

CREATIVE HYPOTHESIS GENERATING IN PSYCHOLOGY: Some Useful Heuristics

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ABSTRACT

To correct a common imbalance in methodology courses, focusing almost entirely on hypothesis-testing issues to the neglect of hypothesis-generating issues which are at least as important, 49 creative heuristics are described, divided into 5 categories and 14 subcategories. Each of these heuristics has often been used to generate hypotheses in psychological research, and each is teachable to students. The 49 heuristics range from common sense perceptiveness of the oddity of natural occurrences to use of sophisticated quantitative data analyses in ways that provoke new insights.

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INTRODUCTION

Psychologists know well that research involves generating hypotheses and theories as well as testing them. However, our methods courses and textbooks concentrate heavily on procedures for testing hypotheses (e.g. measurement, experimental design, manipulating and controlling variables, statistical analysis, etc) and they largely ignore procedures for generating them. This pedagogic neglect probably reflects, not failure to appreciate the importance of creative hypothesis generating, but despair of teaching or even describing it. I have contended (McGuire 1973, 1983) that creative hypothesis-generating aspects of research on both strategic and tactical levels can be taught. While in the past (McGuire 1989) I have discussed creative hypothesis generation on the strategic level, here I address it at the tactical level by describing a variety of creative heuristics psychologists have used and that can also be taught.

My “Yin and Yang” article (McGuire 1973) gave some examples of hypothesis-generating techniques that can be described and taught. Shortly after that article appeared I was surprised to receive a curt note from an annoyed reader pointing out that in my article I mentioned having taught a “dozen” such creative techniques but then in the article I gave only nine examples. Where, this reader wanted to know, were the other three? The request struck me as a bit pedantic, but before I could reply “Who’s counting?” I received two more inquiries from readers demanding, “Where are your other three examples?” My articles usually evoke at most a few reprint-request postcards from East Europe, so the receipt of three letters of complaint seemed like a mass protest and raised the specter that I might be called before some ethics committee for giving short weight. In a nervous rush to write down a few more examples of creative heuristics, so that I could send a baker’s dozen to any future inquirer, I overshot the target and generated dozen after dozen until the list grew to the 49 heuristics shown in Table 1.

Any list with 49 items would be cruelly long if left unorganized. Therefore, in Table 1 these creative, hypothesis-generating techniques are grouped into five increasingly demanding categories, each with subcategories. Category I

includes nine observational heuristics that simply require sensitivity to provocative natural occurrences (e.g. Subcategory IA calls for noticing and accounting for the provocative oddity of exceptional occurrences). Categories II and III call for going beyond observational sensitivity by requiring also conceptual analysis, either by direct inference, such as accounting for the contrary of a banal hypothesis (Category II), or by more complicated mediated inference, such as using a thought-diversifying structure (Category III). The final two categories, IV and V, go beyond a priori conceptual analysis by requiring some wrestling with empirical data, either by retrospectively examining past studies, such as by decomposing a complex obtained relation into multiple simpler components (Category IV), or by prospectively reanalyzing old data or collecting new data, such as by content-analyzing participants' open-ended responses to obtain new insights (Category V). For each of the fourteen A through N subtypes of these five categories (see Table 1), I describe one illustrative heuristic with examples of its uses in psychology and then mention more briefly additional heuristics within the subcategory.

I. HEURISTICS REQUIRING SENSITIVITY TO PROVOCATIVE NATURAL OCCURRENCES

The relatively simple heuristics in Category I require no special training in subject matter (e.g. psychology) or in formal analysis (e.g. statistics) but call only for cultivating habits of observation that focus one's attention on fertile aspects of natural experience. Everyone tends to focus on unexpected nonobvious relations (McGuire 1984), but appropriate training may strengthen and refine this productive tendency. Table 1 groups simple observational techniques for producing new insights into four subcategories of increasing complexity and deliberateness.

The simplest, Subcategory A, involves responding to the provocative oddity of exceptional occurrences. The slightly more complex Subcategory B requires introspective self-analyses in addition to external observation. Subcategory C calls for retrospective comparisons such as extrapolating from similar problems already solved. To use heuristics in these first three subcategories, it is sufficient to react to fortuitous experience, but Subcategory ID requires deliberately immersing oneself in sustained, purposeful observation, such as compiling intensive case studies. Nine heuristics are grouped within these four (A through D) subcategories.

A. Recognizing and Accounting for the Oddity of Occurrences

1. ACCOUNTING FOR DEVIATIONS FROM THE GENERAL TREND Researchers tend to be so preoccupied with searching for regularities that they tend to

Table 1 Creative heuristics used to generate psychological hypotheses

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- I. Heuristics Simply Calling for Sensitivity to Provocative Natural Occurrences
- A. Recognizing and Accounting for the Oddity of Occurrences
 1. Accounting for deviations from the general trend
 2. Accounting for the oddity of the general trend itself
 - B. Introspective Self-Analysis
 3. Analyzing one's own behavior in similar situations
 4. Role playing one's own behavior in the situation
 - C. Retrospective Comparison
 5. Extrapolating from similar problems already solved
 6. Juxtaposing opposite problems to suggest reciprocal solutions
 - D. Sustained, Deliberate Observation
 7. Intensive case studies
 8. Participant observation
 9. Assembling propositional inventories
- II. Heuristics Involving Simple Conceptual Analysis (Direct Inference)
- E. Simple Conversions of a Banal Proposition
 10. Accounting for the contrary of a trite hypothesis
 11. Reversing the plausible direction of causality
 12. Pushing an obvious hypothesis to an implausible extreme
 13. Imagining the effects of reducing a variable to zero
 14. Conjecturing interaction variables that qualify a relation
 - F. Multiplying Insights by Conceptual Division
 15. Linguistic explorations
 16. Alternative manipulations of the independent variable
 17. Dividing the dependent variable into subscales
 18. Arranging output subcomponents into a sequence
 - G. Jolting One's Conceptualizing Out of its Usual Ruts
 19. Shifting attention to an opposite pole of the problem
 20. Alternating preferred with nonpreferred research styles
 21. Expressing one's hypothesis in multiple modalities
 22. Disrupting ordinary states of consciousness
- III. Heuristics Calling for Complex Conceptual Analysis (Mediated Inference)
- H. Deductive Reasoning Procedures
 23. Generating multiple explanations for a given relation
 24. Alternating induction and deduction
 25. Identifying counterforces obscuring an obvious relation
 26. Hypothetico-deductive sets of postulates
 - I. Using Thought-Diversifying Structures
 27. Using an idea-stimulating checklist
 28. Constructing provocative complex generating structures
 29. Formalizing explanatory accounts
 - J. Using Metatheories as Thought Evokers
 30. The evolutionary functionalism (adaptivity) paradigm
 31. Transferring conceptualizations analogously

Table 1 (continued)

32. Quixotic defense of a theory
IV. Heuristics Demanding Reinterpretations of Past Research
K. Delving into Single Past Studies
33. Accounting for irregularities in an obtained relation
34. Decomposing nonmonotonic into simpler relations
35. Deviant-case analysis
36. Interpreting serendipitous interaction effects
L. Discovery by Integrating Multiple Past Studies
37. Reconciling conflicting outcomes or nonreplications
38. Bringing together complementary past experiments
39. Reviewing and organizing current knowledge in an area
V. Heuristics Necessitating Collecting New or Reanalyzing Old Data
M. Qualitative Analyses
40. Allowing open-ended responses for content analysis
41. Participating actively in the research routine
42. Exploring a glamorous technique
43. Including low-cost interaction variables in the design
44. Pitting confounded factors against one another
45. Strategic planning of programmatic research
N. Quantitative Analyses
46. Multivariate fishing expeditions
47. Subtracting out the effect of a known mediator
48. Computer simulation
49. Mathematical modeling

suppress exceptions to the general trend as distracting aberrations. Heuristic A1 calls for a two-step analysis of experience, beginning with the usual teasing out of a general relation followed by noticing and accounting for deviant cases.

The challenge to use exceptions creatively can vary over several levels of difficulty. A relatively easy subtype is when the exceptionality receives wide publicity and discussion, in which case the researcher need not discover the oddity but only accept the challenge to account for the aberration, e.g. the paradoxically greater resistance to extinction of habits established by partial reinforcement than by 100% reinforcement. A more demanding variant of this heuristic calls for the researcher's actively seeking out nonsalient exceptions, as when a developmental psychologist, aware that children with traumatic childhoods tend to grow into disturbed, noncontributing adults, selects out for special study cases of traumatized children who in maturity became exceptionally high contributors to society. A third, still more demanding variant of heuristic A1 requires that the researcher show initiative in recognizing that an event is unusual. For example, all great cultural ages are by definition exceptional, but most are readily accounted for by unusually favorable circum-

stances (e.g. there is an *embarrass de richesses* to explain the greatness of Periclean Athens, Medician Tuscany, Elizabethan England). However, more interesting and creatively provocative are more puzzling cultural flourishings (e.g. *fin-de-siècle* Hapsburg Vienna, which was so productive in music, psychoanalysis, philosophy of science, Zionism, etc), which occurred under conditions that seem especially inauspicious and constitute exceptions even among the exceptional eras and so especially invite notice and explanation.

Students can be trained in the creative use of heuristic A1 by exercises that guide them through a series of steps that differ slightly among the three variants just mentioned. In general, a training trial consists of showing the students a scatter plot and regression line depicting a relation in the domain under study. For example, in a US presidential-performance study the abscissa might be labeled “Age at which first elected to the presidency” (the independent variable) and the ordinate might be labeled “Rated level of achievement in office” (the dependent variable) with 25 dots distributed in the quadrant space, each labeled by the name of one of the 25 most recent US presidents. The trainee is given the open-ended task of interpreting the scatter plot to indicate what questions it raises and what answers it suggests. In some training conditions the student is given a series of probes that guide him or her first to report the general relation indicated by the graphed data, and then (specific to heuristic A1) to note outliers and conjecture multiple situational and dispositional variables that might account for that president’s deviation from the general trend line. (In other training conditions the student is not given a guiding probe, but instead his or her free responses are later given a critique that covers the same steps.)

Typically, the trainee goes through three such 15-min trials. Each trial presents a new scatter plot, relating a new pair of independent and dependent variables. At a fourth meeting, the trainee is given a test trial, without prompts, and again two months later a delayed test trial (to evaluate longer-term effects of the training). The test performances of students serving in different training conditions (and in control, no-training conditions) are also evaluated for (a) the extent to which that training procedure enhances use of heuristic A1, and (b) the extent to which the training (and use of heuristic A1) enhances the creativity exhibited by the trainee in his or her two test performances, as scored by trained judges on various indices of creativity.

I have developed training procedures for each of the heuristics shown in Table 1, but space limits here restrict me to illustrate training procedures only for heuristic A1. For each of the remaining 48 heuristics I describe only what it entails and illustrate some of its uses in psychological research, without describing further how students can be trained to use it creatively.

2. ACCOUNTING FOR THE ODDITY OF THE GENERAL TREND ITSELF Further to save space, only one heuristic in each of the 14 subcategories A through N is described in any detail, so only a brief description can be given of heuristic A2, which concerns situations in which it is the general trend itself, rather than the deviant case, that needs to be recognized as provocatively paradoxical. Often the mere familiarity of the odd general trend hides its peculiar violation of some common sense principle, as in the case of the prevalence of punishing nightmares, recognized by Freud as violating the obvious pleasure principle he was loathe to abandon. Indeed, critics from Aristotle to today's cineastes have wondered at the popularity of tragedies, tearjerkers, and horror movies. Tragedy and terror may be unavoidable in the real world, but why seek them in fantasy? This odd tendency to seek out punishing effects in fantasy has provoked ego psychologists to conjecture a dozen ways in which apparently self-punishing fantasies like nightmares can be reinforcing, and these conjectures have deepened our appreciation of human needs. Festinger's (1957) dissonance-theory formulation was similarly provoked in part by his noticing and conjecturing why actual catastrophes tend to be followed by punishing rumors that further disasters are immanent, rather than by reassuring rumors of impending relief.

B. Introspective Self-Analysis

The heuristics in Subcategory IB are available especially to researchers in the human sciences whose profession it is to think about thinking and who are therefore in the noetically privileged position of being able to introspect on the processes to be explained, a hermeneutic luxury rarely available to physical scientists whose conjectures tend to be irrelevant or even contrary to phenomenal experience (e.g. when they conjecture laws of motion in a frictionless vacuum).

3. ANALYZING ONE'S OWN BEHAVIOR IN SIMILAR SITUATIONS The gist of heuristic B3 is to provoke and deepen insights into a specified human situation by recalling how and why one behaved on past occasions in similar situations. Empirical evidence suggests that people's insight into the reasons for their own behavior is highly flawed (Nisbett & Wilson 1977), but here I discuss techniques for generating hypotheses, not for collecting data to test them. One should retrieve more than a single self-experienced incident of the type in question to recall a set of such experiences, partitioning them into subsets in which one made contrasting types of responses. An illustration is Freud's development of his early psychoanalytic insights by self-analysis in his Fliess letters and in the numerous personal examples that Freud used in his early monographs on wit, dreams, and psychopathology of everyday life (Anzieu 1986).

4. ROLE PLAYING ONE'S OWN BEHAVIOR IN THE SITUATION Introspective heuristic B4 is like B3 except that it does not require that the researcher has actually experienced situations of the type in question. Instead, it suffices for the researcher to do thought experiments, imagining variants of the situation and imagining how she or he would behave in each variant type, thus getting some insight into what changes in the situation would be necessary for behavior to change. For example, the editors of Abelson et al (1968) expanded the richness of Heider's rather banal A-B-X balance theory by imagining triadic relations that, while technically unbalanced, would seem not to be bothersome (e.g. Ted loves Mary, Mary likes knitting, Ted dislikes knitting). These editors then conjectured why each of these imbalanced situations would not be troublesome, thus generating reconceptualizations (e.g. sex-role appropriateness) and interactional qualifications that made balance theory more subtle.

C. Retrospective Comparison

Subcategory C heuristics are slightly more demanding than heuristics in subcategories A and B in that they call for going beyond current observation or imagination to retrieve and compare past experiences.

5. EXTRAPOLATING FROM SIMILAR PROBLEMS ALREADY SOLVED Use of this creative technique is inhibited by researchers' liking to feel that their current thinking is dramatically novel. This enhances its excitingness but at the cost of increasing the difficulty of transferring to it insights from similar problems solved in the past. Possibilities and problems of using this transfer technique are illustrated by my experience while participating in an interdisciplinary conference on hypertension convened to solve the problem that most hypertensives do not adhere to the pharmaceutical regimen prescribed for them. The conference organizers asked us to focus on the reinforcement difficulty that hypertension itself causes little direct discomfort while the prescribed drugs often do produce bothersome side effects. Their question was, is there some way to motivate patients to adhere to a punishing drug-taking regimen to reduce a nonpunishing condition.

Using this C5 heuristic, I mentioned at the conference that there may be some lessons in the success of many birth-control campaigns, which faced an analogous problem in that the condition to be corrected, fertility, causes no direct discomfort while recommended contraception procedures often do have some bothersome side effects. It is revealing that later in the day a physician at the conference gently explained to me that as a social scientist I was quite understandably unaware of an essential difference between the two conditions that caused my analogy to limp, namely, that hypertension involves the circulatory system whereas fertility involves the endocrine. Use of this transfer

heuristic comes more readily to researchers whose own interests have shifted among areas, as when Hovland et al (1949) looked for delayed-action “sleeper effects” in persuasion that would be analogous to the delayed-action reminiscence effects in the rote-memory phenomena they had previously investigated.

6. JUXTAPOSING OPPOSITE PROBLEMS TO SUGGEST RECIPROCAL SOLUTIONS
The related C6 heuristic in this subcategory calls for juxtaposing the problem at hand with a seemingly opposite problem and examining how each of these contrary problems suggests solutions to the other. For example, the above-mentioned nonadherence by hypertensives to their prescribed medication can be brought into confrontation with the opposite problem of excessive self-drugging in America (e.g. elderly peoples’ overdosing on useless or harmful arthritic medications). It is a paradoxical contrast that one segment of the afflicted public won’t take drugs they need while another segment won’t stop squandering money for drugs that are harming them. An understanding of what causes each of these opposite problems can provoke insights into how the contrasting problem might be mitigated.

D. Sustained, Deliberate Observation

The three subcategories of observational heuristics discussed so far depend on incidental discovery by fortuitous observation or post factum retrospections on past experiences. The observational heuristics in Subcategory D, however, are more purposeful and programmatic in that they involve sustained observation deliberately undertaken to evoke insights into the topic under study. They include case studies, participant observations, and propositional inventories.

7. INTENSIVE CASE STUDIES Case-study analysis has long been used by decision makers in the governmental and private sectors for informal policy guidance; by historians, political scientists, and other academics for analysis and exposition (Neustadt & May 1986); and in medical, law, and business schools as a favorite teaching method that allows students actively to abstract principles, even principles that the instructor is unable to articulate. Students often regard case histories as interesting teaching materials, although Jung, an old pro, complained in his letters to Freud that case histories are “unbelievably monotonous.”

Creative insights can be derived from each of three phases of case-history development, namely, selecting which cases to write up, deciding how to write them, and devising ways of using the case studies once written.

(a.) The criteria for selecting which occurrences will make provocative case histories are so unclear that it may be cost-effective to settle for whichever cases happen to be already available. Choosing familiar cases (e.g. Piaget’s observing cognitive development in his own children or Freud’s using data

from his patients) entails surplus knowledge that can be a danger in critical thinking but an advantage in creative thinking. It may be optimal to use cases with intermediate puzzlingness, not so obvious as to be devoid of new information and not so obscure as to be baffling. Contrasting paired cases that are superficially similar but which had opposite outcomes may be especially provocative.

- (b.) Research is also needed on how to write up the history, however the case is selected. One suspects that 90% of the details could be omitted with little loss, but which 90%? As the researcher accumulates experience at the task, a standard format for writing up cases develops, but standardization might adversely effect provocativeness and novelty.
- (c.) Finally, how case histories should be used, once written up, to maximize their creative evocativeness can be studied by evaluating the productiveness of a variety of case studies used in law and business school curricula, where credible evaluation criteria (starting with student ratings) may be available. The challenge and promise of developing teaching procedures that will exploit the creative potential of this one heuristic, case histories, warrants a whole program of research by itself.

8.-9. OTHER SUSTAINED OBSERVATIONAL HEURISTICS Besides case histories, other examples of sustained observational procedures that can be deliberately and programmatically undertaken to promote hypothesis generation include A8, participant observation, and A9, assembling propositional inventories. Cultural anthropologists and sociologists often use participant observation as their method of choice. Its unsystematic open-endedness, which arouses worries when used to collect evidence for hypothesis testing, makes it a rich source of new hypotheses (e.g. E Goffman's observations of what constitutes total institutions and how they affect inmates). Psychologists might find it provocative to leave their computer terminals, laboratories, and books more often to observe the variables of interest operating in the complex natural environment. Heuristic A9, collecting propositional inventories, can be a rich source of new insights, especially when the topic has a long tradition of practitioner interest relatively isolated from basic research, as is the case with attitude change. Quintilian, in his *Institutio oratoria*, takes four volumes to present the rules of thumb of Hellenic and Roman classical practitioners of persuasive oratory, providing a gold mine of provocative hypotheses largely neglected by attitude-change researchers. Hovland and his colleagues in their 1940s attitude-change research used politicians' working assumptions as springboards for deriving testable hypotheses, and Cialdini (1993) has pulled together practitioners' compliance-gaining tactics such as "low-balling," "foot-in-the-door," "and "door-in-the-face."

II. HEURISTICS INVOLVING SIMPLE CONCEPTUAL ANALYSIS (DIRECT INFERENCE)

Heuristics in Category I above require simply observing and interpreting natural occurrences, while heuristics in Category II, to which we now turn, are more demanding in that they require thought experiments consisting of simple, direct conceptual manipulations. Such direct-inference procedures will be grouped here into three increasingly demanding subcategories: E, simple conversions of a banal hypothesis; F, multiplying insights by conceptual division; and G, jolting one's conceptualizing out of its usual ruts.

E. Simple Conversions of a Banal Proposition

10. ACCOUNTING FOR THE CONTRARY OF A TRITE HYPOTHESIS A dramatically effective, readily available simple thought experiment for evoking creative hypotheses is to convert an initially obvious hypothesis about the relation between two variables into a more exciting conjecture by standing it on its head, as Marx did Hegel, and thinking of circumstances in which the contrary relation would likely obtain between the variables. Simone Weil (1952) epitomized this process: "Method of investigation: as soon as we have thought something, try to see in what way the contrary is true." Even if the initial banal direction of the relation has wider ecological validity, and its counterintuitive contrary obtains only in exceptional circumstances, these exceptional cases will disclose overlooked mediators that operate to some extent even in the typical situation, where they will be manifested in interaction predictions that interestingly modify the initial banal hypothesis. This heuristic is a key component in a "perspectivist" strategy (McGuire 1989) for creating programs of research. For example, one might start with the banal prediction that the more likable the perceived source of a persuasive communication, the more attitude change this source produces. One then uses this E10 heuristic by generating counterexamples, special circumstances in which a less-liked source will paradoxically be more persuasive (e.g. in situations involving praise from a stranger, identification with the aggressor, traumatic initiation, daring to deviate, insufficient justification, ingratiation attribution, etc).

11.-14. OTHER HYPOTHESIS-GENERATING SIMPLE CONVERSIONS OF BANAL HYPOTHESES Space limitations restrict me to mentioning only briefly four other types of creative thought experiments in Subcategory E. Heuristic E11 involves conceptually reversing the direction of causality of a banal hypothesis. For example, the hypothesis that watching TV violence increases viewers' aggression is converted to the reverse causality hypothesis that viewers' aggressiveness increases their watching of TV violence. The researcher then conjectures explanations of why the relation may operate in the reverse causal direction as well

(e.g. because of ostracism, esthetic predilection, etc). An underlying assumption is that an adaptive level of cognitive and social stability is maintained by establishing reciprocal causal links. Festinger and his followers in the dissonance movement revitalized the attitude-change area by reversing the trite hypothesis that attitude change produces behavioral change and exploiting the reversed hypothesis that behavioral change leads to attitude change.

Heuristic E12, the thought experiment that involves pushing a reasonable hypothesis to an implausible extreme, can be illustrated by the familiar hypothesis that eye contact increases liking, which is plausible because as eye contact varies from 10 to 20 to 30% of the time, increasing eye contact is likely to be interpreted as interest and liking. However, as eye contact becomes extreme, increasing from 70 to 80 to 90% of the time, liking will tend to decrease. Such intense scrutiny suggests hostility, pathology, and privacy invasion. This implies new mediational and interaction hypotheses, as well as that the main effect of eye contact on liking will be nonmonotonic. A "golden mean" metatheorizing underlies the power of this nonmonotonic, pushing-to-an-extreme type of thought experiment.

Heuristic E13 involves arithmetical thought experiments such as imagining the effect on the dependent variable of reducing each conjectured antecedent to zero, thus helping the theorist decide whether each antecedent is a necessary or contributing cause. Examples include Clark Hull's exploration of whether "habit strength" and "drive" combine additively or multiplicatively to affect behavior, and NH Anderson's (1982) development of a cognitive algebra that could handle the "set size" effect.

Heuristic E14, conjecturing interactional multipliers of the banal hypothesis, serves as a final example of these Subcategory E "Simple Conversion" hypothesis-generating techniques. The thought experiment here involves mentally multiplying banal hypotheses by potential interaction variables. For example, starting with the banal hypothesis that the more similar the other person, then the greater one's liking for her or him, we then elaborate it by conjecturing how various situational and dispositional interacting variables would affect the parameters of the similarity-liking relation and why. Along these lines Byrne (1971) explored whether issue importance affected the height or the slope of the similarity-liking relation to discover the extent to which interpersonal similarity operates as a cue versus as a reinforcement.

F. Multiplying Insights by Conceptual Division

Defining a hypothesis as the assertion of a relation between variables clarifies the difference between Subcategories E and F heuristics. The five Subcategory E thought-experiment heuristics just considered all involve some mental manipulation of the relational component of the hypothesis (e.g. reversing its sign

or its causal direction). In contrast, the four heuristics in this Subcategory F all involve mentally manipulating the hypothesis's variables rather than the relation between them. They involve playing some kind of word game to analyze a gross conventional variable into components that relate differently to the other variable in the hypothesis. Thus one multiplies relations by dividing variables. These verbal divisions that multiply insights can be done on any of the five logical types of variables that enter one's experimental designs (dependent, independent, mediating, interactional, and controlled variables). The word games proposed in the Subcategory F heuristics F15–F18 help bridge the gap between one's insight per se and the words one uses to express this insight to oneself and others by playing with labeling the variables in order to grasp more fully one's initial thought, much of which is lost in any given labeling discussed in McGuire (1989).

15. LINGUISTIC EXPLORATIONS The labels one initially uses for one's variables can usually be much improved by a variety of verbal explorations that provide a fuller grasp of one's initial insight. For example, one can develop alternative formal definitions in terms of genus and specific differences and examine which best catches the variable's crucial aspect that best accounts for its hypothesized relation to the other variable in the hypothesis. Alternatively, connotative definitions can be used by generating (or picking out of a thesaurus) synonyms (and antonyms) for the label. One can then "explore the limits" by examining which synonyms do versus do not enter easily into the hypothesized relation and analyzing why some synonyms fit better than others. One can then organize the sufficing synonyms by grouping and subordination, as when Campbell (1963) listed and organized multiple terms used interchangeably with attitudes. It is also clarifying to list attributes of the concept and rate them for centrality or organize them into a tree diagram.

A more complex variant is to list and organize alternative distinctions that have been made between one's own label and similar others, as McGuire (1985) did for the distinctions that have been drawn between attitudes and opinions. More formally, one can do a categorical meta-analysis, as in Johnson & Eagly's (1990) analysis of how persuasive impact is affected by different senses of involvement. One can also list and analyze conceptual distinctions that have been drawn by different researchers, e.g. McGuire's (1986) analysis of six quite varied characteristics that have been proposed to determine when social cognition or social representations are indeed social.

Denotive definitions also can be used, as when one analyzes what one means by "conservatism" by assigning familiar political figures to the different locations on the conservatism variable and then conjectures which of each politician's characteristics has determined one's perception of his or her loca-

tion on the variable. Other wordplay usable as discovery tools are free associating to the label, analyzing its metaphorical or other figurative transformations, or tracing its etymology. This F15 heuristic includes word games so diverse that it probably should be divided into several distinct heuristics, each deserving its own training regimen.

16.–18. OTHER HYPOTHESIS-GENERATING CONCEPTUAL DIVISIONS Brief mention will be made of three other, more specific heuristics of this linguistic/conceptual analysis type as listed under Subcategory F in Table 1. F16 focuses on the independent variable of a banal hypothesis and conjectures alternative partial definitions in terms of which to vary it. For example, starting with the trite hypothesis that the credibility of a message's source enhances her or his persuasive impact, one can devise interesting partial definitions of credibility by reviewing a list of nonverbal cues—visual and vocalic—and noting or conjecturing which ones people use to infer a speaker's knowledgeability or trustworthiness.

Heuristic F17 focuses on the dependent rather than independent variable of the banal hypothesis, typically by selecting several alternative subscales for measuring it. For example, in the familiar hypothesis that frustration leads to aggression, one can generate a varied list of aggression measures and conjecture how they are differently affected by frustration and thus gain new insights into the meaning of aggression (e.g. it can even take the form of gift-giving as among the Kwakiutl, and can be turned inward as well as outward).

Heuristic F18 goes further in analyzing the dependent variables, not just into parallel subtypes as in F17, but into sequential steps. For example, one can analyze the output side of the communication/persuasion input/output matrix (McGuire 1985) by analyzing the persuasion process into its successive mediating substeps (exposure, attention, comprehension, agreement, etc) and conjecturing how one's independent communication variable of interest (e.g. the message's humorousness) will affect ultimate persuasive impact via its effect on each of these contributing mediating substeps. This often leads to predicting a nonmonotonic overall relation between the gross independent and dependent variables, and to predicting a plethora of interaction effects on the curve's parameters (McGuire 1968).

G. Jolting One's Conceptualizing Out of Its Usual Ruts

Subcategory G, the third subcategory of simple reconceptualizing procedures for generating new insights, includes four heuristics, G19–G22, that involve propelling one's thoughts out of their accustomed ruts by diverse modes that vary from simple mental gymnastics to dangerous pharmaceutical roulette.

19. SHIFTING ATTENTION TO AN OPPOSITE POLE OF THE PROBLEM This heuristic of reversing one's focus of attention (e.g. from the independent to the dependent variable of one's hypothesis, or from costs to benefits of a behavior, etc) is particularly useful when one's thoughts tend to be constrained within a conventional channel by barriers due to habituation, limited knowledge, emotional blocks, or cognitive styles that make it difficult to generate a diverse range of ideas about the hypothesis as initially approached. For example, if one is trying to develop a persuasion campaign to deter heroin abuse, one tends to do a "Casablanca" routine of rounding up the usual suspects by focusing on the drug's negative effects (physiological damage, diminished control by the addict over his or her life, dangerous illegality, overdosing, etc). However, these negatives are already well known by most addicts and are not deterring their doing heroin. Heuristic 19 calls for shifting one's thinking to an opposite pole by considering not the costs of heroin but the benefits that attract so many users to it. By understanding its attractions to users, one's campaign against heroin abuse can be made more relevant.

However, this conceptual shift from the costs to the benefits of a practice one regards as repulsive may itself arouse other creativity-stifling emotional blocks. Thinking creatively about appealing aspects of heinous behaviors such as heroin addiction, child abuse, or rape is distasteful, even if one is trying to appreciate their appeals the better to fight them. One can usually think of a few salient benefits, but it may be difficult to sustain enthusiasm for the task. To sidestep this new block one can shift perspectives from focusing on the dependent variable (requiring that one generate heroin addiction's benefits) to focusing on the independent variable (allowing one to go through one of the many lists of human motives or needs and conjecturing regarding each need how a life on heroin might be satisfying it). By diversifying and propelling one's thoughts by using such an available list of heterogeneous needs, one is provoked to recognize a wide spectrum of gratifications that might be obtained (at least in the short term) from using heroin. One's antiheroin campaign can then be made more sophisticated by taking those gratifications into account and showing their inadequacy. Another variant of this reversal heuristic is to start at the desired end state and work back to the current problem situation, as when Max Planck developed his revolutionary 1900 law of heat radiation by working backward from the desired explanation (Heilbron 1986).

20.–22. OTHER HEURISTICS FOR GETTING OUT OF ONE'S USUAL RUTS There is room here for only a brief description of three other Subcategory G techniques (listed in Table 1) for jolting one's thinking out of well-worn ruts. Heuristic G20 involves deliberately reversing one's accustomed thinking style. If ordinarily one goes for depth, then switch to seeking breadth. For example, when trying to

identify origins of substance abuse, if ordinarily one would plunge deeply into a single category such as peer pressure, then this heuristic G20 calls for deliberately switching to considering less deeply each of a wide variety of causes such as peer pressure, mass media, physiological deficits, and lack of purpose. Or, if one is chronically a splitter and sees differences (e.g. between legal tobacco addiction and illegal cannabis addiction), then one might deliberately switch to being a lumpner by considering how findings about abuse of one substance may be generalized to abuse of quite different substances. Training in use of this heuristic should start with diagnosing one's customary thought style and recognizing and trying out alternatives.

Heuristic G21 involves reexpressing one's hypothesis in multiple modalities [verbal, pictorial, logistical, symbolic, tabular, etc (McGuire 1989)]. Social scientists tend to be verbal types but should practice expressing hypothetical insights in other modalities, as when Petty & Cacioppo (1986) represent their evaluation-likelihood model as a flow chart. Some modalities may be especially apt for expressing certain insights or for certain purposes, and an individual researcher may resonate best with communicating her or his insights to self or others in one preferred modality. However, translating from one to another modality in either direction is likely to be provocative, so the researcher should work at gaining facility in moving among modalities in either direction, even though chronically each researcher will tend to use his or her most ego-syntonic modality.

Heuristic G22 involves using some physiological prod to jolt one's thinking out of the usual ruts. Chemical stimulants might be legal and conventional like caffeine, or illegal and stigmatized like LSD. If one is to use chemicals as a jolt to enhance hypothesis generating, one should lower one's base level of the substance so that when needed it will make a difference (e.g. one should forego drinking coffee until one needs it to keep alert through an all-nighter). Instead of chemical doses, one can use behavioral prods like hyperventilation or jogger's high, or purportedly mind-altering meditation tricks, or musical backgrounds, or massed practice to extinguish responses normally prepotent in the habit-family hierarchy. Low-inhibition states such as daydreams or even night dreams may allow elusive insights to surface, as when Kekulé formulated the hexagonal-ring model of the benzene molecule after dreaming of a serpent biting its own tail.

III. HEURISTICS CALLING FOR COMPLEX CONCEPTUAL ANALYSIS (MEDIATED INFERENCE)

Category III includes 10 heuristics that, like those in Category II, require conceptual analyses that go beyond the simple perceptual processes used in Category I but that do not require further analyzing of old or collecting of new

data (as do the heuristics in Categories IV and V below). The 13 Category II heuristics above require only direct conceptual analyses in the form of thought experiments that take an isolated banal hypothesis and transform it by some simple mental operation such as asserting its contrary. The 10 Category III heuristics use conceptual analyses of more complex mediated types that bring the initial hypothesis into confrontation with additional propositions that allow mediated derivation of new insights. Three increasingly demanding subcategories of Category III heuristics are described in turn: H involves various uses of deductive reasoning from general propositions; I involves using conceptual structures to generate and diversify ideas; J uses general general metatheoretical intellectual schemata as scaffolding for building new conceptual structures.

H. Deductive Reasoning Procedures

23. GENERATING MULTIPLE EXPLANATIONS FOR A GIVEN RELATION Vienna Circle logical empiricism has, since the 1930s, habituated psychologists to recognizing that scientific hypotheses should be embedded in broader theoretical explanations rather than being investigated as isolated ad hoc assertions. Unfortunately, the search for at least one explanation tends to become a search for at most one explanation, in violation of the perspectivist tenet (McGuire 1983, 1989) that any relation is best thought of as obtaining for a multiplicity of reasons. Explaining relations once is not enough; the researcher should routinely go beyond a first explanation by using the “method of strong inference” to test not if a given explanation does or does not account for a significant proportion of the variance in the hypothesized relation, but to test to what extent the relation is accounted for by each of several explanations. In their World War II army indoctrination studies, Hovland et al (1949) accounted for purported delayed-action persuasion effects not only by the “discounting cue” explanation that has received a great deal of subsequent attention (Pratkanis et al 1988), but also by another half-dozen promising explanations such as sensitization, consistency, and two-step flow. That the field subsequently focused almost exclusively on the discounting cue explanation illustrates how needed this heuristic is, in that even when the initial report of a relation proposed multiple theoretical explanations, follow-up researchers tend to overcongregate on just one explanation.

24.–26. OTHER DEDUCTIVE-REASONING HEURISTICS Heuristic H24 involves alternating induction with deduction. One starts with a purported relation, e.g. the report by Hornstein et al (1975) that people become more helpful after hearing good news of a dramatic rescue from danger. One can induce several different principles that explain the relation, such as an affective principle (e.g. that helpfulness is promoted by people’s tendency to act in accordance with their hedonic good mood, here induced by hearing of the happy escape) and a

cognitive principle (e.g. that people tend to be more helpful to one another when they perceive human beings as generally helpful, as in the brave rescue report). After inducing such explanatory principles—*affective* and *cognitive*—one then shifts direction from induction to deduction by inferring new specific hypotheses. By reiterative inductions and deductions one can generate a program of research designed to exploit the ways in which altruism is an *affectively* and a *cognitively* determined process.

Heuristic H25, identifying and subtracting obscuring counterforces, is particularly useful in those all-too-common awkward histories where researchers have been testing a hypothesis that is so obvious that they have to apologize for bothering to test it, only to be further embarrassed when their obvious hypothesis fails to receive confirmation. An example is the hypothesis that the higher the perceived credibility of the source of a persuasive message then the more attitude change the message will induce, a hypothesis that might seem trivially obvious but that often fails to be confirmed in empirical tests. Using heuristic H25, one first abstracts the obvious mediator that makes the prediction trite (e.g. that more expert sources are more persuasive because they are perceived as knowing better the facts on the issue). One then conjectures counteroperating mediators (e.g. that the source's expertise evokes an audience's suspicion of guilty knowledgeability and prejudicial involvement, that the source is remote and unlike the audience members, etc) that tend to reduce persuasive impact. One then measures or manipulates the contrasting mediators and derives distinctive interaction predictions of each, e.g. when a highly expert source is shown taking a ludicrous but humanizing pratfall (Deaux 1972) his or her persuasive impact increases. Application of heuristic 25 to the credibility/persuasiveness relation provoked Petty & Cacioppo's (1986) evaluation-likelihood model and their theorizing about alternative paths to persuasion.

Heuristic H26, the *hypothetico-deductive* method, is more demanding of deductive elegance, calling for the researcher's generating a set of axioms (often obvious ones) covering the domain of inquiry and from their combinations deducing new, often surprising theorems for testing. The classical example is Euclid's geometry. A prime psychological example is Clark Hull's (1940, 1952) axiomatic rote-learning and behavioristic theories, from whose obvious general postulates were derived nonobvious predictions such as the *reminiscence*, *asymmetrical serial position*, *partial reinforcement*, and *goal-gradient* effects.

I. Using Thought-Diversifying Structures

This second type of Category III complex-inferential heuristics encourages constructing or borrowing a conceptual framework (ranging from a simple

checklist to a formal polysyllogism and input-output matrix structure) and using it to propel and diversify one's thinking on a topic.

27. USING AN IDEA-STIMULATING CHECKLIST The utility of checklists for propelling and diversifying thought is recognized in a variety of practical undertakings and deserves more explicit consideration in scientific methodology. The researcher may take over a list, intact or with modifications, or may construct a new list during his or her continuing work in an area. For example, a health psychologist trying to select appeals that will be useful in a public health campaign may borrow an available list of wants [e.g. the Rokeach (1973) list of 16 instrumental and 16 terminal values] or may develop his or her own list, as was done by McGuire (1985) when he developed 2^4 partial views of human nature and used each to suggest health appeals. Each item in one's list can be divided into sublists, thus allowing the researcher either to keep a broad perspective on the big picture by using the first-order list or to fine-tune some specific aspect of the campaign by focusing on a sublist. Cross-fertilization among the sublists can improve each. For example, Table 1 lists five broad categories (I–V) divided into subcategories on different bases, thus offering the possibility of cross-fertilization (e.g. Category IV heuristics are subdivided into those involving single vs multiple studies while Category V heuristics are divided into qualitative vs quantitative). New heuristics might be suggested for each category if one interchanges their basis of division.

Constructing a new checklist calls for creatively developing a tool to augment creativity. With experience in an area one tends to develop a favorite checklist, but one should be on guard against drifting into a petrified routine that makes mechanical use of a once-successful type of list that blinds one to alternative ways of slicing the process. There may be a common danger that creative heuristics carry within themselves the seeds of their own destruction, in that as experience in their use makes one more sophisticated at constructing lists or case histories or whatever, one becomes increasingly stereotyped in using the technique, with the result that it eventually ends up narrowing rather than diversifying one's thoughts.

28.–29. OTHER HEURISTICS USING THOUGHT-DIVERSIFYING STRUCTURES Checklists are the most familiar thought-diversifying structures, but other, more elaborate structures can be still more provocative. Heuristic I28 involves converting simple checklists into more elegant structures, such as input/output matrices, tree diagrams, and flow charts. For example, McGuire (1985) combined diverse partial views of the person into a 2^4 matrix that can be used to generate motivational appeals in persuasive communications. Heuristic I29 involves formalizing the logical structure of one's conceptualization, e.g. into a formal polysyllogism. Some researchers regard logical formalization of a theory

as antithetical to creative freedom, or at best as a postcreative cleaning-up for publication. However, McGuire (1989) shows how a theory's creative provocativeness is enhanced by formalization into a polysyllogism, each premise of which constitutes a creative catapult for generating new situational and dispositional interaction hypotheses.

J. Using Metatheories as Thought Evokers

A final triad of complex mediated-inference heuristics—J30, J31, and J32—encourages the researcher to exploit his or her preferred metatheoretical orientation to generate further insights.

30. THE EVOLUTIONARY FUNCTIONALISM (ADAPTIVITY) PARADIGM A functional, adaptivity orientation deriving from evolutionary presuppositions is probably the most common metatheory guiding contemporary psychologists, at least implicitly. When used to promote creative insights into behavior, this approach begins with considering the needs and capacities of human beings in relation to the opportunities and demands of environments in which the species has evolved and the individual has matured. One then conjectures behavioral principles by which people must be operating to have survived and evolved under such phylogenetic and ontogenetic conditions. Functional analysis often yields obvious propositions, such as that people behave in ways for which they have been rewarded for behaving in the past, but propositions that are individually trite can jointly yield unexpected theorems (e.g. Hull et al 1940). Further, not all functional postulates are individually obvious when one thinks dialectically. For example, even obvious behavioristic postulates (e.g. that reinforced performance strengthens habits and that unreinforced performance extinguishes habits) may have to be supplemented by corrective counterpostulates such as reactive inhibition and spontaneous recovery.

Thinkers who resonate with evolutionary adaptivity theorizing can enhance its provocativeness by considering behaviors like altruism and homosexuality, which paradoxically persist even though they seem to impose a reproductive disadvantage. It is accounting for these hard cases that guides the thinker in expanding his or her concept of adaptive selectivity [e.g. adding to it mechanisms like inclusive fitness, reciprocity, cognitive distortions, etc (A McGuire 1994)], which makes the concept more provocative. Evolutionary metatheorizing can lead the researcher into the political minefields of social Darwinism and sociobiology, but it would be maladaptive to abandon all use of intellectual tools that could lead to error or be politically incorrect.

31.–32. OTHER HEURISTICS USING METATHEORIES The evolutionary (functional, adaptivity) approach is not the only type of metatheorizing that can be used as a creative device. Heuristic J31, analogy, is the conceptual transforma-

tion most commonly used for creative hypothesis generating. My own most sustained use of this heuristic (McGuire 1964) chose biological inoculation (as in vaccination against smallpox, where an overprotected organism is preexposed to a weakened virus strong enough to stimulate but not strong enough to overcome the organism's immune system). I used biological inoculation as an analog for building up the belief defenses of a person raised in an ideological "germ-free" environment. I exposed the believer to a weakened dose of the attacking arguments, strong enough to stimulate without overcoming belief defenses before exposing the believer to a massive attack. The analogy suggested numerous hypotheses about inducing resistance to persuasion. Analogs may involve methods as well as substance, as when graph theory, previously used for analyzing interpersonal social systems (e.g. to predict how the group members will divide into cliques) is transferred analogously for use in analyzing intrapersonal cognitive systems (e.g. to predict how the person's thoughts will be partitioned into logic-tight compartments). Some analogs are widely shared by researchers in an era, as when the reflex arc metaphor underlying stimulus-response theorizing was used early in the twentieth century and then by midcentury had been largely replaced by the computer flowchart in cognitive theorizing.

The odd-sounding heuristic J32, quixotic defense of a theory, probably receives more use as a creative technique than is recognized. It involves embracing and sticking with a theory, continuing to derive testable implications from it despite its superficial implausibility, its obvious oversimplification, or its poor empirical track record. For example, Max Plank ended up with a fuller grasp of the revolutionary quality of the elementary quantum construct by his creative conservatism in stubbornly and unsuccessfully trying to fit the construct into classical physics theory. Greenwald et al (1986) discussed circumstances when it is productive to stonewall in defense of a nonconfirmed theory, in their case the discounting cue theory of delayed-action effects in persuasion. Not uncommon are prolonged Stakhanovite attempts to make do with an overly simplistic principle, as when congruity theorists (Estes 1950) maintained their revolutionary austere position in insisting that mere contiguity, without adverting to reward or punishment concepts, sufficed to explain learning. Attempts to make do with the linear operator model (Bush & Mosteller 1955) or signal-detection theory are other examples of the creative provocativeness of seeing how far one can get with a simplistic theory.

IV. HEURISTICS DEMANDING REINTERPRETATIONS OF PAST RESEARCH

Category IV heuristics, more than those in the preceding three categories, call for a professional background in that researchers using them must have some facility for working creatively with the area's research literature. Heuristics in

a first Subcategory K call for delving into single past studies, while heuristics in a more complicated Subcategory L require bringing together multiple past studies.

K. Delving into Single Past Studies

33. ACCOUNTING FOR IRREGULARITIES IN AN OBTAINED RELATION Esthetic preference, such as a predilection for austere elegance, can serve as a creative tool. Such a minimalist esthete, when he or she finds that two variables are related by some complex function that looks like George Washington's profile, typically tries to decompose this complex relation into several rectilinear components. For example, dissonance theorists exhibited such an esthetic when they accounted for the several peaks and troughs in the relation between postchoice time passage and liking for a chosen alternative (Festinger 1964) or again, in accounting for the complex relation between confidence in one's own belief and avoiding exposure to counterarguments. In each of these cases the complex obtained relation was accounted for by multiple monotonic mediating relations. My rule of thumb is to decompose a tortuous obtained function into $N + 1$ underlying (mediational) processes, where N is the number of inflection points in the gross functional relation between the independent and dependent variables under study.

This research strategy may be carried out by one researcher or by an invisible college of researchers working on different ranges of a relation, as in the case of visual-perception researchers studying the relation between I and ΔI , where ΔI is the proportional change in illumination level (I) needed to produce a just-noticeable brightness difference. The complex relation between I and $\Delta I/I$ was gradually accounted for by successive conceptual decompositions. First, rod-vs-cone subprocesses were teased out to take into account what appeared to be two successive negatively accelerated curves; then special processes were postulated at very high and low illumination levels to account for observed oddities in the relation at both extremes of illumination; and then logarithmic and other scaling transformations were used to flatten out nonrectilinear functions, until the unwieldy $\Delta I/I$ curve was decomposed into an austere set of straight lines.

Such a search for monotonic and rectilinear parsimony is less a logical necessity than an esthetic preference. Even as an esthetic criterion, the austerity of rectilinearity is only one preference among many. Contemporary science may reflect a taste for austere simplicity but a zest for baroque, even rococo, may reassert itself, as when a new generation prefers not the Danish furniture cathected by their parents, but the beaded lampshades beloved by their grandparents. In the discovery phase of science, esthetic predilection, however arbitrary, can be valuable in pushing thinking in fertile new directions. Each scientist should be allowed, *de gustibus*, to follow his or her own esthetic radar

for detecting the signal masked by a crescendo of noise. It is probably desirable that the Establishment esthetic criterion shifts periodically (e.g. either tactically, as between a preference for negatively accelerated growth curves vs one for sigmoid curves, or by a strategic shift, as when preference shifts between continuous vs discontinuous relations).

34.–36. OTHER HEURISTICS INVOLVING DELVING INTO SINGLE PAST STUDIES
 Heuristic K34 is a specific subtype of K33 that deserves separate mention because the opportunity to use it occurs often and is simple to exploit creatively. It arises in the common case where a nonmonotonic inverted-U relation is found between independent and dependent variables. Such relations can be creatively interpreted as the resultant of two opposed mediating processes, both monotonic. For example, the finding that persuadability has an inverted-U relation to many personality variables suggests (McGuire 1968) that it is the resultant of two opposed underlying processes (e.g. self-esteem tends to enhance persuadability via the argument-comprehension mediator and to reduce persuadability via the argument-acceptance mediator). Heuristic 34 has been used creatively on inverted-U relations in the case of the reminiscence phenomenon, the serial-position curve, and the sleeper effect.

Heuristic K35, deviant case analysis, corrects the tendency of published studies to stress the overall obtained relation (as indicated by the regression line or by the piling up of cases in one diagonal of a 2×2 cross-tabulation) while downplaying outliers, the deviant cases that lie far off the secular trend line. McClelland's (1961) analyses showed that emphasis on achievement themes in nations' school storybooks in 1950 predicted the nations' economic growth from 1952 to 1958. Use of heuristic K35 involves going further by interpreting the outcome, not only as regards this general trend, but also as regards the deviant cases, the exceptional nations that fall far off the trend line, and so suggest new corrective insights (e.g. by considering why Poland, low in schoolbook achievement themes, showed high productivity growth, while Tunisia, high in achievement themes, showed low growth).

A fourth heuristic in this Subcategory K36, interpreting serendipitous interaction effects, exploits the fact that experimental procedures almost inevitably introduce into the design powerfully diagnostic variables (e.g. sex of participant, first vs second half of the trials, etc) that have a good track record for producing sizable main and interaction effects. Heuristic K36 calls for systematically analyzing and interpreting effects of these variables and cross-validating any post factum discoveries in subsequent studies.

L. Discovery by Integrating Multiple Past Studies

The four Subcategory K heuristics discussed above invite one to delve into results obtained within a single past experiment for discovery purposes. The

three heuristics that illustrate Subcategory L, to which I now turn, are more demanding in that they require not simply reaching to one study but actively bringing together results of multiple past experiments.

37. RECONCILING CONFLICTING OUTCOMES OR NONREPLICATIONS Grim experience so accustoms psychologists to failures to replicate and even to seemingly opposite outcomes in similar studies that it takes an effort to regard such disappointments as particularly interesting. Yet conflicting results can reward closer scrutiny, especially when the conflicting studies are carried out by researchers with solid track records. When sets of conflicting studies are closely compared (either informally or in a meta-analysis) differences may be detected in definitions, measures, procedures, samples, etc. that suggest explanations of the conflicting outcomes and the relation's overlooked interactional boundaries. Most researchers can recall advances made in their area by reconciling conflicting outcomes. Examples from the attitude-change area with which I am fairly familiar include discrepancies between laboratory and field persuasion studies (Hovland 1959), the forced-compliance studies on whether the size of the inducement for public counterattitudinal advocacy increases or decreases internalized attitude change (Collins & Hoyt 1972), sex difference in persuadability (McGuire 1968), the selective-exposure prediction that people avoid belief-discrepant material, and delayed-action persuasive effects (Pratkanis et al 1988). Analyses of different experimental conditions that might reconcile conflicting results tend to reveal overlooked mediational and interactional variables. More elegantly, meta-analyses can be used creatively for across-study investigation of interaction variables that may affect the relation between the variables initially under study, as when Eagly & Carli (1981) used meta-analysis to investigate whether the sex difference in persuadability differed between public and private conformity conditions.

38.–39. OTHER HEURISTICS INVOLVING INTEGRATING MULTIPLE PAST STUDIES Several other heuristics that involve bringing together the results of multiple past studies will be mentioned briefly. Heuristic L38, creative exploitation of the complementarity of past studies, is more difficult to use than L37 because it is harder to detect complementarity than conflict among past studies. At least five subtypes of complementarity among studies can be looked for and exploited: (a) a moderating subtype, as when Milgram (1976) confronted obedience-to-authority studies with unresponsive-bystander studies; (b) a parallel subtype, as when Hull (1933) applied known principles of memorization to hypnotic phenomenon; (c) a differentiation subtype, as when one partitions a previously lumped set of studies into two distinctive subtypes (such as motor vs sensory suggestibility); (d) a mediational subtype, as when Petty & Cacioppo

(1986) distinguished between attitude-change studies in which central vs peripheral processing is involved; and (*e*) a labeling subtype, as when “foot in the door” studies are irresistibly contrasted with “door-in-the-face” studies.

This subcategory includes also heuristic L39, writing a review of the area in question. Reviewing the literature or writing a theoretical integration requires one to organize and integrate a heterogeneous set of studies, interpreting them creatively so that the whole set is more meaningful than the sum of the individual studies, as patterns emerge and new integrating and bridging hypotheses suggest themselves. Festinger (1957) developed dissonance theory while writing a review of the literature on rumors. Another illustration is the academic joke that if a professor wants to learn about a new area, she or he signs up to teach a course on it.

V. HEURISTICS NECESSITATING COLLECTING NEW DATA OR REANALYZING OLD DATA

This fifth broad category includes creative heuristics more demanding of professionalism than are categories I to IV in that they call for collecting new data or at least reanalyzing old data. I group these heuristics in qualitative Subcategory M and quantitative Subcategory N.

M. Qualitative Analyses

Six Subcategory M qualitative-analysis heuristics are listed in Table 1 in order of increasing demandingness of a priori theoretical guidance, beginning with simply allowing participants more freedom in expressing their responses to carrying out an elaborate strategy for developing a whole program of research.

40. ALLOWING OPEN-ENDED RESPONSES FOR CONTENT ANALYSIS A simple but productive way of obtaining revealing data is for the researcher to present a low profile, allowing the participant more leeway in responding. Research on a popular topic tends to be channeled into ruts worn by constant use of a few familiar manipulations and a few reactive scales that measure some conventional researcher-chosen dimensions. Stifling examples are the long preoccupation of human learning and memory research with nonsense-syllable material, and the confinement of self-concept research to the one dimension of self-esteem (as if people think of themselves only in terms of how good or bad they are). Such reactive measures provide as-if information on where the respondent would place the stimulus on the researchers' favorite dimension were the respondent ever to use that dimension, but fail to provide crucial as-is salience information on the extent to which the respondent actually does use this dimension. Reactive measures have an attractive economy when one wants to measure stimuli on the

popular dimension. Self-esteem is admittedly an important dimension of the self-concept, and if one insists on studying self-esteem it is efficient to use a reactive measure focused on it, rather than a less focused, laborious open-ended "Tell me about yourself" probe. Still, open-ended responses should be collected and analyzed at least occasionally (even though content-analysis systems are laborious to develop and use), because they tend to suggest neglected dimensions and provide insights into people's own phenomenological world as well as to the field's currently fashionable issues (McGuire 1984).

41.-45. OTHER QUALITATIVE ANALYSIS HEURISTICS Space limitations allow only brief mention of five other hypothesis-generating heuristics (M41-M45), which fall into the qualitative-data-analysis Subcategory M. Heuristic M41 calls for more hands-on participation by the principal investigator in the research routine (e.g. constructing stimulus and response material, collecting and entering data, talking with the subjects, etc) rather than leaving these tasks wholly to assistants. Such routine tasks serve to keep one's attention focused on the topic under study but also are undemanding enough to allow insight-provoking reverie that may enable the researcher to pick up unsuspected response patterns.

Heuristic M42, applying a current enthusiasm, does carry the risk of encouraging researchers to follow current fashions, applying some fad mechanically to diverse issues in a "have technique, will travel" style that is a bit ludicrous though sometimes useful. The enthusiasm may be for a new independent variable (e.g. nonverbal cues, facial neoteny), or a new dependent variable measure (e.g. facial EMG, magnetic resonance imaging), or a new explanatory mediational variable (e.g. implicit stereotypes, mood congruence), or a new analytic technique (meta-analysis, structural equation models). A slight variant, heuristic M43, encourages the enthusiast to ride off in all directions on his or her hobbyhorse, routinely introducing some favored variable (sex stereotypy, cognitive complexity, reaction times, etc) into the experimental design of every study, analyzing for new main and especially interaction effects. In the long run such enthusiasms are self-correcting, either paying off in revelations or losing the interest of the field (and perhaps even of the enthusiast).

Heuristic M44 involves pitting confounded factors against each other, as when Brock (1965) weighed source expertise against source similarity or when Argyll & Cook (1976) investigated the trade-off between interpersonal distance and eye contact as mutually substitutable nonverbal channels for communicating intimacy. Particularly provocative is heuristic M45, strategic planning of programs of research. McGuire (1989) has pointed out how our methodological books and courses focus almost entirely on tactical issues that arise in individual experiments (e.g. manipulating and controlling variables, meas-

urement, statistical analysis, etc) to the neglect of strategic issues that arise in planning multiexperimental programs of research. McGuire (1989) describes how training in strategic planning of multiexperiment research programs can be carried out and how it is particularly effective in generating and testing new hypotheses, as well as in testing the initial hypotheses in more meaningful contexts.

N. Quantitative Analyses

Subcategory N moves beyond the qualitative heuristics for generating new hypotheses described above in Subcategory M. It includes heuristics demanding quantitative sophistication such as the four, N46–N49, ordered in Table 1 according to their increasing demandingness of a priori theorizing.

46. MULTIVARIATE FISHING EXPEDITIONS Multivariate analysis can focus narrowly on whether a conventional variable such as self-esteem is a unitary trait or whether self-esteem as regards physical appearance, intelligence, social acceptance, etc, might be at least partially independent and so relate differently to other variables. Multivariate analysis can also be used for the broader task of getting insight into a large, amorphous domain, as when one begins a program of research on nonverbal behavior by reducing the dozens of interrelated nonverbal behaviors to a more manageable subset of factors that not only achieves economy of grouping but also suggests underlying latent variables (e.g. intimacy, vocalic fluency) that mediate the effects of nonverbal cues on other variables. Analytical procedures such as factor analyses and structural equation modeling may serve better for testing among explicit a priori theories than for discovering new theories (Breckler 1984), but they also have their uses for discovering new relations (which can then be validated in subsequent studies).

OTHER QUANTATIVE ANALYSIS HEURISTICS The three other Subcategory N heuristics call for progressively more a priori theorizing and greater knowledge of quantitative methods. Heuristic N47 involves subtracting out of a relation the covariance due to a powerful, well-recognized mediator whose effect is so large that it obscures the lesser roles of other mediators of more theoretical interest. An example is Hovland's (1952) approach to concept learning by subtracting out the amount of information actually contained in positive vs negative instances, thus making it possible to analyze the remaining covariance to test for asymmetries in how well people can actually process equal units of affirmational vs negational information. Similarly, to study how message variables affect attitude change, it is revealing to subtract out the overpowering mediating effect of the amount of learning of message content, to determine the additional mediating role of cognitive elaboration (as emphasized by the cognitive-response theorists), or the role of source perception (as stressed by Eagly 1974).

Heuristic N48, computer simulation, is a discovery process that is becoming increasingly available and suited to problem areas that have resisted natural language and mathematical analyses (Ostrom 1988), as in Rumelhart & McClelland's (1986) exploration of whether and how children's mastery of regular and irregular English verb forms can be accounted for by associations, without recourse to rule learning. Researchers drawn to computer simulation of actual human processes must resist the danger of drifting into an artificial intelligence effort to describe an ideal operator, and the danger of settling for a product rather than process simulation of actual cognition.

Similarly demanding is heuristic N49, mathematical modeling, which is doubly suggestive in indicating both how well the model accounts for the relation in question and also what covariation remains (indicating the involvement of further independent variables) after adjusting for the account given by the mathematical model. For example, rich implications can be drawn regarding how well a simple model (like signal-detection theory) or a complex model (like a LISREL formulation) can account for obtained relations among variables of interest; and then still more novel inferences can be drawn to account for the covariations that remain after adjustment for the variance explained by the mathematical model.

FUTURE DIRECTIONS

In assembling this long list of techniques for creative hypothesis generating I have tried to be inclusive, allowing some of the heuristics to overlap, e.g. several heuristics use variants of interaction effects or of deviant-case analysis as a creative device. A vigorous shaking down may reduce the list to a slightly smaller set of more independent techniques. Conversely, the list could be expanded, both by subdividing some of the present heuristics (e.g. D7 or L38) and by adding new ones.

In addition, the classification system that I use to order and group the heuristics is sometimes based on superficial descriptive criteria. Other classifications might be more provocative or might better reflect intellectual processes involved in discovery and the means by which researchers can be trained in using these heuristics creatively. One elegant advance would be to organize the list into a matrix with current Categories I to V as the five row headings, and then to identify column headings that cross all five of the categories similarly, with the separate heuristics constituting cell entries.

The heuristics have been described in isolation, but they work synergistically, so that some combinations can together augment creativity more than the sum of their individual effects. How several heuristics can be combined into an effective programmatic strategy has been described in McGuire (1989).

Also needed are descriptions of how each heuristic can be effectively taught. I have developed training procedures for these 49 heuristics that use worksheet exercises to teach students each of the steps that the heuristic involves. Space limitations preclude my describing these training procedures here, except for giving some illustrative training procedures specifically for heuristic A1.

There is a need for more empirical work to test the heuristics' usefulness in creative hypothesis generating. I have done informal pedagogical evaluations of the training procedures for some of the heuristics with encouraging results, but systematic evaluation studies are needed to determine if each heuristic is effective in enhancing creativity, under what conditions, for whom, and for what reasons. Two training questions need answering: Do the training procedures enhance students' use of a given heuristic? Does enhanced use of the heuristic increase the creativity of the student's thinking? Such research could be productive, not only for the practical end of enhancing scientists' creativity but also for a basic theoretical yield of clarifying the nature of thinking.

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