecting data and deducing a theory from them. One can watch an object for years without ever producing any observation of scientific interest. Before making a valuable observation, it is necessary to have some idea of what to observe, a preconception of what is possible. Scientific advances often come from uncovering some previously unseen aspect of things, not so much as a result of using some new instrument, but rather of looking at objects from a new angle. The look is necessarily guided by a certain idea of what so-called reality might be (...) *Scientific investigation begins by inventing a possible world, or a small piece of a possible world, [but] at every step, it has to meet with criticism and experimentation in order to determine what might reflect reality and what is mere wishful thinking.* For science, there are many possible worlds; but the interesting one is the world that exists and has already shown itself to be at work for a long time. Science attempts to confront the possible with the actual. It is the means devised to build a representation of the world that comes ever closer to what we call reality."

In this quote, the author emphasizes the role that the scientist/learner's imagination plays in delimiting that which seems possible. The result of this creative effort is a hunch, hypothesis, or theory. A theory is a characterization of how the world might be, that is, of an imagined world, a mythical world, a possible world. The main difference between a world imagined by a literary, religious, or mythical mind, on the one hand, and a scientific mind, on the other, is that the world imagined by the scientist (his or her theory) *has to* survive a collective, continuous, and very demanding examination of its correspondences with the observed world in order to be accepted by other researchers.

Your research problem should be very specific and focused to make it easier to execute.

This emphasis on very specific problems is also based on the fact that scientists *have to* simplify or idealize whatever-it-is-that-they're-studying (the "object of study"). If the problem is too complex, then they cannot understand it as clearly. Humans can only systematically observe or study a few characteristics of something at any one time, so we "abstract away" the existence of other aspects that are not of immediate interest and stop paying attention to them, for the time being at least. Idealization or simplification of the object of study, i. e., studying it a part at a time, therefore, is a crucial strategy of learning in general, and of the scientific method in particular. It also means that researchers have to make their goals explicit, so that their choices about which parts to study can be evaluated.

This makes it seem like analysis (breaking things down into parts to understand them) is the most important thing in research. However, being forced to simplify also means that:

It is only the *sum* of these partial observations, studies or experiments – their synthesis – that will eventually offer a more complete or accurate view of the object of study.

This is very important: it means that no one has the whole truth about even the most specialized topic. It means that every researcher has only a part of the whole story. It means that no one is "right" and that collaboration is essential. In science, idealization means that selective attention is made explicit: the choice of what to observe and how to observe it are problems for systematic discussion rather than intuitive guessing. The issue of idealization is often contentious in research because in practice what you focus on or ignore is most often based on a subjective assessment about which is the best strategy for learning at a given point in history. Exaggeration in either direction ("wallowing in the data" [not enough theorizing] or "pie-in-the-sky theorizing" [not enough use of data]), however, interferes with the progress of science and fragments researchers into groups that have a harder time collaborating.

Your project will only deal with a tiny research problem. You need to be clear on how your part is related to broader problems – this will be a part of your literature review.

Formulating your Research Problem: checklist

- ☑ **1. Which approach will you use? This course emphasizes the scientific approach: empirical research based on experimentation. [See approach]**
- ⇨ 2. What are the parts of a research problem? What information do you need to describe a research problem? [See parts]
- 3. Who will you work with? [See collaboration]
- 4. What *sub-process* are you studying? [See sub-process]
- 5. What factors affect this sub-process? [See factors]
- 6. Who do you want to observe carrying out this sub-process? [See participants]
- 7. What kind of changes do you think will happen? [See changes]

Understand the parts of a research problem

To transform a general "topic" into a research problem, you have to focus or specify the topic by adding more details. In general, experimental research focuses on what causes what, that is on relations that we *think* may be cause and effect. Your specific problem will focuses on how much of a measurable **effect** one or two **factors** will have on a psychological **sub-process** during a study with **participants** from a chosen population. The terms in bold indicate the parts of a research problem, and are described below.

Processes. A research problem usually focuses on some sort of change: a process or action. Psychologists normally choose mental processes and actions (or behaviors) that are specific to people.

One simple example is the process of reading. If you show a text in some language to a person who knows how to read in that language, then something mysterious happens: the person starts to think about some specific ideas. Almost everyone who reads the same text starts thinking about the same ideas, even though there is some variability. Apparently, several things happened inside the person's head and these things what we call the mental process of reading.

Similarly, people can see objects, colors, or changes in the environment and recognize them or give them names. When people see a computer stop working normally, some can understand what the problem is, fix it, and/or explain what happened. Other people have no clue. Both face the same stimuli; how are their mental processes different? In a wide range of situations, people have to decide on how to behave (bet more in Vegas? eat more chocolate? drive home drunk?) – exactly what happens between seeing the situation and behaving one way or the other?

Sub-processes. The term "process" basically means that we assume that several things are happening over time. Researchers want to identify what is happening and what kinds of things can make the process happen differently. In the case of reading, the process is complex and made up of many different steps, which we call *sub-processes*. Therefore, a sub-process is just a part, step, or phase of a process. Most researchers believe that reading has sub-processes like:

- Word recognition (what happens *between* when you see a word *and* when you can recognize it or say what it means),
- Sentence building or grammatical analysis (what happens *between* when you can recognize a word *and* when you can see how it's related to previous words in the sentence),
- Semantic interpretation (what happens *between* when you can see how words are related to other words in the sentence *and* when you can see what the sentence means), and

• Knowledge integration (what happens *between* when you can see what the sentence means *and* when you can see how the sentence meaning is related to other things that you know).

As research progresses, we build up a better idea of which sub-processes there are and what kinds of factors make them faster, slower, more accurate, more difficult, etc. In addition, researchers usually pick one sub-process (*e.g.*, word recognition) to study in more detail, rather than study the whole process (*e.g.*, reading) in less detail. See the section called **Identify the process and sub-process that you want to study** for more information.

Factors. Processes in people are very variable and one of the goals of research is to understand where this variability comes from. Are some parts of this variability just random? Are some parts systematic and caused by specific factors, for example, by the characteristics of the people observed or of the stimuli or the situation where they are observed?

In the case of reading, we already know that the length of the individual words, the length of the sentences, and the amount of time available are important factors in how well people can read a text. We also know that how much knowledge the readers have about the topic of the text and how much experience the have reading are also very important factors in predicting how easy or difficult reading the text will be. Things like ambient noise or music, pictures or drawings, the reader's physiological state (sleepy, drunk, alert, etc.), and the wording of reading instructions or comprehension questions are also important factors. Many, many factors may influence a given sub-process. One of the things that define a research problem is which factors the researcher chooses to focuses on.

factor(s) - Some characteristic(s) that the researcher suspects can causes changes in the sub-process. The factors correspond to the *independent variables*.

independent variable(s) - The measures of the factors. For example, the factor Age can be measured by making groups like young and old.

You can usually measure a factor in different ways. The theoretical factor called Word Length can correspond to several different **measures** that we call *independent variables*: number of syllables, number of characters, short vs. long, etc. Factors are theoretical entities; independent variables represent these factors mathematically.

In sum, lots of factors affect each psychological process and researchers are interested in identifying which factors are most important, exactly how they affect each process, and whether the factors interfere with each other or are additive. See the section called **Identify two factors that you think affect your sub-process** for more information.

Effects. We know that a factor is important when we can show that changes to that factor have systematic, observable effects in the people who we are studying. When the factor is present, the people behave one way; when it is absent, they behave another way. For example, when people have more time to

effects - Researchers predict that changes in a factor will have certain measurable *effects* on a process. The effects correspond to the *dependent variables*.

dependent variable(s) - The measures of the effects. For example, Answer Accuracy (*dependent variable*) can indicate changes in reading comprehension (*process*).

read, they produce more correct answers to comprehension questions; when they have less time, the produce fewer correct answers. We can say that a change in accuracy is one of the effects of differences in the factor called Reading Time.

We can usually measure effects in different ways, as well. The theoretical effect that we call Accuracy can correspond to several different **measures** that we call *dependent variables*: number of questions correct, proportion of target words used, high vs. low, etc. Effects are theoretical entities; dependent variables represent these effects mathematically. See the section called **Identify how you think your sub-process will change** for more information.

Participants. When you collect data, a (usually) small group of **participants** in your study will do something for you to observe. In many cases, researchers are interested in choosing a sample of participants from a specific population, for example, 5-year-olds, Alzheimer patients, expert radiologists, engineering majors, etc. See the section called **Identify who you want to study** for more information.

A research problem, then, focuses on how much of a specific **effect** one or two **factors** will have on a psychological **sub-process** during a study with **participants** from a chosen population. Figure 1.1 below represents the parts of a research problem graphically.

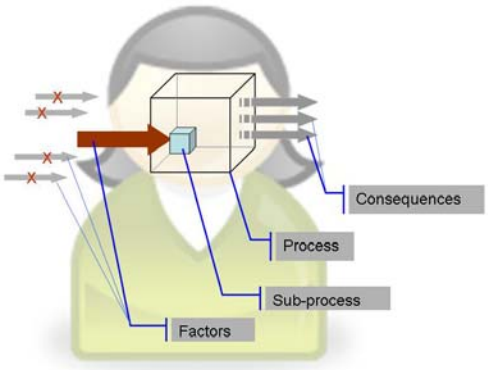


Figure 1.1. Visual representation of the parts of a research problem. The large cube represents a mental process; the small blue cube represents a part of that process (the sub-process). The arrows with Xs represent factors that may affect the sub-process studied, but are not the focus of a particular research problem.

Focus. Note that the discussion so far has focussed on understanding your research *problem*, not the methods you will use or the specific tasks that your participants will be doing. Some students try to start to plan their research by imagining exactly what their participants will be do and then try to

work backwards from there. In my experience, this ends up being very confusing for them: they can figure out *what* to do but get stuck when can't explain *why* they're doing it.

> Don't think about what your participants will be doing quite yet. For now, focus on **what you want to understand** with your experiment.

Formulating your Research Problem: checklist

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- 4. What *sub-process* are you studying? [See sub-process]
- 5. What factors affect this sub-process? [See factors]
- 6. Who do you want to observe carrying out this sub-process? [See participants]
- 7. What kind of changes do you think will happen? [See changes]

Identify who you will collaborate with

Don't work alone. A partner will help you divide up the work, keep your sanity, buy you a drink, talk through technical issues, keep you on track, double check your writing, and help in a dozen other ways. Choose a partner who shares similar interests with you and one you can rely on. Reliability is hard to judge at first sight, so it's best to work with people you've worked with before. Double check that you can identify times in your schedules when both of you are available to work together in the same place.

There are more technical reasons that lead scientists to work with others. Scientists devised a very important strategy to overcome the limitations of individual observation that were discussed at the beginning of this task package. That strategy is collaboration with other researchers. (Salomon, 1994).

> Knowledge is produced by whole communities, not by individuals acting alone.

The role of the individual researcher is to provide the input (data, hypotheses, arguments, theories) for this process. The objectivity or "intersubjectivity" of scientific hypotheses that Popper (1959) placed so much importance on is only one aspect of this strategy. Comparison of the observations of different researchers can contribute to determining which aspects observed are likely to be subjective or individual and which are not. The same argument is doubly true for hypotheses and theories, which are initially produced from individual intuitions, imagination, and interpretations of available data.

The key to collaboration in learning and research, then, is knowing how to deal with multiple perspectives: how to compare and contrast them, how to evaluate their relative merits, how to accept none as the truth but each as a distinct and valid contribution. Multiple perspective taking leads to more complex and complete ways of looking at things and it also expands the kinds of observations and data that will be useful for checking these perspectives. This is a major improvement over individual learning. The collective evaluation of hypotheses and theories is more complete and more demanding than individual evaluation, ensuring greater reliability of those hypotheses that are accepted. This is just a more systematic reformulation of the prosaic "two heads are better than one" (and two thousand better still). This is also another reason why simplistic "right" and "wrong" judgments are useless: these judgments assume one true perspective and in so doing, they undermine collaboration. This same approach is making its way into the workplace: companies have seen that having people who are more diverse leads to more ideas about how to understand their customers, products, and business processes.

The necessity for collaborative research is what underlies the importance that the scientific community accords to publication, since this is the main channel of communication and therefore most important tool for the evaluation of ideas. An unpublished hypothesis or theory is worthless because the

parts of it that are true do not contribute to the progress of the research community and the parts of it that are false go undetected. Similar considerations hold for non-professional learners: "peer teaching" and communication among learners allow the individuals to adjust their understanding to reflect the group's consensus, thus building collective knowledge. Moreover, in research and in collaborative learning, one person's insight advances several people's understanding simultaneously, but *only* if the insight is published and discussed.

Collaborative research also compensates for the fragmenting nature of idealization cited above. Collaboration and communication are needed to sum existing studies, with their differing simplifications and different perspectives. Only this sum is what can be evaluated in terms of completeness, coverage, and progress of learning.

> **You will have to do your project with a partner, so you both need to agree about a common sub-process to focus on.**

Team Datasheet

a) Fill out the following information.

b) Make sure that *both* team members have a copy of this information.

c) Hand in a copy.

Partner 1

Name: _____

Two best ways of contacting me: (fill in e-mail address, phone number, IM; whatever's best)

_____ _____

Partner 2

Name: _____

Two best ways of contacting me: (fill in e-mail address, phone number, IM; whatever's best)

_____ _____

Meeting times

Make a list of the days and times when you are BOTH available to work together. If you cannot identify ***at least two*** meeting times, then find a different partner.

_____

_____

_____

_____

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- ☑ **3. Who will you work with? [See collaboration] Hand in your Team Datasheet.**
- ⇨ 4. What *sub-process* are you studying? [See sub-process]
- 5. What factors affect this sub-process? [See factors]
- 6. Who do you want to observe carrying out this sub-process? [See participants]
- 7. What kind of changes do you think will happen? [See changes]

Identify the process and sub-process that you want to study

Choose a *process* to study. (Ex: reading, writing, translating, pronouncing, problem solving, word choice, etc)

Choose a *sub-process* or part of the process to focus on. (Ex: word recognition (part of reading), word choice (part of writing), sentence reordering (part of translation), etc.)

Take an example that's totally off topic: assembling a car is a complex process. If you describe the whole process, you can only say things like it costs *x* dollars and takes *y* minutes for each car. When you try to compare two factories, one might be cheaper or faster than the other but you can't say why. This general kind of description just doesn't provide a lot of information. To understand how or why one factory is faster than the other, you need to break down the assembly process into parts or sub-processes: build the engine, install all the windows, put together the seats, etc. Describing the factories in terms of these more detailed, more precise sub-processes will allow you to understand better exactly how the factory works and why it might be better or faster.

Back to psychology. Clearly, *communication* and *behavior* are processes or actions, but they are far too general to be an acceptable research problem, like "assembling a car". Writing, reading, translating are much better as a start – because they are much more specific than behavior in general. So, by moving from a general process (communicate) and to a more specific process (reading) you make your problem more specific and easier to research effectively. In the case of psychology, you can't observe the sub-processes directly, as you can in the case of car factories. This means that researchers have to be more creative in how they measure what's happening during different sub-processes.

You want to get to a point where you define a research problem like this one:

Do Letter Size and Word Frequency affect **difficulty of** word recognition during reading in Psychology Students?

The general format of the problem is:

Does <factor> affect <consequence> of <sub-process> during <process> in <participants>?

The following sections will walk you through building up this problem step-by-step. Just for this example, then, say that the **process** that you want to study is **reading**.

So far, the formulation of your research problem would be just: **Reading**

However, there are very, very many studies of reading. It is still too broad for a research problem. You want to take your thinking a step further than that and define which *sub*-process of reading that you will focus on. Reading for your Lit Review will help you identify the sub-process that interests you. Reading is usually viewed as having parts like word recognition, sentence building, sentence interpretation, use of topic knowledge. For this example, then, assume that **word recognition** is the **sub-process** of reading that you want to study.

The same is true of other psychological processes: existing research breaks each process like thinking, learning, seeing, etc. into more specific sub-processes. To make your research problem more specific and more focused, you have to identify both the process and the sub-process that you want to study.

Now, the formulation of your research problem would be: **Word recognition during reading**

The general format of the research problem, so far, is:

<sub-process> during <process>

Other examples are in Appendix A: Sample Research Problems. You should definitely look at the research papers from previous semesters for ideas and examples.

> **Think ahead. More specific problems are easier to search for.**

Formulating your Research Problem: checklist

- ☑ 1. Which approach will you use? This course emphasizes the scientific approach: empirical research based on experimentation. [See approach]
- ☑ 2. What are the parts of a research problem? What information do you need to describe a research problem? [See parts]
- ☑ 3. Who will you work with? [See collaboration]
- ☑ **4. What *sub-process* are you studying? [See sub-process]**
- ⇨ 5. What factors affect this sub-process? [See factors]
- 6. Who do you want to observe carrying out this sub-process? [See participants]
- 7. What kind of changes do you think will happen? [See changes]

Identify two factors that you think affect your sub-process

Different things can make your sub-process more error prone, slower, faster, more variable, etc. There may be several of these factors. You will only study two, but it is good to identify others.

As mentioned above, empirical research focuses on what causes what, so your problem will zoom in on a process, action, or some characteristic, not an object. If you focus on an object, like the heart, then your research will often focus on describing the parts of the object, how the are related, and perhaps how they change over time. If you focus on a process, like listening or deciding, then your research will focus on identifying the factors that lead to changes in the process, for example: noise with the stimuli, sleepiness of the participant, stress, etc.

The main question is: What actually determines how a process happens? To make your research problem more specific, you have to decide what you think will lead changes in your process. For example, does letter size affect word recognition? Does word length affect word recognition? Letter Size and Word Length here are examples of **factors** (which are measured by **independent variables**) – characteristics that the researcher *thinks might* cause a change in the sub-process studied (here, word recognition). By convention, we write factor names with capital letters, so that they stand out.

You cannot call this thing that might affect your sub-process a "cause" because you do not know yet if it really does cause anything and you do not want to prejudge the results. Most researchers will call it a "factor" because it may be a factor in the changes of the sub-process.

What kinds of things determine or cause changes in the sub-process that you want to study? Here are the usual kinds of factors that researchers investigate.

1. Do you think differences in **people** lead to differences in your sub-process? Maybe you think that Native language (Chinese speakers vs. Russian speakers) determines how people spell things. Maybe you think that Gender (men vs. women) determines how often people interrupt each other. Maybe you think that Expertise or Knowledge (Students vs. Experts) determines how you understand a particular kind of text. The effects of Age will be difficult for us to investigate – college students don't vary very much in terms of age.

2. Do you think that differences in the **materials** or stimuli that you give them leads to differences in the sub-process you want to study? Maybe you think that Letter Size is important: smaller letters (e.g., 10 pt) are harder to read than larger letters (e.g., 18 pt) or that low-frequency words are harder to read than high-frequency words.

3. Maybe you think that doing different **tasks** with the same materials can lead to different things happening during your sub-process: maybe word recognition during reading for fun is different from word recognition during reading to answer questions. For example, it could be that writing to a future boss and to a future spouse will make you choose different words or different topics (I hope so!).

4. Do you think that the **situation** in which people do things affects what happens? Is reading a technical text in a silent room different from reading it while there is loud music or an interesting movie? Will a strong smell of popcorn affect how well children read?

Specifying the factor(s) that you want to study is the key step to focus your research problem. However, there is another reason to include the factors: they help the researcher keep on track when trying to relate the hypotheses (like the role of the factor) and observations (which we will collect later). The factors provide a link to the hidden mechanisms that have to be imagined or hypothesized. When you are focus on looking for hidden causes, it guarantees that you will reason about observations, rather than just collect them. Jacob, once again, summarizes this principle very clearly:

> "In some respects, at least, myths and science fulfill a similar function: they both provide human beings with a representation of the world and of the forces that are supposed to govern it. They both fix the limits of what is considered as possible. (...) In their attempt to perform their function and to transform the chaos of the world into order, myths and scientific theories operate on the same principle. The [goal] is always to explain visible events by invisible forces, to connect what is seen with what is assumed. (...) **A phenomenon is considered to be explained if it can be viewed as the visible effect of some hidden cause related to the whole network of invisible forces that are supposed to govern the world**." (Jacob, 1982, p. 359-362, emphasis added)

This is particularly important for formulating research problems: scientific problems include both a mechanism and the factors that can affect that mechanism. This is one reason why so many research articles have titles like "Effects of marijuana on short-term memory for numbers": the researcher, in this case, is investigating how marijuana causes changes to the (invisible) mechanisms of short-term memory, which in turn cause observable effects in behavior that the researcher measured.

To judge the possible effects of a factor (like Letter Size in the example), researchers will design different experimental situations where everything is the same *except* for the factor: in the simplest situation, there would be two different **levels** of the factor. For example, an experiment might compare 10 pt letters with 18 pt letters. To keep the factor names clear, they are capitalized, so researchers talk about "Two levels (10 pt, 18 pt) of Letter Size". The term "levels", then, just refers to the different values that a given factor has in a particular experiment. There is more on levels and designing experiments in **Task 4**.

You have enough information to formulate the research problem in a much clearer way: as a simple yes/no question. Now, then, the formulation of your example research problem is:

Do Letter Size and Word Frequency affect word recognition during reading?

The general format of the research problem, so far, is:

Do <factor and factor> affect <sub-process> during <process>?

See Appendix A: Sample Research Problems for several other examples.

Formulating your Research Problem: checklist

- ☑ 1. Which approach will you use? This course emphasizes the scientific approach: empirical research based on experimentation. [See approach]
- ☑ 2. What are the parts of a research problem? What information do you need to describe a research problem? [See parts]
- ☑ 3. Who will you work with? [See collaboration]
- ☑ 4. What *sub-process* are you studying? [See sub-process]
- ☑ **5. What factors affect this sub-process? [See factors]**
- 6. Who do you want to observe carrying out this sub-process? [See participants]
- 7. What kind of changes do you think will happen? [See changes]

Identify who you want to study

Another component of a research problem is *who* is doing the sub-process. Who are you going to study? Who will be reading? People with (or without) special skills? Regular people? Differences in the participants may well be the factor that you want to study, for example, Gender, Major, or IQ.

In this course, you'll be limited to studying university students. You may, however, want to compare different *kinds* of students.

> **NOTE:** For Research Methods, you can only choose a research problem that will NOT CREATE ANY POSSIBLE RISKS AT ALL for either you, the experimenter, or for the participants who you recruit.

That means no experimental surgery; no drugs; no dangerous, vulnerable, or at-risk populations; no dangerous tasks or settings!

In practice, this means that you have to ask for special permission if you want to study people who are not adult university students. There is more about this in Task 4. For now, assume that you will be studying adult university students.

Now, then, the example research problem is:

Do Letter Size and Word Frequency affect difficulty of word recognition during reading **in Psychology Students**?

The general format of the problem is:

Does <factor> affect <consequence> of <sub-process> during <process> in <participants>?

> **Think ahead.** **It is very important for you to have easy access to a couple dozen (in most cases) of the people that you want to study. For this course, you will have to focus on normal adults, usually university students. More discussion of this is in Task 4.**

Formulating your Research Problem: checklist

- ☑ 1. Which approach will you use? This course emphasizes the scientific approach: empirical research based on experimentation. [See approach]
- ☑ 2. What are the parts of a research problem? What information do you need to describe a research problem? [See parts]
- ☑ 3. Who will you work with? [See collaboration]
- ☑ 4. What *sub-process* are you studying? [See sub-process]
- ☑ 5. What factors affect this sub-process? [See factors]
- ☑ **6. Who do you want to observe carrying out this sub-process? [See participants]**
- ⇨ 7. What kind of changes do you think will happen? [See changes]

Identify how you think your sub-process will change

The factors should make the sub-process or its outcomes different. What kind of differences do you think you will observe because of your factors? What are you going to pay attention to in order to check whether there was a change or not? If the factor really *does* cause changes in the sub-process, what will the observable consequences be?

You may not be sure which specific changes to expect right now. For Task 1, you may need to just guess and then check out your guess when you do a review of other research in Task 2.

In the example research problem – **Do Letter Size and Word Frequency affect word recognition during reading?** – there is nothing yet about how the expected effects of Letter Size and Word Frequency will show up. Will the reader find it *harder to pronounce* a word with smaller letters? Many experiments about word recognition predict that different factors will affect *how quickly* someone can read a word. Other experiments look at consequences like accuracy and speed, as well. If you cannot measure the effects that your factor will supposedly have, then you cannot collect the data that you need and you do not have a researchable problem.

Now, then, the example research problem is:

Do Letter Size and Word Frequency affect **difficulty of** word recognition during reading in Psychology Students?

The general format of the problem, so far, is:

Does <factor> affect <consequence> of <sub-process> during <process> in <participants>?

> **Think ahead.** **Start thinking about how you will *measure* these differences. If you cannot measure them, then you need to look at different consequences.**

Formulating your Research Problem: checklist

- ☑ 1. Which approach will you use? This course emphasizes the scientific approach: empirical research based on experimentation. [See approach]
- ☑ 2. What are the parts of a research problem? What information do you need to describe a research problem? [See parts]
- ☑ 3. Who will you work with? [See collaboration]
- ☑ 4. What *sub-process* are you studying? [See sub-process]
- ☑ 5. What factors affect this sub-process? [See factors]
- ☑ 6. Who do you want to observe carrying out this sub-process? [See participants]
- ☑ **7. What kind of changes do you think will happen? [See changes]**

⇨ Now write up your research problem. [See the next sections]

Describe why your research problem is important

A very important part of planning a research project is to make explicit *why* the researcher is doing it – this is called the "motivation" of the study. One reason why this part is so important is that it is often essential to explain to other people why the project should be done, so that they can give permission, supervision, and funding to make the project possible. Another reason is that a clear idea of why the project is being done helps the researcher avoid wasting time on things that are less important. Finally, to communicate with the general public, it is essential to have a clear idea of why the project was or will be carried out.

motivation - The collection of reasons why a particular research problem is important.

You may not have a clear idea yet of why your problem is important. For Task 1, you can sketch some ideas and then improve them after you've done the review of other research for Task 2. It's important, though, not to forget to find some bibliography to help you explain why your problem is important. Often statistics or government reports are useful for documenting how many people may be affected by the problem that you are studying. The *kinds* of reasons given below will help you get some ideas.

Researchers can be doing research just out of curiosity -- to learn more -- or they may have some potential application in the back of their minds. They may also have a specific practical problem to solve.

One way of classifying research by the researcher's goals is the standard distinction between basic research, applied research, and technological research (see Bunge, 1989).

In *basic research*, the researcher's main goal is simply understanding, with no regard to how that understanding might be used in practical situations. The best-known example is nuclear physics: many of the researchers in this field just want to know how to take apart an atom and see how it works.

In *applied research*, the researcher's main goal is understanding, but there is also the hope that the understanding may eventually be useful for solving some practical problem. In general, applied researchers reinterpret the results of basic research and go into more detail about some specific cases that may eventually be useful. Research into how well people can study in noisy environments is a good example of applied research that focuses on how reading happens, but may be used by architects for designing libraries and study areas for students.

In *technological research*, also called R&D (which stands for for "research and development"), the researcher's main goal is solving an immediate practical problem. Companies have to *research* how to solve different problems and how potential clients perceive the usefulness of different products and then *develop* their own products so that clients will understand their usefulness well enough to buy them. Technological researchers use the results of the applied researchers to solve specific practical problems. For example, which sequence of topics or organization of materials makes learning statistics (for example) fastest and most accurate? Which kinds of music are more relaxing? How long should sentences be to optimize reading comprehension? These are all questions that can be researched to help solve some practical problem like learning better or understanding more.

It is important to point out that all of these are equally valid kinds of research that simply reflect the researcher's preference for different kinds of more or less practically oriented problems.

More on motivation. This simple classification is not very helpful if you have to write a research proposal or thesis in which you have to motivate your project in detail. In this situation, you often have to convince the reader *why* it is important enough to give you a lot of time and/or money to get the project done. One way of explaining in more detail why a research project is important (or motivated) is by going through the following ways in which finishing the project can make different kinds of contributions to science in particular and to society in general.

Theoretical contributions. Once the research project is done, what will we understand better? What parts of which theories will be stronger, clearer, or more reliable? Will we be able to accept or reject competing hypotheses about the sub-process that you are studying? Answers to these questions help define the theoretical contributions of a research project. Most often, researchers have to describe this *before* they actually do the research, as part of the proposal process. So it is essential to think through why it might be

important for different theories even if the hypothesis that you are studying turns out *not* to be important or relevant.

Empirical contributions. Once the project is done, will new data be available for the research community to use? If the data is unusual or hard to get, then this might be an important contribution of the project. In some cases, just collecting and organizing data, without much analysis, is an important contribution – if it is published.

Methodological contributions. Once the project is done, will we have important information about how relevant or reliable specific research methods are? Some studies examine in great detail the same methods that other researchers just assume are reliable – to document when the methods are reliable and what their limitations are. Other studies introduce new methods or tests and document how valid and robust they are. This is important so that other researchers can use these methods with confidence.

Practical contributions. Once the project is done, will we be closer to solving some practical problem? Did the project produce information about, for example, how to organize technical information so that people can understand it more easily? About which colors to use in traffic lights so that drivers can see them from further away? About how distracted drivers really get when they are talking on their cell phones?

No single kind of contribution is obligatory, but different contributions will seem more important to different readers. This is particularly important when writing research grants: you need to provide more information about the kinds of contributions that the grant reader is interested in. Of course, the more contributions that you can come up with, the more important the project will seem.

Sample. Here is a sample description of the importance of a research problem, taken from a student paper. Note the importance of citing reliable sources to back up the facts and opinions that you use.

> Across the nation, only 30% to 40% of students read and comprehend information at their grade level, and they continue to struggle each year that follows because they do not get enough help (Southwest Educational Development Laboratory, 2007). As adults, fewer than half of workers meet proper literacy levels. This data has not shifted in over 20 years of research on reading comprehension and knowledge integration, suggesting a need for change (Sum, Kirsch, & Taggart, 2002).
>
> By studying the role of (visual vs. auditory) modality in comprehension, teachers can gain an understanding of what their students need to succeed and implement these methods to create an effective and productive atmosphere in their classrooms. Thus, students should have greater opportunities in the career world. In the case that students comprehend information visually, teachers can implement videos, overheads and textbooks to convey the information. Conversely, if students comprehend more from listening to the material, teachers can lecture

and use recordings to meets their students needs. In addition, students will benefit from the knowledge they are gaining through the preferred modality, and have a greater chance of continuing on to an institution of higher learning once they are capable of retaining vital information.

Describe your research problem

The deliverables for this Task will help you form a team, choose a specific, focussed research problem for study, and evaluate how easy or difficult it will be to find background research about your problem.

1. Fill out the Team Datasheet with your partner. Hand in a copy and make sure that both teammates have their own copies of of the information.

2. Use the Research Problem Worksheet below to think through the parts of a research problem one by one with your partner. Hand in a clean copy with the responses that you finally agree on.

3. Hand in a list of at least 10 references, in APA-format, to empirical articles related to your research problem. You don't have to actually *read* them all, you just need to find them and double check the abstracts to make sure that they're relevant. The more references you find at this point, the better. See **Task 2** for more information about finding and formatting your references.

The purpose of this part of the task is for you to judge together how easy or difficult it will be to find background research about your problem. If you have a hard time finding 10 references, then that's a clear signal that you should **change your problem** to one with more available research.

> **Hint**: If you find it hard to locate other research about your problem, then you should **choose a different research problem**.

Your bibliography must have **at least 10 references** that will be **relevant and useful** for your research problem, including:

- At least four references to journal articles that are as closely related as possible to your research question;

- At least four other references to articles with information about related methods, about your participants, or about similar materials.

- At least two books, book chapters, theses, review articles, encyclopedia articles, etc.

Don't use web pages as sources, but you definitely should use web sites to search for publications.

Use APA format for all of your bibliography entries. Start right away. You need to look your very best in everything you hand in! There is an APA "refresher" in **Appendix A** of **Task Package 2**.

Research Problem Worksheet

This worksheet summarizes the components of a research problem.

Who is studying this research problem? Write in the names of your team members.

_____ _____

1. What *process* will you study? (Ex.: reading, writing, translating, problem solving, word choice, etc.)

   _____

2. What *sub*-process or *part* of the process will you focus on? (Ex.: word recognition (part of reading), word choice (part of writing), sentence reordering (part of translation), etc.)

   _____

3. Which *factors* affect this sub-process? What makes it more frequent or more error prone or more variable? There may be several of these factors. Circle the two factors that you want to study.

   _____

4. *Who* do you want to observe carrying out this sub-process? You might want to compare two different groups of people: which groups and why?

   _____

5. What kind of changes do you think will happen? How will the sub-process or its outcomes be different? (Ex.: slower, faster, more difficult, less accurate, more variable, etc.)

   _____

6. Why bother studying this? Why is this problem important? Who should care about this problem and why? Be as specific as possible. Write a paragraph and print it on the back of this sheet.

Think ahead

Now that you have a detailed sketch of your research problem, it is time to take a step back and evaluate it. In particular, is it something that you can get done? That will depend on how you determine the details. Thinking about feasibility and operationalization will help get you ready to start designing your data collection and analysis methods.

For Task 1, you just need to start thinking about how you'll be able to actually collect and analyze your data – and whether it seems like something that will be reasonably easy to do. Examples from other studies are a very good place to start.

For Task 2, you'll review the existing research to find examples of how other researchers have studied your research problem and to see the results they've found. This information will help you adjust your research problem to make it more likely to produce useful information in an effective way.

A feasible (or "doable") research problem is formulated in such a way that it is clear that the researcher can measure both the factors and the effects or consequents reliably, with the resources available, and without undue hardship to the researcher. This means that a research problem that requires the researcher to measure the weight of microbes on Saturn or count the number of ferns in a Jurassic landscape is simply not feasible. A research problem that requires an apparatus that measures the contents of people's thoughts and dreams or an apparatus that permits time travel is not feasible. A research problem that requires fieldwork in Lake Baikal, Siberia, or following the development of a child over 10 years, or collecting and analyzing 17 terabytes of astronomical data is not feasible for most single-semester Research Methods courses.

Practical limitations of time, money, and human resources simply mean that research problems have to be **operationalized,** which means that they have to fit the resources available. For your project this semester, manned space exploration and neurosurgery are not options.

To make your research problem fit your resources, you have to reformulate it more and more narrowly until it becomes feasible. For example, given a perfectly good research problem like: Do text characteristics make reading easier? You will have to make both "text characteristics," "reading," and "easier" narrower, more detailed and more precise. For example, you will need to choose only one or two examples of

Ethical research. The simple definition of ethics in research is: an ethical research problem is one that can be done without undue hardship to the animals or people being studied (one of the advantages of studying rocks is that there are very few ethical restrictions) and one whose results are unlikely to cause (or be used to cause) harm. Of course, different opinions of "harm" and "undue hardship" lead to very much discussion.

"text characteristics". You will need to specify "reading" of what and for what purpose, for example, reading your history text to study for an exam. Wait. Who is doing the reading? 7 year olds or professional proofreaders? You will also need to find a measurable (with your resources!) way of saying what is easier, for example, by answering questions.

You can see from the example that this is where defining the problem and building a method have to be done together. The most common way of doing this is by generating **operational definitions** or operationalizing your research problem. Operational definitions are "disposable" definitions that are formulated in terms of concrete situations or methods of a research project; definitions that you use just for a specific project. What does "text characteristics" mean in the context of your individual research project? "Sentence length" and "readability" might be one answer. What does "reading" mean in the context of your individual research project? "20-year-old physics majors reading silently two pages from one specific history text to answer test questions" is probably fine.

This is one of the ways in which research is open ended: you can use the same research problem with hundreds of variants of the operational definitions and get many other excellent research projects. This is also why it is crazy to worry about someone else working on the same research problem: there is room for hundreds of researchers "on board" each problem.

Operationalize your research problem to make it fit with the resources available for each project by adding more details to *how* you will carry it out.

Glossary

approach The collection of assumptions, techniques and background knowledge that guides a researcher's choices in what to study and how to study it.

dependent variable(s) The measures of the effects. For example, Answer Accuracy (*dependent variable*) can indicate changes in reading comprehension (*process*).

effects Researchers predict that changes in a factor will have certain measurable *effects* on a process. The effects correspond to the *dependent variables*.

empirical research Systematic learning through studying data. *Experimental research* is one kind of empirical research that uses experimental methods.

factor Some characteristic that the researcher suspects can causes changes in the sub-process. The factors correspond to the *independent variables*.

independent variable(s) The measures of the factors. For example, the factor Age can be measured by making groups like young and old.

motivation The collection of reasons why a particular research problem is important.

process, sub-process One of the psychological activities that underlie behavior. A *sub-process* is one step or phase in a multi-step *process*.

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Further Resources on Formulating Research Problems

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Appendix A: Sample Research Problems

Note: You do not have to do an experiment in cognitive psychology for this course. Remember, though, that you have to collect data from real people in a short period of time, so you have to pick a topic that's both ethical and doable.

To give you some ideas, this is a list of titles of past student research papers. Most of them focus on aspects of cognitive psychology for simple reasons: a) they're from previous courses in psycholinguistics and cognitive psychology; b) most cognitive studies are easy to do and present no risks for participants.

For even more ideas, look at other papers that past students have done and in the articles that you find during your literature search.

Various questions

- The Accuracy of Interpretation of Lip-read Messages in Deaf Adults and Adolescents
- Effects of Culture on Scene Perception
- Effects of Anxiety on Fluency in Public speaking
- Effects of Gender on Mathematical Problem Solving
- Effects of Gender on Long-term Memory
- Effects of Domain-specific Expertise on Medical Diagnosis
- Effects of Major on Perception of Art
- Effects of Culture on Politeness
- Effects of Adjective choice on Ratings of Text "Interestingness"

Text comprehension

- The Effects of Music and Text Type on Reading comprehension
- The Effects of Picture content and time limitations on Reading comprehension
- The Effects of Time constraints and Television exposure on Reading comprehension
- The Effects of Pictures on the Reading comprehension of Deaf adults
- Effects of Picture-only and Text-only instructions on Comprehension
- Effects of Document Format on Content Retention
- Generational differences in Text Interpretation
- Effects of Accent on Student Comprehension of Lectures

Writing

- Effects of Instant Messaging on Chinese College Students' Writing in Academic English
- Effects of Reader models on Pronoun choice in Writing
- Effects of Instructions on Writing "ability"

Analysis of sample study titles

Study titles	Factors	Consequences	Sub-process	Process	Materials
The Accuracy of Interpretation of Lip-read Messages in Deaf Adults and Adolescents	deafness	accuracy	interpretation	lip reading	
Effects of Culture on Scene Perception	Culture			Scene perception	
Effects of Anxiety on Fluency in Public speaking	Anxiety	Fluency		public speaking	
Effects of Gender on Mathematical Problem Solving	gender		mathematics	problem solving	
Effects of Gender on Long-term Memory	gender		long-term memory	memory	
Effects of Domain-specific Expertise on Medical Diagnosis	expertise		medical diagnosis	problem solving	
Effects of Major on Perception of Art	major			perception	art
Effects of Culture on Politeness	culture		polite behavior	speaking	
Effects of Adjective choice on Ratings of Text "Interestingness"	adjective choice	interestingness		perception	
The Effects of Music and Text Type on Reading comprehension	Music; Text type		comprehension	reading	
The Effects of Picture content and time limitations on Reading comprehension	Picture content; time limitations		comprehension	reading	
The Effects of Time constraints and Television exposure on Reading comprehension	time contraints; television exposure		comprehension	reading	
The Effects of Pictures on the Reading comprehension of Deaf adults	pictures; deafness		comprehension	reading	
Effects of Picture-only and Text-only instructions on Comprehension	pictures		comprehension		
Communicating the Surgeon General's Warning on Cigarettes: Recall and Believability by College Students		recall; believability	comprehension		surgeon general's warning
Effects of Document Format on Content Retention	format	retention	comprehension		
Generational differences in Text Interpretation	age		interpretation		
Effects of Accent on Student Comprehension of Lectures	accent		comprehension	(listening)	lectures
Effects of Instant Messaging on Chinese College Students' Writing in Academic English	IM experience	WST score		writing	
Effects of Reader models on Pronoun choice in Writing	Reader model	pronouns	pronoun choice	writing	
Effects of Instructions on Writing "ability"	Instructions	ability		writing	