

# Doing the Homework for Theory-Driven Research

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We are often receptive to advice about the design of experiments and the use of statistics. However, doing the literature review is seldom discussed or taught explicitly, as if its principles are self-evident or we are born knowing them. So that we may avoid complacency, this contribution to the panel on theory-driven research deals with the manner in which we explore the background for such research. This article contains some general guidelines for searching the literature, followed by some guidelines for evaluating theories that we find in the literature. Finally, a database is introduced as a method for organizing the storage and search of information.

## SEARCHING PREVIOUS RESEARCH

The first big job in doing research is to search the landscape of our investigation so that we may find the most fertile groundwork for the study we want to do. The following guidelines begin with the attitude that we carry into an investigation.

### **Be Dispassionate**

Having a passion for the process of discovery keeps us doing research, but we explore the literature with the dispassionate attitude that characterizes the scientific method. We do not stalk the library when developing a rationale. If we are hell-bent on pleading our own cause or bringing someone else down, we try to keep it under control. In the multidisciplinary arena of aphasiology, investigators may become passionate about their own discipline's approach to the study of language or the brain. A science journalist,

visiting a conference on memory, was amazed to find neuroscientists, psychologists, and others behaving like warring tribes suspicious of each other's customs (Johnson, 1991). A dispassionate attitude does not raise artificial walls around a literature search and can maximize the insights available to a clinical investigator.

## Be Comprehensive

Experiments are supposed to result in a modification or evolution of theory. A historical perspective can take us back as far as we can go regarding any commentary about language, the brain, or brain dysfunction. Our initial thought might be to look only for theory-driven studies. However, once we become comfortable with how theories are tested, we may also consider backtracking by recognizing new relevance in old work, especially in clinical research that has been largely empirical or atheoretical. Such studies may coincidentally address theoretical questions that had not been recognized by the investigators. We might also give new relevance to old theory, such as old studies of short-term memory that may now be understood within the framework of working memory and storage buffers.

In addition to the historical dimension, we also contend with the breadth of contemporary work created partly by the multiple disciplines that have different ways of characterizing the jobs performed by the brain. We discover that clinical aphasiologists are not the only ones who have developed paradigms for the study of word finding, for example. When we are broadly comprehensive, we also discover quite similar theories beyond the shores of our own approach. So-called mapping therapies turn out to be nearly identical to Luria's externalization of schemas, but this link has been ignored in reports of mapping therapy (Byng, 1988) or similar treatments (LeDorze, Jacobs, and Corderre, 1991).

A few clinical investigators may avoid dealing with disciplines like cognitive psychology because they tolerate alternative theories rather than a single answer to a problem. Yet, the existence of alternative theories is common in any science. Besides being closer to the truth than simple answers, multiple theories provide opportunity. Experiments are created to compare two theories dispassionately rather than prove that a favorite theory is correct. For example, in psycholinguistics, a study of normal object-naming compared a serial activation theory to a parallel activation theory (Levelt, Schriefers, Vorberg, Meyer, Pechmann, and Havignat, 1991), and a study of the bilingual mental lexicon compared a *word association* theory and a *concept mediation* theory of lexical-semantic storage (Kroll and

Stewart, 1994). Clinical research may also help determine which of these theories is best.

## Be Selective

Being comprehensive can lead to a seemingly overwhelming compilation of ideas or theories about the domain of investigation. We become selective, perhaps, as selective as a courtroom judge must be in admitting evidence to a trial. One criterion for selection is the relevance of evidence to the study under consideration.

The number of available theories varies as a function of the level of a domain we are thinking about. If we are considering theories of language processing, there are many theories. If we are considering comprehension, there are several. If we are considering sentence parsing or lexical storage, there are relatively few theories to consider. Some theories are too general, and a selective focus is achieved partly by confining a literature search to the level of language function being studied.

Some theories were developed too long ago to be useful. Because we do research to learn something new, we determine what is new by reviewing **current research**. The review process for grant proposals may be the most demanding in this regard. Reviewers want to see that we are on the proverbial cutting edge, which was defined best by the hockey star Wayne Gretzky, who said, "Most hockey players skate to where the puck is. I skate to where the puck is going to be." If we want to know the future of an applied discipline, we examine what is going on in basic disciplines. Grant proposal reviewers know we are on the cutting edge when we report conversations with other investigators as well as the latest conference presentations. Almost published work gives us an idea of where the puck is going.

A desire to advance clinical aphasiology obligates us to evaluate the quality of sources. Some are better than others. When we want to refer to Wernicke, we read Wernicke. A biographer examines letters written by the subject rather than relying on other biographies. A witness in a trial is expected to provide eyewitness testimony, not hearsay. **Primary sources** enable us to be accurate in representing the relationship between data and theory in an investigation. We might be particularly concerned about a secondary source that is advancing one theory or paradigm. This source may emphasize only certain parts of another theory that put the source's own theory in a better light. Use of an expert witness is suggestive of a similar consideration, and we rely on **primary expertise**. We need to read psycholinguists, not aphasiologists or neurologists, for information about psycholinguistics.

## Be Knowledgeable

What if we're not knowledgeable enough about what the disciplines are and who the primary experts are? A computer search can be risky because of variations in terminology created by the multidisciplinary study of language. We need to do some homework in preparation for doing the homework. Here are some suggestions: (1) If you are a clinician in a hospital, you may consider getting help from your local professor. If you are a professor, you may consider getting help from your local clinician. Clinical research benefits from a **team approach** in which someone contributes clinical expertise and someone else contributes research expertise. (2) When pursuing an unfamiliar topic, seek texts or chapters intended to explain the topic to undergraduate students. These sources tell us what the main theories are and who the leaders are. (3) Some journals like *Psychological Review* contain excellent reviews and critical essays on specific topics. Secondary sources often help us understand a theory better. (4) If a psycholinguist at the local university is giving a public lecture on sentence comprehension, go to it.

## Be Nosy

This is called the *Geraldo principle*. Dig deep for the contextual forces such as geographic location of the work in relation to its location in time. For example, what was taught about language in European universities to influence Wernicke's or Head's thinking about language? Who did they know? Did it matter whether aphasia was being studied in England or France? Regional chauvinism may imprison a body of work. Are Russian authors referring only to Russians? Are Bostonians referring only to other Bostonians? Do approaches vary as a function of whether they are utilized mainly in Europe or the United States, or the Mayo Clinic, or Kansas? Is an approach drawn solely from friends? Regional chauvinism is a signal telling us to consider that there may be substantive weaknesses in the research.

## EVALUATING PREVIOUS RESEARCH

As the first speaker for a one-day conference in Cincinnati several years ago, Bob Brookshire said something like, "Don't believe anything I say today and don't believe anyone else either." We realize that Brookshire was imploring the audience to be analytical as it listened to what was being said. We need not be in awe of any work, because it is in the nature

of the beast we are studying that some factors will not be controlled and some parts of a body of data will be hard to explain.

We may feel that we do not know enough to be critical of theories developed in another discipline. As Dirty Harry said, "A man's gotta know his limitations." Critical essays in the cognitive sciences have a great deal to teach about how theoretical issues are maturely argued. The following questions are commonly addressed in these essays.

### **Is the Theory Explanatory?**

Is the theory explanatory? In other words, is it really a theory? Theoretical propositions should address cognitive or neural phenomena that account for observations. One of the most common mistakes is to offer an interesting description of behavior as an explanation of the behavior. For example, to say that aphasia is a multimodality disorder is offering a description of the disorder. What we need is an explanation for why it is a multimodality disorder.

### **Is the Theory Explicit?**

The explicitness of a theory is like the measurability of a treatment objective. Is the theory transparently suggestive of a method for testing it? Byng (1988) worried that the theory of semantic mapping in sentence comprehension is not explicit enough to be clearly suggestive of procedures intended to repair the mapping process. What are the distinctive mental processes that enable someone to relate a syntactic structure to thematic roles? Such specificity should be suggestive of experiments that would distinguish between tests of parsing and tests of semantic mapping.

Lack of explicitness seems to coincide with the ambiguity of a theoretical construct. For example, it may be unclear as to whether an investigator is studying perception or recognition. Making the distinction leads to an experimental method that also makes the distinction, such as ensuring that one procedure requires a subject to access information in long-term memory and another procedure does not require this process. This permits an investigator to interpret a problem more accurately. A similar ambiguity can exist in fuzzy theory of so-called lexical-semantic processing in which there is a failure to distinguish between accessing the lexicon and accessing concepts. As a result, an investigator may use words to study the status of concepts without recognizing the involvement of lexical memory in the task. Similarly, vague references to a *lexical system* may not distinguish between lexical storage and lexical activation and, thus, do not lay the foundation for testing this distinction (Hillis, 1993).

### **Is the Theory Complete?**

The aforementioned vagary of theoretical constructs leads to having an insufficient number of conceptual tools for predicting and explaining experimental results. Cognitive theorists agree that a complete theory of any function should account for the knowledge and processing required to perform the function. A theory may not account for all that we want to know in treatment research. Caramazza (1989) and Holland (1994) worried that theory of disorder by itself is inadequate for providing a theory of treatment. Theory of treatment should account for the manner in which psycholinguistic processes might change in response to behavioral manipulations. Also, in evaluating the work of others, we should look for whether the investigator deals with unpredicted results in a forthright and convincing manner.

### **Is the Theory Parsimonious?**

Researchers commonly remark on whether a theory is economical or elegant. Parsimony means frugal to the point of being stingy. Scientists often strive to achieve a theory that explains the most observations with the fewest propositions. The Nobel Prize winning physicist, Richard Feynman, wanted to explain everything in the world in one sentence. Chomsky's goal was similar, namely, to discover a universal grammar with the fewest possible rules. For example, Government-Binding theory substitutes a single movement rule for several transformations in previous grammars (Grodzinsky, 1990). Striving for simplicity is motivated by the assumption that people process information in the most efficient manner possible.

### **Is the Theory Comparable to Others?**

We may be confronted with the challenge of determining the logical similarities and differences among theories. Some of the many process models used in cognitive neuropsychology differ only in artistic style or in names used for the same components (e.g., *visual analysis* and *word perception*). We should be careful not to confuse a theory in different packaging as being two different theories. On the other hand, seemingly similar theoretical schemes may contain significant differences. Process models differ with respect to the kinds of phenomena that boxes and arrows refer to. Sometimes the arrows are said to refer to the informing connections between processors located in boxes. Other times the arrows are said to

refer to processes, while the boxes refer to storage. Still other times an author does not clearly say it is one way or the other.

More substantial differences exist. Theories of lexical access for word recognition and retrieval are available in cognitive psychology (Forster, 1976; Marslen-Wilson, 1989) and cognitive neuropsychology (Hillis, 1993; Patterson and Shewell, 1987). One difference is the extent to which a theory predicts performance based on a detailed characterization of lexical knowledge, such as network theories in cognitive psychology. Also, in theories of word reading, the location of grapheme-phoneme conversion differs. In dual-route theory from cognitive psychology, conversion is one route to the lexical activation required for word recognition (Garnham 1985); whereas, in task-related process models from cognitive neuropsychology, conversion mediates between input and output processing and bypasses the central lexicon (Patterson and Shewell, 1987; Raymer, Thompson, Jacobs, and Le Grand, 1993). Cognitive neuropsychology seldom represents dual-route options for word recognition.

Thinking of two theories in conflict is tempting, especially when conflict is interesting and the two theories appear to account for the same observations. However, conflicts are often more apparent than real. Conflict exists when two theories are trying to walk through the same door at the same time, and the door is only big enough for one. Schuell's so-called unidimensional and Boston's multidimensional views are incompatible for capturing the essence of aphasia. However, they were based on quite different types of observations (Davis, 1993). Reconciliation is possible when two theories account for different types of data.

## Is the Method Appropriate?

Appropriateness of an experiment is like appropriateness of a treatment relative to a treatment objective. That is, will the method actually answer the question being asked? Furthermore, was a method capable of eliciting all the conclusions that were made? For example, off-line procedures are sometimes used for examining presumably automatic processes, when such processes are best examined with on-line procedures.

Subtle aspects of procedure became important in *Brain and Language* regarding application of the lexical decision paradigm. In the 1980s, Milberg and Blumstein made admirable attempts to determine whether these two types of aphasia differed in their activation of meaning upon hearing a word (Milberg, Blumstein, and Dworetzky, 1987). Their results indicated surprisingly that people with Broca's aphasia did not activate meanings automatically. Subsequently, other investigators simplified the task and paid more attention to variables that had been shown in

psycholinguistics to be important in differentiating automatic from controlled processes. They found evidence that Broca's subjects could activate meanings automatically (Hagoort, 1993; Ostrin and Tyler, 1993). These studies do not conflict, because their methods were different; the second group of studies may be said to have corrected a limitation of the earlier studies.

### **Are the Conclusions Believable?**

As Brookshire's warning in Cincinnati implies, the possibility of methodological error should remind us to be careful to avoid automatically accepting anyone's conclusions. We sometimes fret about conclusions drawn from statistically nonsignificant results. Occasionally, we read about a "right visual field effect that was nonsignificant" instead of a clear statement that "there was no difference." These are attempts to make it sound like there was a difference when there was no difference according to the statistics. In case studies, it behooves us to ask ourselves if we are convinced that a dissociation has occurred based on the data. Look at the number of items presented for a task. Consider that no objective statistic was applied to determine differences in performance.

In a hemifield study with a semantic priming task, Deloche and Seron concluded that the left hemisphere dominates in the processing of low-imagery word meanings (Deloche, Seron, Scius, and Segui, 1987). The study depended on presentation of 16 semantically ambiguous French words, each with a high-imagery meaning and a low-imagery meaning. The study would have been convincing if the article had presented examples of ambiguous high- and low-imagery words. Yet, not one example was provided, not even one or two in the methods section of the article. Journals such as *Journal of Memory and Language* now commonly include a complete list of stimuli in an appendix so that we can evaluate whether each item in a condition is representative of a concept being studied.

### **THE DATABASE: A TECHNIQUE FOR TRACKING RESEARCH**

Some of the aforementioned recommendations, such as being comprehensive and selective, can be managed by using a computer database for tracking details about a vast amount of research. A database system is particularly useful for doing increasingly popular meta-analyses of the literature, such as the tracking of clinical research by Horner and Loverso (1991) and Kearns and Thompson (1991). Manuals for *Access* (Microsoft Corporation 1992), or any other database, assume that it will be used for business pur-



poses such as storing information about products and customers (Simpson 1993). Instead of information about companies, contacts, customers, products, etc., *Access* also can store information about references pertaining to many topics about language and language disorders.

The initial and most basic task is to build a TABLE in which all information is stored. In these tables, an item includes authors, title of an article, and any attribute of articles that we want to record. These tables may also contain as many as 40 to 60 types of information about an article. However, not all the information can be seen in a table's window. A FORM is created in order to view all the stored information about each reference in the computer's window. The form is also used for all work with a file, such as depositing a reference, recording information about it, and searching for a subset of references in a particular file. One feature of a form is the *drop-down box*, which can be used for maintaining a permanent list of several journal names. Simply click a journal name, rather than having to type it over and over for each reference from that journal.

There are several ways in which information about a study can be deposited into a form: (1) *Yes-no boxes* tell us whether a study contains certain essential features, such as modalities of stimulus and response or whether variables include word frequency or grammatical category or whether a study supports a serial or interactive theory of language processing; (2) *drop-down boxes* allow the maintenance of a hidden list of descriptive features pertaining to, for example, the type of subject group or the particular theory supported by the study; (3) a *memo box* stores a summary of any length that can be copied back and forth between the database and a word processing file.

Three databases deal with normal language, language disorders, and rehabilitation. Each of these databases has several files for which tables and forms have been created. That is, the normal language database contains files for lexical recognition, lexical comprehension, sentence comprehension, language production, etc. For an idea of the amount of information that can be handled, 360 references are currently stored for the lexical recognition file; and each item contains around 45 attributes of articles in this category. A *sorting system* retrieves subsets of references according to any feature or combination of features, in alphabetical or chronological order.

## CONCLUSION

As part of a tutorial about conducting theoretically motivated research, this article contains some general guidelines for searching the literature followed by some guidelines for evaluating theories that we find in the literature. The

article also describes a sophisticated database for organizing a comprehensive and balanced storage of information and facilitating a focused search of information pertinent to a particular experiment. Clinical aphasiologists have a demanding responsibility for ensuring that experiments are conducted and reported in accordance with the basic sciences dealing with the phenomena being studied, namely, language functions.

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