The *International Journal of Clinical and Experimental Hypnosis*
2003, Vol. 51, No. 3, pp. 195–231

0020-7144/03/5103-195$16.00


# THE FOUR CAUSES OF HYPNOSIS

PETER R. KILLEEN[1]

*Arizona State University, Tempe, Arizona, USA*

MICHAEL R. NASH

*University of Tennessee, Knoxville, Tennessee, USA*

**Abstract:** Aristotle's model of comprehension involves the description of a phenomenon and identification of its efficient causes (triggers), material cause (substrate), formal cause (models of structure), and final cause (function). This causal analysis provides a framework for understanding hypnosis and the hypnotic state. States are constellations of parameters within specified ranges; they name, but do not explain, a phenomenon. Concerns about reification of states are matters of semantics and pragmatics, not ontology. Isolation of efficient causes (e.g., procedure, context, social variables) is but one component of understanding. Experimental, technical, and conceptual advances have carried us into a century where the substrates and functions of hypnosis may be represented in synoptic theories that comprise all 4 causes of hypnosis.

> Hypnosis is the black sheep of the family of problems which constitute psychology. It wanders in and out of laboratories and carnivals and clinics and village halls like an unwanted anomaly. It never seems to straighten up and resolve itself into the firmer proprieties of scientific theory.
>
> Jaynes (1976, p. 379)

Explanations of ordinary phenomena regularly exercise scientists; explanations of extraordinary ones such as hypnosis often just fatigue them. Where does one start? ''Divide and conquer'' is the preferred strategy of more aggressive professions, but division works best along natural lines of fracture. Where are those for hypnotism? Aristotle, who confronted a much larger range of unexplained phenomena than we, provides a model of analysis.

## AN ARISTOTELIAN FRAMEWORK

Aristotle described four components of explanations (Aristotle, 1929; Hocutt, 1974):

Manuscript submitted August 15, 2002; final revision received November 15, 2002.
[1]Address correspondence to Peter Killeen, Department of Psychology, Box 1104, McAllister St., Arizona State University, Tempe, AZ 85287-1104, USA. E-mail: killeen@asu.edu

*1. Efficient causes.* These are events that occur before a change of state and trigger it (sufficient causes) or events that don't occur before an expected change of state and whose absence prevents it (necessary causes). These kinds of events are what most people think of as *causes*. Over the centuries since Hume, philosophers have refined the criteria for identifying efficient causal relations. Efficient causes identify the early parts of a stream of events that are essential for the later parts; they tell us what initiates a change of state.

*2. Material causes.* These are the substrates, the underlying mechanisms. Neuroscientific explanations of behavior exemplify such material causes. Many consider the description of material causes the most satisfying kind of explanation: Until they can ''open the hood'' and look inside, the phenomenon is not understood.

*3. Formal causes.* These are analogs, metaphors, and models. They are the structures with which we describe phenomena, and which permit us to predict and control them. Aristotle's favorite formal cause was the syllogism. The physicist's favorite formal cause is a differential equation. The chemist's is a molecular model. The Skinnerian's is the three-term contingency of stimulus, response, and reinforcer. Models do not constrain the machinery of the processes they describe. Simple harmonic motion may describe equally well the swing of the pendulum of my grandfather clock and the spin of the tires of my grandfather's auto. Models are structures put into correspondence with phenomena, and the same structure may fit more than one phenomenon.

All understanding involves finding an appropriate formal cause—that is, mapping phenomena to explanations having a structure similar to the thing explained. Our sense of familiarity with the structure of the model/explanation is transferred to the phenomenon with which it is put in correspondence.

*4. Final causes.* The final cause of an entity or process is the reason it exists—what it does that has justified or sustained its existence. Not all phenomena have final causes: A rock *in situ* does not have a final cause. But a rock on the dining-room table does. It might serve as a trivet or paperweight or object d'art; or it might be in transit to the rock garden. A biological feature may exist because of its function (i.e., why it was selected) or because the feature was associated with another which did increase fitness.

Final causes were considered opprobrious because physicists and biologists mistook them for time-reversed efficient causes. That is teleology. Effects of phenomena cannot be efficient causes of that which birthed them. The timing is wrong. But final causes are a different kind of cause. Explanations in terms of reinforcement or evolutionary fitness are explanations in terms of final causes. Almost all of modern physics

may be explained in variational terms—laws of least action. To say that light follows the path that minimizes travel time is explanation by final cause. Whenever individuals seek to understand a strange machine and ask ''What does it do?'', they are asking for a final cause. Given the schematic of a device (a description of mechanism), we can utilize it best if we are first told the purpose of the device. There may be many final causes for a phenomenon; ultimate causes have to do with evolutionary pressures; more proximate ones may involve a history of reinforcement or intentions.

*Confusing Aristotle.* Why did Aristotle confuse posterity by calling these different kinds of explanation causes? He didn't. Posterity did. Santayana (1957, p. 238) characterized Aristotle's medieval mistranslators and misinterpreters as ''learned babblers'' (Hocutt, 1974). For consistency with contemporary usage, the four becauses may be called *causal, reductive, formal,* and *functional* explanations, respectively. No single type of explanation yields understanding: Comprehension involves getting our fingers on all four types. To understand hypnosis, we should know something about: (a) the immediate stimuli that are necessary for it, those that are sufficient for it and those that merely predispose; (b) the underlying physiological state; (c) how best to talk about it—a theory of hypnosis; and (d) its function (see Figure 1).

*Nesting Aristotle.* Once mechanisms are found, it is possible to treat them as the unit of analysis, describing them with formal models, seeking triggers and functions, and dissecting their mechanism. The schematic of an electronic device is a formal representation of its electronic machinery; in concert with inputs (efficient causes) and outputs (final causes), it helps us understand and troubleshoot it. Conversely, the phenomenon may be treated as a module, or mechanism, in a metaphenomenon to be studied at the next level up. Material scientists may study the causes of friction in molecular adhesion; civil engineers may take the resulting coefficients of friction as givens, inputs in their design of highways. The process of unpacking material causes for phenomena re-engages the explanatory mechanism one level down—one man's fact is another man's enquiry.

Many phenomena are recurrent—they are parts of systems that they affect in ways that redound to affect them. They iterate, and in their iterations output becomes input, effect becomes cause. This does not discomfit the Aristotelian quarter. A thermostat is a device whose function is to control temperature, whose operation is triggered by a change in temperature, whose machinery may involve the warped expansion of a bimetallic strip, and which may be represented by a comparator module in linear systems theory. Nothing stands in the way of a similar dissection of the dynamics of human interactions.

*Embellishing Aristotle.* Successful application of Aristotle's four causes depends on the existence of a coherent entity they can be applied to. To achieve this, a clear definition and ramified description of the candidate is necessary. We must know that elephants are large mammals that have tails as well as trunks and tusks. This description includes statements of what the thing is, how it is related to other things, and what it is not. Because one or more of the four causes are sometimes included in such descriptions, people confuse descriptions with explanations. It is more useful to keep these functions separate. Definition identifies the phenomenon: It answers the *what?* question of the investigative reporter. *Who? when?* and *where?* describe the actors and their spatiotemporal loci. *Why?* is satisfied with efficient and final causes. Assessments that start with description and end with causal analyses provide complete understanding.

Proponents of one approach often derogate explanations involving different kinds of causes than those they practice. Excessive concern with efficient causes is *mechanistic*. Exclusive focus on material causes is *reductionistic*. Exclusive involvement with theories and models is *airy*; explanation in terms of final causes alone is *teleological*. But mechanistic, reductive, theoretical, and functional explanations are not by themselves wrongheaded, just incomplete. They are monochromes.

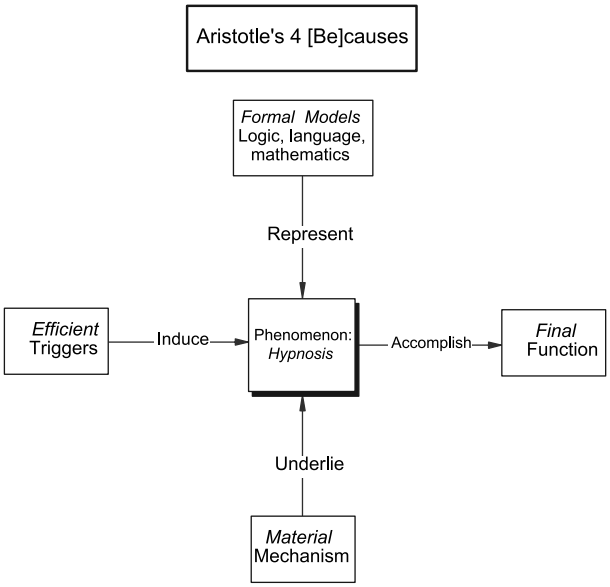


***Figure 1.*** **The four causes of hypnosis.**

Drawn together, they suffuse a simple descriptive sketch with the multidimensional hues of understanding.

## DESCRIPTION

*When is a Phenomenon?*

We engage causal analysis in order to understand an event or phenomenon. But first we must know that we have a phenomenon to understand. Discontinuities—qualitative differences—make categorization easy. A bird is a different entity than a bird-dog; flying is a different phenomenon than retrieving. Ice is different than water, even though both are $H_2O$. They are different states of the same thing. But how do we parse continuua? Is hot dirty water something different than cold pure water? Are very compliant passive individuals in a different state than active recalcitrant ones? Is hypnosis properly called a state if it is merely a constellation of traits that—in less extreme form—is part of the normal state? What are the rules for entity-hood?

The question is one of parsimony, not metaphysics. All events are unique, but we have neither the memory nor vocabulary to name them all. When Adam named the animals, he wasn't calling them ''Rex'' and ''Mitten'' and ''Wiggles'' and ... How do we prudently allocate our finite capacity for names? Costs and benefits decide when a thing justifies special treatment. The cost of a category is the label and its demands on memory, the rules for using it and associated costs such as the risk of reification—leading others to mistakenly assume a thing is an entity when it might not satisfy other criteria for that status (e.g., be different in any relevant way). The benefits of categorization are economy of representation and enhanced ability to predict features, knowing the category. The state of a system such as a thermostat may be given in qualitative terms—''closed''—or in quantitative terms—''within half a degree of tripping.'' The binary nomenclature is simpler, because it conveys one bit of information. Temperature, humidity, and wind-speed vectors are more precise but often have too fine a point; it is often simpler and more useful to know whether it's balmy or brisk. Both reports characterize the state of the weather, are convertible to one another, and are each useful in their own way. So it is with hypnosis.

*States 'n' states.* The state of a system is the status of its key variables at a point in time. A change in these indicates a different state. Sometimes states change in dramatic ways. Something special happens when ice melts or water evaporates. Over a large range of the controlling variable, the output is simply ''more of the same''; then suddenly new features arise. Cold water sinks, ice floats; water mixes, ice coheres. Now the utility of a special name is manifest—this is state with a capital

S. Does hypnosis just change the state of the system, or can we say it induces a new State?

Wittgenstein (1965) counsels us to turn back to the natural language game of a word to help understand its purview. Water and ice are a paragon for States. Ice seems like a radically different substance than water. But as temperatures drop, properties of ice start to materialize before the water crystallizes. Cold water starts to get lighter and more viscous just before it freezes. It is the speed of the change in properties as a function of change in the controlling variable that makes water and ice different States. Snap your fingers above a bowl of super cold water, and it will immediately crack into ice.

*Describing Hypnosis*

A definition is a concise description. Definitions are a sketch; descriptions the chiaroscuro. A good contemporary definition of hypnosis, and an excellent basis for elaboration, is by Kihlstrom (2001):

> Hypnosis is an altered state of consciousness, involving imaginative experiences associated with subjective conviction bordering on delusion and experienced involuntariness bordering on compulsion, which takes place in the context of a particular social interaction between hypnotist and subject, itself embedded in a wider sociocultural matrix of understanding about mind and behavior.

Hypnotized subjects feel and behave differently than most people behave most of the time. But they do not demonstrate extra-human abilities: Various operations will drive many people into the same states—from lassitude to catalepsy, from docility to roboticity, from visionary to hallucinatory (Barber, 1969). Such changes of state are parts of everyday life, becoming larger than life in religious transport, hysteria, frenzy, shock, and nightmares, as well as in victims of brain dysfunctions such as schizophrenia and autism:

> Most people probably fall several times a day into a fit of something like this: The eyes are fixed on vacancy, the sounds of the world melt into confused unity, the attention is dispersed so that the whole body is felt, as it were, at once, and the foreground of consciousness is filled, if by anything, by a sort of solemn sense of surrender to the empty passing of time . . . somehow we cannot *start*. (James, 1890, p. 404)

Hence, it is not that hypnosis imparts unique properties to the system that sets it apart from other attainable states. Rather, it is the speed of the change in properties—alterations in cognition, perception, volition—as a function of change in the controlling variables—the suggestions and context—that distinguishes the hypnotic from other states of the system. Merely snap your fingers and a hypnotized subject cannot identify his mother. Snap again, and the memory returns. This ease of manipulation is one of the reasons that some researchers

interested in attention, memory, pain, and perception use hypnosis to alter the state of the system.

To say that a person is hypnotized, it is necessary (but not sufficient) that the constellation of behaviors defined by some instrument (e.g., the Stanford Scales; Weitzenhoffer & Hilgard, 1959, 1962, 1967) that occurs following hypnotic suggestions exceeds some criterion or some critical change from baseline. We may report the state of the individual as scores on each of the dimensions, as their sum, or in terms of their principle component. We abbreviate responses typical of the hypnotized subject as HR, for *hypnotic responses*. These responses may occur in nonhypnotized individuals, such as those dissembling or merely trying to please. Because the efficient causes of such responses are often uncertain, we use HR to refer to the behavior, without prejudging its provenance from a hypnotic state. The *hypnotic state* (HS) is the constellation of HRs that occurs following certain hypnotic operations in certain organisms (hypnotizable subjects). It includes both objective changes in performance and subjective reports of perceptions, memories, and abilities.

To speak of a hypnotic state is tendentious, because it is a commitment to the position that hypnosis involves an altered state of consciousness, and some researchers deny this, preferring to reserve the term *altered state* for states never visited by unhypnotized people. But as far as we know, there are no such unique states. We use the term, and its abbreviation HS, for the reasons detailed in this paper and for another, pragmatic reason. The term hypnosis is ambiguous, sometimes meaning the process of induction, sometimes meaning the State, and sometimes meaning the state without meaning the State. Hypnotism also means all of the above, and is thus equally compromised in any discourse where clarity is required.

Hypnosis is startling because it manifests as the absence of a much more startling facility that we have grown used to, having spent most of our lives habituating to it: Self-consciousness. Hypnosis dissociates self-knowledge from action and perception. This is why hypnosis is so relevant to the study of human nature. Disconnects between self-knowledge, action, and perception are crucial, whether they occur in a psychiatric facility, a Christmas party, or an oval office. It is a short step from disconnection to self-deception, a phenomenon of both philosophical interest (Fodor, 1983; Mele, 1987; Pears, 1984) and psychological import (Taylor, 1991).

A distinctive aspect of the HS is the apparent ease with which HRs are emitted or inhibited. Hypnotized subjects suspend their ability to monitor the effort required for an action or perception. Some HRs seem to occur so readily that they are involuntary; others seem so difficult that they are impossible. Some images seem so easy to conjure that they must be real; other things so difficult to perceive that they must not be

there. Some pains seem so easy to tolerate that they are not painful. The hypnotic state is a species of ''deficient second-order awareness'' (Lambie & Marcel, 2002): not a deficiency in our ability to perceive, feel, or do but a deficiency in our ability to take note of the fact that we are doing so. Skinner (1935) called awareness ''seeing that we are seeing,'' and imagination ''seeing without the thing seen.'' It is the first seeing in each phrase, the meta seeing, the *seeming*, that hypnosis bedevils. Ultimately, the hypnotic state is the abeyance of our ability to *seem* or to say what we seem. It epitomizes the dumbness against which the oracle cautioned *know thyself*.

*The number of the beast*. States, like categories, are often treated as homogenous entities. There is, however, a continuum of hypnotic involvement, sometimes called ''depth,'' indexed in part by the degree to which suggestions are accepted. If this variable were continuous within each individual, it would somewhat undermine the utility of a State denotation. There are graded effects in hypnosis: Training can increase scores on hypnotizability tests (Kirsch & Lynn, 1995), at least for the easier items, and getting deep effects sometimes requires a longer induction (Hilgard, 1971). This is captured in the rounded shoulders of the top and bottom of the ogives in Figure 2. In the main, however, the HS is a relatively homogenous state within individuals, while differing substantially across individuals (Figure 3). Hypnotizability remains stable over the adult's lifetime (Nash & Nadon, 2002). The continuum of effect arises from variation in the susceptibility of individuals to hypnosis, not variation in what an individual will do while in the state. People are made of different mettle; many may be hypnotized, but the degree to which hypnotism aligns them with the influence of the hypnotist differs, and this difference is stable. That no standard personality trait correlates with hypnotizability (Glisky, Tataryn, Tobias, Kihlstrom, & McConkey, 1991; Hilgard, 1965;

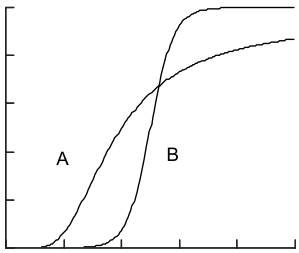


*Figure 2.* **The abrupt acceleration of Process B recommends considering its high and low domains as different States; this is less the case for Process A.**

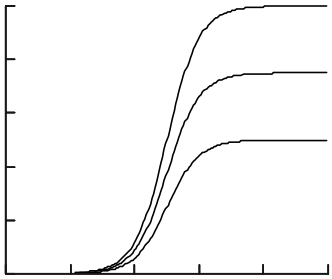

*Figure 3.* **The graded differences found in the HS are primarily due to individual differences in the degree of hypnotizability, represented by the different ogives.**

Kihlstrom et al., 1980) does not mean that hypnotizability is not a trait—but rather that it is an orthogonal trait, one that cannot be subsumed under or predicted by other traits. Modern experimental techniques provide an increasingly clear description of the nature of this beast (Bowers & Woody, 1996; Kihlstrom, 1998; Nash, 2001; Szechtman, Woody, Bowers, & Nahmias, 1998; Woody, Drugovic, & Oakman, 1997).

*Hypnosis is just...* Prudent scientists investigating a phenomenon first exploit existing theories, applying them broadly to see how much extra duty can be gotten from an already well-known structure. So, too, it is with hypnosis. Mesmer (1766/1971) first sought to understand hypnosis in terms of magnetism. Almost immediately, a scientific review (Franklin et al., 1774/1775) showed the phenomenon had nothing to do with lodestones but a lot to do with imagination, social influence, and even sexual tension. Later generations attempted to embrace it within one existing theoretical scheme or another (for a review, see Shor, 1979a). A time-honored candidate is that hypnosis is just a manifestation of general suggestibility (Bernheim, 1887/1965). Curiously, the phenomenon changed with its descriptions, taking on some of the aspects of the assumptions of successive generations of theories. Hypnotism hypnotized hypnotists.

Imagine all the people sharing all the world. Can you do that? Or even just hear John Lennon singing that line? If so, perhaps you have a better imagination, or are more suggestible, than others. Perhaps hypnosis is nothing but hypersuggestibility; that is, perhaps we can usefully investigate the hypnotic state as an instance of general suggestibility or social influenceability. This saves inventing new states and is thus a more parsimonious approach. It may be useful even if hypnosis *is* something more, as long as a lot of the variance in the phenomenon is accountable for by standard traits such

as suggestibility. *Hypnosis is Just Suggestibility* is not a new hypothesis:

> ''*The theory of Suggestion* denies that there is any special hypnotic *state* worthy of the name of trance or neurotic. All of the symptoms . . . are results of that mental susceptibility which we all to some degree possess, of yielding assent to outward suggestion''. (James, 1890, p. 598)

Even James recognized that this was insufficient; today, we further understand that suggestibility itself is more than one thing. Eysenck and others believe it to be as many as three relatively distinct tendencies (Benton & Bandura, 1953; Duke, 1964; Eysenck & Furneaux, 1945; Grimes, 1948; Hammer, Evans, & Bartlett, 1963; Stukat, 1958). Hypnotic responsiveness does not correlate with most types of suggestibility. In their day-to-day lives, people who respond well to hypnosis are not unusually gullible; they are no more responsive to placebos than others; their memory is no more (nor less) influenced by embedded misinformation; they are not particularly influenced by social pressure; and their response to authority figures is unremarkable. Although changes in suggestibility are one of the main effects of hypnosis, suggestibility is not one of the causes of hypnosis. As James noted: ''Even the best hypnotic subjects pass through life without any one suspecting them to possess such a remarkable susceptibility, until by deliberate experiment it is made manifest.'' Then they are hypnotized and ''no ordinary suggestions of waking life ever took such control of their mind'' (James, 1890, p. 600).

*Effort and agency.* Although hypnotic responses are not abnormal, they are often unlikely or difficult. One way to achieve difficult things is to apply considerable force, as one might in moving a heavy container across a floor (Figure 4). That the box can be moved—the subject's arm lifted—may demonstrate a response similar to that obtainable in other ways. But the responses per se are not the phenomena of interest. A hypnotic procedure achieves the same result by a different technique: It makes the hypnotic response seem effortless, perhaps inevitable. Hypnosis greases the way, removes the friction, achieves the effect with minimal experienced effort.

Ask someone what would happen if large balloons were tied to her wrist and were pulling her arm skyward. She would say her hand would go up. If then asked to demonstrate she would probably move her right hand from her lap until it is high above her head. There is nothing interesting about this. We understand why the hand moves: The subject is moving it and experiencing the usual effort it takes to decide to comply, to issue the motor commands, and to engage the muscles. If queried, she will tell you about that voluntary act and its effort. When a hypnotized subject is told that balloons are pulling her

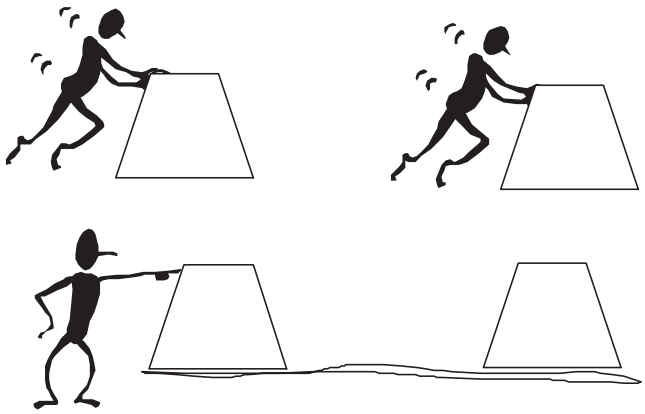

*Figure 4.* **Getting an inertial object such as a box or an arm to change position is not hypnosis. Doing it with seeming ease after a hypnotic procedure characterizes the hypnotic state.**

wrist higher and higher, the right hand gradually moves up because—once again—the subject is moving it. The crucial distinction is that the hypnotic subject experiences the entire enterprise as effortless: ''My arm just got light and I watched it move up.'' This is the ''classic suggestion effect'' described by Weitzenhoffer (1974, 1978). This miscarriage of experienced agency indicates a realignment of critical parameters of volition. Or, as Bowers nicely put it, the hypnotic response is ''purposeful in the sense that it is goal-directed and achieves the purposes described by the suggestions; but . . . it is not performed on purpose'' (Bowers & Davidson, 1991, p. 128). There is little question that the way hypnotic suggestions are typically worded—factually, with some authority, and in the passive voice—communicates this notion of nonvolitional response. Subjects who do not experience this effortlessness often fail to move their hands. Hypnotized subjects are in a different state; those who are unresponsive are in a mundane state. In both cases, hypnotic suggestions are necessary but in the latter case not sufficient. As James concluded 2 centuries ago, ''[It is not that the suggestion-theory is wrong: It] may be approved as correct, provided we grant the trance-state as its prerequisite'' (James, 1890, p. 601).

*Counting the ways.* Another argument for nominating a phenomenon as a State is that the differences between objects in it and out of it differ along many dimensions (Cloninger, 1989; Meehl, 1995). The more distinctions a State denotes, the more value (prediction of a variety of effects) we get for its theoretical cost. Can the HS can be reduced to the shift along a single dimension—perhaps a familiar and broadly

accepted dimension of social influence, involving compliance, placebo, role-play, social desirability, self-expectations? Considerable heat has been generated around just how many factors underlie hypnotic effects. Most theorists acknowledge that hypnosis is a social phenomenon. The question pivots on whether there is anything other than social influence involved. Some say ''no'' and identify a single dimension of hypnotic effect (e.g., compliance for Wagstaff (1991); goal-directed fantasy for Spanos (1991); role-playing for Coe and Sarbin (1991). Most factor-analytic studies of hypnotizability yield a 2- or 3-dimensional factor structure (for review, see Balthazard & Woody, 1985). Certain effects, such as inhibition of movement, are rarer than others, such as instigation of movement; perhaps they appear to be parts of independent factors because only more hypnotizable subjects manifest them. This is Coe and Sarbin's (1971) argument. Reducing the hypnotic State from multidimensional to unidimensional reduces the justification for capitalizing the S. Coe and Sarbin identify the single dimension as the ability to adopt an ''as if,'' or role-playing, approach. It is for this reason that drama students are more hypnotizable than science students. In an elegant analytic response to this reduction, Tellegen and Atkinson (1976) were able to score each of the traits in such a way as to equate the difficulty of attaining them; they still found a multidimensional structure to the state. Beauchaine and Beauchaine (2002) is an important recent source on taxonomic approaches to the definition of states, for carrying forward Tellegen and Atkinson's work.

One promising psychometric approach has already yielded important findings. As noted earlier, conventional factor analyses of items on hypnotizability scales suggest that the domain of these scales is not unidimensional (see Balthazard & Woody, 1985, for a review). Woody and his colleagues (Woody, Bowers, & Oakman, 1992) note that factor analysis typically reveals fan-shaped distributions of items on two dimensions.

> The position of an item in this fan or 'spectrum' is closely related to the item's difficulty level: The more difficult the item, the higher its correlation with one of the two underlying dimensions of hypnotic ability, and the lower its correlation with the other dimension.'' (p. 15)

Woody and his colleagues (1997) found that passing easy items on hypnotizability tests (e.g., hands moving together) correlates more highly with measures of social influence (biserial correlation circa of .30) than does passing difficult items (e.g., amnesia, biserial correlation with measure of social influence of circa .05). In addition, Balthazard and Woody (1992) found that the more difficult an item, the more likely performance on that item is correlated with the Tellegen Absorption Scale (TAS; Tellegen & Atkinson, 1974). The biserial correlation between the TAS and passing or failing the easy hands-together item was

.16. For the difficult amnesia item, the same correlation was .43 (but see: Kirsch & Lynn, 1995). Social compliance may constitute much of what is required to respond to easy items; response to more difficult items might require the cognitive shift of attention and absorption that is constitutive of the HS.

## Causal Analyses

Definitions and descriptions identify the object of interest and its characteristics. Explanations are accounts of the four causes of the object.

### *The First Cause of Hypnosis: Efficient Causes*

Efficient causes are triggers. Triggers are parts of machines, and those machines must be understood to understand the function of the triggers. Efficient causes are part of a contextual nexus of events. Within this context, *sufficient causes* are those that, when added, bring about an effect. There may be many alternative causes sufficient for an effect—there are many ways to scare a cat. We may write sufficient causes as $C_S \bullet C \rightarrow E$. This material implication states that a sufficient cause is that which, when added to a context *(C)*, will bring about an effect. *Necessary causes* are those events that, when missing from the context, prevent an otherwise expected outcome. A lit match may normally be sufficient to start a fire; when it fails to do so, we may find that dry tinder or oxygen—normally presumed to be part of the context—was missing. Oxygen and dry tinder are necessary causes. We may write necessary causes as $\sim C_N \bullet C \rightarrow \sim E$; a necessary cause is that which, when removed from a context, will arrest an effect. Contexts often provide many necessary causes that go unnamed because they are present and taken for granted. It is usually only when things don't go that a missing necessary cause is sought. In general, a context will bring about an effect $(C \rightarrow E)$ if the context contains all the necessary plus at least one sufficient cause. The constellation of necessary and sufficient components is not independent: Different sufficient causes may require different constellations of support from necessary causes. What we call sufficient and what we call necessary depend on how we dissect the causal context.

This analysis is simplistic, because it limits causal relations to binary events, ones present or absent. The languages of statistics and measurement theory permit generalization to probabilistic and graded events. In the case of probabilistic relations, the material implication may be generalized with conditional probability, permitting us to speak of the probability of an effect given a (probabilistic) cause: $p(E|C_P)$. If this conditional probability is above the base-rate for that

effect $p(E)$, then $C_P$ plays the role of a *part-time* sufficient cause; if below base rate, it plays the role of a part-time inhibitor (a role not given a special name in classic logic). If $p(E|\sim C_P)$ is below baseline, then $C_P$ plays the role of a part-time necessary cause; and above it, a part-time inhibitor.

When combined in a contingency table, these conditional probabilities provide a matrix from which various measures of correlation can be derived. It is sensible to talk of events as causes, even if they are only probabilistically related to their effects. We say that cigarette smoking is a cause of lung cancer, even though it is neither necessary nor sufficient for the disease in the classic all-or-none sense of those terms. When a part-time cause fails to have its usual effect, observers infer that some part of the usual causal context was absent in that instance—that an unspecified necessary cause was missing.

A lot is known about the necessary and sufficient causes of the HS. Elaborating these causes first requires a procedural definition of the paradigmatic *situation* in which hypnosis occurs. With this established, we can then move to consideration of facilitators and inhibitors of hypnotic response.

*Sufficient causes*. Many have struggled with defining the domain of hypnosis (Hilgard, 1965; Kihlstrom, 1998; Nadon, 1997). A critical element in this endeavor is to provide some usable procedural definition of what constitutes a hypnotic context or situation, so that laboratory research can proceed accordingly. The trick is to do so without sacrificing too much of the term's ecological vitality and relevance to the human condition in vivo. Following Kihlstrom (1998), we offer:

> A hypnotic *procedure* is a protocol used to establish a hypnotic situation and evaluate responses to it. In such situations, one person (the *subject*) is guided by another (the *hypnotist*) to respond to suggestions for alterations in perception, thought, and action. If the constellation of responses to standardized suggestions satisfies a criterion, we infer that the procedure induced a hypnotic *state*. Hypnotic *responses* are those responses and experiences characteristic of the hypnotic state.

The particulars will differ depending on the framework of the investigator and the purposes of the procedure. Procedures typically involve instructions to relax and suggestions that permit the extent of hypnosis to be calibrated by comparing the responses to standards (e.g., the Stanford scale). The responsiveness of the individuals may range from high to negligible. Criteria are usually established for research purposes, for example, groups divided into high (score 8–12), medium (score 5–7), or low (score 0–4). As is the case for states such as *attentive* and *aware*, the salience of the evidence for having achieved a hypnotic state increases with the individual's score.

The hypnotic situation involves two efficient causal elements: (a) There is a preamble to the procedure during which the subject is told that the nature of what is to follow involves suggestions for imaginative experiences; (b) The imaginative suggestions are administered. For the purposes of our definition, what is typically referred to as an induction is merely an extended introductory suggestion that may (or may not) contain further elaborations of the preamble.

When the preamble and the suggestions are in place, the probability that hypnosis will occur is increased: Together they denote a part-time sufficient cause of hypnosis. The hypnotic procedure does not ensure that the hypnotic state—hypnosis—will occur: The necessary elements must also be present. Those begin well before the first suggestion and extend well beyond it. Many types of preambles will work. The content of those preambles affects subsequent response to the suggestions (e.g., Orne, 1959). Using the word *hypnosis* as part of the hypnotic situation may be helpful, but is not necessary nor does its use ensure that the sequalae will satisfy our criteria for hypnosis.

*Necessary causes: Attitude and aptitude.* As with perhaps all performances, whether they are spelling bees, SAT exams, or job evaluations, much variance in performance is explained by attitude and aptitude. So it is with hypnotic response. Without the right attitude—motivation, expectations, and willingness—the subject will not experience hypnosis. The correlations between these variables and hypnotizability scores is typically in the range of .20 to .30 (de Groh, 1989). Even this very modest relationship between attitude and hypnotizability must be qualified. Spanos and his colleagues (Katsanis, Barnard, & Spanos, 1988; Spanos, Brett, Menary, & Cross, 1987) warned that the relationship between these variables and hypnotic performance is fan-shaped, such that ''strong negative attitudes and expectations suppressed hypnotizability, whereas positive attitudes and expectations allow subjects to attain high hypnotizability scores. However, positive attitudes and expectations in and of themselves do not engender high hypnotizability'' (Spanos, 1991, p. 331). In other words, the relationship between attitude and hypnotizability is less like a dosage effect (the more positive, the better the performance) and more like a threshold effect (one need not be especially willing to do well, but must be at least *somewhat* willing).

The necessary cause that ''keeps on giving'' in hypnosis research is aptitude: hypnotizability. One of the earliest and most surprising facts uncovered by hypnosis research is that the extent of a subject's behavioral response to hypnosis is as stable across time as IQ tests (25–30 years, Piccione, Hilgard, & Zimbardo, 1989) and is stubbornly robust across a host of contextual features that one might otherwise expect would impact performance rather dramatically: wordings of procedures, length of procedure, experience level of operator, sex of

operator, and perceived prestige of operator. This qualifies hypnotizability as a necessary cause—in the complete absence of hypnotizability, there exists no preamble, no series of suggestions that can induce hypnosis. No wood, no fire; just a spent match. Of course, in most cases, there is at least some kindling, and in this sense then hypnotizability is a part-time necessary cause: the less the subject possesses, the more likely his or her hypnotic responsiveness is below baseline. When a hypnotic virtuoso is encountered, the experimenter becomes aware of just how unimportant the wording and timing of the suggestions can be (''my hand felt heavy and started to move down before you said anything about it'').

The motor responses of a hypnotized subject provide publicly measurable dependent variables. But there is little that is unique about them. It is the subject's experience that makes the hypnotic state exceptional. A key aspect of the HS is a befuddling of the subject's ability to identify the causal agent of an action; what caused the hand to rise—the subject's own thoughts or the words of the hypnotist? ''The experience of willing an act arises from interpreting one's thoughts as the cause of the act. . . . The thought must occur before the action, be consistent with the action . . .'' (Wegner & Wheatley, 1999, p. 480). This has the earmarks of classic conditioning (Coleman, 1985). We are regularly conditioned to think of *thoughts* as the agents of our actions; but thoughts are as often posthoc (Bargh, 1997). To experience willing, ''the thought must . . . not be accompanied by other causes.'' (Wegner & Wheatley, 1999, p. 480). When a subject has spent 15 minutes obeying the hypnotist's instructions to relax, the hypnotist's suggestion that the arm is lifting becomes a salient potential cause of the arm's lifting. The hypnotist's matching of bodily postures and leading of action may also serve to confuse the subject about the regnant causal agent. Double-bind requests of the ''challenge'' type (''Your arm is unbendable'' . . . ''Try to bend your arm'') may leave subjects in a quandary easily filled by deference to the emphases of the hypnotist (Haley, 1972; Sheehan, 1980; Sheehan & Dolby, 1979). Hume noted the great power of extrinsic stimuli: ''No internal impression has an apparent energy, more than external objects have'' (1888/1939, pp. 400–401). Perceptions of external objects often trigger responses without the mediation of awareness (Bargh & Chartrand, 1999). The fundamental misattribution error of hypnotized subjects is failing to attribute action to the conscious self (Spanos & Chaves, 1989). Because the ego is such an equivocal cause of action in any case, such confusion should not be surprising.

What if the hypnotic situation is not obviously present: Do behaviors resembling those of individuals in the HS permit us to assume the presence of the state? The presence of familiar triggers such as standardized hypnotic protocols increase confidence that what follows is the HS; but it is a rare phenomenon that has only one sufficient cause.

There may be other ways to induce the state (see Garvin, Trine, & Morgan, 2001). The hypnotist is primarily a guide to help individuals hypnotize themselves. In some sense, all hypnosis is self-hypnosis. Other agents, including the subject herself (Fromm & Kahn, 1990), a computer (Grant & Nash, 1995), a videotape (Repka & Nash, 1995), an audiotape (Shor & Orne, 1963), or even a typed transcript (Johnson, Dawson, Clark, & Sikorsky, 1983) may play that role. But in all cases it is necessary to measure the constellation of evidence, both subjective and objective, to validate for the presence of the HS. Having a blank mind is not the same as being hypnotized, nor is stoicism in the face of pain, nor is faking it, nor is simple deference to the wishes of a hypnotist.

*States are not sufficient causes.* They are the operations of a system within a range of parameter values of key variables. An iron may be said to be hot if it glows or if its temperature is above 300° F. States may be part of the causal context; at best, they are necessary causes. I didn't get burned because of the state of the iron; I got burned because I touched the hot iron. It is easier to get a subject to comply with instructions if they are hypnotized, but it is the instructions (within the context) that are the efficient causes. Hilgard (1971) draws the analogy to dreams. Sleep is part of the necessary context for dreams; the state of the bodily system must be *asleep* in order to dream. But we also sleep without dreaming. Sleep is part of the causal context of dreaming, but not a sufficient cause of dreams. The HS is part of the causal context of hypnotic responses, but not a sufficient cause of them.

Is the HS necessary for HRs? No, those may be achieved in other ways, such as by strong social pressure (Barber, 1969) or simply by the desire of a well-informed subject to deceive an onlooker (Orne, 1971). The altered subjective state that accompanies a hypnotic procedure may be approximated by monotonous environments (Barabasz, 1982), meditation or drugs (Diamond, 1974), or the hypnogogic state that borders sleep (Delmonte, 1984; Schacter, 1976). It is the constellation of the hypnotic situation (efficient cause) and able and willing subjects (necessary causes) resulting in altered responses (HRs)—both objective (e.g., inability to make certain responses, effortlessness of other responses) and subjective (e.g., reports of altered sensations)—that constitute hypnosis. Any one of these can be present with or without the others; our evidence for the HS decreases as does knowledge of these factors. But this does not mean that the depth of the HS is itself decreased if one of these factors is unevidenced; we are just less certain of its presence. Much of the controversy concerning the nature of hypnosis hinges on this distinction: Uncertainty of evidence for a state vs. uncertainty of state.

The role of the HS in mediating HRs is similar to the role of awareness in mediating conditioning. The evidence for being aware is based on

self-report, as is much of the evidence for being hypnotized (i.e., the reports of changes in perceived effortfulness of responses, etc.). In both cases, the effects—overt behaviors: HRs or conditioned responses (CRs)—can be objectively measured. In both cases, demand characteristics may lead a subject to behave in ways that confound the interpretation of results. In a thoughtful analysis of the logic and literature on conditioning and awareness, Lovibond and Shanks (2002) take pains to generate criteria for the reliability and validity of measures of awareness and of the nature of the responses conditioned. These authors found that the evidence for conditioning without awareness was generally weak. Though not uncontroversial, their conclusion was authorized because the CRs were responses such as eye blinks to tones that have low base rates in unconditioned subjects. In the case of hypnosis, the effect of interest is not the mere presence of characteristic objective responses, because their base rates are not so low, and other events may be sufficient to occasion them. The effect of interest is the presence of HRs *in conjunction with* hypnotic contexts and subjective reports. Because this is less definitive than many would like, additional evidence for the HS has been sought in its material causes.

*The Second Cause of Hypnosis: Material*

> All we have to do is to find those parts of the brain that are responsible for consciousness, then trace out their anatomical evolution. . . . Now this sounds like an excellent scientific program. [But] there is a delusion in such reasoning. . . . Even if we had a complete wiring diagram of the nervous system, . . . though we knew the connections of every tickling thread of every single axon and dendrite in every species that ever existed, together with all its neurotransmitters . . . we would still never—*not ever*—from a knowledge of the brain alone know if that brain contained a consciousness like our own. We first have to start from the top, from some conception of what consciousness is, from what our own introspection is. We have to be sure of that, before we can enter the nervous system and talk about its neurology.
>
> Jaynes (1976, pp. 16, 18)

Humans are fascinated by mechanisms. It is a rare child who hasn't dissected some hapless bug or worm to find its essence, a rare adult who doesn't inspect the engine before buying the car. A common result of the operations is a sense of satisfaction; a less common result is a sense of enlightenment. If areas of the brain lit up upon the onset of the HS with a brightness correlated with depth of hypnosis, many doubters would consider the case closed. When we ''look under the hood'' upon the hypnotized but untasked brain, no definitive neural signature of the HS has thus far been identified. But the HS is not an object, like a carburetor; it is a mode of functioning of the nervous system. To determine how the engine is functioning, it must be put into operation,

loaded, tasked. The same is true of the HS. The material causes of the HS might be better revealed when hypnotized subjects are tasked with suggestions for HRs (e.g., hallucination, analgesia, amnesia). What happens then? Does the brain function differently from that of non-hypnotized subjects given the same tasks?

The HS is not a sufficient cause of the HRs. The HS changes the nature of the response to a suggestion; within the hypnotic context, it is the suggestion that is a sufficient cause—it triggers the HR. Neuropsychological research likewise tests whether there is a characteristic response to suggestions that differs for those in the HS. As this conference shows, modern neuropsychological tools are beginning to provide both satisfaction and enlightenment concerning the material causes of hypnosis.

*EGGs and sleep.* From the late 19th century (Charcot, 1886), there has been an enduring interest in brain changes during hypnosis. Indeed, Charcot and his acolytes held that when a patient responded to hypnosis it was pathognomonic for the existence of a subtle neurological disease. Formal theories of hypnosis eventually drifted away from neuropathy and toward the older notion of hypnosis as a sleep-like state. Even Pavlov (1923) offered that hypnosis, like sleep, is a product of cortical inhibition. Armed with the newly developed electroencephalograph (EEG), researchers soon reasoned that if it looks like sleep, it must share some common neurophysiological process with sleep. They enthusiastically applied their electrodes and proceeded to find nothing that looked like sleep records, nothing in fact very different from the records of control subjects (Barker & Burgwin, 1949; Darrow, Henry, Gill, Brenman, & Converse, 1950; Goldfarb & Kiene, 1945; Jenness, 1934; Wible & Jenness, 1936). By the late 1960s, this line of research atrophied (see Evans, 1977). There were two good outcomes of this research: The hypnosis-as-sleep hypothesis was rejected; and a precedent for hypothesis-guided research was established.

The search for a sleep-hypnosis link was replaced by a neurophysiological approach to hypnosis that, until the 1990s, was methodologically driven, somewhat frenetic, and, as a result, bewildering. Studies were either explicitly exploratory or grounded to theory in only the most tenuous manner. Methodologies and procedures varied so widely that replication was nearly impossible. A hodge-podge of claims and counter claims about Alpha, Beta, Theta, power, hemispheric lateralization, cortical depression, developmental aberrations, attentional processes, alpha asymmetry, and reflex inhibition ensued. Though there were noble attempts to draw this literature together in some coherent fashion (Crawford & Gruzelier, 1992; Gruzelier, 1988; D. A. Spiegel, 1991; Spivak, Puzenko, Medvedev, & Polyakov, 1990), they were not convincing.

Beginning in the 1990s, some modest progress has been made in our understanding of the brain and hypnosis. This has occurred for four reasons: first, brain-savvy theorists are crafting models of hypnosis with direct implications for neurophysiological functioning (Crawford, Knebel, & Vendemia, 1998; Gruzelier, 2000; Oakley, 1999; Ray, 1997; Woody & Bowers, 1994). Second, researchers more commonly examine brain function while the subject responds to hypnotic suggestions (e.g., analgesia and hallucination; Rainville, Duncan, Price, Carrier, & Bushnell, 1997; Szechtman et al., 1998, respectively), not while the subject rests peacefully doing nothing. Third, advances in traditional EEG and imaging techniques have enabled researchers to track changes in brain functioning with greater precision. Fourth, though the research over the previous decades was decidedly disjointed, it provided some ''likely candidates'' for closer examination in light of advances in theory and technique.

It is the purpose of this special issue of the *Journal* to map the landscape of the brain-hypnosis field. We will allow the other papers to detail that topography. Here we offer a bird's-eye view.

*Theta and hypnotizability.* There appears to be a relationship between hypnotizability and electro-cortical activity in the theta frequency range across a wide variety of sites (De Pascalis, Ray, Tranquillo, & D' Amico, 1998; Graffin, Ray, & Lundy, 1995; Ray, 1997). Theta has typically been associated with hypnogogic imagery, meditation, rapid-eye-movement sleep, continuous concentration, and selective concentration (Ray). Highly hypnotizable subjects are higher in theta than low hypnotizable subjects, both during hypnosis and at baseline (i.e., when hypnosis is not involved at all). As such, theta activity seems to be one of the rare individual differences that correlates with hypnotizability. These authors posit that prominent theta expresses the highly hypnotizable subject's ability to narrowly focus attention so as to be relatively distraction-free (Crawford et al., 1998; Ray).

*Dissociated control and frontal lobe involvement.* The theory of hypnosis that speaks most clearly to mechanical cause is the dissociated control theory of Woody and Bowers (1994). This theory posits an inhibitory process of executive control mechanisms that might be reflected in frontal lobe activity during hypnosis tasks. A number of research findings support this notion. The evidence comes in two forms. Both at baseline and during hypnosis, highly hypnotizable subjects have more difficulty with some tasks sensitive to frontal lobe functioning (Aikins & Ray, 2001; Farvolden, in press). Second, some EEG, event-evoked-potential, and brain-imaging studies find alterations in frontal lobe activation of the sort predicted by theory. To what extent these alterations are common and to what extent they are suggestion-specific

remain uncertain. (Crawford, 1994; Graffin et al., 1995; Gruzelier, 1998; Isotani, Lehmann, et al., 2001; Isotani, Tanaka, et al., 2001; Kallio, Revonsuo, Hämäläinen, Markela, & Gruzelier, 2001; Rainville et al., 1997).

*Affect modulation, attention, and the anterior cingulate cortex.* Several PET studies find that the anterior cingulate cortex (ACC), a cortical structure associated with affect, imagery, hallucination, and lower limbic functioning (Bush, Luu, & Posner, 2000), is activated during hypnotic suggestions for changes in pain suffering/intensity, and auditory hallucination. Remarkably, in the study by Szechtman and colleagues (1998), subject ratings of the ''externality'' and ''clarity'' of the hypnotically suggested auditory hallucination correlated with ACC activation at .95 and .84, respectively. Smaller positive correlations between the extent of suggested pain experience and ACC activation were found by Rainville et al. (1997). The ACC is implicated in both pain and hallucinatory phenomena outside hypnosis. It is instructive that a hypnotic procedure administered to good hypnotic subjects appears to change the probability that ACC involvement will occur in response to these specific types of suggestions. When a hypnotic procedure was not administered or when it was administered to a subject who could not experience the phenomenon, the extent of activation was less.

### *The Third Cause of Hypnosis: Formal*

> What this field needs is a good nomological network.
>
> Nadon, 1997

Theoretical structures often originate as analogies. Consider ''Hypnotism is to humans as magnetism is to metals.'' In both cases, an induction operation is performed on a neutral object, which is then tested to see if it has changed state. In both cases, the best test of the susceptibility for induction of the object is to actually perform the induction and test the result (Kihlstrom, 1998; Nash & Nadon, 2002). In both cases, some objects can be strongly induced, others only weakly. Hot objects do not magnetize; recalcitrant subjects do not hypnotize. In neither case does the induction add anything new to the object: Magnetic induction aligns the orientations of the atoms of the object with the direction imposed by the inductor; hypnotic induction aligns the perceptions of the subject with the direction imposed by the inductor.

But analogies are not theories. They are systems displaying properties similar to the ones in question. Theories rise above empirical systems to model them in representational media such as words or equations. The material causes of such diverse systems are radically different, but they may support a similar formal analysis. Examples

from the physical sciences abound. Bohr's planetary and water-drop models of the atom led no one to look for humanoids on the electrons nor to get wet-spots from the nucleus. Hypnosis magnetizes a subject no more than magnetism hypnotizes metals (Franklin et al., 1784/1785). Analogies stimulate potentially useful questions, but what matters is how we finally address the phenomenon within a formal system, how we characterize the variables and their relations in discourse that resolves into firmer scientific theory.

*An analogical framework: Signal detectability theory (SDT).* Ever since Fechner, psychophysicists recognized that judgments concerning ambiguous stimuli depend on both the clarity of the stimuli and the bias to categorize in one manner or another. In the 20th century, the theory of signal detectability (Green & Swets, 1966) quantified the relation between signal strength and bias. The two classes of stimuli to be discriminated in the paradigm experiment are viewed as a distribution of exemplars around their prototypes, with the observer charged to say whether a particular exemplar was more like A or B (Figure 5). Given an observation $x$, what shall we call it? Depending on its intensity, it could be an A or a B. Observers set a criterion on the decision axis, above which observations will be called *B*, and below which *A*. The line *C* is one such criterion. The distance between the middles of the distributions—the prototypes—is measured as a *z*-score called *d′:* the distance between them is normed by their standard deviation. This distance *d′* is a measure of signal strength. The location of the criterion *C* is a measure of bias. When placed where the two distributions cross, the observer is said to be unbiased, placed above that *conservatively* biased, and below that *liberally* biased. Given stimuli of fixed signal strength, organisms adjust the criterion as a function of a history of reinforcement to maximize their payoff. Bias may be varied by instructions, signal presentation probability, and payoffs. The results of such experiments

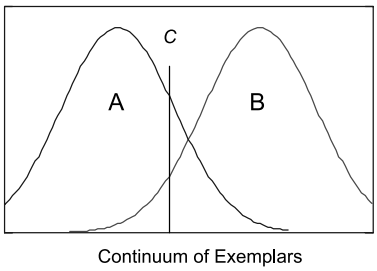


***Figure 5.*** **The allocation of exemplars to categories. Exemplars of Categories A and B are dispersed along the evidence dimension. Subjects set a Criterion *C*, above which instances are called B, and below which they are called A.**

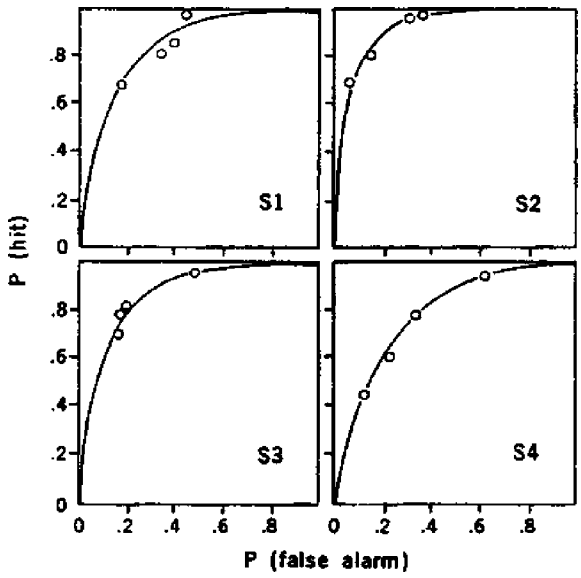


*Figure 6.* **ROCs for causal attribution. *P(hit)* is the probability of a true positive response—a correct attribution of internal locus of control. *P(false alarm)* is the probability of a false positive. The subjects are pigeons (Killeen, 1978).**

are usually plotted as Relative Operating Characteristics (ROCs) (Swets, 1986).

Figure 6 shows ROCs from four subjects asked to discriminate whether an observed effect was caused by their behavior or independent of it. The distances of the ROCs from the positive diagonals reflect the signal strength *(d')*. The positions of the data along the curve measure the subjects' placement of the criterion, low being conservative and high liberal. That placement was varied by manipulating the amount of reward given for true positives (''I caused it'') versus that given for true negatives (''I did not cause it'').

Using the framework of SDT, we may say that the major effects of the HS are on *C*, not on *d'*. Individuals in the HS are as able to see, hear, and do things as when out of the HS (Kihlstrom, 1998); but it does not *seem* to them that they are as able. Inability to report seeing things that are present corresponds to a very conservative criterion. Reporting things to be present that are not surely seen corresponds to a very liberal setting of the criterion. Similarly, inability to seem that we can make a movement is a conservative bias, the ability to seem that we can make a difficult move a liberal bias. The reports of the subjects shown in Figure 6 reveal that the perception of causal efficacy is also under the control of rewards and punishments.

The important changes in *C* under hypnosis are not to its location but to its lability. Contrast the clustering of data points for subject S3 in Figure 6 with the spread of the data for subject S4. The differential payoff was the same for both subjects, yet it shifted the bias for subject S4 much more than for S3. In part, this was because the discriminative ability of S4 was poorer than that of S3—his ROC curve was lower. It makes more sense to let payoff be your guide when stimuli are ambiguous. The virtue of a SDT analysis is that measures of detectability, bias, and change in bias with respect to changes in payoff may be parsed in an orthogonal manner. This last concept, the relative lability (λ; lambda) of the criterion, may be measured as the average marginal change in the criterion as a function of the marginal change in payoff *(P)*: $\lambda = dC/dP$. This index provides an experimental measure of suggestibility. Measured in the normal state it tells us how ready an individual is to recategorize based on payoffs. Measured in the HS, it tells us the power of the demand characteristics of the hypnotic procedure to alter that subject's categorization. It tells us how suggestible subjects are in terms of the monetary payoffs they would sacrifice to the control of the hypnotist. Differences in λ succinctly characterize the difference between Alice and the White Queen:

> ''I can't believe *that*!'' said Alice.
> ''Can't you?'' the Queen said in a pitying tone. ''Try again: draw a long breath, and shut your eyes.''
> Alice laughed. ''There's no use trying,'' she said. ''One *can't* believe impossible things.''
> ''I daresay you haven't had much practice,'' said the Queen. ''When I was your age, I always did it for half-an-hour a day. Why, sometimes I've believed as many as six impossible things before breakfast.''

SDT provides an analytic framework that effectively parses the factors operative when organisms make categorical judgments. HRs do not involve changes in discriminability *(d')* whether of extrinsic stimuli, remembered events, or physical abilities; they involve changes in bias *(C)* and its lability (λ). SDT helps describe the phenomenon; but it does not constitute a theory of hypnosis.

### *Theories*

A complete theory of hypnosis awaits a complete theory of mind and consciousness, but piecemeal theories abound (e.g., Libet, 1985). Hippolyte Taine (1871) provided an early theory of mind with implications for hypnosis. He recognized that perception is a negotiation between primitive sensations and memorial clarifications and ramifications of them. Perception is active: ''Is that a shadow or something in the road? What might it be?'' Some of these alternative hypotheses are so unlikely they never reach consciousness. Like Leibniz before him

and James after him, Taine understood the implication of a sea of unconscious mental processes of which only a small set makes its way to the shores of consciousness. Taine's theory of negotiation between top-down templates and bottom-up sensations was modernized by Shepard (1987), mathematized by Grossberg (e.g., 1980), and neurologized by Mozer (2002). The relative weight of what we impose on the input, and what we settle for as a resolution of the match, depends on the state of the subject. It varies with sleep, health, and hypnosis. In Grossberg's theory, it is represented by a *vigilance parameter*.

This interactionist line of theory, has not yet been well-deployed in the analysis of hypnosis. More representative is the work of individuals such as Kihlstrom (1998), who takes hypnosis to be ''a state of (sometimes) profound cognitive change,'' involving a dissociation among cognitive, emotional, behavioral, and physiological responses (p. 474), and brings the tools of modern experimental psychology to bear upon that dissociation. He labors in a well-articulated tradition (Bowers & Davidson, 1991; Hilgard, 1992). Contemporary theorists who study the disruption in cognitive functioning associated with hypnosis have not neglected the key role of social interaction and context (Bowers & Davidson; Kihlstrom, 1998; Nash, 1997; Orne, 1971; Woody et al., 1992). All recognize the abiding individual difference in hypnotic responsiveness and attribute this directly to hypnotic aptitude. The formal aspects of the hypothesized disregulation or disruption in cognitive functioning differ widely among these theorists, but pivot on the idea of executive control (Fodor, 1983).

*Loosening the connection between control and awareness.* Hilgard's (1992) neodissociation theory holds that hypnosis alters executive and control functions such that when the hypnotic response is rendered, the experience of volition is dissociated from it. Because the effort is dissociated from awareness, the subject experiences the response as ''happening by itself.'' These processes cannot be fully explained by alterations in attention or automaticity (Kihlstrom, 1998). Oakley (1999) offers a similar model that again characterizes the hypnotic state as one involving split awareness. H. Spiegel and Spiegel (1978) characterize the HS as a transient disconnect similar to that found among dissociative disorders.

*Loosening the connection between control and response.* Woody, Bowers, and Oakman (1992) posit a direct effect of hypnosis on executive control whereby the usual self-monitoring is relaxed, and the hypnotic suggestion itself then affects control structures without taxing executive functioning. The hypnotic response is experienced as ''happening by itself,'' because it is actually occurring without much participation by central mechanisms. The Woody and Bowers position provides some

interesting testable predictions about the neural substrate engaged during hypnotic response (e.g., frontal lobe disruptions). H. Spiegel and Spiegel (1978) likewise posit a loosening of the connection between control and response. Nash (1992) characterizes hypnotic response as expressing a shift from secondary to more prominently primary process thinking (i.e., the topographic regression of Freud).

Some theorists minimize the importance of cognitive shifts, construing hypnosis as a product of social forces alone, or almost alone (Coe & Sarbin, 1991; Kirsch & Lynn, 1995; Spanos & Coe, 1992). There are considerable differences among these theorists regarding the nature of hypnotic response (goal-directed fantasy; compliance, role-play, expectations). Hence, if forced to epitomize these formal models, they might be something like, ''hypnosis as strategic play,'' or ''hypnosis as deference,'' or ''hypnosis as acting,'' or ''hypnosis as self-fulfilling prophesy.'' But two characteristics hold this family of theories together and distinguish it from the cluster of theories described above. They are single-process models, and that process is social. The empirical foundation of this argument is that various instructional manipulations do change the behavior and self-report of hypnotized subjects (Barber, 1969), sometimes dramatically (Orne, 1959). If a place is made for aptitude, it is usually construed merely as a product of attitude (but see Spanos & Coe, 1992). The extent of a subject's responsiveness to hypnosis is stable not because it is a trait, but because the attitudes and expectations determining hypnotic response are themselves stable. Apparent disruption in the experience of volition and agency are tied to the demand characteristics and explicit instructions of the hypnotic situation. This places the full burden of causal analysis onto the social interaction. Over the decades, these researchers have helped debunk the exaggerated claims about hypnosis and established the importance of social context in determining hypnotic response, both in its proximal aspect (e.g., immediate relationship with the hypnotist and demand characteristics) and the more distal aspect of how hypnosis is portrayed in the media and society.

The whole of this long paper has now positioned us to capture the position of the social theorists within a larger explanatory framework. These theorists have focused on efficient causes. Their analysis has clarified and sharpened our understanding of them. In *describing* hypnosis, they have denied the appropriateness of designating it as a State. That is a matter of semantics and pragmatics, not ontology. If individuals have been subjected to attitude adjustments and are thereby different than controls, they are in a different state. States are not, after all, causal variables; they are indications that key parameters of a system are within a new range. Social theorists have ignored material causes. Until recently, that was a prudent decision. It has become clear, however, that the operation of the brain is different in important ways

for subjects in the hypnotic state engaged in hypnotic responses versus those engaged in the same responses absent the hypnotic protocol. Perhaps this newly attained dimension—measurable differences in material causes—will reconcile the efforts of researchers toward more synoptic formal theories: Ones that will, as we said earlier, ''straighten hypnosis up and resolve it into the firmer proprieties of scientific theory.''

*The Fourth Cause of Hypnosis: Final*

> It is a general principle in Psychology that consciousness deserts all processes where it can no longer be of use.
>
> (James, 1890, p. 496)

To understand a phenomenon, we must know why it happens, what it does, what purpose it serves. Some kinds of answers to these final cause questions refer to proximate factors such as intention or purpose—that is, reasons: *I turned my head better to hear you.* Other kinds of answers address ultimate factors such as selection: *Our outer ears serve to concentrate sounds and provide directional information.*

*Proximate causes.* The proximate final causes of hypnosis tell why subjects comply with a hypnotist's suggestions. Proximate causes are easily conflated with efficient causes under the rubric *demand characteristics*. Demand characteristics are aspects of the context that elicit characteristic behavior from subjects. They are the implicit social sanctions that await failure to comply, the implicit approbation that awaits ''good behavior.'' They can be as crass as a stage hypnotist's promise of special personalized sessions to improve sex appeal for the best subjects. They can be as spiritual as a subject's hope to realize a transcendental level of existence. They can be as germane as scientific curiosity, as irrelevant as garnering course credit. They are not efficient causes, because they are not triggers of the responses. Because some motivation has been shown to be necessary for hypnosis to occur, such proximate causes may be best treated as instances of the class of necessary causes.

*Ultimate causes.* The ultimate final causes of hypnosis concern the role that hypnotic ability played in the phylogeny of *Homo sapiens.* We can seek the roots of hypnosis in advantages it may have given the species over evolutionary time; or we can contemplate the advantages of conscious control and accurate self-monitoring—and note that some evolutionary projects never reach perfection, as witnessed by the proclivity to slip into the HS. Consciousness is a modality that permits us to ''play out'' various response strategies and evaluate the hedonic consequences of their likely outcomes (Damasio, 1994). The mental models must be good enough to be predictive; but they must not be so

good that we become lost in them. And in fact it is the distinction between the ability to generate a plan *vs.* the tendency to become enraptured by a plan that is the best predictor of who won't and who will make a good hypnotic subject (Nash, 1991). Evolutionary pressures bore on communities as much as individuals, and it was a fortunate community that housed both people of action and people of vision, pragmatists and dreamers.

*Seers, sergeants, & sheep.* Individuals in the HS process information more holistically, with little effort and greater verbal automaticity. They often experience their words, ideas, and actions as visitations, as do many poets and writers while at work (Madigan & Elwood, 1982). The boundaries between self and other, outside and inside, event and fantasy, can be quite permeable. If the HS were a chronic condition, the individual would be profoundly compromised in her adaptation to the rigors of reality. However, if mastery of the physical and social environment is enhanced by brief, but compellingly absorbing, forays into such a state, high hypnotizability might well improve fitness of the individual who possesses it and of the society in which she lives. There is reason to believe that for some creative problem solving, sheer effort may be counter-productive (Amabile, 1987; Barron & Harrington, 1981; Hennessy & Amabile, 1988). Being receptive to freely rising playfulness and impulse might, on special occasions, enable an individual to solve a problem by temporarily setting aside orthodox wisdom. C. S. Lewis advised students who wrestled with one of the perennial problems of literature—*Hamlet*—to:

> remove the veil of familiarity [by making] the imaginative effort of looking at the mass of criticism as if you had no independent knowledge of the thing criticized. (Lewis, 1969, p. 90)

No doubt students varied in their ability to make that imaginative effort. Hypnotizability may be an attribute that, under the right circumstances, renders the individual more likely to solve creatively, relate empathically, and therefore communicate compellingly. These would have been useful qualities for students of Lewis. They are no less useful for a seer.

Vision is not enough to move the community. Great leaders have long recognized the power of circumstance, regalia, cadence, repetition, and crescendo in enlisting the hearts of their audience. They knew that their minds, relieved of decision, would rush to follow. Shor (1979b) calls this surrender to the superego of the leader *archaic involvement.* For most people, reality is socially, not scientifically, constructed. And it may be easily constructed by circumstance: Mass hysteria peaks at the same age as the ability to be hypnotized, pre- and early teens, but both have a long tail into maturity.

Even when the situation is action-oriented, there are many contexts in which undue attention to some aspect of experience is counterproductive (e.g., Beilock, Carr, MacMahon, & Starkes, 2002). Krebs and Davies demonstrated the utility of self-ignorance in conflicts where self-knowledge would give away the game (1978). It is not just that some things we are not wired to know; some things we are wired not to know. Pangs of conscience make cowards of those who are conscious. Bryant and Kourch (2001) have shown that hypnosis can numb those pangs when violence occurs. One of the great breakthroughs in modern warfare was regularizing the consciousness of the soldiers. The key instrument was ''keeping together in time''—marching (McNeill, 1995). And when the battle went bad, shock helped dissociate the soldier from the pain of his injuries. A more beneficent, but similarly focused, rhythmic connectedness occurs between mother and infant at feeding time (Winnicott, 1965). The HS may be just the modality needed for situationally-dependent suspension of self-awareness (Oakley, 1999).

## Summary & Conclusions

Definitions get us in the ballpark. Descriptions tell us who's at bat or at first and his or her statistics. Causes tell us about the action: What starts it (efficient causes) and what its ends are (final causes). They also tell us about the machinery (balls and bats and diamonds) and its formal rules. Definitions, descriptions, and causes may be deployed on many levels. No one kind of causal analysis is sufficient for understanding a phenomenon.

Hypnosis is an altered state of consciousness involving imaginative experiences associated with subjective conviction and experienced involuntariness. It takes place in the hypnotic situation, itself embedded in a wider sociocultural matrix of understanding. The process of bringing a subject to this state is called a hypnotic procedure, a name that singles out salient operations within the hypnotic situation. The hypnotic responses involve physical movements and subjective reports of them, with the correspondence between those atypical and often surprising, both to the subject and to the audience.

Different combinations of necessary causes will bring about a phenomenon. When all but one of the jointly necessary causes are present, the last to be added brings about the effect. This last is often called a sufficient cause, but it is only that within the nexus of other necessary causes filling the background. It is often better to talk about the nexus than to assert the sufficiency of any one cause. Our generic term for this nexus is hypnotic situation. When it suffices, we speak of the hypnotic state (HS) in which the subject's responses (HRs) are characteristic and different than without the state.

The formal causes of hypnosis are the theories that best describe it. They are our current understanding of how it functions. They include theories of modularity, of dissociation, and of changes in parameters of neural models. Material causes are the subject of this conference: They are the physiological substrates of hypnosis.

The final causes of hypnosis are evolutionary. Hypotheses about final causes may cast the hypnotic state as a bug—a failure of conscious control residual from paleo-consciousness. Or they may cast it as a feature, a useful suspension of critical regard that enables individuals and communities to creatively problem-solve, to empathically engage with one another, to respond in coordinated unison to leaders, to engage in difficult, painful or opprobrious behaviors, and to return to a semblance of normalcy when the battle is done. Today, some might call this feature, also, a bug.

## REFERENCES

Aikins, D., & Ray, W.J. (2001). Frontal lobe contributions to hypnotic susceptibility: A neuropsychological screening of executive functioning. *International Journal of Clinical and Experimental Hypnosis*, *49*(4), 320–329.

Amabile, T.M. (1987). The motivation to be creative. In S.G. Isaksen (Ed.), *Frontiers of creativity research* (pp. 1–18). Buffalo, NY: Bearly.

Aristotle. (1929). *The physics* (P.H.W.F.M. Cornford, Trans., Vol. 1). London: Heinemann.

Balthazard, C.G., & Woody, E.Z. (1985). The ''stuff'' of hypnotic performance: A review of psychometric approaches. *Psychological Bulletin, 98*, 283–296.

Balthazard, C.G., & Woody, E.Z. (1992). The spectral analysis of hypnotic performance with respect to ''absorption.'' *International Journal of Clinical and Experimental Hypnosis, 40*(1), 21–43.

Barabasz, A.F. (1982). Restricted environmental stimulation and the enhancement of hypnotizability: Pain, EEG alpha, skin conductance and temperature processes. *International Journal of Clinical and Experimental Hypnosis*, *30*, 147–166.

Barber, T.X. (1969). *Hypnosis: A scientific approach*. New York: Van Nostrand Reinhold.

Bargh, J.A. (1997). The automaticity of everyday life. In R.S. Wyer Jr. (Ed.), *The automaticity of everyday life: Advances in social cognition* (Vol. 10, pp. 1–61). Mahwah, NJ: Erlbaum.

Bargh, J.A., & Chartrand, T.L. (1999). The unbearable automaticity of being. *American Psychologist*, *54*, 462–479.

Barker, W., & Burgwin, S. (1949). Brain wave patterns during hypnosis, hypnotic sleep and normal sleep. *Archives of Neurology and Psychiatry Chicago*, *62*, 412–420.

Barron, F., & Harrington, D.M. (1981). Creativity. In T. Newcomb (Ed.), *New directions in psychology* (Vol. II, pp. 1–134). New York: Holt, Rinehart, & Winston.

Beauchaine, T.P., & Beauchaine III, R.J. (2002). A comparison of maximum covariance and K-means cluster analysis in classifying cases into known taxon groups. *Psychological Methods*, *7*, 245–261.

Beilock, S.L., Carr, T.H., MacMahon, C., & Starkes, J.L. (2002). When paying attention becomes counterproductive: Impact of divided versus skill-focused attention on novice and experienced performance of sensorimotor skills. *Journal of Experimental Psychology: Applied*, *8*, 6–16.

Benton, A.L., & Bandura, A. (1953). ''Primary'' and ''secondary'' suggestibility. *Journal of Abnormal and Social Psychology*, *48*, 336–340.

Bernheim, H. (1965). *Hypnosis and suggestion in psychotherapy* (C.A. Herter, Trans.). New Hyde Park, New York: University Books. (Original work published 1887)

Bowers, K.S., & Davidson, T.M. (1991). A neodissociative critique of Spanos's social-psychological model of hypnosis. In S.J. Lynn, & J.W. Rhue (Eds.), *Theories of hypnosis: Current models and perspectives* (pp. 105–143). New York: Guilford.

Bowers, K.S., & Woody, E.Z. (1996). Hypnotic amnesia and the paradox of intentional forgetting. *Journal of Abnormal Psychology*, *105*, 381–390.

Bryant, R.A., & Kourch, M. (2001). Hypnotically induced emotional numbing. *International Journal of Clinical and Experimental Hypnosis*, *49*, 220–230.

Bush, G., Luu, P., & Posner, M.I. (2000). Cognitive and emotional influences in anterior cingulate cortex. *Trends in Cognitive Sciences*, *4*, 215–222.

Charcot, J.M. (1886). *Oeuvres completes* [Complete works]. Paris: Aux Bureaux du Progres Medical.

Cloninger, C.R. (1989). Establishment of diagnostic validity in psychiatric illness: Robins and Guze's method revisited. In L.N. Robins & J.E. Barrett (Eds.), *The validity of psychiatric diagnosis* (pp. 9–18). New York: Raven Press.

Coe, W.C., & Sarbin, T.R. (1971). An alternative interpretation to the multiple composition of hypnotic scales: A single role-relevant skill. *Journal of Personality and Social Psychology*, *18*, 1–8.

Coe, W.C., & Sarbin, T.R. (1991). Role theory: Hypnosis from a dramaturgical and narrational perspective. In S.J. Lynn & J.W. Rhue (Eds.), *Theories of hypnosis: Current models and perspectives* (pp. 303–323). New York: Guilford.

Coleman, S.R. (1985). The problem of volition and the conditioned reflex. Part I: Conceptual background, 1900–1940. *Behaviorism*, *13*, 99–124.

Crawford, H. (1994). Brain systems involved in attention and disattention (hypnotic analgesia) to pain. In K.H. Pribram (Ed.), *Origins: Brain and self organization* (pp. 661–679). Hillsdale, NJ: Erlbaum.

Crawford, H.J., & Gruzelier, J.H. (1992). A midstream view of the neuropsychophysiology of hypnosis: Recent research and future directions. In E. Fromm & M.R. Nash (Eds.), *Contemporary hypnosis research* (pp. 227–266). New York: Guilford.

Crawford, H.J., Knebel, T., & Vendemia, J.M.C. (1998). The nature of hypnotic analgesia: Neurophysiological foundation and evidence. *Contemporary Hypnosis*, *15*, 22–33.

Damasio, A.R. (1994). The brain binds entities and events by multiregional activation from convergence zones. In H. Gutfreund & G. Toulouse (Eds.), *Biology and computation: A physicist's choice. Advanced series in neuroscience*, (Vol. 3, pp. 749–758). River Edge, NJ: World Scientific Publishing.

Darrow, C.W., Henry, C.E., Gill, M., Brenman, M., & Converse, M. (1950). Frontal-motor parallelism and motor-occipital in-phase activity in hypnosis, drowsiness and sleep. *Electroencephalography and Clinical Neurophysiology*, *2*, 355.

de Groh, M. (1989). Correlates of hypnotic susceptibility. In N.P. Spanos & J.F. Chaves (Eds.), *Hypnosis: The cognitive behavioral perspective* (pp. 32–63). Amherst, NY: Prometheus Books.

De Pascalis, V., Ray, W.J., Tranquillo, I., & D'Amico, D. (1998). EEG activity and heart rate during recall of emotional events in hypnosis: Relationships with hypnotizability and suggestibility. *International Journal of Psychophysiology*, *29*, 255–275.

Delmonte, M.M. (1984). Meditation: Similarities with hypnoidal states and hypnosis. *International Journal of Psychosomatics*, *31*(3), 24–34.

Diamond, M.J. (1974). Modification of hypnotizability: A review. *Psychological Bulletin*, *81*, 180–198.

Duke, J.D. (1964). Intercorrelational status of suggestibility tests and hypnotizability. *Psychological Record*, *14*, 71–80.

Evans, F.J. (1977). Hypnosis and sleep: The control of altered states of awareness. *Annals of New York Academy of Science*, *296*, 162–174.

Eysenck, H.J., & Furneaux, W.D. (1945). Primary and secondary suggestibility: An experimental and statistical study. *Journal of Experimental Psychology*, *35*, 485–503.
Farvolden, P., & Woody, E.Z. (in press). Hypnosis, Memory, and Frontal Executive Functioning. *International Journal of Clinical and Experimental Hypnosis*.
Fodor, J.A. (1983). *The modularity of mind*. Cambridge, MA: Bradford Books.
Franklin, B., Majault, Roy, L., Salllin, Bailly, D'Arcet, et al. (1775). *Rapport des commissaires charges par Le Roi de l'examen due magnetisme animal*. In D. Faigman, D. Kaye, M. Saks, & J. Sanders (Eds.). [English translation by W. Godwin, Report of Benjamin Franklin and the other commissioners, charged by the King of France, with the examination of the animal magnetism, as now practised at Paris]. (Original work published 1784)
Fromm, E., & Kahn, S. (1990). *Self-hypnosis: The Chicago paradigm*. New York: Guilford.
Garvin, A.W., Trine, M.R., & Morgan, W.P. (2001). Anxiolytic and metabolic outcomes of hypnosis, autogenic relaxation, and quiet rest. *International Journal of Clinical and Experimental Hypnosis*, *49*, 5–18.
Glisky, M.L., Tataryn, D.J., Tobias, B.A., Kihlstrom, J.F., & McConkey, K.M. (1991). Absorption, openness to experience, and hypnotizability. *Journal of Personality and Social Psychology*, *60*, 263–272.
Goldfarb, W., & Kiene, H.E. (1945). The treatment of the psychotic-like regressions of the combat soldier. *Psychiatric Quarterly*, *19*, 555–565.
Graffin, N.F., Ray, W.J., & Lundy, R. (1995). EEG concomitants of hypnosis and hypnotic susceptibility. *Journal of Abnormal Psychology*, *104*, 123–131.
Grant, C.D., & Nash, M.R. (1995). The Computer-Assisted Hypnosis Scale: Standardization and norming of a computer-administered measure of hypnotic ability. *Psychological Assessment*, *7*, 49–58.
Green, D.M., & Swets, J.A. (1966). *Signal detection theory and psychophysics*. New York: Wiley.
Grimes, F.V. (1948). An experimental analysis of the nature of suggestibility and of its relation to other psychological factors. *Studies in psychology and psychiatry at the Catholic University of America*, *7*(4), 1–46.
Grossberg, S. (1980). How does the brain build a cognitive code. *Psychological Review*, *87*, 1–51.
Gruzelier, J. (1988). The neuropsychology of hypnosis. In M. Heap (Ed.), *Hypnosis: Current clinical, experimental and forensic practices* (pp. 68–76). New York: Croom Helm.
Gruzelier, J. (1998). A working model of the neurophysiology of hypnosis: A review of evidence. *Contemporary Hypnosis*, *15*, 3–21.
Gruzelier, J. (2000). The relevance of neuro-psychophysiological evidence to cognitive, social and phenomenological theories of hypnosis. *International Journal of Psychophysiology*, *35*, 40.
Haley, J. (1972). *Strategies of psychotherapy*. New York: Grune & Stratton.
Hammer, A.G., Evans, F.J., & Bartlett, M. (1963). Factors in hynosis and suggestion. *Journal of Abnormal and Social Psychology*, *67*, 15–23.
Hennessy, B.A., & Amabile, T.M. (1988). The conditions of environment. In R.J. Sternberg (Ed.), *The nature of creativity: Contemporary psychological perspectives* (pp. 11–38). Cambridge, UK: Cambridge University Press.
Hilgard, E.R. (1965). *Hypnotic susceptibility*: NY, Harcourt, Brace and World. (1965). xiii, 434 pp.
Hilgard, E.R. (1971). Hypnotic phenomena: The struggle for scientific acceptance. *American Scientist*, *59*, 567–577.
Hilgard, E.R. (1992). Dissociation and theories of hypnosis. In Fromm, Erika (Ed.) Nash, Michael R. (Ed). (1992). *Contemporary hypnosis research* (pp. 69–101). New York, NY, US: The Guilford Press. xv, 591 pp. SEE BOOK.
Hocutt, M. (1974). Aristotle's four becauses. *Philosophy*, *49*, 385–399.

Isotani, T., Lehmann, D., Pascual-Marqui, R.D., Kochi, K., Wackermann, J., Saito, N., et al. (2001). EEG source localization and global dimensional complexity in high- and low-hypnotizable subjects: A pilot study. *Neuropsychobiology*, *44*(4), 192–198.

Isotani, T., Tanaka, H., Lehmann, D., Pascual-Marqui, R.D., Kochi, K., Saitoh, N., et al. (2001). Source localization of EEG activity during hypnotically induced anxiety and relaxation. *International Journal of Psychophysiology*, *41*(2), 143–153.

James, W. (1890). *Principles of psychology*. New York: Henry Holt & Co.

Jaynes, J. (1976). *The origin of consciousness in the breakdown of the bicameral mind*. Boston: Houghton Mifflin.

Jenness, A. (1934). A comparative study of sleep and hypnosis by means of the electrocardiograph and the pneumograph. *Psychological Bulletin*, *31*, 712.

Johnson, L.S., Dawson, S.L., Clark, J.L., & Sikorsky, C. (1983). Self-hypnosis versus hetero-hypnosis: Order effects and sex differences in behavioral and experiential impact. *International Journal of Clinical and Experimental Hypnosis*, *31*(3), 139–154.

Kallio, S., Revonsuo, A., Hämäläinen, H., Markela, J., & Gruzelier, J. (2001). Anterior brain functions and hypnosis: A test of the frontal hypothesis. *International Journal of Clinical and Experimental Hypnosis*, *49*, 95–108.

Katsanis, J., Barnard, J., & Spanos, N.P. (1988). Self-predictions, interpretational set and imagery vividness as determinants of hypnotic responding. *Imagination, Cognition and Personality*, *8*, 63–77.

Kihlstrom, J.F. (1998). Hypnosis and the psychological unconscious. In *Encyclopedia of mental health* (Vol. 2, pp. 467–477). New York: Academic Press.

Kihlstrom, J.F. (2001, August). *Foxes and Hedgehogs and Hypnosis, Oh My!* Paper presented at the annual meeting of the American Psychological Association, San Francisco, CA, USA.

Kihlstrom, J.F., Diaz, W.A., McClellan, G.E., Ruskin, P.M., Pistole, D.D., & Shor, R.E. (1980). Personality correlates of hypnotic susceptibility: Needs for achievement and autonomy, self-monitoring, and masculinity-femininity. *American Journal of Clinical Hypnosis*, *22*(4), 225–230.

Killeen, P.R. (1978). Superstition: A matter of bias, not detectability. *Science*, *199*, 88–90.

Kirsch, I., & Lynn, S.J. (1995). The altered state of hypnosis: Changes in the theoretical landscape. *American Psychologist*, 846–858.

Krebs, J.R., & Davies, N.B. (Eds.), (1978). *Behavioural Ecology: An evolutionary approach*. Oxford, UK: Blackwell Scientific Publications.

Lambie, J.A., & Marcel, A.J. (2002). Consciousness and the varieties of emotion experience: A theoretical framework. *Psychological Review*, *109*, 219–259.

Lewis, C.S. (1969). *Selected literary essays by C.S. Lewis*. Cambridge, UK: Cambridge University Press.

Libet, B. (1985). Unconscious cerebral initiative and the role of conscious will in voluntary action. *Behavioral and Brain Sciences*, *8*, 529–566.

Lovibond, P.F., & Shanks, D.R. (2002). The role of awareness in Pavlovian conditioning: Empirical evidence and theoretical implications. *Journal of Experimental Psychology: Animal Behavior Processes*, *28*, 3–26.

Madigan, C.O., & Elwood, A. (1982). *Brainstorms and thunderbolts*. New York: Macmillan.

McNeill, W.H. (1995). *Keeping together in time: Dance and drill in human history*. Cambridge, MA: Harvard University Press.

Meehl, P.E. (1995). Bootstrap taxometrics: Solving the classification problem in psychometrics. *American Psychologist*, *50*, 266–275.

Mele, A.R. (1987). Irrationality: An essay on akrasia, self-deception, and self-control. New York: Oxford University Press.

Mesmer, F.A. (1971). Dissertation physico-medicale sur l'influence des planetes. In R. Amadou (Ed.), *Le magnetisme animal*. Paris: Payot Press. (Original work published 1766)

Mozer, M.C. (2002). Frames of reference in unilateral neglect and visual perception: A computational perspective. *Psychological Review*, *109*, 156–185.
Nadon, R. (1997). What this field needs is a good nomological network. *International Journal of Clinical and Experimental Hypnosis*, *45*, 314–323.
Nash, M.R. (1991). Hypnosis as a special case of psychological regression. In S.J. Lynn & J.W. Rhue (Eds.), *Theories of Hypnosis: Current Models and Perspectives* (pp. 171–194). New York: Guilford.
Nash, M.R. (1992). Hypnosis, psychopathology, and psychological regression. In E. Fromm & M.R. Nash (Eds.), *Contemporary hypnosis research* (pp. 149–169). New York: Guilford.
Nash, M.R. (1997). Why scientific hypnosis needs psychoanalysis (or something like it). *International Journal of Clinical and Experimental Hypnosis*, *45*, 291–300.
Nash, M.R. (2001, July). The truth and the hype of hypnosis. *Scientific American*, 36–42.
Nash, M.R., & Nadon, R. (2002). The scientific status of hypnosis. In Faigman et al. (Eds.), *Modern scientific evidence.* St. Paul, MN: West.
Oakley, D.A. (1999). Hypnosis and consciousness: A structural model. *Contemporary Hypnosis*, *16*, 215–223.
Orne, M.T. (1959). The nature of hypnosis: Artifact and essence. *Journal of Abnormal and Social Psychology*, *58*, 277–299.
Orne, M.T. (1959). The simulation of hypnosis: Why, how, and what it means. *International Journal of Clinical and Experimental Hypnosis*, *19*, 183–210.
Pavlov, I.P. (1923). The identity of inhibition with sleep and hypnosis. *Scientific Monthly*, *17*, 603–608.
Pears, D. (1984). *Motivated irrationality*. New York: Oxford University Press.
Piccione, C., Hilgard, E.R., & Zimbardo, P.G. (1989). On the degree of stability of measured hypnotizability over a 25-year period. *Journal of Personality and Social Psychology*, *56*, 289–295.
Rainville, P., Duncan, G.H., Price, D.D., Carrier, B., & Bushnell, M.C. (1997). Pain affect encoded in human anterior cingulate but not somatosensory cortex. *Science*, *277*(5328), 968–971.
Ray, W.J. (1997). EEG concomitants of hypnotic susceptibility. *International Journal of Clinical and Experimental Hypnosis*, *45*, 301–313.
Repka, R.J., & Nash, M.R. (1995). Hypnotic responsivity of the deaf: The development of the University of Tennessee Hypnotic Susceptibility Scale for the Deaf. *International Journal of Clinical and Experimental Hypnosis*, *43*, 316–331.
Santayana, G. (1957). *Dialogs in limbo.* Ann Arbor, MI: University of Michigan Press.
Schacter, D.L. (1976). The hypnagogic state: A critical review of the literature. *Psychological Bulletin*, *83*, 452–481.
Sheehan, P.W. (1980). Factors influencing rapport in hypnosis. *Journal of Abnormal Psychology*, *89*, 263–281.
Sheehan, P.W., & Dolby, R.M. (1979). Motivated involvement in hypnosis: The illustration of clinical rapport through hypnotic dreams. *Journal of Abnormal Psychology*, *88*, 573–583.
Shepard, R.N. (1987). Evolution of a mesh between principles of the mind and regularities of the world. In J. Dupré (Ed.), *The latest on the best: Essays on evolution and optimality* (pp. 251–275). Cambridge, MA: MIT Press/Bradford Books.
Shor, R.E. (1979a). The fundamental problem in hypnosis research as viewed from historical perspectives. In R.E. Shor & E. Fromm (Eds.), *Hypnosis: Developments in research and new perspectives* (pp. 15–44). New York: Aldine Publishing.
Shor, R.E. (1979b). A phenomenological method for measurement of variables important to an understanding of the nature of hypnosis. In E. Fromm & R.E. Shor (Eds.), *Hypnosis: Developments in research and new perspectives* (pp. 105–135). New York: Aldine.
Shor, R.E., & Orne, E.C. (1963). Norms of the Harvard Group Scale of Hypnotic Susceptibility, Form A. *International Journal of Clinical and Experimental Hypnosis*, *11*, 39–47.

Skinner, B.F. (1935). The generic nature of the concepts of stimulus and response. *Journal of General Psychology, 12*, 40–65.

Spanos, N.P. (1991). A sociocognitive approach to hypnosis. In S.J. Lynn & J.W. Rhue (Eds.), *Theories of hypnosis: Current models and perspectives* (pp. 324–361). New York: Guilford.

Spanos, N.P., Brett, P.J., Menary, E.P., & Cross, W.P. (1987). A measure of attitudes toward hypnosis: Relationships with absorption and hypnotic susceptibility. *American Journal of Clinical Hypnosis*, *30*(2), 139–150.

Spanos, N.P., & Chaves, J.F. (1989). *Hypnosis: The cognitive-behavioral perspective*. Buffalo, NY: Prometheus Books.

Spanos, N.P., & Coe, W.C. (1992). A social-psychological approach to hypnosis. In E. Fromm, & M.R. Nash (Eds.), *Contemporary hypnosis research* (pp. 102–130). New York: Guilford.

Spiegel, D.A. (1991). Neurophysiological correlates of hypnosis and dissociation. *Journal of Neuropsychiatry and Clinical Neurosciences*, *3*, 440–445.

Spiegel, H., & Spiegel, D. (1978). *Trance and treatment: Clinical uses of hypnosis*. New York: Basic Books.

Spivak, L.I., Puzenko, V.Y., Medvedev, S.V., & Polyakov, Y.I. (1990). Neurophysiological correlates of the altered state of consciousness during hypnosis. *Human Physiology*, *16*, 405–410.

Stukat, K.G. (1958). *Suggestibility: A factorial and experimental analysis*. Stockholm: Almqvist and Wiksell.

Swets, J.A. (1986). Form of empirical ROCs in discrimination and diagnostic tasks: Implications for theory and measurement of performance. *Psychological Bulletin, 99*, 181–198.

Szechtman, H., Woody, E., Bowers, K.S., & Nahmias, C. (1998). Where the imaginal appears real: A positron emission tomography study of auditory hallucinations. *Proceedings of the National Academy of Science USA*, *95*(4), 1956–1960.

Taine, H. (1871). *On intelligence* (T.D. Haye, Trans.). London: L. Reeve.

Taylor, S.E. (1991). *Positive illusions: Creative self-deception and the healthy mind*. New York: Basic Books.

Tellegen, A., & Atkinson, G. (1974). Openness to absorbing and self-altering experiences (''absorption''), a trait related to hypnotic susceptibility. *Journal of Abnormal Psychology*, *83*, 268–277.

Tellegen, A., & Atkinson, G. (1976). Complexity and measurement of hypnotic susceptibility: A comment on Coe and Sarbin's alternative interpretation. *Journal of Personality and Social Psychology*, *33*, 142–148.

Wagstaff, G.F. (1991). Compliance, belief, and semantics in hypnosis: A nonstate, sociocognitive perspective. In Lynn, Steven Jay (Ed.); Rhue, Judith W. (Ed.). (1991). *Theories of hypnosis: Current models and perspectives. The Guilford clinical and experimental hypnosis series* (pp. 362–396). New York, NY, USA: The Guilford Press. xx, 634 pp. SEE BOOK.

Wegner, D.M., & Wheatley, T. (1999). Apparent mental causation: Sources of the experience of will. *American Psychologist*, 54, 480–492.

Weitzenhoffer, A.M. (1974). When is an ''instruction'' an ''instruction''? *International Journal of Clinical and Experimental Hypnosis*, *22*(3), 258–269.

Weitzenhoffer, A.M. (1978). Hypnotism and altered states of consciousness. In A. Sugarman & R.E. Tarter (Eds.), *Expanding dimensions of consciousness* (pp. 183–225). New York: Springer.

Weitzenhoffer, A.M., & Hilgard, E.R. (1959). *Stanford Hypnotic Susceptibility Scale, Forms A and B*. Palo Alto, CA: Consulting Psychologists Press.

Weitzenhoffer, A.M., & Hilgard, E.R. (1962). *Stanford Hypnotic Susceptibility Scale, Form C*. Palo Alto, CA: Consulting Psychologists Press.

Weitzenhoffer, A.M., & Hilgard, E.R. (1967). *Revised Stanford Profile Scales of Hypnotic Susceptibility*. Palo Alto, CA: Consulting Clinical Psychologists Press.

Wible, C.L., & Jenness, A. (1936). Electrocardiograms during sleep and hypnosis. *Journal of Psychology*, *1*, 235–245.
Winnicott, D.W. (1965). *The maturational processes and the facilitating environment: Studies in the theory of emotional development*. New York: International Universities Press.
Wittgenstein, L. (1965). *Philosophical investigations 1965*. New York: The Macmillan Company.
Woody, E.Z., & Bowers, K.S. (1994). A frontal assault on dissociated control. In Lynn, Steven Jay (Ed.); Rhue, Judith W. (Ed.). (1994). *Dissociation: Clinical and theoretical perspectives* (pp. 52–79). New York, NY, USA: The Guilford Press. xvii, 477 pp. SEE BOOK.
Woody, E.Z., Bowers, K.S., & Oakman, J.M. (1992). A conceptual analysis of hypnotic responsiveness: Experience, individual differences, and context. In E. Fromm & M.R. Nash (Eds.), *Contemporary hypnosis research* (pp. 3–33). New York: Guilford.
Woody, E.Z., Drugovic, M., & Oakman, J.M. (1997). A reexamination of the role of nonhypnotic suggestibility in hypnotic responding. *Journal of Personality and Social Psychology*, *72*(2), 399–407.

## Die vier Ursachen der Hypnose

**Peter R. Killeen und Michael R. Nash**

**Zusammenfassung: Das aristotelische Modell des Verstehens beinhaltet die Beschreibung eines Phänomens und die Identifikation seiner Wirkursache (causa efficiens, Auslöser), seiner materiellen Ursache (causa materialis, Substrat), seiner Formursache (causa formalis) sowie seiner Zweckursache (causa finalis, Funktion). Diese kausale Analyse bietet einen Rahmen zum Verständnis von Hypnose und hypnotischem Zustand. Zustände sind Konstellationen von Parametern innerhalb festgelegter Bereiche; sie bezeichnen ein Phänomen, erklären dieses jedoch nicht. Bedenken bezüglich der Vergegenständlichung der Zustände betreffen eher Semantik und Pragmatik, nicht aber die Ontologie. Die Isolierung der Wirkursachen (z. B. Vorgehensweise, Kontext, soziale Variablen) trägt lediglich teilweise zum Verständnis bei. Die experimentellen, technischen und konzeptionellen Fortschritte unserer Zeit ermöglichen, das Substrat und die Funktion von Hypnose in umfassenden Theorien unter Berücksichtigung der vier Ursachen der Hypnose darzustellen.**

RALF SCHMAELZLE
*University of Konstanz, Konstanz, Germany*

## Les quatre causes de l'hypnose

**Peter R. Killeen et Michael R. Nash**

**Résumé: La compréhension du modèle d'Aristote implique la description d'un phénomène et l'identification de ses causes efficaces (déclenchements), de cause matérielle (substrat), d'une cause formelle (modèles de structure), et d'une cause finale (fonction). Cette analyse causale fournit un cadre pour la compréhension de l'hypnose et de l'état hypnotique. Ces états sont une constellation de paramètres à l'intérieur de marges indiquées; ils nomment mais n'expliquent pas un phénomène. Les particularités concernant la réification des états sont des sujets de sémantique et de pragmatique, et**

**non pas d'ontologie. L'isolation des causes efficaces (procédures, contexte, variables sociales) n'est qu'une composante de cette compréhension. Les avances expérimentales, techniques, et conceptuelles nous ont portés dans un siècle où les substrats et les fonctions de l'hypnose peuvent être représentés dans les théories synoptiques qui comportent chacune des 4 causes de l'hypnose.**

VICTOR SIMON
*Psychosomatic Medicine & Clinical Hypnosis Institute, Lille, France*

**Las cuatro causas de la hypnosis**

**Peter R. Killeen y Michael R. Nash**

**Resumen: El modelo de conocimiento de Aristóteles incluye la descripción de un fenómeno y la identificación de sus causas eficientes (incitadores), causas materiales (sustratos), causas formales (modelos de estructura), y causas finales (funciones). Este análisis causal provee una estructura para comprender a la hipnosis y al estado hipnótico. Los estados son las constelaciones de parámetros dentro de rangos especificados; nombran, pero no explican, al fenómeno. La preocupación sobre la reificación de los estados es un problema de semántica y pragmática, no de ontología. La identificación de las causas eficientes (p. ej., procedimiento, contexto, variables sociales) es tan sólo un elemento de nuestro entendimiento. Los adelantos conceptuales, técnicos, y experimentales nos han llevado a un siglo en donde los sustratos y funciones de la hipnosis pueden ser representados por teorías sinópticas que abarquen las cuatro causas de la hipnosis.**

ETZEL CARDEÑA
*University of Texas, Pan American, Edinburg, Texas, USA*