Second Purdue Symposium on Psychological Sciences

Psychology of Science: Implicit and Explicit Reasoning

Sponsored by the Department of Psychological Sciences
of the
College of Liberal Arts
At
Purdue University

Friday June 4 & Saturday June 5, 2010

Psychology of Science: Implicit and Explicit Reasoning

Organized by
Robert W. Proctor and E. J. Capaldi

On behalf of the Department of Psychological Sciences at Purdue University, we welcome you to the ***Second Purdue Symposium on Psychological Sciences***. This recurring event showcases current and emerging topics within psychology and related disciplines. It will form the basis for an edited volume following each symposium (with this year's volume to be published by Oxford University Press).

The application of psychology to science (the psychology of science) is a young, rapidly growing and important area of study. Consequently, we have selected the theme and title for the symposium of "Psychology of Science: Implicit and Explicit Reasoning." Our intent is for the talks to represent a broad array of opinion on a wide variety of issues in the psychology of science, with emphasis on the roles of implicit and explicit psychological processes in the creation of science. Although implicit processes have attracted some attention, most prior work in this area has emphasized the role of explicit reasoning in science. Contemporary research in psychology, however, has shown the importance of implicit processes in decision-making and choice, and that performance of many tasks involves a complex relationship between implicit and explicit processes. For this symposium, we have gathered leading researchers and theorists not only in the psychology of science, but also in the philosophy of science and in implicit/explicit psychological processes. Each contributor will highlight her or his current work and views related to the psychology of science, including to the extent possible the roles of implicit and explicit processes in science. It is our hope that this symposium will lead to more detailed consideration of implicit and explicit processes in scientific thinking.

Program

Friday June 4, 2010

Stewart Center, Room 302

12:00 noon	**Registration Opens**
1:00	**Opening Remarks**

Role of the Psychology of Science

1: 15	**Keynote Address: The Psychology of Science is off and Running but Where Do We Go from Here?** Gregory J. Feist, San Jose State University
2:15	**The Role of Psychology in an Agent-Based Theory of Science** Ronald N. Giere, University of Minnesota
2:45	**The Theory Ladenness of the Mental Processes used in the Scientific Enterprise: Evidence from Cognitive Psychology and the History of Science** William F. Brewer, University of Illinois at Urbana-Champaign
3:15-3:30	**Break**

Implicit and Explicit Processes in the Cognitive Psychology of Science

3:30	**What are Implicit and Explicit Processes?** Jan De Houwer & Agnes Moors, Ghent University
4:00	**Implicit Cognition and Researcher Conflict of Interest** Anthony G. Greenwald, University of Washington
4:30	**The Interaction of Implicit vs. Explicit Processing and Problem Complexity in Scientific Reasoning** Corinne Zimmerman, Illinois State University
5:00	**How Should We Understand the Implicit and Explicit Processes in Scientific Thinking?** Donelson E. Dulany, University of Illinois at Urbana-Champaign

Saturday June 5, 2010

Stewart Center, Room 302

7:30 a.m. **Continental Breakfast**

Methods in the Psychology of Science

8:30 **Methods for Studying Scientific and Technological Expertise**
Michael. E. Gorman, University of Virginia and National Science Foundation

9:00 **The Practice of Psychological Science: Evidence for Cronbach's Two Streams in Social-Personality Research**
Jessica L. Tracy, University of British Columbia; Richard W. Robins, & Jeffrey W. Sherman, University of California, Davis

9:30 **How Explanation Makes Information Evidentially Relevant**
Barbara Koslowski, Cornell University

10:00-10:15 Break

Cognitive Psychology of Science – I

10:15 **From Genes to Complex Theories: How Individuals and Groups Discover and Construct Science**
Kevin N. Dunbar, University of Toronto

10:45 **Creative Conceptual Combination in Scientific Discovery**
Paul Thagard, University of Waterloo

11:15 **On the Unreasonable Reasonableness of Mathematical Physics: A Cognitive View**
Ryan D. Tweney, Bowling Green State University

11:45-1:00 **Lunch – STEW 306**

Cognitive Psychology of Science – II

1:00 **Transforming Implicit Misconceptions into Explicit and Correct Knowledge via Adaptive Tutoring**
David Klahr & Stephanie Siler, Carnegie Mellon University

1:30 **Scientific Creativity as Blind Variation: BVSR Theory Revisited**
Dean Keith Simonton, University of California, Davis

A Different Perspective on the Psychology of Science

2:00 **Problems of Ontological Dualism in Psychological Science**
Brent D. Slife, Brigham Young University

2:30-2:45 Break

Cultural and Social Factors in Psychology of Science

2:45 **Feminism and the Psychology of Gender**
Alice Eagly, Northwestern University

3:15 **The Acting Person in Science Practice**
Lisa M. Osbeck, University of West Georgia, & Nancy J. Nersessian, Georgia Institute of Technology

3:45 **What does it Mean for Cognitive Psychologists to Study Groups of Scientists at Work? The Interplay of Cognitive and Social Variables**
Christian Schunn & Susannah Paletz, University of Pittsburgh

Discussion of Talks (4:15-5:00)

Abstracts

(in alphabetical order by speaker)

The Theory Ladenness of the Mental Processes used in the Scientific Enterprise: Evidence from Cognitive Psychology and the History of Science

William F. Brewer
University of Illinois at Urbana-Champaign

Hanson (1958) and Kuhn (1962) made strong psychological claims in favor of the theory ladenness of scientific observations. In this talk I argue that the field of Philosophy of Science has taken too narrow a view of this issue--focusing almost exclusively on visual perception. I propose that to understand the issue of theory ladenness in the scientific enterprise one must take a much broader view of the psychological processes involved in scientific research and explore the theory ladenness of perception, attention, data interpretation, data production, memory, and scientific communication. This talk uses evidence from Cognitive Psychology and the History of Science to explore these issues. The evidence shows theory ladenness occurring in many cognitive processes needed for carrying out science thus supporting Hanson and Kuhn's original claims. The evidence suggests that these top-down processes typically operate outside of awareness. The evidence also shows that the top-down influences are only strong when the bottom-up information is weak or ambiguous. The paper concludes that the top-down, bottom-up synthesis in current cognitive psychology supports the general arguments in the Philosophy of Science for theory-ladenness and against the earlier positivist position that sensory data can provide an objective foundation for science, but does not lead to epistemological relativity.

What are Implicit and Explicit Processes?

Jan De Houwer and Agnes Moors
Ghent University

We define “implicit” as synonymous to “automatic”. In line with a conditional approach to automaticity (Bargh, 1992; Moors & De Houwer, 2006), the concept “automatic” is regarded as an umbrella term that refers to a variety of automaticity features that do not necessarily co-occur. Each automaticity feature refers to the absence of certain other processes or elements in the environment. Hence, implicit processes are defined as processes that operate under suboptimal conditions, that is, even in the absence of certain goals, awareness, processing resources, or time. This definition implies that researchers should always specify the way in which a process is implicit (i.e., the automaticity features to which they refer) and provide evidence to support the claim that the process actually is implicit in that manner, that is, operates under certain suboptimal conditions. We will illustrate this approach in the context of research on implicit measures of attitudes and will explore its implications for the role of implicit processes in research in general.

How Should We Understand the Implicit and Explicit Processes in Scientific Thinking?

Donelson E. Dulany
University of Illinois at Urbana-Champaign

Psychology of science can now be a blend of basic science of psychology, for implications, and aspects of philosophy of science, descriptive and normative.
1. One thesis for this talk follows from a mentalistic metatheory on which symbolic representations are carried solely by conscious states. On a standard view, explicit processes are conscious processes and implicit processes are unconscious processes. A mentalistic metatheory, however, implies theories in which explicit and implicit processes are orthogonal to the conscious and nonconscious. Explicit processes are deliberative mental episodes in which propositional contents are interrelated by deliberative operations—inference, decision. Implicit processes are evocative mental episodes in which sub-propositional contents are interrelated by associative-activational operations—thus automatic. In both cases, the contents are carried by conscious states and the mental operations are non-conscious (Dulany, 1997, 2004, 2009). Learning may be explicit or implicit, but the explicit better handles transfer to the novel, as experimentally illustrated. Bayesian inference, an explicit process, is also a normative standard for competitive support of theories, even with hypothetical process constructs. 2. Drawing on social psychology of science, descriptively, I will suggest that historical episodes and ideological commitments have influenced credibility of (a) identifying “implicit” with “unconscious”, and of (b) questionable supportive methodology—in the psychology of some of our science .

From Genes to Complex Theories: How Individuals and Groups Discover and Construct Science

Kevin N. Dunbar
University of Toronto

The nature of science, how to conduct science, and how to teach and learn science are constant questions for the Psychology of Science. Thus, over the past 40 years educators have debated whether students should be taught key scientific concepts per se, be taught to think like scientists, how to use scientific methods and interpret data. This has resulted in the publications of many reports from organizations such as the National Academies of Science. However, despite the large number of reports there has been little consensus on the above questions. In our research, we have investigated the ways that scientists, children and families reason about science in naturalistic situations such as the science laboratory and the science museum to determine how scientists and students think about scientific concepts outside the classroom. We have then investigated (using brain-imaging techniques in controlled experiments) the ways that students use scientific concepts. Most recently, we have investigated the ways that students understand scientific concepts using contemporary brain imaging techniques such as functional Magnetic Brain Imaging (fMRI) and functional Near Infrared Spectroscopy (fNIRS). All three methods have led us to the conclusion that acquiring new concepts in science, such as going from pre-Newtonian to Newtonian conceptions of motion, or understanding what happens when a substance changes from a liquid to a gas, is different for certain types of concepts. For some concepts students must learn to inhibit the old concepts, for other types of concepts students must learn to categorize the concepts differently (and the learning context can change the way the brain is activated for these concepts), for a third type of concept they must reorganize and construct the new concept de novo. Thus, rather than there being a one-size-fits-all view of science, or a -one-size fits-all learning strategy different types of scientific concepts need to be taught in ways that are relevant to student's current understandings. Our work is leading is to propose that there are core areas of knowledge that students bring to the lab, the classroom and the world in general that shape science learning in real and meaningful ways. In addition, our work shows that specific learning strategies such as analogical thinking and causal reasoning help students integrate their nascent ideas into long-lasting and useable knowledge.

Feminism and the Psychology of Gender

Alice Eagly
Northwestern University

During feminism's "second wave" of activism, feminist psychologists argued that psychology was profoundly biased in its understanding of women and gender. These critiques included Weisstein's (1968) scathing ridicule of psychologists' characterizations of women as childlike, unassertive, and interested only in finding a husband and bearing children and Shields' (1975) listing of psychology's "social myths" such as maternal instinct. An outpouring of criticism converged on several conclusions:

1. Many phenomena relevant to women's lives had been neglected—for example, violence against women. Even developed research areas such as the study of prejudice rarely considered gender.
2. The small then-existing body of gender research usually reflected a male perspective that depicted men as superior to women and invoked biological explanations with little evidence of their validity.
3. Contributing to psychology's misunderstandings were methods that neglected social context and generally disallowed qualitative descriptions that would allow women's voices to be heard.
4. Hewing to a naïve positivism by which research is objective, psychologists failed to recognize the biases flowing from their own patriarchal society and (for men) from their dominant position within that society.

The talk will consider the ways in which the science of psychology has reacted to this feminist critique and describe current discourse on these issues.

Cross Cultural Decision Making: Impact of Values and Beliefs on Decision Choices

Gregory J. Feist
San Jose State University

Since 2006, the psychology of science has become an established discipline, taking its place among the older studies of science, philosophy, history, and sociology. In 2006, the first international conference on the psychology of science was held in Zacatecas, Mexico, from which the “International Society for the Psychology of Science and Technology” (ISPST) was officially launched. The following year, the first peer-reviewed journal was started, the *Journal of Psychology of Science and Technology.* This symposium at Purdue itself is a sign of the field’s emergence. To be sure, however, the society and journal are still relatively small and young. But with lots of room to grow, the question arises, Where next? To survive and thrive we need graduate training programs, federally funded grants, research centers, and undergraduate and graduate courses and even degrees. Along with Mike Gorman, I have been working on proposals for training grants and other graduate student-oriented initiatives, such as ISPST awards and scholarships for the best undergraduate and graduate research projects on the psychology of science. My talk will review some of the brief history of the field and detail some of the initiatives we are undertaking to ensure its healthy maturation in the future.

The Role of Psychology in an Agent-Based Theory of Science

Ronald N. Giere
University of Minnesota

The reigning theories of science in the philosophy and sociology of science have been dismissive of any role for psychology in a general theory of science. This is true of historical approaches to the philosophy of science, based on some notion of a research tradition, well as older logic-based accounts emphasizing the logical structure of scientific theories and inductive logic. And it has been a prominent feature of recent sociology of science. However, if one takes a natural scientific agent (as opposed to an idealized rational agent) as the fundamental unit in a theory of science, there is the possibility of a genuine role for the psychology of science within a general theory of science. In this presentation, I will explore this possibility with special attention to the view that much scientific cognition is distributed among numerous agents as well as a vast array of instrumentation.

Methods for Studying Scientific and Technological Expertise

Michael E. Gorman
University of Virginia and National Science Foundation

There is a growing literature in psychology of science on the acquisition of expertise and its application in a variety of domains. There is also a new research program in science and technology studies devoted to Studies of Expertise and Experience. This presentation will briefly link these two literatures, using methodological strategies as an organizing framework, focusing especially on the relationship between explicit and implicit knowledge. These strategies include: 1. In vitro research using laboratory tasks that emulate scientific reasoning. Research on implicit knowledge in artificial grammars would fit this category as well. 2. In Vivo research, involving direct observation of scientists and engineers working on problems they encounter in the course of their work. 3. Sub species historiae research using notebooks and other records for Faraday, Bell and the participants in the Great Devonian controversy. Because these records are explicit, it is harder to track implicit knowledge than in the in vivo case. 4. In silico computational simulations of scientific and technological thinking. The late David Gooding combined historical research with computational simulation and reproduction of experiments to construct a picture of Faraday's expertise that combined both implicit and explicit components.

Implicit Cognition and Researcher Conflict of Interest

Anthony G. Greenwald
University of Washington

Decision makers are expected to identify and perhaps recuse themselves from actions that affect entities (such as relatives or corporations) to which their relationships create an appearance of conflict of interest. The science of implicit cognition helps us to identify sources of conflict of interest that many researchers, editors, grant decision makers, and reviewers may be blithely or self-deceptively unaware of. This talk illustrates these conflicts of interest (mostly from the author's own experience) and suggests ways of avoiding them.

Transforming Implicit Misconceptions into Explicit and Correct Knowledge via Adaptive Tutoring

David Klahr and Stephanie Siler
Carnegie Mellon University

In our work on teaching elementary school children about experimental design, we have discovered that they have a variety of characteristic – and typically only implicit -- misconceptions about several of the fundamental aspects of experimental science. In particular, they misconstrue what a "fair" test is, apply engineering rather than science goals, and fail to understand the logic for designing unconfounded experiments (e.g., they try to test multiple variables in a single experiment). Our research grows out of our earlier focus on the relative effectiveness on what we initially defined as "direct instruction vs. discovery learning". That work has evolved into our current project in which we are creating an intelligent computer based tutor designed to detect these implicit misconceptions, adapt instruction to the precise nature of the misconception, transform the implicit knowledge into explicit (albeit still incorrect) knowledge, and finally to remediate so as to wind up with a correct understanding of the conceptual and procedural basis of simple experimental design.

How Explanation Makes Information Evidentially Relevant

Barbara Koslowski
Cornell University

To explain an event, one must (among other things) sort through what is often a large body of implicit information and decide which information is likely to be explicitly relevant to the event. Several factors make this increasingly likely to happen. One is having a possible causal explanation—however rudimentary—for the event. Information is increasingly likely to be seen as evidentially relevant to an event when an explanation becomes available that can accommodate both the event and the information into a single causal framework. In addition, what we see as relevant to explaining an event is not an absolute; rather, it depends on the alternatives against which the target explanation is evaluated. Different information will be seen as more or less relevant depending on which alternatives are being presented as competing accounts. Furthermore, explanations can also structure the extent to which anomalous information becomes explicitly seen to be problematic. In addition, whether information is seen as relevant is also affected by whether there is a motivation either to confirm or to disconfirm an explanation, although the effect of motivation is not what confirmation bias might lead one to expect. Finally, information processing demands can interfere with realizing that certain information is relevant.
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The Acting Person in Science Practice

Lisa M. Osbeck and Nancy J. Nersessian
University of West Georgia and Georgia Institute of Technology

This talk foregrounds a need for accounts of science practice that demonstrate the intricate interrelationship of cognitive, social, and material domains, along with what is best described as the particularity of the scientist. Described here is an approach analyzing cognitive and learning practices in interdisciplinary research laboratories organized around *the acting person in normatively structured contexts of practice* as a unit of analysis. Responding to the methodological challenge following from this analytic focus, the investigation described combines a framework of distributed and situated cognition with a methodology of coding discursive strategies in individual interviews. The laboratories analyzed are two biomedical engineering laboratories on the campus of a large research university, and the scientists interviewed are of varying levels of expertise and different disciplinary backgrounds. We provide examples of discursive strategies that implicate affect/emotion and identity formation, both of which are critical to a focus on the acting person as a unit of analysis. In each case, three levels or forms of strategy are extracted and discussed. The examples help to illustrate how emotional expression and identity formation are continuously negotiated in relation to problem solving goals, other persons, and with the objects and artifacts important to that context of practice.

What does it Mean for Cognitive Psychologists to Study Groups of Scientists at Work? The Interplay of Cognitive and Social Variables

Christian Schunn and Susannah Paletz
University of Pittsburgh

Scientific reasoning is clearly a cognitive process. In actual science settings, however, this reasoning takes place in highly social settings. These social elements are typically ignored by cognitive psychologists as part of the usual scoping of research into subdisciplines. This decomposition or scoping strategy helps to create communities of researchers around manageable research questions. But important moderations and mediations might be missed. We consider the case of social and cognitive processes vis-à-vis studies of scientific reasoning, in particular the commonly examined social process of conflict from studies of functioning teams and the commonly examined cognitive process of analogy in creative thinking like scientific discovery. We have examined over 11 hours of audio-video data from informal conversations of the Mars Exploration Rover scientists as they analyzed rover data and planned new rover data collection activities, coding for different types of analogy and conflict. Using time-lagged logistic multilevel models we found that a complex pattern of association: Within-domain analogies, but not within-discipline or outside-discipline analogies, led to science and work process conflicts. These results suggest that social processes might lie between cognitive processes and performance outcomes, rather than simply as functionally independent levels of analysis, as is typically assumed.

Scientific Creativity as Blind Variation: BVSR Theory Revisited

Dean Keith Simonton
University of California, Davis

Campbell's (1960) blind-variation and selective-retention (BVSR) theory has now reached the half-century mark. In that time interval, BVSR has undergone considerable theoretical and empirical development, especially as a general theory of scientific creativity. An update on these developments begins with revised conceptual definitions, with special emphasis on the distinction between blind and sighted variations. Those definitions then provide the basis for criteria that can be used to identify when blind variation (BV) takes place in scientific creativity and discovery. These identification criteria are grouped into intended BV and inferred BV. Intended BV includes all instances where variations are blind by design, including both systematic and stochastic combinatorial processes. Inferred BV includes both variations that have the properties of blindness (such as superfluity and backtracking) and processes that should yield variational blindness (such as associative richness, defocused attention, behavioral tinkering, and heuristic search). Discussion then turns to common criticisms of BVSR theory. Some criticisms merely represent simple misunderstandings, whereas other criticisms betray profound misconceptions. The update then closes with an argument that BVSR enjoys a distinctive analytical connection with the very definition of creativity, at least if the latter is defined in terms of the generation of ideas that are novel, useful, and surprising.

Problems of Ontological Dualism in Psychological Science

Brent D. Slife
Brigham Young University

This presentation focuses on the ways in which psychological science has grounded its many method practices on an implicit, Cartesian philosophy. Separate subjective and objective worlds are taken for granted in these practices, along with many formal and informal method implications, such as objective (value-free) facts, the desire to eliminate subjective biases, objective data, the testing of subjective hypotheses, and the need for a correspondence of the subjective and objective to find the truth of the world. Unfortunately, there is considerable consensus that this dualistic worldview is deeply problematic. Yet, the degree of the Cartesian grip on psychology is so extensive that even the "softer," more humanistic approaches to investigation, such as case histories, are profoundly marked with its conceptual fingerprint. As a contrast from outside of psychology, a nondualist approach to knowledge advancement is described that assumes a disclosure, rather than a correspondence, theory of truth.

Creative Conceptual Combination in Scientific Discovery

Paul Thagard
University of Waterloo

Many writers on creativity have claimed that creativity requires the generation of new representations from old, and Terry Stewart and I have recently produced a neurocomputational model of how new concepts can be combined from old. We have shown how such combinations arise from mechanisms that bind together neural activity by a process of convolution, a mathematical operation that interweaves structures. Our computer simulations show the feasibility of using convolution to produce emergent patterns of neural activity of the sort that can support human creativity thought processes that are both cognitive and affective. But what is the evidence that all creativity results from novel combinations of mental representations? I will review a large sample of great scientific discoveries in order to assess the plausibility of the claim that scientific discovery requires conceptual combination. For each case, I will identify concepts that are surprisingly combined, and assess the representational format (e.g., verbal, mathematical, visual) of the initial concepts and the resulting combination. I will also consider arguments against and apparent counterexamples to the claim that all scientific discovery requires conceptual combination.

The Practice of Psychological Science: Evidence for Cronbach's Two Streams in Social-Personality Research

Jessica L. Tracy, Richard W. Robins, and Jeffrey W. Sherman
University of British Columbia and University of California, Davis

A recent study examining citation trends across psychological disciplines found that social-personality is a "broker" subfield, or hub of knowledge, in that it is both the largest provider and consumer of research within psychology as a whole (Yang & Chiu, 2009). Given the widespread dissemination of social-personality research to other subfields of psychology, it is critical that social-personality methods be widely accessible and understandable. In fact, findings from a recent study examining the practice of psychological science among social-personality researchers suggest that the structure of social-personality research may be ideally suited toward its becoming a microcosm of the larger field (Tracy, Robins, & Sherman, 2009). Specifically, social-personality research encompasses and integrates the two major "streams of thought," *correlational* and *experimental*, which characterize the field as a whole (Cronbach, 1957). This finding, which is based on factor analyses of leading social-personality psychologists' research approaches, methods, statistical procedures, and processes assumed to underlie effects, suggests that a distinction that at least implicitly characterizes all psychological subfields has, in social-personality, been explicitly codified. Indeed, the terms "social" and "personality" have come to mean much more than an emphasis on situational versus dispositional factors, and instead are indicative of a much broader range of theoretical assumptions and methodological approaches. In the present chapter, we review these findings, and discuss how they may relate to social-personality's status as a hub discipline.

On the Unreasonable Reasonableness of Mathematical Physics: A Cognitive View

Ryan D. Tweney
Bowling Green State University

Mathematics plays an essential role in physics, yet little attention has been given to the cognitive structures and processes that underlie this role. The computational and derivational advantages of mathematical approaches in physics are central, but there is also an important representational role. What, exactly, is a mathematical representation and how does it work in the thinking of physicists? The present paper suggests that several aspects can be cognitively described. First, mathematical representations can aid and extend visual representations, adding, for example, a dynamic aspect to otherwise static images (e.g., the equation of a parabola as a "movie" of a particle traversing a path), or even representing entire sets of such "movies" (e.g., a differential equation as capturing many possible paths of a particle). Second, even nonvisual imagery can be accommodated mathematically (as in "Maxwell's Equations," the partial differential equations which can be taken as representing stresses and strains within an invisible field). Such mathematical representations depend upon a set of well-learned expert skills that function partly as sophisticated retrieval devices, the "Long Term Working Memory" skills proposed by Ericsson and Kintsch. A cognitive-historical case study of Maxwell's development of his mathematical representations will be used to illustrate these claims.

The Interaction of Implicit vs. Explicit Processing and Problem Difficulty in Scientific Reasoning

Corinne Zimmerman
Illinois State University

Common theoretical models of cognition assume two modes of processing: implicit and explicit. These two modes of processing have been documented in processes of learning, memory, reasoning, and problem solving. Many of the reasoning tasks used previously have been based on hypothetical algorithms. We replicated and extended previous work on implicit and explicit approaches to problem solving with a real-world physics task. Strategy (implicit or explicit) and problem difficulty were manipulated, and their interaction was observed in three experiments using a balance-scale paradigm. The explicit, rule-seeking strategy led to rule induction for some participants. Among nondiscoverers, participants in the implicit condition (who did not seek the rule) were faster and more accurate on difficult problems compared to those using the explicit approach. The use of misleading exemplars led to fixation on inappropriate hypotheses for explicit but not implicit participants. When more diagnostic learning exemplars were used, explicit nondiscoverers still performed worse than implicit participants on the most difficult problems. In two of the experiments, an implicit approach led to better post-test performance (near transfer) than an explicit approach, suggesting that implicit processing allows the expression of passively acquired knowledge.