A CRITIQUE OF PROMINENT COGNITIVE SCIENCE ACCOUNTS OF CREATIVE THINKING

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A Critique of Prominent Cognitive Science Accounts of Creative Thinking

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Abstract

A Critique of Prominent Cognitive Science Accounts of Creative Thinking

A comprehensive theory of human cognition must explain thinking processes associated with truly novel learning, that is, the kinds of creative thinking which move human knowledge and practices forward to new, more complex levels of understanding. Though traditionally considered an elusive mystery of the mind, some cognitive psychologists claim that they can explain creative thinking and that there is nothing mysterious about it. Examining the viability of their claims constitutes the main theme of this thesis.

Two different perspectives on creative thinking are compared—those of acknowledged creative thinkers with those of two prominent cognitive psychologists. Creative thinkers consider their thought processes to be unique experiences. Doing the work of creating as they commonly represent it means using different types of thinking that converge or combine to bring about desired results. From this perspective, "creative thinker" pertains to a few unique, exceptional individuals. Creative thinkers draw upon their own and each other's experiences to describe how they think. To them, thinking is multi-faceted and many view the rational mode of thinking they use to complete or convey their achievements to others to be plodding and inefficient compared to the subliminal modes used in the work of creating.

Conversely, cognitive psychologists look at creative thinking from the perspective of ordinary thinking, meaning the thinking that people ordinarily use to solve problems. Because it is commonplace, there is nothing special about it. Cognitive psychologists draw support from data derived from lab studies to show how problem solving is inclusive of "creative" thinking. They argue that the testimonials of creative thinkers are unreliable, subject to

distortions and inaccuracies, and occasional willful miscontrual of mental events. Reconstructed in problem solving terms, these events follow a step-by-step continuity of thought, a traceable process explainable in rational terms. Events like "insight" or "unconscious thinking," traditionally regarded as the means by which radical breakthroughs come about, are, it is claimed, incidences of analogical thought, and so comprehensible according to extrapolations from models of everyday problem solving. This thesis concludes that reductive arguments that seek to characterize creative thinking as simply an extrapolation from more routine forms of thinking are inadequate.

Dedication

To
Bert Schoner
in appreciation for his unfailing support
and enduring patience during the course of this work.

And, with love

To my parents,
Donald and Estelle Merrill

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Chapter One: Introduction and Overview

Part I: Introduction

The traditional and, until recently, prevailing view of creative thinking argues that it is a phenomenon characterized by the dramatic and transformative accomplishments of mind arising from the efforts of a small number of unique individuals possessing unique abilities. A new school of thought has come forward that now presents a distinct challenge to the traditional view of creative thinking. Some cognitive psychologists holding a generally constructivist view of human cognition pose important and fundamental questions about creative thinking.[1] They ask, does something specifically called creative thinking actually exist? Is there such a thing as a special form of thinking that is unique, extraordinary, and mysterious as is traditionally held to be the case? Or, on the other hand, is it much more commonplace and ordinary in nature than has heretofore been realized? Based on evaluations of previous theories and related research and on their own empirical research, some cognitive psychologists have come to the conclusion that the traditional view of creative thinking is untenable. The overall purpose of this thesis is to investigate whether or not such a conclusion is warranted.

1. As a point of clarification, "Cognitive psychology" here refers to those psychologists holding a generally constructivist point of view on human cognition as discussed more fully in chapter three of this thesis. In a recent article in the October, 1995 issue of the *Educational Researcher*, D.C. Phillips provides a critical overview of the "many faces" of constructivism of which the "face" discussed here is but one. I have focused exclusively on the problem solving model of human cognition embedded within the framework of information processing explanations of human cognition as it is invoked to "explain" creative thinking. Thus issues pertaining to social constructions of meaning and to the impact of political, social, cultual, and historical factors on human learning, while implied in the brief discussion concerning how one might come to be a distinctively creative thinker, are not of central concern to this work.

The fundamental issue concerns how to explain the nature of creativity, particularly the thought processes employed in the creation of a work that exhibits originality, high quality, and is one of great social and cultural worth. Even a brief overview of the literature shows this issue to be multifaceted and exceedingly complex. Investigators have typically taken into account the creative individual's health, family experiences, personality characteristics, mentoring and other social, cultural, and educational influences in his or her formative years and throughout the person's life. In one sense there is a wealth of information to draw from, namely, acknowledged creative thinkers' descriptions of their own experiences, diaries, journals, biographies, descriptions of works in progress, empirical studies, and the like. In another sense, however, significant differences arise from the various ways such data may be interpreted, including what counts as acceptable data. The following brief overview is by no means comprehensive but it does provide some indication of the wide scope of work done in the area of creativity and creative thinking.

The "creativity literature" is so variable and prolific that it is difficult to judge just how much real progress has been made toward acquiring a good understanding of creative thinking, or indeed just what would constitute real progress in this field. The literature typically covers such wide ranging issues as the creative person's hereditary endowment, formative years, schooling and influential mentoring, ways of working, psychological states and traits, personality quirks and characteristics, and the spectacular faculties of mind with which these individuals are believed to be imbued. In short, no aspects of creative people's personal and professional lives have escaped scrutiny in the search to understand what it means to be creative. Because much of this effort specifically focuses on identifying the mental abilities and processes or factors of intelligence believed to be associated with creative thinking (and related personality characteristics) it is difficult to get a "handle" on both its scope and direction.

A brief scan of the field well illustrates the variety of approaches taken to study the creative act. Efforts have been made, for example, to identify clusters of intellectual abilities and aptitudes that may contribute to creativity (Guilford, 1959); or to investigate whether or not distinctions can be discerned between specifically creative and specifically intellectual abilities (Getzels and Jackson, 1963; Wallach and Kogan, 1965). Some investigators search for the personality variables that may be strongly associated with the intellectual abilities of creative persons (Barron, 1955, 1988; MacKinnon, 1960, 1962); some have tried to measure the presence or absence of creative ability in various populations (Torrance, 1966, 1988), and others have devised programs that purport to train people to be more creative (Parnes, 1963; deBono, 1985). Further, much attention has been devoted to articulating the process of creativity from inspiration to completion (Wallas, 1926; Hadamard, 1945; Harding, 1967), and attempting to understand it within a particular framework such as the behavioural approach (Skinner, 1972), or various psychological approaches (Jung, 1923; Rank, 1932; Schachtel, 1959; Roe, 1963), or, more recently, the cognitive science approach (Gardner, 1987, 1988, 1993; Perkins, 1981; Sternberg, 1988; Weisberg, 1993). Finally, philosophers too have had a hand in the effort to come to terms with explaining creativity, within a scientific framework (Blanshard, 1964) and within the scope of philosophical thought itself (Kearney, 1988; Warnock, 1976). At the very least, the current proliferation of theories, models, general descriptions, and the like, indicates a strong, sustained high level of interest in creativity, if not perhaps actual progress in understanding it.

Those interested specifically in creative thinking try to unravel the reasons why the process seems so enigmatic and mysterious, even to those who experience it personally. Certainly, much good work has been done on identifying, describing and analyzing environmental, educational, and personality factors and characteristics in the lives of creative individuals. Though the focus may differ, in many cases these studies do seem to enjoy a fair degree of consensus about the nature and types of life, schooling, work experiences, and other situations commonly found in the backgrounds of

known creative people (see, for example, John-Steiner, 1985; Shepard, 1988; West, 1991; or Gardner, 1993 for a discussion of commonalities). But the most difficult, elusive, and intriguing question still remains; how can creative thinking itself be explained? More specifically, how can we identify, describe, and explain the mental structures and thinking processes that bring about creative achievement? Is creative thinking different in some way from other "types" of thinking, and if so, how, and to what extent? Or is it, in fact, no different from ordinary thinking, in the sense that what differences there are may be attributable to varying degrees of motivation and commitment to the work itself?

Thus, there is available an impressive and extensive literature on human creativity. The body of work I have selected from it embodies one common purpose: to understand how the transformative power of human thought comes about, that is, how we think creatively. Being creative refers to the human ability to generate important new and original compositions, discoveries, inventions, solutions to problems, and the like, that occur from time to time throughout history and are deemed to be of great worth and value to humanity. Just how the dramatic accomplishments of mind that expand or transform human understanding and the growth of knowledge are achieved still remains, for many, one of the most intriguing and elusive mysteries for students of mind.

Indeed, there is little agreement about what we mean when we refer to "creative" thinking. Definitions range from the "nothing special" point of view promulgated by some cognitive psychologists, to the notion that the truly creative experience is given to a few unique individuals. Often, creative thinkers themselves are just as puzzled by the experience as the rest of us. Some describe their inspirations or insights as "divinely inspired" and feel powerless to resist the urge to create. Others accept their abilities as a gift which they are able to use but nonetheless do not understand very well. If the many different self-reports from various disciplinary perspectives are indicative, however, few appear to regard their abilities as "nothing special."

Such descriptions of thinking processes by creative thinkers themselves provide a rich source of comparative information on how a work is conceived and generated within the mind. These are anecdotal and, as such, are open to charges of distortion and fanciful self-aggrandizement. Perhaps some of this is due to the difficulties encountered when trying to depict the complexity of such thinking processes in language too conceptually inadequate to capture the full range of the experience. Such descriptions are often imbued with metaphorically rich language which makes them seem more like fiction than reality as creative thinkers struggle to capture and convey the whole of their own complex thinking processes. Some examples drawn from Shepard (1988) and Ghiselin's (1952) anthology of creativity, representing different areas of creative work are illustrative.

A boy of sixteen once imagined himself travelling beside a beam of light. While moving along at 186,000 miles per second, he was suddenly struck with the observation that what he "saw" did not correspond to anything heretofore experienced as light, either as particles or waves. The boy, of course, was Albert Einstein and this oft-quoted story about one of his now famous "thought experiments" marked the beginning of the transformation of our perception of the space-time continuum (Shepard, 1988). Einstein had a particular ability to think in "signs and more or less clear images which can be 'voluntarily' reproduced and combined" (p. 155); words played no part in these thought experiments and translating the knowledge gained from them into the verbal and mathematical symbols of his discipline was "sought for laboriously." Einstein described thought experiments as a form of "combinatorial play" which did not brook interference or intrusion from what he considered to be the different type of thinking associated with the more formal concepts of his discipline.

Einstein's work occurred in two stages as he described it. First came the mindwork of discovery which consisted of combinatorial or associative play. At this stage, he was able to compress a great amount of knowledge into certain images which allowed him to put together any number of configured

and reconfigured combinations in any way desired. While doing this, Einstein could clearly "see" the implications of the various combinations. Such work necessarily preceded the second stage where the findings are logically constructed in terms of the common discourse of the discipline in which he worked so they may be communicated to others (Ghiselin, 1952, p. 43).

A letter allegedly written by Mozart tells a similar story. Mozart speaks of composing in a state resembling a "pleasing lively dream." The times when he felt rested, relaxed, and "of good cheer," were the times he was at his productive best for it was then that unbidden melodies came to him. If undisturbed, Mozart was able to work with the melodies in his mind in ways that allowed him to draft complete compositions, including those with full orchestration. His greatest joy was that he actually *heard* the music in its entirety. Then he wrote it down (Ghiselin, 1952, pp. 44–45).

Although Mozart, in this letter, claims to have written down his music with little difficulty, and perhaps he sometimes did, in fact some extant manuscripts of his work indicate that editing and rearranging were also very much a part of the process (Weisberg, 1993, p. 225), testimonial perhaps to the same difficulties experienced by Einstein when committing his thought experiments to paper. As it was with Einstein, there were two stages to Mozart's creative work; in the first stage, Mozart was able to concentrate fully on the auditory spectrum of melody played out in his mind which he would later translate, in the second stage, into a form of written composition, laboriously reworking the composition until it conveyed just what he had "heard." The appearance of melodies was involuntary; Mozart could "hear" them and so could choose to work with those which appealed to him just as Einstein could "see" the implications of particular visual images, and decide which ones were best to work with. Those selected provided the best means to convey just what it was that the discoverer sought or the composer wished to express. For both, mindwork in the first stage consists of an ability to gain direct access to powerful pre-symbolic forms of thinking from which the discovery or composition is then formed and subsequently expressed, with

difficulty, in the appropriate language . Thinking with the visual or auditory forms of direct meaning germane to a discipline allows the mind to experience much more meaning than can be conveyed in its translation for the benefit of others.

The poet, A.E. Housman, again, tells a similar story about his own experiences (Ghiselin, 1952, pp. 86–91). He refers to the first stage of composing as an involuntary and passive process. By passive, Housman means that the "centralised tyranny of the intellect" is quiescent when inspiration "bubbles up" bringing with it the urge to compose. This occurs, as in the case of Mozart, when the mind is relaxed and thinking of nothing in particular. During a country walk, or some other pleasant activity, lines or fragments of poems "stray" into the mind. The inspiration might take the form of a "line or two of verse," or occasionally an entire stanza, bringing with it "a vague notion of the poem" in which such fragments ultimately appear. The arrival of various bits of a poem may continue in an interrupted fashion over an indeterminate period of time. Housman wrote them down at the earliest opportunity in hopes that further inspirations would come to complete the work. Sometimes they did, but when they didn't, the poem "had to be taken in hand and completed by the brain, which was apt to be a matter of trouble and anxiety, involving trial and disappointment, and sometimes ending in failure." Housman describes these occasions as having to "turn and compose it myself, and that was a laborious business." Using the intellect to make poetic meaning was only resorted to in this case when the "passive" mode failed to be invoked.

While Einstein thought in images and Mozart in sounds, Housman was inspired by expression conveyed in verbal fragments where meaning was felt as much as "thought." Each tended to work in the same sequence of "stages" which represented quite different modes of thinking. This was also true of the philosopher, Nietzsche, but in this case, while composing *Thus Spake Zarathustra*, translation seemed not to be the same agonizing problem it was for Einstein and Housman.

According to Nietzsche, both *Zarathustra* the novel and Zarathustra the character "came to me—perhaps I should rather say—*invaded me.*" This happened during the course of long, rambling walks in one of his favourite parts of the country (Ghiselin, 1952; pp. 201–203). In describing the feeling and meaning of inspiration, Nietzsche referred to it as a "revelation" meaning that "something profoundly convulsive and disturbing suddenly becomes visible and audible with indescribable definiteness and exactness." Again, the intellect appeared to be quiescent, as Nietzsche states he had little choice in the matter. In his words, "Everything occurs quite without volition, as if in an eruption of freedom, independence, power and divinity . . . everything offers itself as the most immediate, exact, and simple means of expression." And further, "one's progress varies from involuntary impetuosity to involuntary slowness" during the course of the experience. Nietzsche returned to the same pleasant spot, to conceive the second part; the third part came to him in the same way in other equally pleasant circumstances. In all, *Thus Spake Zarathustra* was subsequently written out with no difficulty within thirty days, ten for each part, though not consecutively.

Of all the foregoing examples, Nietzsche's experiences appear to most closely capture a sense of the mystery of the process which he does refer to as an "ecstasy." It may also be reasonable to conjecture that the more Houseman's "intellect" is disengaged in the process and the greater the rush and tumult of the appearance of involuntary and direct meaning, the greater the feeling that the work is divinely inspired. This does suggest that the power and comprehensiveness of meaning more directly experienced during the involuntary part of creative thinking may be more marked in some than in others, or, perhaps that the nature and type of the discipline involved may be a determining factor. It is well known that Einstein was not much given to verbal rhapsody!

In these instances of creative thinking and in more to be discussed in the ensuing chapter, there is a keenly felt need to bind the different stages of the creative process even though the two stages of thinking are experienced as

discrete, as witnessed by the freedom felt in the one and the restrictiveness felt in the other. Einstein, for example, was driven by an intense desire to seek the order of "symmetry and invariance" both within the imagic work of the thought experiments and between ensuing acts of visual discovery and the more difficult abstract, logical symbolic expression of them that followed. Discovery of symmetry came about by "soaring leaps of spatial and physical intuition" which enabled Einstein to go beyond the known territory and "see" what others before him had missed. According to Einstein "there is only the way of intuition, which is helped by a feeling for the order lying behind the appearance" (from the prologue in Planck, 1933, as quoted by Shepard, 1988, p. 156).

While composing music in his mind, Mozart was able to make his work conform "agreeably to the rules of counterpoint, to the peculiarities of the various instruments, etc." Though he does not refer specifically to 'soaring leaps of the imagination', he does claim to compose and hear the completed work in his mind. It appears that the achievement of balance and harmony in Mozart's compositions were accomplished both before and during the stage of committing the work to written form. Housman's description of Blake's poetry, if not his own, refers to the sound of the "lyrical note" where we can "listen with all our hearing to his celestial tune." Thus, the poet must choose just those word sounds and phrases that most exactly carry the desired meanings by the rhythm and harmony of the lines. This must be done both during the freedom of the involuntary stage of composition and in those periods of "laborious" composing as well, when the intellect is more painfully engaged in the process. Nietzsche captures something of what this is like when he refers to "an instinct for rhythmic relations which embraces an entire world of forms," forms which must be expressed.

For the creative person there is in the desire to find and express symmetry, invariance (exactness), or the lyrical expression of harmony, an aesthetic sense of beauty bringing deep joy and satisfaction which is keenly felt at the very moment of accomplishment, that is, when just the right

sought-for elements are known with surety to be found. These are the moments often described as being captured in leaps of the imagination or flashes of insight from which flows knowledge of how to bring about a near perfect blend between meaning directly perceived in the first stage with structures and forms of expression to be used during the second stage. Often, without the intervention of insight, the inspiration itself may not come to fruition or the symbolic (written) expression of the work may not adequately convey the meanings inherent in the first, direct experience of them. For the creative person this *is* the creative achievement. Though the work of communication to others may yet need to be done, the work itself is essentially finished. A way has been found to express exactly what is needed to be expressed and to some the completed work appears a "dead thing" and little more interest is shown in it, certainly not in its perceived value which, in the main, is left to others.

The assessment of the value of a work rests with the community, not its originator, who may be quite sensitive to anticipated reaction during the process of creating, but nonetheless will, in most cases, adhere to the need to express the original inspiration no matter if it should lead to acceptance or rejection of the work. The production of a work and assessment of its value are two distinct activities. We can learn little of the former from the work involved in the latter; the former is a distinctly individual experience, the latter a normative exercise which imparts the assignation of "creative" by general agreement. As neatly put by Valéry, "producer and consumer are two essentially separate systems. The work is for one the *terminus*, for the other the *origin* of developments which may be as foreign as you please to one another." (Ghiselin, 1952; p. 96). The upshot of it all is that there is still no real consensus about just what it means to be creative or to think creatively even though there may be a great deal of consensus about what works can be designated as truly creative. The focus of this thesis is on studies of how a work may be created, that is, how it might be "thought up" in the first place. There is always a temptation to stray into other areas of interest that impinge in one way or another on creativity; personality characteristics of

creative thinkers, how a product comes to be accepted as creative, or levels of motivation, commitment or productivity, to name a few. This thesis, however, is about "thinking" and every effort will be made to stick to just that topic.

The brief discussion of thinking processes given in the examples of Einstein, Mozart, Housman, and Nietzsche are meant to illustrate both the inherent complexity of thinking involved in their creative work and to give some idea of why it is so difficult to explain. If explanation is equated with theory backed by solid, reliable evidence, then it is immediately apparent that finding data to support such phenomena as insight, unconscious processing, or strategies like thought experiments can be very difficult to produce. Until it is, the mysterious nature of creative thinking remains intact.

Some cognitive psychologists now claim, however, that such data are forthcoming, and what they show is that creative thinking is considerably more mundane and pragmatic than formerly suspected. A specific purpose of this thesis is to make an informed judgement about the adequacy of cognitive psychologist's descriptions of "creative," or rather, what they refer to as "ordinary" thinking by comparing these to the testimonials of acknowledged creative thinkers. At the heart of the controversy is the need to describe or explain how thinking processes converge to bring about the ideas that produce works that are unique, original, and valuable. This is best depicted as the problem of how to explain the thinking processes that bring about the formation of new concepts in the inner workings of the mind; processes pithily described by Perkins (1981) as the "mind's best work." Concept formation is also a key issue for cognitive psychology because any comprehensive theory of human cognition must be able to account for cognitive behaviour that leads to the emergence of new, novel, or truly original learning.

Part II: Overview

Until recently, the traditional and uncontested assumption has been that creative thinking is indeed unique in kind, a particular capacity of mind, considered to be highly developed in only a very few individuals who we identify as geniuses in their fields. In the traditional view, the focus of analysis is generally on the uniqueness of the creative person with respect to intellect, emotion, personality characteristics, childhood development, and the early influences of mentoring and schooling. Though these factors may differ in terms of the importance of the disciplinary focus adopted, or the primary point of entry into the study of creativity, they turn out to be remarkably similar with respect to descriptions of the creative thinking process itself. The four cross-disciplinary examples given in the introduction provide a good illustration of this similiarity.

Biographical and anecdotal materials of creative persons, frequently, but not always, supported by data from interviews and questionnaires, provide most of the information for traditional theories about creativity. Some of the best known studies of this nature are found in the works of Hadamard (1945), Ghiselin (1952), Hutchinson (1959), Koestler (1964), Cannon (1965), Harding (1967), and John-Steiner (1985). These include detailed and valuable information in the way of interpretive work both on all aspects of the process of creating and on the more subtle nuances of creative thinking itself.

The traditional point of view has lately come under the scrutiny of researchers in the field of cognitive psychology as some prefer to call it, such as Newell and Simon (1972), Perkins (1981, 1988), and Weisberg (1986, 1988, 1993). The long-held assumption that a few people have unique intellectual powers associated with the very heart of being "creative" has been cast into doubt by some new and interesting ideas emerging from this field of study. Working in the area of human problem solving, cognitive researchers make the claim that what has been traditionally designated as creative thinking is not necessarily special or unique although it is representative of the very best

kind of thinking that we can do. Their research indicates that such thinking, though its outcomes may be extraordinary, is in itself quite ordinary. Cognitive scientists seek to establish that the mental "mechanisms" engaged in creative thinking are essentially the same as those we use to reason out solutions to puzzles or problems. The cognitive position thus represents a radical change in views of creative thinking; it is a point of view that runs counter to most cherished beliefs.

Cognitive scientists pose a very different kind of question about creative thinking from those traditionally asked. They are not so much concerned to find ways to explain it as something distinct from any other type of thinking. Instead, they are asking the question whether or not there is such a thing as distinctively *creative* thinking at all and their answer is plainly "no" (Perkins, 1981; Schank, 1988; Simon, 1991; Weisberg, 1986, 1993). What we are really looking at, they say, are simply ordinary thinking processes. By ordinary thinking, cognitive psychologists are referring particularly to cognitive information-processing systems engaged in the course of solving problems. Put most simply, they claim that the ways we represent, structure and process information during problem solving are essentially the same no matter whether we are trying to figure out how to fix the family car or to compose an opera. Further, these mental processes are now so well understood that computers can be successfully programmed to engage in the same kind of "creative" thinking behaviour. Some cognitive psychologists make no fundamental distinction, in principle, between the computational nature of both human and artificial intelligence (Simon, 1981). A recent address by Herbert Simon is illustrative.

As the keynote speaker for the 1991 American Psychological Society convention, Simon, known for his ground-breaking work in artificial intelligence and human problem solving, delivered an inspiring message about human thinking. According to Simon, there is

> No need to wait and hope for some future day when we will understand how the human mind works. It's here *now*. We have a cognitive psychology *today* which explains a tremendous range of human behavior, takes the mystery out of it. We now already understand a great deal about how the human mind works, even in some of its more complicated and spectacular workings. The explanations, as it turns out, are relatively simple.

These comments represent a startling declaration to those who find that the most "spectacular workings" of the human mind are still impenetrable to efforts to describe them in such confident terms. It is instructive to contrast Simon's comments with some related remarks made a few years earlier by the psychologist Howard Gardner (1987). According to Gardner,

> Those who seek some explanation for the cognitive processes involved in the creation of a major work would still be better advised to read Thomas Mann's *doktor Faustus* or to examine Beethoven's sketchbooks than to sequester themselves in a psychology laboratory.

Gardner is warmly supportive of developments in cognitive psychology which he casts as the "mind's new science" but his remarks suggest that the jury is still out on the issue of our ability to provide a scientific explanation of the complex cognitive processes involved in the more profound accomplishments of the human mind. Gardner's caution highlights the deep division between the two different approaches to the study of creative thinking briefly described above as the "traditional" and "cognitive" points of view. These are two categorically very different schools of thought which hold fundamentally contrary positions on what it means to think creatively.

Interestingly, the commentaries about creative thinking by creative persons themselves (usually, but not always, of their own experiences) have provided rich sources of information for both positions. Creative thinker's points of view, however, have much in common in their own right and thus can also stand as a distinct body of thought on creative thinking. I hope to show that there is much of theoretical worth in the writings of this group that

differs substantially in important ways from interpretations about their writings made by those in cognitive science schools of thought.

There is some value to be gained from considering such self-report data as a distinct category. Most of these writings have, in the main, become quite fragmented. That is, they have typically been adopted and adapted, usually in a highly selective manner and more in part than in whole, to suit the purposes of a particular investigator working within a particular interpretive framework, be it Freudian, Gestaltist, Jungian, Rogerian, or some other generally more empirical psychological or cognitive point of view. The outcome of such work may or may not agree with the views on creative thinking as expressed by creative persons themselves or, alternatively, may influence the way creative persons describe their own thinking processes.

A case in point is illustrated by the two different schools of thought on creativity. Cognitive scientists typically devise arguments that undermine confidence in the viability of creative thinkers own self-reports about how they think (see especially Perkins, 1981 and Weisberg, 1986, 1993), preferring instead to base a scientific explanation on data gathered from empirical, most notably experimental, studies. Those from the more traditional school of thought, on the other hand, tend to use the very same self-reports as credible witness to the uniqueness and mystery of creative thinking itself (see, for example, Hadamard, 1945; Ghiselin, 1952; Koestler, 1964, or Harding, 1967). Both schools use the biographical data, diaries, notebooks, and works-in-progress of known creative thinkers as rich sources of information to support very different constructions and interpretations of the creative process. These differences naturally arise, then, from divergent theories on the nature of inquiry undertaken and relatedly, what constitutes acceptable sources of data. Cognitive psychologists who find creative thinker's self-reports unacceptable as evidence for extraordinary thinking processes, seek instead to replace them with more appropriate empirical, notably experimental, data. These data, they argue, point to an entirely different

view of how we think creatively. It is a view that is certainly very different than that held by many creative thinkers themselves.

It should be most helpful, then, to begin by carefully identifying and describing just what acknowledged creative thinkers have to say about their own experiences. The point of the exercise is two-fold; it is useful for the information it brings to light, and to provide needed correctives to distortions of their views found in the cognitive psychology literature. In the latter case, some restoration work may have to be done in order to once again establish the credibility of creative thinkers. Thus in chapter two I will present a series of self-descriptions given by creative thinkers themselves in order to get clear on just what they have to say about their own thinking processes. These will be representative of the contributions of creative individuals in a number of diverse disciplines. The chapter concludes with a descriptive sketch of creative thinking as drawn from analyses of the work of creative thinkers reviewed.

The purpose for doing this is to provide a composite model of creative thinking that portrays as accurately as possible the processes embodied in creative thinkers' own views of creative thinking. This will be used as a sounding board for evaluating the adequacy of the criticisms levelled against the traditional point of view by the cognitive scientists, to be presented in chapter three. Acceptance of the cognitive view of creative thinking, or rather just "thinking" in this case, rests on arguments designed to purposely discredit the traditional point of view. For cognitive psychologists, this is a necessary preliminary task of which the purpose is to clear the space for the very different position some of them put forward, one that finds much wrong with an approach predicated on the assumption that something called creative thinking is distinct enough to be worthy of study in its own right.

Chapter three presents arguments for the presence of ordinary, rather than extraordinary thinking from the point of view of Robert Weisberg and David Perkins, two cognitive psychologists who have done extensive work in this area. Others could also be included, but these two are reasonably good

representatives of prevailing views of creative thinking to be found within this discipline. Whether or not the efforts of cognitive psychologists will succeed depends on how well they establish the adequacy of three distinct arguments: first, that the meanings of the concepts intended to replace the more complex concepts associated with creative thinking by creative thinkers themselves (inspiration, intuition, heightened perception, power of emotion, aesthetic beauty, truth of conviction) are sufficient to do the job; second, that the arguments for substituting them in the first place are sound, and finally, that the experimental tasks and other evidence cited in support of this position adequately capture in some important way the nature and type of activities undertaken by highly creative artists, scientists, poets, composers, novelists, dramatists, and the like. To this end the arguments put forward by cognitive psychologists will be judged against creative thinkers self-descriptions in order to assess how well they cover the ground, so to speak. The fundamental question at issue, as I have already indicated, concerns whether or not the cognitive psychologists reviewed here can explain truly novel learning. I will argue that how well they do so rests squarely on how they explain the creative thinkers ability to go *beyond* prior knowledge, belief, or practices.

Theories or models which purport to explain human thinking processes, whether in terms of problem solving or some other approach, must be able to account for occurrences of thinking that are generative of new or novel learning, especially those events that result in important transformations in human understanding and practices (Pascual-Leone, 1976). In other words, cognitive psychologist's explanations of human thinking, to be comprehensive, must include a viable account of the thinking processes that engender more complex learning. If they cannot do this, then such models would be incapable of explaining the full range of human cognitive behaviour. If such explanatory models are thus incomplete, so then is the scientific explanation of human cognition.

How well cognitive psychologist's have succeeded in providing such an explanation is the subject of chapter four. In this chapter the logical and psychological difficulties cognitive psychology must deal with in order to explain how knowledge gets more complex will be put forward. Making knowledge more complex has, of course, been traditionally associated with the accomplishments of a comparatively small number of exceptional individuals who have lived and worked throughout the various periods of human history. I will argue that at this point in time cognitive psychology cannot explain how they accomplished what they did.

It is odd and interesting that the cognitive science explanation of creative thinking turns on the assumption that there is nothing at all special about it. The conclusion of this thesis will attempt to make a small, but hopefully viable excursion into an assessment of the contributions of this approach to explaining creative thinking.

Chapter Two: Creative Thinking

Part I: Introduction

The general purpose of this chapter is to take a close and critical look at creative thinking from the perspective of those persons acknowledged to be highly creative in their respective fields. The intent is to illustrate the richness and detail of creative thinkers' own views and understanding of the mental processes employed during the course of their work. The point of doing so is to explore whether or not a plausible description of cognitive processes that, though the processes may be employed in other types of thinking as well, nonetheless appear to work together in ways common to creative thinking. The nature of this task requires that creative thinking be addressed in a generic sense, that is, the description to be derived from an analysis of the following self-descriptions must ultimately supersede the various areas of knowledge represented. As such, a sensible approach is to draw upon descriptions given by creative people, those arguably in the best position to understand how the creative mind works because they have made original and valuable contributions to the various fields of knowledge they represent.

The selections on thinking by creative thinkers included here are meant to be representative, but not by any means exhaustive, of those reported in the literature. The more comprehensive work has already been done and there are some good volumes available which bring together a variety of descriptive experiences and interpretations of creativity. See, for example, Ghiselin (1952), Hutchinson (1959), Rosner and Abt (1970), Vernon (1970), or West (1991). I have drawn most of the following descriptions from such anthologies but have also used other resources where a single account from a particular creative person is available but scattered about in various works.

Many more could be added to those included here but few cover the scope and detail of the one's I've chosen. Others will, however, be brought in as illustrative where that seems appropriate.

Along with the cases of Einstein, Mozart, Housman, and Nietzsche presented above, the ten descriptions of creative thinking chosen for this section were selected with four criteria in mind. First, they had to be written by persons incontestably known to be creative. Second, the information each contains consists of the person's own first-hand description of the creative thinking experience. The interpretations of others, no matter how close to the creative person they may be, or have been, are sparingly used. Third, each selection is meant to be representative of many more available, which for reason of space could not be included here. Finally, the selection must be of sufficient length to clearly display an emergent pattern of thinking intrinsic to the process. I therefore selected two or three per discipline that may serve as exemplars for the kinds of thinking process that appear to be particular to it. The examples chosen are quite diverse and, as such, are not limited to particular time periods, places, or to any preferred disciplinary specialization.

In my estimation it is important to allow creative people to speak for themselves and I have quoted them liberally and extensively. There are two reasons for doing so, first it should keep in check the temptation to bend or shape what they say according to a particular bias and second, I am of the opinion that no one could say it better, especially in terms of the more subtle and complex nuances of the disciplines creative thinkers themselves are known to influence, shape, or change. These are the individuals who, by the very nature of the original and valuable contributions to knowledge they have made, embody the deepest sense of what it means, in fact, to be truly creative.

The brief introduction to creative thinking from the foregoing chapter indicated that Einstein's, Mozart's, Housman's, and Nietzsche's creative thinking processes occurred primarily in two distinct ways. First is the stage at which the "intellect" (in Housman's sense of the word) was not engaged

and, in fact, was felt to be intrusive and disruptive, and, second, the stage in the process where the intellect does take over the work. The former represents thinking done in a mode quite different from the more deliberative work of the latter, a situation where "thinking" experiences great freedom from the voluntary control of the intellect. The work done is variously described by the creative thinkers as occurring in a reverie resembling trance-like or dream-like states in the subconscious mind. This mode is distinct from the more focused work of the conscious mind in terms of the sheer volume of ideas that come forward and which are conveyed in the types of "language" (imagic, esthetic, symbolic, verbal) associated with the nature of the discipline concerned. The conscious mind itself appears to be quiescent during these periods of subliminal mental activity. The more focused and deliberative work normally carried out by the conscious mind includes completing work generated during the "subliminal flow," and solving problems, editing, revising, and communicating the new information to others.

I have adopted the terminology of the mathematician, Henri Poincaré, to label these two distinct ways of thinking the "subliminal" and "deliberative" modes respectively. The terms are generally uncomplicated and loosely, but I think adequately, reflect the nature of the mindwork done in creative thinking. As the following descriptions of thinking will show, subliminal work is quite involuntary, occurring below the level of full consciousness, while conversely, the work of the "intellect," to use Housman's term, is laborious, deliberative, and primarily occurs under the voluntary control of the conscious mind. Though the two modes represent distinct ways of thinking, they do work together in various ways and, indeed, the manner in which creative thinkers accomplish this is, in itself, quite instructive. There is a third mode of thinking which some creative thinkers describe as a period of gestation or incubation. This occurs unconsciously and thus remains largely a mystery both to those who experience it and those who try to explain it.

The chapter will conclude with a discussion of both the similarities and differences among creative thinkers' ways of working. I will propose that the similarities generally encompass the nature of the work done in the subliminal, deliberative, and gestational modes of creative thinking. I also hope to show that the differences in thinking between various creative thinkers, are not, in fact, relative to the disciplines concerned as is commonly believed, but rather occur on something of a continuum where the preferred cognitive processes individuals employ may range from mostly deliberative (very aware) to mostly subliminal (passively aware) to gestation (completely unaware). In most cases, all three modes are engaged to a greater or lesser extent. Three cases included below best illustrate this point. Robert Nichols *Birth of a Poem* is a fine example of creative mindwork done primarily in the subliminal mode, Steven Spender's *The Making of a Poem* represents mindwork done primarily in the deliberative mode, and Poincaré's *Mathematical Creation* illustrates something of an interactive balance between the deliberative, subliminal, and gestational thinking processes. These cases have the added advantage of representing two disciplines so different in kind that one might readily assume there to be great dissimilarities between them and little in the way of common cognitive processes would be apparent. Nonetheless, striking similarities do exist; the dissimilarities appear to relate more to the preferred modes of thinking used rather than disciplinary boundaries per se.

The description of creative thinking I derive from the personal experiences reported here, while it does not necessarily transcend disciplinary boundaries, certainly points to commonalities across the disciplines. As will be seen, creative thinkers' enthusiasm and preference for subliminal work is much in evidence, presumably because of the freedom from the constraints of the conscious mind and the effortless, sometimes overwhelming ideational flow it represents, but it is important to keep in mind that all three of the deliberative, subliminal, and gestational modes of thinking are critical to the creative process. It is clear that outcomes or products acknowledged to be specifically "creative" do emerge from either end

of the continuum, but the manner in which creative work is done may be quite different.

Some clarification of terminology is needed at the outset because creative thinkers use different, and often very rich, colourful, terms which seem often to reflect the same meaning. For the sake of consistency, I have adopted one inclusive term that represents the specific meaning intended. In doing this, inevitably something of the beauty and complexity of their descriptions are lost, but the essential meaning is, hopefully, clearly preserved. Thus, as already indicated above, uses of the terms "deliberative" and "subliminal" represent cognitive processing in the conscious and subconscious states of mind respectively. Sometimes, creative thinkers will refer to subliminal thinking as the work of the unconscious mind. Because of the similarities in descriptions, I have "reassigned" these to the subliminal category and have reserved the work of the unconscious mind to gestational thinking only. Unconscious is, by definition, not conscious, therefore I restrict the use of this term to cognitive processes of which individuals are completely unaware except to realize, after the fact, that such processes must have occurred. I use the terms "ideas" or "elements" to refer inclusively to images, symbols (verbal, numerical, algebraic, and the like), or geometric patterns when discussing the elements or "language" of thought of the area of knowledge of concern. Finally, conscious, subconscious, and unconscious portray states of mind; these are sometimes, but not always meant to be taken as discrete. In some cases, as will be seen, the thinking processes associated with the conscious and subconscious states work either in tandem or simultaneously. Perhaps the ability to do this is one defining feature of specifically creative thinking.

Overview

The chapter proceeds by first presenting a brief and very general background sketch of the lives of some well-known creative people from various disciplines. Though such a sketch does not provide information that can be

directly associated with the emergence of highly creative persons, it does point to experiences common to them. The primary point of the discussion, however, is to give something of an idea as to how highly creative people may come to think as they do. This section will be followed by the presentation of self-descriptions of creative thinking organized under the various disciplines. The chapter concludes with the presentation of a general description of creative thinking that, although very tentative, is plausible enough to act as a basis for comparison with the cognitive science view of creative thinking that follows in chapter three.

Part II: Background Information

The background context set out below is intentionally sketchy. The points included are frequently but, of course, not always or exclusively, associated with creative persons. They are worth noting in a discussion of creative thinkers because speculation that an idiosyncratic background, which includes individualized educational development and concerted family or mentoring support, impinges in important ways on the choice, development and nature of the work chosen, and on the freedom from traditional disciplinary constraints such an unusual background brings to those who subsequently become highly creative in their fields. Such early experiences of disciplinary freedom no doubt contribute to the commonly held view that creative people are, so to speak, a "breed apart." There is compelling evidence that this is indeed the case. Much has been written about the unusual educational experiences and family lives of creative people, most of which is well documented as noted in the foregoing chapter. Thus, this brief excursion into background information is intended only to highlight the unusualness of some of the early developmental experiences common to acknowledged creative people.

Generally speaking, creative thinkers have found themselves in situations, or found ways since early childhood, to learn independently of

more formal teaching and schooling and the accepted scholarly traditions of the day. A number of them had experienced both ill health and learning problems early in life, leaving home-education and a certain amount of unavoidable isolation the only viable option open to them. Einstein, Edison, Darwin, and Rodin, for example, were believed to have language disabilities which today might be classified as dyslexic (Shepard, 1988). Faraday had an exceedingly unreliable memory, early difficulties with speech, writing, and basic mathematics, and Clerk Maxwell had great difficulty in expressing himself verbally (West, 1991). As children, Maxwell, Mach, and Newton spent many solitary hours constructing and playing with mechanical devices that fascinated them. Newton was known to have made clocks and sundials as well as mechanical toys. Clerk Maxwell, as a youngster, invented a semblance of the perpetual motion machine and, like the young Descartes from an earlier time, "discovered . . . a method for generating a perfect ellipse using two pins and a loop of thread" (Shepard, 1988, p. 157). Einstein's childhood experiences provide one of the best known examples of similar "playfulness." Shepard conjectured that "Einstein's early and often solitary preoccupation within a relatively private visual-spatial domain, in preference to the socially and institutionally controlled verbal domain, set the stage for his later role in the developments that have transformed twentieth-century physics" (p. 156). Einstein's early fascination with the mechanical world likely contributed a great deal to the development of his special ability as an adult scientist to think with mental images and patterns, rather than with words or symbols, thus providing training for his later thought experiments. Early experiences as illustrated by these examples conceivably foreshadowed the great discoveries to come.

Bach, Mozart, Beethoven, Stravinsky, and Shostakovich, to name a few, came from musical families where one or more of parents or relatives took special notice of their gifts and talents. It was not uncommon for such mentors to devote much of their own lives to overseeing the development of the exceptionally talented youngster in their midst (John-Steiner, 1985).

Pablo Casals experience is typical. He remembers the world of music around him from as early as age two and began to play the piano at the age of four. By the time he reached late childhood he could also play the organ and often filled in for his father on certain occasions at church. He discovered the cello at the age of eleven and knew then that it would become his life's work. There was no cello teacher in Casals' village and his mother made a concerted effort to get her son proper musical training at great time and expense to the family (John-Steiner, 1985, p. 144). Michael Faraday also "knew" his vocation early in life. He dropped out of school in the primary grades, no doubt due to his learning difficulties. He worked as a delivery boy and apprenticed as a bookbinder and worked as a janitorial lab assistant in his youth. As a boy he taught himself to read, practiced writing by writing letters to friends and took copious notes at public lectures on scientific matters. From a very early age he was given to using what small amounts of money he made to buy metal, wires and chemicals which he used to make batteries and to conduct experiments (West, 1991). According to West, Faraday "worked continuously and passionately to educate and improve himself" which ultimately included a great store of scientific and technological knowledge (pp. 104–105). Both Mozart's and Bach's accomplishments as children are, of course, well known and documented.

Such early and prolonged experiences of idiosyncratic educational development and in many cases, devoted mentoring, no doubt contributed to one of the most enduring characteristics commonly associated with creative people, that is, they often tend to use eccentric means to achieve their ends, exhibiting peculiarities of practice that impress the rest of us as being anywhere from a little quirky to just plain bizarre. The physicist Richard Feynman, for example, refused to learn from anyone but himself. He claimed not to be able to understand the "official version," that is the text renditions of the field of quantum mechanics and so took five years of intense work to rediscover and reinvent the entire field for himself (Shepard, 1988). The concentrated effort involved greatly impressed his colleagues. Most creative thinkers, in fact, are noted for a fierce need to focus without distraction on

their work which is perhaps due to the isolation experienced during childhood. Schiller, for example, liked to keep rotten apples in his desk because the smell helped him to concentrate; others, like Auden and de la Mare needed to have such stimulants as bottomless cups of tea or coffee, or cigarettes for chain smoking to achieve the same end (Spender, 1946, reprinted in Vernon, 1970).

Creative thinkers have developed many oddities and ritual-like behaviours associated with acts of creating for the purpose of inducing the subliminal mode of thinking in order to begin and to continue working under the spell of the creative mood—an inspirational state of mind that is often described as self-hypnotic, trance-like, meditative, or "hypnogogic" in nature. The poet, Amy Lowell, and writer, Dorothy Canfield, had only to hold a pen and stare at a blank sheet of paper in order to slip into the right mood in order to begin writing. Further, being in the creative mood often required finding a means to keep the "intellect" from intruding and thereby spoiling the mindwork that occurs during subliminal thinking. The needed revising, rethinking, or editorial work normally done by the "intellect" was sometimes personified and thereby internalized in ingenious ways in order to both use the information it provides and to keep it relatively "quiet" at the same time. Some examples from Ghiselin (1952) are illustrative. Rudyard Kipling reports that he could not write without his own special "Daemon" present; work done entirely on his own appeared to him as forced and vacuous. The poet Nichols composed poetry with a "personage" called the "artificer," Picasso painted with his "collaborator," and the artist, Max Ernst, kept creative company with an odd little "head of the birds" called "Loplop" who, to Ernst, is a "very special phantom of exceptional faithfulness, who is attached to my person" (p. 65). Obviously, this is one of the ways the two distinct modes of creative thinking work together and this phenomenon will be discussed more fully later.

There are certain personal attributes identified as prominently associated with highly creative people. These are the ability to persist despite

repeated failures, frustration, and despair; the ability to exercise prolonged, intense concentration sometimes over periods of months or years; the ability to work without the approval of others (even though that may be highly desired) and, most importantly, the ability to think directly with the objects of immediate perception, a habit often formed early in childhood (Shepard, 1988). Thus, creative thinkers typically discover and master their disciplines with a certain educational and personal purity, so to speak, uncluttered by the opinions of others. The very act of doing so likely leaves them with a store of knowledge, skill, and interpretive abilities distinctly of their own stamp and which they regularly replenish and draw upon over the course of their creative lives.

Part III: Creative Thinkers

The following descriptions of creative thinking are organized into four discrete categories: science and mathematics, poetry, music, and stories. Given the integral nature of math and science, particularly physics, it was decided to group these together. Much more could be added to this overview, particularly descriptions provided by inventors like Tesla and Edison, but the selections chosen illustrate the nature of their work as well, as will be noted in the concluding synthesis. It is well to state at the outset that there are those who work mainly, but I found none entirely, in the subliminal mode of thinking, such as the poet Robert Nichols, and those who claim to work exclusively in the deliberative mode like the inventor, Thomas Edison, and the poet Edgar Allen Poe (Perkins, 1981; Weisberg, 1986). Edison and Poe appear to represent the extreme, and because the purpose here is to both describe the modes of thinking and, most importantly, describe how they may interact, it is best to include the extremes mainly to highlight certain points of information.

As a point of clarification, the terms "subliminal" and "intellectual," "conscious" and "subconscious," "voluntary" and "involuntary" are not meant

to be other than loosely descriptive for purposes of discussion. These terms, or variants of them, arose often enough in the writings of creative thinkers themselves so it seemed safe enough to borrow them for descriptive purposes, but none in themselves are wholly adequate to convey the complexities involved in the processes of creative thinking. As such, these terms are inadequate for the detailed definitional work on creative thinking that still needs to be done.

Science and Mathematics

The science and mathematics category begins with two brief descriptions of mental processes described by the nineteenth and early twentieth century scientists, Sir John Herschel and Sir Francis Galton. Herschel draws attention to a special kind of "seeing," and Galton discusses different "locations" in the mind that represent distinct information processing patterns. Their views on the variable nature of the work of the mind sets the stage for Poincaré's descriptive analysis of mathematical discovery as experienced by himself and by other mathematicians (see, for example, Hadamard, 1945). Much that comes to light in this category is repeated, in one way or another, by all the creative thinkers included in this chapter.

Sir John Herschel

In 1858, Sir John F.W. Herschel, addressing the "Philosophical and Literary Society of Leeds," observed that there are two kinds of *seeing*; one with the eyes, of course, and the other as seeing directly within the mind. The former referred to ocular vision, but in the latter case, the function of the mind was to interpret visual stimuli whether or not the eyes were opened or closed. Herschel was looking for an explanation of the origin of such involuntary, recurring patterns, or "spectra" as he called them, that some of us might experience from time to time, but for him, regularly occurred. He did not believe them to be dreams as the conscious mind itself was aware of what it was "seeing" when such phenomena appeared. Nor did these appear to be

memories; they were not recalled, he states, but were created "before the eyes." The effect of the experience was to "*direct* the train of thought into a channel it would not have taken of itself" (p. 441). Herschel observed that these were not the deliberate products of any conscious effort we might make for he reported to have no control over what forms or patterns might emerge, nor could he produce them at will. In short, Herschel described the involuntary appearance of imagic patterns of thinking, images in this instance, that exerted a powerful effect on the ensuing direction of thought.

To Herschel, these appeared as ocular spectra taking the form of colourful geometrical patterns. His experiences of them were not unique as such phenomena have reappeared time and again in creative scientist's descriptions of their own mental processes engaged during the course of the work of discovery, as is, for example, illustrative of Einstein's and Neils Bohr's thought experiments. But Herschel left us with the fundamental question, "Where does the pattern itself or *its prototype in the intellect* originate?" (p. 412).

Sir Francis Galton

Galton (1907) proposed one of the earliest answers to the question but, in this case, he was primarily talking about ideas rather than images. There are, he states, two locations for ideas, one in full consciousness and the other in the "antechamber just beyond the full ken" of consciousness. The ideas in consciousness, usually limited in number but nonetheless subject to one's full attention, of themselves appear to attract a myriad of logically related ideas that reside in the "antechamber" from which the most relevant are "summoned" for full consideration. He echoes Herschel by observing that those selected strongly influence the progress of subsequent thought, and that the process is involuntary, "The thronging of the antechamber is, I am convinced, altogether beyond my control; if the ideas do not appear, I cannot create them, nor compel them to come" (p. 146). Thus, the entire process appears to take place without the rather more arduous mental effort

associated with full conscious attention. Galton notes that its occurrence is preceded by considerable deliberate past and present efforts to deal with the task or problem of concern. In fact, such deliberate efforts act as a precursor to stimulate the collection of related, "cognate" ideas. Galton summed up the experience by surmising that "one portion of the mind communicates with another portion as with a different person" (p. 148). He claimed that those who report having such experiences are capable of "extreme fluency," both imagic or verbal, and are naturally endowed with "a vivid and rapid imagination." These are, he concluded, the qualities of great figures. The self-reports of other creative thinkers that follow strongly support Galton's observations about the inner workings of the mind.

Galton's answer to Herschel's question about the source of subliminal activity concerning the myriad of ideas in the "antechamber" is that the accumulated experience and learning which make up a highly specialized part of the memory and related ideas which are the most logically appropriate to whatever is needed, are the ones that appear to settle in consciousness. The catalyst for activating them is the intense, deliberative work that precedes their appearance, work severely constrained by the limitations of consciousness. The multitude of ideas does not come to the conscious mind by any sort of memory search, however, as the whole process is reported to take place in an involuntary manner. The great volume of ideas is just "there."

In sum, Herschel, and particularly Galton, have put forward a case for the presence of two distinct "portions" of the mind that work together during creative thinking, one under voluntary control and the other involuntary. The following description of Poincaré's experiences of mathematical discovery shows this to be a recurring theme.

Henri Poincaré

Poincaré believed that creative mathematicians possess a special ability to intuit a certain order of syllogistic reasoning which allows them to grasp a complete mathematical argument in an instant. This ability bypasses the need for arduous deliberative search by the much more laborious process of step-by-step calculation and verification. He draws upon his discovery of Fuchsian functions which, he stated, is only one example typical of many similar experiences, both his own and those reported by other mathematicians, to describe the process (Poincaré, *Mathematical Creation*, reprinted in Ghiselin, 1952). Poincaré's work follows a certain pattern of mental activity that illustrates the alteration between the subliminal, gestational, and deliberative modes of thinking.

To begin, for several weeks prior to his discovery of the first set of Fuchsian functions, Poincaré had been working on trying to prove that such functions did not, in fact, exist. His deliberative efforts, which consisted of making many different combinations of elements, had met with no success. After a particularly arduous and frustrating day's work that ended in complete failure, Poincaré spent an entire night on the problem which, at some point during the night, gave over to the more effortless work of the subconscious mind. He described the experience as follows:

> Ideas rose in crowds; I felt them collide until pairs interlocked, so to speak, making a stable combination. By the next morning I had established the existence of a class of Fuchsian functions . . . I had only to write out the results, which took but a few hours. (p. 36)

This experience was then followed by a period of "perfectly conscious and deliberate" activity which resulted in formation of the first set of functions, the "theta-Fuchsian" series. Following this, Poincaré experienced a series of intermittently occurring insights over a lengthy period of time that led to the establishment of an unanticipated second set of Fuchsian functions.

Shortly after forming the first set, the theta-Fuchsian series, Poincaré had to discontinue his mathematical work for a time in order to pursue some other business away from home. There, while stepping onto a bus, he experienced the following insight,

> the idea came to me, without anything in my former thoughts seeming to have paved the way for it, that the transformations I had used to define the Fuchsian functions were identical with those of non-Euclidean geometry. (p. 37)

This first insight occurred while he was engaged in an unrelated conversation with someone started before it appeared and, while continuing to converse, he felt certain that his insight was correct. Indeed, he managed to verify it upon returning home. He found that he had established a set of Fuchsian functions which he suddenly realized came from the "hypergeometric series."

Later still, Poincaré occupied himself with some arithmetic problems he did not at the time associate with the prior work on Fuchsian functions, but like that earlier work, resulted in complete failure to solve them. "Disgusted" with himself, Poincaré set off for the seaside for a rest and a break. While relaxing and altogether off the topic of Fuchsian functions, the second insight occurred.

> One morning, walking on the bluff, the idea came to me, with just the same characteristics of *brevity, suddenness and immediate certainty*, that the arithmetic transformations of indeterminate ternary quadratic forms were identical with those of non-Euclidean geometry. (p. 37, emphasis mine)

Thus, this second insight tied the arithmetic problems he was unable to solve earlier to the discovery in the first insight that the arguments defining Fuchsian functions and the arguments defining the apparently unrelated arithmetic problems were both identical to the arguments of non-Euclidean geometry. Upon returning home, Poincaré worked through the consequences of this latest discovery. The result was the establishment of a second series of

non-Euclidean Fuchsian functions that did not correspond to the hypergeometric series as did the first, but which, being also non-Euclidean, could be applied to the first set, the theta-Fuchsian series. Poincaré then set out to form and verify all of the resulting functions from these discoveries. One, however, resisted his effort to verify it and without it, the whole construction would collapse.

As before, conscious and deliberate efforts to form and verify this one remaining function resulted in failure and frustration. The problem was finally solved by a third insight which, like the other two, came to Poincaré while he was otherwise occupied, this time by a lengthy period of military service. According to Poincaré:

> One day, going along the street, the solution of the difficulty which had stopped me suddenly appeared to me. I did not try to go deep into it immediately, and only after my service did I again take up the question. I had all the elements and had only to arrange them and put them together. (p. 37)

Upon returning home, he easily reconstructed the final argument, completing the work in one sitting. In the beginning Poincaré had set out to prove that Fuchsian functions didn't exist, but in the end, he had discovered two sets of them.

A distinct path can be traced through Poincaré's process of discovery, one that follows a clear and continuous alteration between the deliberative, subliminal, and gestational modes of thinking. The pattern of discovery includes first experiencing frustration and failure through deliberative efforts to solve the problem. This was immediately followed by subliminal work giving rise to "crowds" of ideas from which just the right elements emerged, bringing the first set of functions to conscious awareness. These were quickly verified in an ensuing period of deliberative work. Later, during a period of time spent on other matters altogether, he experienced the first insight about the nature of the functions (non-Euclidean). This was then verified. Poincaré's next task involved trying to solve some other arithmetic problems

not at first recognized to be connected to Fuchsian functions. This too resulted in frustration and failure. He went on a holiday for a break where, while taking a walk, the second insight occurred. The arithmetic problems were also those of non-Euclidean geometry, thereby establishing their relationship to Fuchsian functions. Again, he verified the insight during a following period of focused deliberative work, except for one problem. This was key to the argument, and again efforts to solve the problem were futile. Poincaré set the work aside for a period of military service during which the appearance of a third insight solved the difficulty, which he quickly verified upon returning home. Poincaré's path to discovery, then, involved alternating periods of deliberative, subliminal, and gestational work including effortful problem solving, the involuntary ideational flow of ideas, and the unexpected appearance of three critical insights, each then verified by means of formal mathematical argument. The entire process occurred intermittently over a period of three years.

Although Poincaré refers to the subliminal process as the work of the unconscious, he described it much like Galton had done before him. That is, he was certainly aware of the involuntary mental events during the period of ideational flow, which occurred in the subconscious mind, while being observed by the conscious mind, but more through passive awareness rather than any deliberate effort on Poincaré's part. He described the nature of these two parts of the mind as follows:

> the subliminal self is in no way inferior to the conscious self; it is not purely automatic; it is capable of discernment; it has tact, delicacy; it knows how to choose, to divine. What do I say? It knows better how to divine than the conscious self, since it succeeds where that has failed. (p. 39)

Thus, subliminal thinking played an enormously important function in Poincaré's work of discovery, in this case stepping in when all other efforts had failed.

Poincaré was clearly aware of the ideas that "rose in crowds" and those that "stabilized" were just the ones needed to deal with the problem. What puzzled him was how they came about in the first place, an echo of the same question posed by Herschel. Galton explained the phenomenon by positing an "antechamber" of consciousness filled with information, but only those related in a logical way to the problem at hand were admitted to full consciousness. Poincaré's description of it is essentially the same but with the added realization of the role the emotions play in the process:

> all the combinations would be formed in consequence of the automatism of the subliminal self, but only the interesting ones would break into the domain of consciousness. . . . What is the cause that, among the thousand products of our unconscious activity, some are called to pass the threshold, while others remain below? . . . More generally the privileged unconscious phenomena, those susceptible of becoming conscious, are those which, directly or indirectly, affect most profoundly our emotional sensibility. (pp. 39–40)

Here, Poincaré, as also did Einstein, Housman, and Nietzsche, pointed to the powerful and critical role of esthetic sensibility, that is, the role of the emotions in discovery.

"Esthetic emotion," in this case entails the "feeling of mathematical beauty," the "harmony of numbers and forms" and of "geometric elegance," responsible for experiencing the esthetic sense of the "useful and beautiful." It is these that touch the emotional sensibility of the discoverer which "once aroused, will call our attention to them, and thus give them occasion to become conscious" (p. 40). Thus, the conscious mind *feels* those combinations that are going to be useful. The ability to do so appears to happen, however, only when the more deliberative and focused activity of the conscious mind is quiescent or "passive," as Houseman put it, during the involuntary subliminal thinking process that provides the multitude of elements from which the right combinations are drawn. That certain of them were both "felt" and "known" to be the correct elements is conveyed to consciousness by a heightened sensitivity to their esthetic beauty, that is, their harmony,

elegance, and usefulness. In this way, the feeling of esthetic beauty appears to provide the bind between the subliminal and deliberative experiences of the creative thinking processes bringing forth essential information and thus providing the needed new direction for thought to take. As Poincaré explains, "it is this special esthetic sensibility which plays the role of the delicate sieve" where "the mind without effort can embrace their totality [the mathematical entities] while realizing the details" which acts as "an aid to the mind, sustaining and guiding" (p. 40). Thus, Poincaré, as did Galton before him, describes an esthetic directive intrinsic to the subliminal process of discovery, that is, the critical role of the emotions in redirecting thought from avenues ending in failure into more fruitful and productive paths. Further, it appears to do so in a much more rapid and efficient manner than having to rely solely on the deliberative work of the conscious mind to achieve a similar end.

The mental event that is most difficult to explain is the sudden appearance of what might be called intuitively derived insights. For Poincaré, these functioned to provide the "missing link" that broke an impasse and thus allowed for further productive work. An insight cannot be willed to come. It too is involuntary and obviously directive. But it does seem to be more genuinely intuitively derived than, say, the subliminal process of ideational fluency where the conscious mind is quite aware of the event and receptive to new ideas that result. Unlike ideational fluency, which follows a period of intense concentration, intuitive insights arise unexpectedly at times when subliminal thinking is not necessarily occurring and the intellect is otherwise engaged in unrelated matters. This is why insights of this nature are almost always reported to occur in sudden flashes, or are characterized as sudden illuminations, and the like, but they do not seem to be characterized by the deeply intense and more prolonged emotional directive that is part of the period of ideational flow. Intuition means, of course, to gain understanding of something more by clear, direct perception of it rather than by thinking about it or reasoning it out. Thus the occurrence of an intuitive insight represents a singular mental event and though it is obviously part of an ongoing process, it doesn't necessarily happen when the thinker is actually engaged in the work.

This suggests that unlike the arrival of subliminal insights, the sudden appearance of intuitive insights are products of some sort of unconscious gestational process of which the thinker is unaware.

Poetry

Housman's description of creating showed how the poet is most successfully able to convey meaning by the judicious selection of just the right words and phrases that capture both meaning and feeling tone in the rhythmic blend of metre and sound. Housman hints that the poet is aware of the sense of the rhythm and harmony of the poem somewhat before the words arrive, thus providing something of an initial structure or form for the work to come. This suggests that, while other creative thinkers think in images (Herschel, Einstein) or various verbal or mathematical symbols (Galton, Poincaré), poets tend to think rhythmically, that is, with a sense of the musicality of the words prior to knowing just what the specific words may be. Thus, the feeling for the rhythm and musical tone of the work in process "brings" just the right words or phrases needed to ensure that the intended meaning remains *implicit* in the poem. Of the three examples of poetry composition included in this section, Robert Nichols best illustrates the complexity of the process as it occurs, in this instance, almost exclusively in the subliminal mode. Amy Lowell's efforts, like Poincaré, more resemble the balance struck between the work of the deliberative, subliminal, and gestational processes, and Steven Spender's description depicts the "plodding" work of the intellect following the "spark" of inspiration. The following is taken from Robert Nichols, *Birth of a Poem*, reprinted in Ghiselin (1952).

Robert Nichols

The composition of Nichols' *Sunrise Poem* took place during a journey by ship through the Caribbean Islands. Nichols was deeply affected by the surroundings, particularly the quality of the natural light which aroused in him strong feelings that carried a sense of the significance of the profusion of

elements in the immediate environment—a house, gardens, the sights and sounds of birds, and particularly the ocean. It is noteworthy that Nichols was not just hearing or seeing such elements; what he felt so strongly was the pressing sense of the meanings contained within them. This experience had the effect of opening to him the deeper layers of meaning conveyed by his surroundings and with it came a sense of urgency to begin the poem before the sensations vanished.

Significant elements from Nichols' surroundings thus conveyed a certain meaning which emerged in the mind as a word or a phrase. These were the beginning fragments of new poems. The sensations occurred in rapid profusion, involuntarily and in a rush, and left the poet exhausted by efforts to constrain it all. Only a few emerge, however, that "stick," and these fragments carry the themes or ideas in which the poet "knows" there is a poem. Nichols' ability to sense which emergent fragments contained a poem echoes Galton's and Poincaré's references to the selectivity of the subconscious mind and the way in which elements thus selected direct ensuing thought. Thus, from the profusion of ideas arising in such haste, some carry the inspirations that inexorably lead to the development of a new poem.

The first event to inspire Nichols to write the *Sunrise Poem* was rhythmical; it was the insistent sound of drumming ocean waves on the shore. Somewhat later, the second impetus came while observing the rays of the rising sun on the surface of the ocean. Nichols' inspirations to compose came during a brief period of time when "complete silence reigned . . . and . . . there was silence within . . . I was merely 'being'." (p. 109). Thus, rhythm, vision, sound, feeling, and meaning converged during the moments when the poet experienced a deep stillness of mind. Why some elements were chosen rather than others is felt to be imposed rather than self-selected; Nichols noted that it had "precious little" to do with himself. He was, however, keenly aware of, and attentive to, the insistent nature of certain elements that ultimately inspired the poem.

> I understood that I had only to yield to the emotion evoked by what I beheld to discover a poem, the potentiality of which existed not only in the characters propelled toward me, but all around me, in the entire sea and sky and, more remotely, in my own solitude . . . (p. 110).

Once the basic elements were in place the work of composition could begin. It will be recalled that at the point where the ideational flow had brought the needed elements to the fore, Poincaré began the more focused and deliberative work of the conscious mind. Nichols, in contrast, had developed ingenious strategies for remaining primarily in the subliminal mode throughout most of the composition of the poem. As Poincaré explained, this is the mode that works much more efficiently and effectively than the more deliberative work of the intellect. Following is a detailed presentation of Nichols' description of his thinking processes.

For Nichols, the process of composing a poem 'works' by a convergence of sensation, emotion, and the emergence of particular images from past experience that act as the principle vehicles for finding words and lines to convey the meaning the poet seeks. Nichols now knew that the play of light from the rising sun over the ocean conveyed a powerful message. To begin, the rays of sun "zigzagging" across the ocean portrayed certain hieroglyphics or characters that brought to the poet an awareness of the word "Arabic." It is interesting to note the close pairing of physical sensation with the poet's emotional apprehension of meaning. Nichols describes this as a deeply satisfying experience having a distinctly visceral quality to it. In his words, the hieroglyphics "seemed to flash through me . . . to pass through my body without occasioning any pain" (p. 110). While simultaneously

> My eye dwelled upon the scene and the longer it dwelled—though but a moment passed—the more I was filled with an immense and pure emotion *which was the reflection of what I saw*, that is to say I was conscious of a regular and growing central excitement surrounded by an area of deep, tranquil and joyful satisfaction . . . I was being told something. (p. 110)

At this point, Nichols remembered that he had once seen the peculiarly Arabic style characters before, in a holy book dated around 1500 AD, but could not remember where or when. While, again simultaneously, he instantly "apprehended" the characters "in the most literal sense *being written on the sea by the sun,* a being who was a poet." (p. 110). The sun as poet personified Nichols' sense of having entered a "spiritual plane," where he could feel the presence of a being, the sun, capable of writing in ancient script upon the ocean. This was followed by a pause in his attention, "the halt . . . that precedes recognition" of the line about to come. It was the emotional experience of being before an "august presence" that precipitated the advent of the first line of the poem combined with a memory of a particular postcard.

> so on an instant there was presented to my consciousness a favourite picture-postcard I had twice or thrice bought at the British Museum. Almost simultaneously there formed in my mouth the line "The sun an ancient, serene poet." (p. 111)

The postcard contained the picture of an ancient poet in the Persian style. Once the line arrived, Nichols needed to rework it as it did not adequately convey "the force of the visual experience," nor was it "quite visually correct." While repeating the line to himself a "personage" called "the artificer in the poet" emerged to edit the line such that it permanently settled as "The sun a serene and ancient poet" (p. 112).

Once a line of poetry has set, it is, according to Nichols, "sacrosanct," meaning something very close to Poincaré's description of the esthetic of creating, the perfectly beautiful, useful, and elegant construction that brings with it the absolute certainty of the "correctness" of it. Nichols is emphatic about this.

> The laws of psychological necessity within the art are absolutely inflexible and the poet's personal integrity is involved in his recognition of and reverence for the fact that a line is right and that nothing in heaven and earth can make it otherwise. (p. 112)

It is clear that the "artificer" plays a critical editorial function in setting the lines of the poem. In this instance, moving the first line as it had emerged from "The sun an ancient, serene poet" to "The sun a serene and ancient poet," the artificer, in Nichols' words, "drew my attention to the fact that the line . . . was lacking in the serenity it sought . . . to convey. It was too "jumpy." "Try shifting the order of the adjectives," said the artificer, "and inserting a conjunction between them. That ought to do it . . ." (p. 112). This is but one example of the many exchanges between Nichols and the artificer that occur throughout the development of the poem.

While Poincaré set about verifying his work by writing out the mathematical arguments after discovery, Nichols performs the same function during the process of line-by-line construction of the poem by discussing, arguing, and, in general, interacting with the artificer. The artificer never "surfaced" into the deliberative world of the conscious mind, however. He remained "below" as a function of the subliminal mind where, in this case, the editorial work was done (p. 121). By submerging the artificer in this way, Nichols was able to appropriately order and place the words and phrases that came to him and to judge the logic of the development of the poem, without disrupting the ongoing, largely subliminal, process of composition itself. Thus, unlike Poincaré, whose thinking alternated in a sequential fashion between the deliberative, subliminal, and gestational modes of processing, Nichols could both compose and edit *simultaneously*, without having to "surface" from the subliminal "workshop."

The emergence of the "artificer" with the arrival of the first line thus signalled the beginning of an editorial function that took place throughout the remaining construction of the poem. The artificer and the poet argued back and forth over the course of its development and their interactions increased in frequency and intensity as the poem progressed. In this way, Nichols, in fact, had successfully solved the problem of the "tyranny of the intellect" raised by Housman. With the personification and submergence of the artificer in the subconscious, he could do the deliberative work of the

conscious mind without the disruption that goes with it, and hence without fear of losing the thread of meaning obtained through the momentum of the delicate synthetic balance between emotion, image, and sensation or heightened sensitivity to the surroundings.

As each line emerged and then settled into the poem, Nichols could "use" it to keep the momentum going by repeating it to himself as often as needed to sustain the openness and receptivity to the arrival of the next word, phrase, or line. Thus, words, for Nichols, were the medium to "step up" emotion. Emotions both convey the sensation, that is, the heightened awareness, of meanings inherent in those elements from the immediate surroundings which impose themselves on the poet, and act as a powerful stimulant to invoke particular memories of items containing particular images (ancient book; postcard) from which just the right words were then drawn. The power of feelings and the unerring recall of just the image needed simultaneously occurred.

Thus, once the right word or phrase was found it had the power, upon repeating it, to reinvoke the original emotion that carried it which, in turn, heightened sensitivity and receptivity to what would come next. This entire process is certainly a phenomenon to which the conscious mind is open, receptive, and does not question. As Nichols put it:

> For what has been already created knows better than the poet what the poem is all about . . . .the poem wished to call my attention to the fact that it was in this word that I'd find the answer to the riddle of the next step in the poem's development. (p. 112)

The word in this case was "ancient" and repeating it invoked a certain quality of "'ancientness' . . . felt as august, mysterious and full of power." Along with this feeling came the next line, "Stoops and writes on the sunrise sea" (p. 112). Repetition, then, is a strategy that aids the poet to re-experience the emotional power of the sensations originally brought to mind and by doing so to once again establish the frame of mind that is open and receptive to what comes next. The ability to do this apparently continues long after the

poem has been written, suggesting a clarity of recall that is remarkably pristine. Most importantly, the simple act of repetition proved to be so compellingly rhythmical and unobtrusive that the poet was able to remain all the while in the subliminal mode without having to 'think' about what should next be said. Repetition, then, acts to sustain the rhythmic sense of the poem.

Like the arrival of the first line, the second line, and particularly the word "stoops," came through the combined effects of powerful emotion, heightened sensitivity to surrounding elements, and recalling a particular image of a closely related item. For the second line, Nichols observed, or rather "apprehended," that the sun had risen just enough to be clear of the sea and would now have to stoop and bend down in order to write on it as would the Persian in the postcard. Nichols refers to this process as "thoroughly typical of the mysterious logic that obtains in the act of poetical creation" (p. 113). Why mysterious?

Use of the term "logic" is normally understood to refer to the kind of rational thinking more associated with construction of a linked, step-by-step chain of reasoning, whether used in a formal or more practical sense. In accepted usage, rational thinking is associated with the deliberative work of the conscious mind rather than with the more free-wheeling activities of the subconscious mind. Galton, Poincaré, and Nichols all refer to a logic of selectivity that is clearly tied to a convergence between "knowing" and "feeling" just which particular elements will provide the needed directives from the many rapidly generated through ideational flow from the subliminal activity of the subconscious mind. Those selected are not deliberately chosen, however, as they seem always to be reported to "come" or to "arrive" of their own volition. The appearance of such highly directive elements to the quiescent, but nonetheless observant, conscious mind is preceded by a powerful and distinctly esthetically pleasing sense of the "rightness" they convey. Once known, these elements appear to impart a quality of ease and sureness to further direction of the work in progress. In fact, the whole subliminal experience is commonly felt to be quick, efficient, and effective in a

way not associated with the more plodding, deliberative activity of the conscious mind. Nichols' description of the generation of the second line of *Sunrise Poem* is clearly illustrative of the nature of this process.

Repetition of the word "ancient," along with the feelings it invoked, brought to mind a memory of another postcard once seen, Blake's "Ancient of Days." The figure in this postcard also stoops and the image it invoked appeared to the poet to be inseparable from the word "stoops" which arrived simultaneously. Nichols' description of this experience gives a clear sense of how emotion, feelings, memory, and physical surroundings simultaneously worked together in his mind.

> None of this was . . . reasoned out . . . Instinct had apprehended all this . . . and it was the emotion evoked by the instinctive substitution of Blake's figure for the sun my physical eye beheld that set the word "stoops" upon my lips. Such a substitution has nothing voluntary about it. Here it was the result of the word "ancient", a word which, applicable to the Persian, owed its appearance in the poem to the feelings invoked in me by my surroundings . . . feelings of splendour, grandeur and enduringness. (p. 113)

With the inclusion of this second line, Nichols sensed, speaking through the artificer, that the next few lines would follow with ease.

> "I shan't have to do a thing;" he chirruped, "it's one of these cases which, though they look like descriptions of things, are really transcriptions of experience. For the up-and-downess feeling will give it you." (pp. 113–114)

At this point Nichols realized that he had been waiting for the arrival of the word "Arabian," "to be placed, the artificer murmured, in such a position as to extract its full musical and evocative value" (p. 114). Thus, the next line, "In softly undulant cyphers of gold" ran into the fourth line, "Words of Arabian charactery," bringing with them the "motif" of the poem but not, at this point, its entire sense, a situation that gives Nichols cause for anxiety; for with anxiety comes the risk of "surfacing."

Nichols had now reached a danger point in the composition where anxiety, if allowed to take over the emotions, could destroy subliminal concentration. A situation like this tends to occur at the point where the foundation, structure, "topography," and so forth, of the poem have been established, but the sense of where to go next is not yet clear. What it is important *not* to do, he says, is to start "thinking" about it. That is, the poet must not give in to the urge to figure out the sense of the poem as "this curiosity as to the 'sense' . . . would . . . only 'put him off his stroke', since it could but be a statement stripped of potency and suggestion, that is to say without emotive quality." (p. 114). This is telling because it places the powerful communicative facility of the emotions most clearly and poignantly within the subliminal mode. Nichols does state, however, that some deliberate action may occasionally be needed to prevent a certain inertia that arises when the poet has reached the point of being pleased with his accomplishments so far, but he knows that something different, in this case a new sense of rhythm, is needed in order to go on with the poem. In order to ensure that he doesn't "surface" completely into consciousness the form of action Nichols takes is once again the strategic repetition of the lines.

> The already existent substance has to be both excited and given a little push . . . the lines have to be repeated by the poet in such a manner that they give off some of the emotion they contain and at the same time the rhythm needs to be a little exaggerated in repetition . . . in order that the élan so released may launch the poetic faculty into what comes next. (p. 115)

Interestingly, along with the line repetitions, another, more insistent repetition also ensued; the "tolling" of the word "gold" began and continued just as he became aware that the poem had reached the transitional point in its development.

In order to sense whether or not the tolling of the word "gold" should be attended to, Nichols' "tactical instinct" suggested that he now "surface" from the "reverie within the poem," that is, "out of the world wherein poetry is composed into the world of conscious everyday apprehension" (p. 116).

Nichols notes a stark contrast between this world and the "reverie of the poem." Here, he can, he says, do tasks like arithmetical thinking which are examples of thinking requiring "a direct and highly self-conscious concentration of the faculties." Such thinking, he notes, is the antithesis of the "poetical" cast of mind, each having different "qualities of memory" (p. 116). By this Nichols means that when composing poetry in a state of reverie, he could recall with ease particular images conveying just the right words or phrases needed. By contrast, in the everyday conscious world, he had never been able to master something as straightforward as the automatic recall of simple arithmetic functions. For Nichols, the latter is a world which holds little of "quality" for the poet. He could, after all, completely submerge its function pertaining to poetry in the person of the artificer.

Nichols' inability to do such simple tasks is comparable to Poincaré's observation that he was not much good at doing laborious calculations. Indeed, Poincaré stated that creative mathematicians never worked that way as it was not the way of mathematical discovery (1959, p. 35). What Poincaré was able to grasp in the state of reverie, the "hypnogogic" state as he put it, was the entire mathematical argument which he could later write out with ease. So it was with Nichols, with nearly the entire poem being composed in the subliminal state.

For Nichols, echoing Housman's concern, surfacing into the "conscious" world brings with it the danger of not being able to return to the subliminal "poetic" state.

> For once the poet has returned to it, he may discover the invisible door, by which return was made, to have been silently closed behind him and find himself stranded in a universe wherein such beauty as may exist, is like to be *perceived* as existent as a quality of the scene but not *felt* as such. (p. 117)

Thus, what is lost to him in the world of the conscious mind is the esthetic constituent of the creative process, that which powerfully and unerringly conveys both the sense of the *meaning* that must be expressed and the

knowledge of how to do it. Knowledge, as already discussed, refers to both the form of expression the poem should take and the medium, that is, the words, phrases, lines, and so forth, by which it is conveyed. The medium of expression, of course, is that which pertains to the nature of the discipline concerned. For the poet it is verbal, the physicist, imagic, the mathematician, symbolic, and so forth.

Feeling "spiritually" strong and with "gold" still tolling "below," Nichols could safely surface for a short rest (as advised by the artificer). While "up," he gathered observations of note for his return to the subliminal "workshop" and the artificer. His memory of the surface carried with it a sense of isolation from the emotive quality of the work such that he realized he needed to *feel* his way into a different place before continuing. In order to do this, he immediately and effortlessly relaxed into a memory of a particular beach where he had once spent some time, and where the sound of the waves on pebbles brought the word "rolled" which he recognized instantly as just the one needed to return to the poem, bringing with it the rest of the line. At this point, "gold" stopped its tolling; its function of keeping him connected to the subliminal workshop was now no longer needed.

The remaining difficulty was to sense the climax, that is, what the closing lines of the poem would be. Nothing "came" until Nichols decided once more to surface and forget about writing for awhile. While "up" he noticed, sadly, that the Arabian script had now almost vanished from the surface of the ocean. He had felt a sense of urgency from the beginning that the poem must be written before the sun completed its journey upward. Having discovered that it had indeed risen, he then abandoned the poem, caring little whether or not it would ever be finished. Shortly thereafter, the closing lines unexpectedly arrived; the climax was just there. He completed the poem in two lines.

> I hadn't the faintest idea where this had come from or any doubt whatever but that this was the conclusion and had been intended as such from the first. (p. 122)

As is characteristic of insights, this one arrived without warning, was unquestionably correct, and occurred when his mind was no longer directly concerned with the poem. Nichols' experience of insight, like Poincaré's, is thus also suggestive of resulting from a period of gestation of which he was both consciously and subconsciously unaware.

With the successful return from the surface, the third cycle of composing was completed in the same way as the others, that is, with the simultaneous convergence of perceiving elements in the surroundings, feeling the import of the meanings inherent in them, and "seeing" the words and phrases that arose from the appearance of particular imagic memories. These unerringly expressed the meanings conveyed by specific elements in his surroundings that had "imposed" themselves upon the poet. The poem itself was almost exclusively composed in a state of reverie, that is, a state where the outer world of the conscious mind was closed off, leaving the mind of the poet free to work in the subliminal mode. As each line of the poem "arrives" and is set with the help of the artificer, the practice of repeating words or phrases allows the heightened sensibilities to be retained and the emotions re-experienced, thus leaving the poet open and receptive to what may next arrive. Once the form and content of the poem has been set and a new sense of direction is needed, the danger arises that the poet may start to 'think' about it thus rendering the process vulnerable to intrusion from the conscious mind. Again, the practice of repeating the lines already set sustains the poet through such difficult periods. Should the poet choose to surface, repetition had another purpose, it keeps him connected to the subconscious mind such that he is able to return simply by a process of imagic retrieval. Once key elements in the environment shifted position and the quality of light had changed, Nichols felt unable to complete the poem. Then the sudden and unexpected arrival of an insight brought to mind what was already implicitly there from the beginning, the climax and closing lines of the poem; an experience which bears testimonial to the sustaining power of inspiration. Nichols composes primarily subliminally.

Amy Lowell

The poet, Amy Lowell, introduces a new element to the process of creative thinking that did not, at least explicitly, seem to be a part of either Poincaré's or Nichols' experiences (Lowell, *The Process of Making Poetry,* reprinted in Ghiselin, 1952). She describes prolonged periods of gestation where the end result is the creation of an entire poem. The gestational mode in her case appears to be the primary mode of creative thinking. It is that part of Lowell's thinking that she truly is not aware of in any conscious way until the entire first "draft" of the poem "arrives." This activity resembles the sudden and unexpected arrival of an insight which points to the need to take seriously the notion of a working cognitive dimension of the unconscious mind, that is, the notion that it too "thinks." But in this case, unlike conscious and subconscious mental activity, no one can describe just what that process might be like. Indeed, if it could be described, it would no longer be unconscious. Lowell uses the term "subconscious" to describe both gestational and subliminal work. I have substituted the terms "unconscious" for the former and "subconscious" for the latter to keep them distinct.

For Lowell, creative work begins with inspiration. The source of inspiration can be something occurring externally—a sight or a sound—as was certainly the case with Nichols' *Sunrise Poem*. It could also be a thought, a feeling, or a memory (p. 110). It is not just the event itself, however, but the event and the emotions accompanying it that engender inspiration. As Lowell states, ". . . whatever it is, emotion, apprehended or hidden, is a part of it, for only emotion can rouse the subconscious into action" (p. 110). Thus, in keeping with others' observations about it, Lowell confirms the importance of the emotive quality to the process of creative thinking. Like Nichols, she also needed to be in the right place and frame of mind that left her open to the "arrival" of a poem. She described it thus:

> I am so constituted that poems seldom come when I am out of doors, or actively engaged in company. But when I am alone, an idea contingent upon something I have seen or done when I am out will

> announce itself, quite as though it had been biding its time until it had me quiescent and receptive. (p. 111)

At these times she felt an urgent need to write and would experience extreme stress if unable to begin the work immediately.

Once the inspirational idea had come to mind, Lowell would "register" it as a good idea for a poem and quite literally forget about it. In reference to her poem, "The Bronze Horses," while once observing a pair of bronze horses

> I consciously thought no more about the matter. But what I had really done was to drop my subject into the subconscious, much as one drops a letter into the mail-box. Six months later the words of the poem began to come into my head, the poem . . . was "there." (p. 110)

Thus, unlike Nichols, she was not a witness to the first formation of the poem which for him occurred subliminally, but for her, unconsciously. Instead, poems were composed without any of the passive observance of subliminal events by the conscious mind that Galton, Poincaré, and Nichols experienced. Lowell was completely unaware that the poem was forming or how the process itself was carried out. Gestation periods themselves were variable.

> Long poems are apt to take months preparing in the subconscious mind; in the case of short poems, the period of subconscious gestation may be a day or an instant, or any time between. (p. 111)

Also, unlike Nichols, Lowell does not compose in her head when the poem begins to arrive. She "seeks paper and pencil," which means more than just acquiring the necessary tools to write. "It seems as though the simple gazing at a piece of blank paper hypnotized me into an awareness of the subconscious" (p. 111). She refers to this as a state of "semi-trance" that can sustain, despite interruptions, when a longer poem intermittently arrives over an extended period of time, as well as over the time needed for the shorter poems.

Once the first version of the poem has arrived, the work of "correction" begins. This entails a special kind of concentration that also occurs in a subconscious, trance-like state; one which can be induced as many times as needed, depending upon the length of the poem. It is quite distinct from that done by the more deliberative work of the conscious mind. Correction appears to mean both writing the first draft of the poem and reworking it as well. Lowell, in fact, in her subliminal, trance-like state "hears" the words as she writes. Here, Lowell notes that "the mere sitting down to continue it produces the requisite frame of mind, which holds . . . throughout its correction" (pp. 111–112). Hearing the words as she writes is somewhat reminiscent of Mozart's ability to hear the music as he composed it in his mind and in manuscript form.

The deliberative work of the conscious mind comes to the rescue when the subconscious work stops, or more accurately, suddenly quits and cannot be induced to resume. According to Lowell,

> The subconscious is . . . a most tempermental ally. Often he will strike work at some critical point and not another word is to be got out of him. Here is where the conscious training of the poet comes in, for he must fill in as much as in the key of the rest as possible. (p. 111)

Further, "Every long poem is sprinkled with these *lacunae*; hence the innumerable rewritings which most poems undergo" (p. 111). Thus, deliberative work is needed to "putty up the holes" as Lowell puts it, and requires all the skill the poet has acquired through learning, experience and practice. It is, she says, "a condition of good poetry."

While Lowell's pattern of creative work resembles that of Nichols in some important respects, there are distinct differences. She seems closer to Poincaré in her ability to more easily do the deliberative work when that is required and does not perceive the need to do it as a threat to the ongoing process itself. Rather, such work is accepted as a necessary part of writing poetry. She has not felt the need to develop particular strategies to keep the

entire process submerged, and hence subliminal, except to induce the trance-like state, which she seemed easily able to do. Thus, unlike Nichols, she appears to have no control over how long subliminal thinking will "stay" with her. She has, however, trained herself to induce the subliminal mode merely by sitting down with pencil and paper, which she needs in order to do the first draft and related "corrective" work. Corrective simply refers to working out the poem as she hears it spoken to her within the mind. The most significant difference between Lowell and Nichols is that she seemed able initially to compose entire poems, short or long, the latter intermittently, entirely outside conscious or subconscious awareness of the event, strongly suggesting that her poems develop during periods of gestation of varying length. Like insight, the incubated "product" appears suddenly and unexpectedly; but unlike insight, the poet knows, in this case, that when an inspiration "registers," and is "dropped" into the unconscious, in due time the poem will appear. Nichols had no such confidence and instead developed various strategies (rhythmic repetition, personification of editing, visualization) to either induce the subliminal state or safely return to it.

Stephen Spender

Spender's style of creative work is different from that of both Nichols and Lowell, but particularly Nichols. Nichols worked primarily in the subliminal mode. Spender, on the other hand, is a fine example of the "plodding" poet as he described himself. In his case, most of the work of creative thinking, beyond the strength of initial inspiration, is done by the deliberative efforts of the conscious mind.

In *The Making of a Poem* (reprinted in Vernon, 1970), Spender describes these two different approaches to "concentration" among poets reflective of two very different styles of working.

> one is immediate and complete, the other is plodding and only completed by stages. Some poets write immediately works which, when they are written, scarcely need revision. Others write their

> poems by stages, feeling their way from rough draft to rough draft, until finally, after many revisions they have produced a result which may seem to have very little connexion with their early sketches. (p. 63)

In the first instance the poet is able to "plunge to the greatest depths of his own experience by the tremendous effort of a moment," compared to the second instance where the poet "must dig deeper and deeper into his own consciousness, layer by layer" (p. 64). Great poetry, he states, can develop from either style and, in both cases, it comes from the poet's ability to receive and sustain the poetic vision throughout until the poem is completed. The poet working in the deliberative style then, by the very step-by-step, layer by layer nature of the work, must remain loyal to the original inspiration inherent in the poem, striving to keep it intact over the course of the entire work.

Spender describes himself as more like the deliberative poet, often with too many ideas and a "weak sense of form." While writing, he thinks of many more poems which are not developed at the time and these rough ideas are recorded in a notebook for reference, some for later development. A poem that is subsequently developed may undergo many revisions before it is completed. For Spender, an idea

> exists clearly enough on some level of the mind where it . . . eludes the attempt to state it. At this stage, a poem is like a face which one seems to be able to visualize clearly in the eye of memory, but when one examines it mentally or tries to think it out, feature by feature, it seems to fade. (p. 65)

The challenge is to keep the meaning of the original inspiration, the poetic vision integral to the poem, stating it implicitly within the poem where it can then "speak for itself." The task of line-by-line revising and editing, adding and deleting is to allow the vision to gradually unfold over the course of the work.

Spender provides a detailed example of the making of a poem describing the line-by-line process involved. He takes the reader through the thinking processes engaged in the production of each line of the poem. Suffice it to say that one line, for example, underwent eight rewritings, and was accompanied by much hard, deliberative assessment before the final version was produced (see pp. 65–77). Inspiration is a critical part of the work that goes into composing the entire poem. The meaning it conveys must be sought for in the various iterations of the poem and implicitly expressed in the poem's final version.

For Spender, the least of the whole creative effort is the sudden arrival of inspirations for new poems. These most often came to him in the form of a germinal word, or a vague phrase or line, "a dim cloud of an idea" which carries its own "impulse."

> everything in poetry is work except inspiration, whether this work is achieved at one swift stroke . . . or whether it is a slow process of evolution from stage to stage . . . Inspiration is the beginning of a poem and it is also its final goal. It is the first idea which drops into the poet's mind and it is the final idea which he at last achieves in words. In between this start and this winning post there is the hard race, the sweat and toil. (pp. 67–68)

Work, incidentally, includes setting the poem aside for shorter or longer periods of time and then recommencing the work at various later points in time.

Spender gives a very fine example of how inspiration works for him. I will quote it in its entirety just to demonstrate the striking difference between his experience and that of Robert Nichols. Nichols, it will be recalled, composed the entire *Sunrise Poem* in twenty minutes because he was able to use a combination of heightened sensitivity to elements in his immediate surroundings, powerful emotions, and succinct images from remembered experiences to bring the needed words and phrases rapidly to mind. Even the editorial work undertaken in the person of the artificer was subordinated to

this function. In Nichols' case, these "came" to him while working subliminally. Spender, on the other hand, is talking about the arrival of one line for a poem he had set aside and had yet to write.

The occasion was a train trip through the Black Country of industrial England. The catalyst for the inspiration occurred while standing in the corridor of the moving train and hearing a man say something that echoed his own thinking—"Everything there is man-made." The phrase that suddenly appeared in Spender's mind, the one that provided "the answer before the question," was "a language of flesh and roses." Following is the sequence of thought as he described it:

> . . . the industrial landscape which seems by now a routine and act of God which enslaves both employers and workers who serve and profit by it, is actually the expression of man's will. Men willed it to be so, and the pitheads, slag-heaps and the ghastly disregard of anything but the pursuit of wealth, are a symbol of the modern man's mind. In other words, the world which we create—the world of slums and telegrams and newspapers—is a kind of language of our inner wishes and thoughts. Although this is so, it is obviously a language which has got outside our control. It is a confused language, an irresponsible, senile gibberish. This thought greatly distressed me, and I started thinking that if the phenomena created by humanity are really like words in a language, what kind of language do we really aspire to? All of this sequence of thought flashed into my mind . . . a language of flesh and roses. (pp. 68–69)

Nichols, I think, would have immediately *perceived* the meaning from the surroundings while Spender's style was to deliberate upon it, thinking through to the meaning in a sequence of thoughts which, when done, brought to mind the inspirational line bearing the theme of the poem. The next task was to "think out the logic of images." At this point, if Spender were to have continued with the development of the poem, in accordance with his own account, the deliberative, line-by-line work of constructing it would then begin.

Both Spender, by description, and Nichols, by the examples of the postcards, stressed the important role that memory plays in poetic composition. If the creative mathematician's special ability is to intuit an entire mathematical argument, that of the poet is to remember and simultaneously re-experience certain sense impressions in all their original clarity and feeling as often as they arise. These include, for example, experiences from early childhood which "retain their pristine significance throughout life" (p. 70). The clarity of these experiences, each time they arise, becomes infused with the event that stimulated their recollection. Spender likens these to experiences not so much remembered as to those "lived through again and again" (p. 72).

Spender states that both inspiration and "song" are the two "irreducible final qualities of a poet," those which set him apart as a poet. Of the two, song is the most difficult to explain. It is, according to Spender, "the music which a poem as yet unthought of will assume, the empty womb of poetry forever in the poet's consciousness, waiting for the fertilizing seed" (p. 75). Song, then, appears to be omnipresent to the poet; it provides an incipient rhythmic form or frame for the anticipated poem. Thus, like Housman, Nichols, and Lowell, Spender describes the importance of music to poetry writing. Further, experiencing the sense and presence of music occurs in a state of reverie more closely associated with subliminal thinking:

> I am conscious of a stream of words which seem to pass through my mind, without their having a meaning, but they have a sound, a sound of passion, or a sound recalling poetry that I know. Again sometimes when I am writing, the music of the words I am trying to shape takes me far beyond the words, I am aware of a rhythm, a dance, a fury, which is as yet empty of words. (p. 75)

Although Spender sees himself as more the plodding poet, it is evident that his experiences of the convergence of rhythm and powerful feelings shaped by the musical theme, makes him akin, at least in part, to other poets who evince more the subliminal style of composition. His description of the music, feeling, and ideational flow of the words that carry the meaning, shape

nd tone of the poem are certainly characteristic of subliminal thinking. The logic" of the poem though, in Spender's case, is developed by the more abourious, difficult, and prolonged work of the conscious mind.

Music

Mozart claimed that he could compose entire, lengthy works in his mind before writing them down. As already noted, as he worked he could hear the developing composition, complete with full orchestration. Though his written work did undergo revising and editing, he claimed a goodly portion of it was done before the writing process began. Mozart's style of working was similar in this way to Beethoven, who spent as much of his time composing on paper as in his head. Most composers appear to have recourse to the subliminal mode for inspiration, derivation of the themes of the music, and acquiring ideas about the forms the new pieces should take. The following description by Tchaikovsky illustrates the general pattern that development of a new composition takes.

Tchaikovsky

Tchaikovsky referred to musical composing as a "purely lyrical process," an "organic sequence" and a "magic process." Like Mozart, Tchaikovsky's musical thinking first occurred with the melody and an idea of the form its expression would take appearing simultaneously. A new composition would begin with a sudden inspiration which was sustained throughout the first, rapid sketches of the work (Tchaikovsky, *Letters,* reprinted in Vernon, 1970).

Tchaikovsky explains inspiration as an event entailing the convergence of emotion and the conscious "awakening" to a new idea.

> . . . the germ of a future composition comes suddenly and unexpectedly. If the soil is ready—that is to say, if the disposition for work is there—it takes root with extraordinary force and rapidity . . . the rest goes of itself . . . It would be vain to try to put

> into words that immeasurable sense of bliss which comes over me directly a new idea awakens in me and begins to assume a definite form. I forget everything and behave like a madman. Everything within me starts pulsing and quivering; hardly have I begun the sketch ere one thought follows another. (p. 57)

As is characteristic of other creative thinkers, he experiences distinct emotional and physical responses to the arrival of inspiration, a sense of urgency to begin work, and a period of ideational fluency triggered by the response. Tchaikovsky's initial inspirational work brought the main themes and a general working outline of the composition. It occurred, he said, in a certain "condition of mind and soul" that cannot last too long because of the exhausting concentration, emotional intensity, and rapidity of work involved when bringing forth the piece (p. 57). And, as noted by other creative thinkers, the occurrence and shaping of the first inspiration was accompanied by great emotional enjoyment.

Tchaikovsky experienced the same difficulties with distractions and interruptions as mentioned by Housman and Nichols. If concentration was disrupted, it was often difficult, and sometimes impossible, to pick up the thread of the work from where he had left off. These are the times, he said, when the composer is most likely to give in to apathy or to wait until the inspirational mood returns (p. 58). It was Tchaikovsky's habit to work through such difficult periods, relying upon "cool headwork" and on his technical knowledge of the discipline to carry him through to completion. Working skillfully this way, however, appeared to produce a work that, if not different, was at least harder to develop than the music which came to him in the subliminal mode of thinking. In these instances, Tchaikovsky referred to the need to bring about a "skilful join . . . so that the parts appear as a completely welded whole" (p. 58).

Once the composition was sketched out in full, the second stage of composing would begin. At this point the more deliberative and focused conscious mind would take over the work. For Tchaikovsky, the inspirational state brought the ideas and outline of the new piece, but working out the

content of the piece into its form had to be done with a great deal of deliberative effort, concentration and care.

> What has been set down in a moment of ardour must now be critically examined, improved, extended, or condensed, as the form requires. . . . Only after strenuous labour have I at last succeeded in making the form of my compositions correspond, more or less, with their contents. (p. 59)

During this part of the work, Tchaikovsky forced himself to exercise great self-discipline in order to make drastic changes in the composition that sometimes needed to be done.

> Sometimes one must do oneself violence, must sternly and piteously take part against oneself, before one can mercilessly erase things thought out with love and enthusiasm. (p. 59)

Particularly during this stage of the work, the careful application of great skill was critical to the joining of the revised and extended work with that of the prior inspirational work done in the subliminal mode.

Thus, Tchaikovsky wrote new music in various phases of composition that reflected quite different but interdependent modes of thinking brought into play over the course of the work. First came inspiration, usually rapidly, unbidden, and subliminal, which brought with it the themes or ideas of the piece then written out in something of a frenzy of activity as the ideas rapidly came to mind. At this time, any interruption could break the state of deep concentration, with the accompanying danger that the composer may not be able to return to subliminal work. When this type of work was irretrievably disrupted, and again, during the subsequent stage of editing and rewriting the piece, Tchaikovsky worked with a much more dispassionate, intellectual "coolness." The kind of detachment and ruthless self-discipline needed at this point in the process little resembled the frantic, intense, and passionate mood of the much more pleasurable and fluent flow of the work enjoyed in the subliminal state.

Beethoven

Ludwig von Beethoven's style of composing paralleled that of Mozart and Tchaikovsky in terms of inspiration. Everywhere he went he took along notebooks and staff paper to hastily scribble down the ideas for compositions that spontaneously came to him, usually at any time, a practice common to many creative thinkers. These ideas were roughly worked out in Beethoven's famous "sketchbooks," which now provide the main source of information on the progress of a work (John-Steiner, 1985).

As quoted in Kerst and Krehbiel (1964), on being asked by a pupil where his inspirations came from, Beethoven responded

> You will ask me where I get my ideas. That I can not tell you with certainty; they come unsummoned, directly, indirectly,—I could seize them with my hands,—out in the open air; in the woods; while walking; in the silence of the nights; early in the morning; incited by moods, . . . which are translated by me into tones that sound, and roar and storm about me until I have set them down in notes. (p. 29)

His description of feelings of great passion associated with inspiration is suggestive of something more resembling a possession than whatever else it may have been. Of the few records left by Beethoven himself, another is most indicative of the nature of his inspiration. Hutchinson (1959) notes that

> Beethoven . . . spoke of himself as experiencing a sort of rapture, or *raptus*, as he called it. At such moments he became, as it were, transformed. He no longer belonged properly to himself, being wholly possessed by the idea. Every effort was made not to lose hold of it until it was his by right of conquest. (p. 136)

Nichols, Lowell, and others also make mention of the suspension of self-awareness during periods of inspiration; ideas arrive quickly, usually accompanied by a sense of urgency to get them down before they vanish. Everything else is pushed into the background.

Inspiration came to Beethoven as it did for others, when it would and not by effort of will. He would sometimes try to induce it by placing himself in a state of receptivity which, unfortunately, was not always successful. Hutchinson (1959) notes that "after playing the first chords in an attempt to compose, Beethoven would often say, "Nothing comes to me today; we shall try another time." At these times "his mind seemed paralyzed by futile efforts and adverse moods. Nor could it always transcend them" (p. 52). But when inspiration struck, in Beethoven's own words, as quoted in Hutchinson, the following frantic activity ensued:

> I pursue it, I grasp it, I see it fly from me and lose itself in the seething mass. I seize it again with renewed passion; I can no longer separate myself from it. I have to multiply it in a spasm of ecstasy. (1959, p. 136)

The "seething mass" no doubt refers to the powerful mix of emotion and ideational fluency that frequently accompanies periods of inspiration.

It seems that Beethoven's considerable skills in harmony and counterpoint were applied during the inspirational phase of the work as well as during the later work of editing and revising the written composition. He noted that with a good command of these skills, the composer is ready to quickly and accurately record a sudden inspiration for "when the fancy and emotions awake one shall know what to do according to the rules" (1959, p. 27). His habit was to hastily jot down a "simple chord melody, with simple harmonies, then figurate according to the rules of counterpoint, and beyond them" (1959, p. 27). Like Tchaikovsky's own feelings of bliss during inspirational work, Beethoven felt himself "thus in the midst of art, a great pleasure" (1959, p. 27).

Perhaps reminiscent of Einstein's and Nichols' capacity to work with images and Amy Lowell's ability to hear the words while writing, Beethoven did not just hear the music that came to him, he also, claimed to 'see' it as written, stating "I always have a picture in my mind when composing, and follow its lines" (Kerst and Krehbiel, p. 24). The ability to see or hear the

work within the mind suggests there is present a strong capacity for *inner* perception by the senses that aids the process of creating. That is, the senses, hearing, sight, and the like, are just as stimulated by the inner events of the mind, particularly, if not exclusively, in the subliminal mode, as they are by stimuli in the outer world. These experiences are often described as a state of "heightened sensitivity" or "heightened awareness" which appears to focus, direct, or redirect the work of subliminal thinking. Most of us, of course, are aware of these experiences when we are dreaming, as Herschel pointed out, but I suspect only a very few have such inner perception available to them when they work. It may be the case, however, that the capacity for subliminal thinking so integral to the process of creative thinking as it has been described here is also quite rare.

According to Lockwood (1982), Beethoven's inspirations that brought forth the "concept sketches" for one composition would also provide the themes for other, later works that followed. Lockwood, (quoting Tovey, 1941), described Beethoven as "working at top speed, putting down any cliché that would mark the place where an idea ought to be . . . so that the act of writing had the same continuity as the flow of his thoughts, rather than tinker in isolated passages" (p. 102). And, as he rapidly worked out these sketches, Beethoven would continually foresee new possibilities. This ability was not exclusively "of the moment," so to speak, as Beethoven apparently could carry inspirational ideas over long periods of time before writing them down. Though he doesn't describe anything like the presence of an "artificer," he does claim to do as much of the necessary writing and revising work in his mind before doing the written work. As is common to other creative thinkers, Beethoven's mental and written work is done in such a way as to expressly retain original inspirations throughout the period of composition. As quoted in Kerst and Krehbiel,

> I carry my thoughts about me for a long time, often a very long time, before I write them down; meanwhile my memory is so faithful that I am sure never to forget, not even in years, a theme that has once occured to me. I change many things, discard, and try

> again until I am satisfied. Then however, there begins in my head the development in every direction, and, inasmuch as I know exactly what I want, the fundamental idea never deserts me,—it arises before me, grows,—I see and hear the picture in all its extent and dimensions stand before my mind like a cast, and there remains for me nothing but the labor of writing it down . . . (p. 29)

The "labor," of course, refers to the work now extant in Beethoven's famous notebooks. Thus, both subliminal and deliberative thinking were equally important to Beethoven's creative work.

It is interesting to note just how Beethoven managed to carry his inspirations over long periods of time. The ability to do this could not be entirely credited to a good memory because during inspirational phases of his work Beethoven recorded in brief musical sketches many varied ideas, or series of ideas, that were to be fully developed later. These generally were "no more than four to five bars long, concern only the first phase, and employ two staves" (Reynolds, 1982, p. 61). His habit was to rapidly scribble in notations of the ideas and then leave "place-holders" interspersed throughout the sketch. But memory certainly played a critical part in Beethoven's creative work. In reference to the "Eroica," Lockwood (1982) notes that Beethoven had only to hum the thematic melody in order to recall the entire symphony (p. 89), somewhat like Nichols' strategy of repeating the lines to stimulate the pristine reappearance of the original idea. This suggests a remarkable capacity for remembering. Hence, it is not surprising that Beethoven could also work out entire compositions in this way. The fact remains that Beethoven could work with these sketches many years after the original inspirations and still remember the possibilities he originally saw as inherent in them, continually expand the works, and discover new possibilities besides.

Completion of a work was followed by the prolonged, laborious layer by layer revising and editing work for which Beethoven is now famous. According to Spender (in Vernon, 1970),

> Beethoven wrote fragments of themes in note books which he kept beside him, working on and developing them over years. Often his first ideas were of a clumsiness which makes scholars marvel how he could, at the end, have developed from them such miraculous results. (p. 64)

Reynolds (1982) has completed detailed analyses of many of Beethoven's extant sketches and provides a good description of how he must have worked. In discussing the process of writing out a number of variations, for example, Beethoven's procedure was first to rapidly write the pieces down individually with no particular concern to establish order or continuity. At this point the works tended to be only about four or five bars in length. These provided the primary sources for the sketches that followed. As the variations took shape, methods and formats tended to change over the development of the work. During this process the original fragments became complete drafts of each of the variations. At the point where he could complete each variation, Beethoven would then begin the work of order and continuity which may or may not include the work of revising. If it did, a whole new draft of the composition could be rewritten, or the same or similar bars, conclusions, and so forth, would be used as connectors from one variation to another. As it was for Tchaikovsky, Beethoven's "joining the seams" of the pieces required a great deal of laborious work.

Beethoven evinced the same, similarly occurring periods of rapid-fire inspirational work alternated by periods of deliberate, controlled intellectual work as did Lowell, Tchaikovsky, and others. It appears that Tchaikovsky, Mozart, and Beethoven could do a great amount of work in the subliminal mode, and Mozart could do the more deliberative work whether alone or in the midst of other activities, whereas the others needed to work with minimal or no interruption. If it could be argued that Mozart worked primarily subliminally, then Beethoven, it appears, was equally at home in both the deliberative and subliminal modes of thinking. Beethoven and Tchaikovsky, like Lowell, well understood the importance of the mastery of knowledge skill and craft which was brought to bear in the deliberative mode when the "joining of seams" was needed to complete the composition. In terms of

mindwork, it may be that different composers have, over time, learned to concentrate more effectively in one mode or the other. Whatever the case, it seems to have made little difference to the beauty, originality, and quality of the final product.

Stories

The thinking processes of creative people discussed to this point have, in the main, shown evidence of certain common patterns. In some cases pertaining to the sciences or mathematics, creative work begins when efforts to solve a problem have been futile, thus inspiring the need to discover new directions. In poetry and music, work begins with the appearance, usually sudden and unexpected, of an inspiration which both acts as a catalyst to begin the creative process and to sustain it throughout the periods of subliminal and deliberative modes of thinking it engenders. Though there may be a tendency to work more in one mode of thinking than the other (this could be difficult to determine), it seems clear that both play a critical role in the development of the creative product.

Nietzsche's description of the creation of *Thus Spake Zarathustra* provides a case in point for the writing of novels and short stories. Nietzsche appears to have worked out most of the story more subliminally than deliberatively. Because of the length of the work involved, it seems reasonable to assume that this would be the exception rather than the rule amongst creative story tellers. The following two examples indicate, however, that the same preference for particular thinking processes found in other disciplines also pertains here. The novelist, Henry James, illustrates the patterns of thinking associated with sustained deliberative work, and Thomas Wolfe, worked primarily in the subliminal mode. For Henry James, the first inspiration typically brings the feeling tone, central themes, and ideas for the story. His *Preface to the Spoils of Poynton* (reprinted in Ghiselin, 1952) provides one of the most detailed descriptive examples of inspiration to be found.

Henry James

Henry James' source of inspiration for a story was frequently sparked by quick, fleeting remarks made by someone or other during the course of a social event or any such occasions where people were gathered together. The inspiration for "Poynton," for example, occurred while at a dinner party where a woman made some remark that included the phrase "the spoils of Poynton." James described his immediate reaction upon hearing her speak as

> . . . one of those allusions that I have always found myself recognizing on the spot as "germs." The germ, wherever gathered, has ever been for me the germ of a "story," and most of the stories straining to shape under my hand have sprung from a single small seed . . . a mere floating particle in the stream of talk . . . reduced . . . to its mere fruitful essence . . . at touch of which the novelist's imagination winces as at the prick of some sharp point . . . it communicates the virus of suggestion, anything more than the minimum of which spoils the operation . . . one's subject is in the merest grain, the speck of truth, of beauty, of reality, scarce visible to the common eye . . . (p. 147)

It is clear that James' "germs" are immediately detached from the context in which they appeared. Indeed, anything more intrusive than the sudden appearance of an isolated kernel of inspiration risked spoiling for him the purity of the information seized for the promise of the story it holds.

Why one particular "floating particle" rather than another? Here, James makes a comment reminiscent of Einstein's, Galton's, Poincaré's, and other's references to the intrinsic logic of selection which takes place at moments like these. James refers to it as the "logic of the particular case" by which he means the way the writer immediately relates to it in his own deeply personal way. Any further discussion about it amidst the company of people around him had to be shut out as it threatened to cloud the clarity of the moment by intrusion of the actual situation from which it had sprung. As James puts it:

> I instantly became aware . . . of the prick of inoculation; the *whole* of the virus . . . being infused by that single touch. There had been but ten words, yet I had recognized in them, as in a flash, all the possibilities of the little drama of my "spoils," which glimmered then and there into life; so that when in the next breath I began to hear of action taken, on the beautiful ground, . . . It was clumsy Life again at her stupid work. (p. 149)

Thus, unless the author is vigilant, any discussion of the actual situation from which the "germ" was culled intrudes on development of the particle now "transplanted to richer soil." Clearly James' experience of the sudden flash of recognition of just the right "germ" of an expression depicts the sudden appearance of an insight; in this case sparked by an event in his immediate surroundings. According to James, once the germ has taken hold in the mind, the newly established relationship "forms in itself a little world of exercise and agitation" (p. 148). At the point of inspiration, then, the incipient story exists in something of a microcosm filled with ideas where the writer may "hold himself perhaps supremely fortunate if he can meet half the questions with which that air alone may swarm" (p. 148). Selecting the elements of the story out of the "swarm" describes the experience of ideational fluency as similarly described by others.

James next received the first intimation of the personalities of the characters in the story and how they would begin to develop. He is unable to explain to himself or anyone else just why they appeared to take on the particular characteristics and attitudes that they did, but the fact that these elements are just the "right" ones is testified to by the confidence James felt about them as they arose in his mind. Such confidence for the writer, he says,

> . . . resides in the strong consciousness of his seeing all for himself. He has to borrow his motive, which is certainly half the battle; and this motive is his ground, his site and his foundation. But after that he only lends and gives, only builds and piles high, lays together the blocks quarried in the deeps of his imagination and on his personal premises. (p. 150)

Here, James gives a fine description of the place and power of inspiration in the conception and development of a story. Clearly, the notion that the "moment" of inspiration is just that—a fleeting insight that "sparks" an idea and then vanishes, leaving the rest to the hard work of the writer, does not go far enough. While inspiration does provide the catalyst, in this case the motive for the story, it also brings with it the foundation upon which the rest of the story is to be constructed. Most importantly, inspiration provides the needed sustaining power that directs and channels the construction of the entire story. And, according to James, there can be no deviation from the import of its meaning. The author

> . . . thus remains all the while in intimate commerce with his motive, and can say to himself—what really more than anything else inflames and sustains him—that he alone has the *secret* of the particular case, he alone can measure the truth of the direction to be taken by his developed data. There can be for him, evidently, only one logic for these things; there can be for him only one truth and one direction—the quarter in which his subject most completely expresses itself. (p. 150)

There is no question, then, of the need to justify choosing one type of character over another or of the author's ability to draw "the positive right truth out of the so easy muddle of wrong truths" from the "swarm" of possibilities available to him. As far as development of the story is concerned, these elements are just "in it" (p. 150). Further the first inspiration, the "prime impression," remains as fresh upon rereading the story, even after many years, as it did when first experienced (p. 151), an ability common to Beethoven, Nichols, and so many others.

James discusses the *Spoils of Poynton* as one of many examples of how inspiration works. It is a story about a mother and a son locked in a vicious dispute over possession of some pieces of furniture and other household goods left them as an inheritance. James' "first blush" of inspiration immediately captured the sordidness of the situation and the strong feeling that the value of the story would lie in "the sharp light it might project on that most modern

of our current passions, the fierce appetite for . . . material odds and ends, of the more labouring ages." (p. 150). With the appearance of the two characters and the household goods "I found myself—beguiled and led on. The thing had "come," the flower of conception had bloomed" (p. 151). Along with it came the first sense of the form the story would take; one in a series of installments, or as James called it, "the poor "little" long thing." (p. 151). At this point James was ready to begin the more deliberative process of writing the story.

Thomas Wolfe

Many of the features associated with Thomas Wolfe's creative thinking processes are characteristic of the subliminal mode. What is interesting in the case of writing a novel is the pattern of creating Wolfe portrays. Because of the subliminal nature of most of the work, the periods of writing in Wolfe's case were characteristically emotionally intense, having an abundance of ideas coming in batches, relentlessly, rapidly, profusely, over many years. The first of three novels in a series took close to five years to complete, having been written while travelling back and forth between England and America (Wolfe, *The Story of a Novel*, reprinted in Ghiselin, 1952). The salient characteristic of Wolfe's subliminal style was the critical role of memory in his work.

Most of the creative thinkers in the foregoing have described an unerring ability to recall or remember an event as it was first experienced. This included all of the vividness of the senses, the detail, the feelings invoked, time, setting, and place associated with it. Nichols' recall of the two postcards provides one example of how memory contributes to the composition of a poem. Thomas Wolfe's description of it is exceptionally rich. His memories pursued him day and night for the better part of the time it took to produce two novels over the four to five year period. He described the quality and abundance of them as follows:

> . . . my memory is characterized . . . in a more than ordinary degree by the intensity of its sense impressions, its power to evoke and bring back the odors, sounds, colors, shapes, and feel of things with concrete vividness. Now my memory was at work night and day, in a way that I could at first neither check nor control and that swarmed unbidden in a stream of blazing pagentry across my mind, with the million forms and substances of the life that I had left, which was my own, America. (p. 186)

It is evident that for Wolfe the ideational flow of memories were not only vividly relived they were distinctly palpable. There is also a strong sensation not only of reliving the memory as freshly as the first experience but also of now seeing in it what was not before evident. In reference to remembering a particular iron railing, for example, Wolfe describes it such that he

> . . . could see it instantly just the way it was, the heavy iron pipe; its raw, galvanized look; the way the joints were fitted together. It was all so vivid and concrete that I could feel my hand upon it and know the exact dimensions, its size and weight and shape. And suddenly . . . this utterly familiar, common thing would suddenly be revealed to me with all the wonder with which we discover a thing which we have seen all our life and yet have never known before. (p. 186)

It was from memories such as these, particularly from America, that Wolfe found the inspiration to write. While in Paris, he describes the powerful effect that one memory of a particular scene from America had on his developing desire to write:

> . . . my life would ache with the whole memory of it; the desire to see it again; somehow to find a word for it; a language that would tell its shape, its color, the way we have all known and felt and seen it. And when I understood this thing, I saw that I must find for myself the tongue to utter what I knew but could not say. And from the moment of that discovery, the line and purpose of my life was shaped. The end toward which every energy of my life and talent would be henceforth directed was in such a way as this defined. (p. 187)

Wolfe's procedure was to progress through the recording of the welter of memories in such a way that they eventually achieved both coherence and cohesion in the form of a novel. He describes it as a very gradual process.

> It was a progress that began in a whirling vortex and a creative chaos and that proceeded slowly at the expense of infinite confusion, toil, and error toward clarification and the articulation of an ordered and formal structure. (p. 187)

The "whirling vortex" was of a magnitude of intensity similarly felt by Beethoven. But, in this case, Wolfe had little control over it.

> It seemed that I had inside me, swelling and gathering all the time, a huge black cloud, and that this cloud was loaded with electricity, pregnant, crested, with a kind of hurricane violence that could not be held in check much longer; that the moment was approaching fast when it must break. (p. 187)

When it finally did break, Wolfe felt swept along by the momentum.

> . . . this great black storm cloud . . . had opened up and, mid flashes of lightning, was pouring from its depth a torrential and ungovernable flood. Upon that flood everything was swept and borne along as by a great river. And I was borne along with it. (p. 187)

Wolfe refers to the urgent need to write felt as a "ravenous desire" which could not be dealt with by a faculty of reason. "It was in no way possible for me to reason it out of me . . . The only way I could meet it was to meet it squarely, not with reason but with life" (p. 190). He worked furiously, through the days and the nights recording the "unceasing nightmare of blazing visions that swept across my fevered and unresting mind . . . the nightmare pageantry to which my consciousness lay chained a spectator" (p. 195). This experience leaves little doubt that the power and intensity of the subliminal process held a tight, relentless, and prolonged grip on the progress of Wolfe's work.

There appeared to be no recourse here to a helpful "artificer" to choose, weigh, or evaluate the worth of anything from the ideational flood; nor could the author find a way to "surface" and rest awhile as Nichols had been able to do; nor were there any breaks like Poincaré had enjoyed, thus allowing for the emergence of a clarifying insight to bring order and direction to the work. None of this outpouring, then, remotely resembled a novel. It took a full year before Wolfe began to see some sense of design to it which he likened to working on "a great block of marble" from which, eventually, the work would emerge.

As remarked upon by every other creative thinker included here, there was from the outset an absolute commitment on Wolfe's part to record and faithfully preserve the theme and purpose of his writing as it had come to him from the earliest inspiration. "From the beginning," he states, "the idea, the central legend that I wished my book to express had not changed" (p. 188). It was this that sustained him throughout the long and difficult periods of writing where was "packed a hundred lives of birth and death, despair, defeat, and triumph and the sheer exhaustion of a brute fatigue" (p. 188), which gives some indication of the sheer depth and intensity of the work he had undertaken. After several years of this, and at the lowest point of despair that he should ever finish the work, Wolfe's editor (and friend) stepped into the process and the deliberative work that was needed to turn the "flood" into a novel was begun.

At this point, Wolfe felt himself in need of rescue. The editor did, in fact, assume the more deliberative control of the work, including keeping the novelist at his writing, but not without peril.

> My friend, the editor, has likened his own function at this painful time to that of a man who is trying to hang on to the fin of a plunging whale, but hang on he did, and it is to his tenacity that I owe my final release. (p. 194)

The editor, in short, told him the one thing that he was quite unprepared to hear, that is, that the book was finished. The work needed to make it both

readable and publishable still needed doing but at least the fragments were complete. All of the editing, cutting, revising, and rewriting was done under the eye of the editor. For Wolfe, this was an exceedingly painful process.

> Cutting had always been the most difficult and distasteful part of writing to me . . . When a man's work has poured from him for almost five years like burning lava from a volcano; when all of it . . . has been given fire and passion by the white heat of his own creative energy, it is very difficult suddenly to become coldly surgical, ruthlessly detached . . . My spirit quivered at the bloody execution. My soul recoiled before the carnage of so many lovely things cut out upon which my heart was set. But it had to be done, and we did it. (p. 197)

The "we" suggests that Wolfe would not have been able to do much of the deliberative work without the gentle insistence of the editor. It was the editor who made him realize that he had many more books "in him" and that this first one must be done and gone. The editor made him realize that he must move on, would mature as a novelist and eventually "learn to work without so much confusion, waste, and useless torment" (p. 198) and achieve the unity so painfully sought in the first novel, with "a unity and sureness" so hard won this time.

Wolfe's experiences represent the only instance I could find of the "novice" creative thinker. It is apparent that much excessive torment and wasted time do diminish with more experience, practice, and, of course, success. Certainly Poincaré, Nichols, Tchaikovsky, Beethoven, and others, could use the considerable knowledge and well developed skills of their respective crafts to select, channel, and direct the outpourings from the subconscious mind. Perhaps the control and balance between subliminal and deliberative thinking, no matter how that is achieved, comes only with experience.

Part IV: Summary and Conclusion

Throughout this chapter I made mention of the ways in which certain structures and processes of the mind appear to be engaged in creative thinking. In brief, the structures include the conscious, subconscious, and unconscious states of mind, and the thinking processes associated with them are the deliberative, subliminal, and gestational modes respectively. My justification for using these particular terms is quite straightforward. I wanted to present creative thinkers as they speak for themselves which implies, of course, a commitment to the position that the terms of reference they use are legitimate. I have, indeed, taken them to be so and the repeated occurrence of the terms, or their related variants, across different persons and quite different areas of knowledge lends some support to this position.

There is no escaping the fact, however, that to generalize is to obscure the particulars. Hence, the "reduction" of the sheer dynamism and beauty of the testimonials I've read to simpler, more comprehensive terms, does a great disservice to each creative thinkers' attempt to portray the inner workings of his or her mind. The mind is exceedingly complex and my simplification of its grander inner workings no doubt stretches credulity. Nonetheless, the very generality of the terms I have borrowed from the persons reviewed here, first, allays the temptation to over "romanticize" about creative thinking and thus lose the thread of emergent patterns, and second, leaves more freedom to speculate on the patterns, scope, and depth of creative thinking that emerge in the course of their work.

Creative thinkers have made the point often enough that when the "creative mood" is upon them, there is an instantaneous convergence of intellect, emotion, sensation, a sense of urgency to begin immediately, and sheer energy to produce, to the point where all conscious sense of self is suspended while absorbed in the work. The experience is often metaphorically expressed as akin to the growth of a plant. Stephen Spender (1946), for example, describes writing poetry as

> . . . a focussing of the attention in a special way, so that the poet is aware of all the implications and possible developments of his idea. Just as one might say that a plant was not concentrating on developing mechanically in one direction, but in many directions, towards the warmth and light with its leaves, and towards the water with its roots, all at the same time. (p. 113)

Tchaikovsky (1878) puts it thus:

> . . . the germ of a future composition comes suddenly and unexpectedly . . . it takes root with extraordinary force and rapidity, shoots up through the earth, puts forth branches, leaves and finally, blossoms. (p. 57)

These metaphors convey a strong sense of the speed, simultaneity, and convergence of mental events associated with creative thinking. Any attempt to put forward more generally descriptive terms to capture their meanings should proceed with this framework in mind. The very act of explaining or describing how something works requires that one take a rational and more or less sequential approach to it in order to put forward a reasoned, well organized case. When talking about creative thinking, however, particularly in the case of subliminal processing, this approach is, in the main, at odds with the very thing being described. Further, the plant metaphor quite clearly shows that efforts to compartmentalize and allocate specific functions in this or that part of the mind is likely to miss altogether the integral nature of the phenomenon and the intrinsic dynamism associated with it.

This makes efforts to depict processes of creative thinking somewhat difficult to do without fitting them into something of a descriptive framework. I will, however, try to do just that by placing key concepts from the foregoing descriptions onto something of a continuum designed to show how the various states of mind and related processes "work" in the creative act. The following is a summary of the three modes of thinking processes that emerge from the foregoing descriptions of creative thinking. Each will be discussed in terms of the state of mind in which it occurs, the particular characteristics of thinking associated with it, the related cognitive activities and outcomes pertaining to

it, the constraints on the flow of thinking that may disrupt or limit the process in critical ways, and finally, how these processes appear to work together, either in tandem or simultaneously, in the act of creating.

The purpose of the summary is to make clear the types of thinking associated with the emergence of highly creative outcomes, and the meanings of the particular concepts associated with them, as these are described and understood by creative thinkers. This is a necessary task prior to taking a critical look at how cognitive psychologists try to explain creative thinking in terms of "ordinary" thinking. Their approach is to first reanalyze and then redefine most of these same modes of thinking (cognitive processes) and associated concepts in keeping with their claim that there is no such thing as specifically creative thinking.

The ways of thinking presented in the foregoing chapter show there to be three more or less discrete "states" of mind wherein creative thinking may occur; these are the conscious, subconscious, and unconscious states. Each appears to have its own particular mode and related characteristics of thinking associated with it and the processes of thinking in each, insofar as these are known, are quite different in nature. Each state appears to operate under different levels of self-awareness, different cognitive constraints, and may or may not "work" with other modes of thinking. Because of the salient differences between these modes of thinking and the states of mind associated with them, they appear to be quite discrete both in terms of their intrinsic operations and by the breaks in the entire process of the creative endeavour that may lead to switching from one mode of thinking to another. Nonetheless, it is not unusual for all three to be more or less involved, either continuously or intermittently (but still continuous to the particular task), during the period of time taken to produce the desired outcome. Poincaré, for example, used all three modes intermittently over a period of several years to come up with proof of the existence of Fuchsian functions, while Nichols, using the same processes simultaneously, managed to compose the *Sunrise*

Poem in twenty minutes. Time appears to be of little consequence to the inception and subsequent completion of a given creative endeavour.

It seems evident from the descriptions recounted in the foregoing that some creative thinkers tend to prefer one mode over another but are adept at using more than one with relative ease, and some find working in anything other than the preferred mode a disruptive and unwelcome prospect. Thomas Edison, for example, declared there is only one mode of thinking, that of the reasoned, rational work of the conscious mind; he dismissed the idea of "insight" as merely fanciful. Edison claimed never to have an insight in his life and made no mention of recourse to insights or to subliminal ideational fluency. He was, though, exceedingly fluent in terms of hypotheses generation. His tactic was to think up hosts of them and then put each to the test in hopes of finding the one that worked (Hutchinson, 1959; Weisberg, 1993). As history shows, Edison's deliberative approach was effective, if not very efficient (Hutchinson, 1959). Robert Nichols, on the other hand, developed a number of strategies designed to keep out rational intrusions from the "intellect" altogether; subliminal thinking, he argues, is far more effective, efficient, and comprehensive than any other. Poincaré worked in all three modes in tandem and thus had no need to close off one from the other. Perhaps it is this variability in work styles that has led to so many different interpretations of just what "creative" thinking must be like, thus lending one part or another of this particular phenomenon to be considered a good "fit" for a given school of thought on the matter. My contention is that conscious-deliberative, subconscious-subliminal, and unconscious-gestational modes of thinking largely occur on something of a continuum. In this sense, they are all integral to the creative process itself even though each performs quite different functions at the same or different times.

Conscious-deliberative Thinking

Deliberative thinking has been variously referred to as the work of the intellect (Housman), cerebral (Nichols), cool headwork (Tchaikovsky), plodding (Spender), inefficient (Poincaré), and insufficient (Nichols). It is understood to be "fully conscious" work and is, thereby, the type of thinking that requires full attention to the task at hand. That is, the focus of the work is *deliberately* invoked, chosen, or selected by the individual in a manner entirely under the voluntary control of the conscious mind. It is, in short, the work of the "intellect."

Typically, the individual's attention is directed toward a few key ideas at a time, and the work done is effortful, sequential, and narrowly focused. Deliberative thinking is associated with the more arduous mental effort involved in step-by-step reasoning or the trial and error search for proofs or solutions to problems, variously described by creative thinkers as "hole-plugging," "seam-binding," and the like. These are the mental activities invoked to expand or contract the work, complete it, verify or check it, and ultimately, to communicate its import to others. In the main, deliberative thinking is not associated with discovery so much as it is seen to be either the means to apply the craft of a discipline to new ideas in order to edit, refine and polish the work, or it is used to provide a necessary "check" on new ideas obtained through either subliminal or gestational work. It can, of course, be associated with creative work as witnessed by the examples of Edison, Tesla, Poe, and others (Perkins, 1981).

The need for deliberative work in creative thinking is considered to be necessary to the enterprise, but may not, in fact, be particularly welcome. Wolfe and Tchaikovsky, for example, make reference to the more or less brutal stance that must be adopted to make the necessary edits, cuts, and revisions to their works, while Lowell appeared to take it all in stride. Comparatively, Mozart, Poincaré, and Beethoven seemed able to work with ease in the deliberative as well as other modes. Nichols had the remarkable ability to personify the deliberative function in the "artificer," who performed

the needed editorial work in his "subliminal workshop," as similarly did Kipling's "daemon," Picasso's "collaborator," and Max Ernst's "Loplop." Wolfe, on the other hand, needed an actual person to assist him with deliberative work. Conversely, once the original inspiration had taken hold, Spender and, to a lesser extent, James, worked almost entirely in the deliberative mode.

The limitations of deliberative thinking were noted to be the inability to experience the richness of feelings, emotions, and heightened sensitivity to one's inner and outer perceptions and, the inability to deal with more than a few ideas at a time in the conscious state. Further, access to memory is by directed search and therefore exceedingly restricted, usually recovering a few items at a time, and the need to work within the restrictions of the "language" or code of one's calling in order to communicate new understanding and ideas to others.

Subconscious-subliminal Thinking

Subliminal thinking appears to be the antithesis of deliberative thinking. It could conceivably be the very heart of creative thinking and perhaps the cognitive "seat" of the human imagination. The subliminal thinking process is associated with the subconscious mind and tends to occur in a state of suspended self-awareness variously described as dream-like, trance-like, meditative, a reverie, or self-hypnotic. It may also be induced by some means as in the examples of Amy Lowell and the writer, Dorothy Canfield; or stirred by some chance event in the immediate surroundings as reported by Spender, James, and Lowell. In this frame of mind thoughts, feelings and emotions, images, memories or sensations, including visceral sensations "come" and are simultaneously "received" without effort by the person concerned. The creative thinker experiences them in a powerful *convergence* of emotion, of memories, and of direct perceptual experiences, resulting in a state described as one of heightened sensitivity and awareness that creates a "window" within the mind ready to receive new direction. Sensations and emotions impinge on the mind from the outer world and from the inner world of the mind itself,

thereby bringing about the keen state of heightened awareness and openness to discovery not often encountered in any other way. These experiences can be stimulated by particular scenes or events in the world external to the mind, or by feelings of frustration and despair induced by repeated failures to solve particular problems. Whatever the source of stimulation, the effect on the individual is an immediate, deeply felt need to begin the work of creating. Though he or she is vividly "aware" of subliminal events, the conscious mind remains entirely passive and unintrusive during this process.

Besides the experiences of powerful feelings and heightened perceptions, one striking event that pertains only to subliminal thinking is the occurrence of ideational flow where an array of ideas, images, musical scores, sounds or symbols, and the like, flow through the mind in ways variously described as coming in "floods," "clouds," "crowds," or "myriads." The phenomenon is described by those experiencing it as a kind of involuntary "free fall" of ideas—effortless, rapid, automatic, immediate, and completely undirected. In this state heightened perception and/or powerful emotions, such as despair, awe, or frustration, are believed to rouse the subconscious mind and thus invoke the onslaught of ideational flow. Whatever the case, a strongly felt need, be that intense curiosity, inspiration or awe, frustration, or some other, acts as a catalyst to subliminal thinking. Most creative thinkers found the sheer energy needed for subliminal concentration to be extremely exhausting and thus could not do sustained work in this mode for very long periods of time.

Interestingly, although ideational flow is experienced passively, that is, where the conscious state of deliberative thinking remains quiescent, there is a certain *aesthetic judgement* exercised in the process. Creative thinkers report that those ideas most likely to bring needed new channels of thought or that convey just the right meanings, themes, rhythms, sense of form, and so forth, clearly emerge from the flow. These are simultaneously both "known" and "felt" to be right, or correct, and once discovered may attain pristine levels of aesthetic beauty at the moment of emergence in the mind's eye. Such a convergence of knowledge and feeling brings with it a strong

sense of pleasure and satisfaction at knowing the discovery to be one of beauty, certainty, and usefulness. This facet of creative thinking led Poincaré, for one, to observe that the subliminal mind has "discernment," "tact," and "delicacy," and that it can "choose" or "divine" in a manner wholly superior to that of the plodding work of the conscious mind (Ghiselin, p. 39).

The emergence of particular ideas from the ideational flow (often very suddenly) is variously described as experiencing insight or inspiration within the given context. It does seem to be the case that the inspiration, insight, or intuition arising from the convergence of emotion and heightened sensitivity to one's inner or outer world is the means by which "felt" or "sensed" knowledge is transformed into something immediately recognizable as just that needed to carry the import of a new short story or novel, or convey the implicit meaning of a poem, for example, or the solution to an elusive and difficult problem. While the term "insight" is frequently used to describe the different nuances of this experience, it seems clear that insight itself is quite complex. Insights arise from ideational flow, from inspiration, from periods away from an activity, or from the intuitive experience of direct perception.

Heightened sensitivity and ideational flow can sometimes be stimulated, aroused, induced, or inveigled to come, but, unlike deliberative thinking, never willed or summoned to come. Subliminal thinking can be willful, sometimes suspect, and quite unreliable. It may or may not come when needed, or will suddenly "quit" work at the worst possible times. Thus, one constraint of subliminal thinking is its inherent capriciousness. Another is susceptibility to external events that threaten to disrupt the entire process, which can occur at any point from inception to completion. Generally, certain recognizable signs of difficulty (concern about where to go next, what the conclusion should be, and so forth), or adverse moods, can give rise to anxiety that may disrupt the process, or the need to "surface" for a rest may be prohibitive of return to the subconscious state of the mind. In most cases, external intrusions or deliberative intrusions from the "intellect" are the most disruptive and, as noted in the foregoing chapter, creative thinkers who do

primarily subliminal work have, in the main, developed an array of odd and ingenious strategies to keep the "conscious" mind quiescent or completely at bay, thus leaving the subconscious mind free to function unhindered.

Once realized, the subliminally achieved directives must then undergo the scrutiny of reason either in the deliberative mode, or in some personification of deliberative thinking within the subliminal mode itself. Though subliminal thinking is known to those who experience it to be highly effective and efficient, little of its results are communicated to others without first undergoing a rigorous process of testing, trying, rethinking, reworking, validation, or verification. Translating complex meanings, new discoveries, forms, themes, and the like, generated from the subliminal process into the language of the genre concerned so that these can readily be appreciated and understood by others is often reported to be a slow and arduous task. Slow, that is, compared to the ease and efficiency of subliminal thinking. It appears to be universally held by acknowledged creative thinkers that the import of the original inspiration, that is, the "truth" of the discovery, whether it be science, mathematics, poetry, music, or literature, must be sustained throughout the various iterations of the work. If such cannot be done, then the work is either abandoned until new directives are found or it is altogether discarded.

In sum, subliminal thinking communicates via the emotions, via images from memories or dreams, or perceptually via the individual's experiences of heightened sensitivity to his or her external surroundings or to inner events of the mind, and by the particular language of the genre concerned—words, symbols, images, and the like. These converge in various ways and those selected, or rather those that "present" themselves, from the ideational flow become the very source of discovery. Although sometimes maddeningly capricious, creative thinkers report subliminal thinking on the whole to be an efficient, effective, direct, and unmediated, experience in the sense that Shepard (1988) characterized it as the ability to think "directly with the objects of perception."

Unconscious Gestational Thinking

It is not at all clear whether periods of gestation can be referred to as unconscious "thinking" per se, but something like that must be the case. Amy Lowell's poem, *The Bronze Horses*, for example, was "dictated" to her after the stimulus for it had been "dropped into the unconscious" and thought no more about for a period of six months or so. She was unaware of how the poem was constructed, or indeed, that it had been composed at all until it quite suddenly emerged. In this case, she wrote it down from auditory dictation as heard in the mind's ear, so to speak, in a manner similar to Mozart's and Beethoven's inner auditory experiences. Other examples of the work of the unconscious are found in Creative thinkers' writings reporting instances of insights appearing while the mind was entirely preoccupied with other matters. Poincaré received three of them over a number of years that perforce solved difficult problems he had been unable to resolve while working either deliberatively or subliminally. Nichols "surfaced" from his subliminal reverie in frustration at being unable to find the appropriate ending for the *Sunrise Poem* and, after abandoning attempts to do so, put the unfinished poem aside in anticipation of having a good breakfast instead. Having thus put his mind at rest, he then suddenly and unexpectedly "saw" how the poem should end. Though creative thinkers could sometimes find ways to induce subliminal thinking, this was not the case with gestational work. Such occurrences were always reported to be a complete surprise.

That the mind appears to suddenly "know" something by intuition does seem to be the case with occurrences of insights when the thinker is not preoccupied with the issue at the time. It seems to be the case that if subliminal thinking comes in when deliberative work has failed, or deliberative work comes in when subliminal work is disrupted or remains uncompleted, then gestational-type insights seem to appear when both of these modes have failed. Under these circumstances, insights provide the "missing link" without which the work cannot continue. Though they are

experienced as appearing entirely like a "bolt from the blue," it is apparent that they are part of the larger process of creative thinking.

Insights do spring from sources other than the need to find missing links, however. Henry James' "germs," for example, were insights that suddenly riveted his attention from the buzz of conversation around him. These immediately stirred his imagination with the resultant quick onset of ideational flow that generated the basics of the story to be written. Thomas Wolfe's sudden, powerful vision of the American bridge provided the catalyst, not for a novel, but the entire purpose for becoming a writer. Though these experiences do not at first glance appear to be gestational, creative thinkers who have insights of this nature do talk about a latent, powerful need to begin work, to produce, in terms of feeling "driven" to do so. This need could, at least in part, be generated from a gestational core of ideas, feelings, and emotions that keep the individual in something of a state of "readiness" to suddenly recognize as soon as it appears just the stimulus needed to begin a work. These insights are *inspirations* that bring meaning and import to the ensuing work. Whether insights serve as missing links, inspirations, or as a series of inspirations, they either bring the import of the work or, like other facets of creative thinking, bring further ideas that remain true to the original import and meaning of the work as it develops from inception to completion.

To conclude, one thing seems readily apparent from the three modes of thinking culled from the foregoing testimonials about ways of thinking. The deliberative, subliminal, and gestational modes seldom stand alone. They form something of a continuum of strands of thinking that perform critically different functions throughout the creative process. They can operate, singly, in tandem, or simultaneously, sometimes with a preference for using one particular mode over another. Many creative thinkers had attained a certain balance between the various strands, using one or the other when the process either stopped, failed, or was in some way disrupted. Others preferred one

mode exclusively, but seldom worked without recourse to another at various points in the process of creating. The implication is that creative thinking can and does occur in any one of the three modes of thinking; an important consideration to keep in mind when looking at the cognitive science point of view to be presented next.

A number of complex concepts critical to creative work arise from the foregoing discussion. These concern the place and role of reason, insight, inspiration, memory and analogy/metaphor, ideational fluency, perception, and emotions and feelings in the formation or transformation of meaning and understanding in the generation and expansion of human knowledge. As these are the subjects of redefinition from the cognitive point of view, they will be discussed in the next chapter both comparatively, and more fully, in that context.

Chapter Three: Ordinary Thinking

Part I: Introduction

Hutchinson (1959) reports an incident in creative problem solving that provides a good example of how different preferred modes of thinking can work at cross purposes. The problem concerned finding the right blend of chemicals needed to soften the wax of phonograph cylinders. The two principal investigators were Thomas Edison and his long-time lab assistant, M.A. Rosanoff. Edison's description of how he solves problems sets the tone for the incident:

> when it comes to problems of a mechanical nature, I want to tell you that all I have ever tackled and solved have been done by *hard logical thinking*. . . . I speak without exaggeration when I say that I have constructed three thousand different theories in connection with the electric light, each one of them reasonable and apparently likely to be true. Yet in two cases only did my experiments prove the truth of my theory. (1959, p. 14)

Thus, Edison's style of working involved generating many hypotheses and then discarding them one at a time by experimental elimination. Rosanoff, on the other hand, suffered a great deal of frustration when forced to use the "Edison method."

At Edison's insistence, Rosanoff had made a year-long "superhuman" effort to solve the problem using the Edison method, with frustrating results. Edison had purposely kept from him information about previous work on the problem in order to foster in Rosanoff what he (Edison) believed to be the best method of investigation. For Rosanoff, the effort proved futile. Then, to quote him at length, the solution to the problem

> came like a flash of lightning—not the Edison way. . . . On a Sunday evening I lay on my couch with a headache, smoking cigarettes. I tried to keep my mind a blank; but after a year or more of being held down to my problem by Edison, I could no longer shut out the waxes, even in my sleep. And suddenly, through headache and daze, I saw the solution! . . . by a physico-chemical process which instantly quickened in my mind, I could modify the intimate physical structure of the wax almost at pleasure, and thus bring about any desired change in hardness. A positive solution to my despicable problem! . . . the first thing the next morning I was at my desk, and half an hour later I had a record in the softened wax cylinder. . . . The acoustic reproduction was correspondingly excellent . . . It was the solution! I had learned to *think* waxes, and the solution had *come without effort*, after a year of Edisonian blind groping that had led nowhere. (p. 24)

Edison worked exclusively in the deliberative mode using systematic reasoning to construct, test, accept or reject a series of hypotheses. Rosanoff worked best in the subliminal mode where an insightful solution to the problem came to him in a sleepy daze after a year of "Edisonian blind groping" that ended in complete failure. As the ensuing discussion in this chapter will show, for cognitive psychologists seeking to explain creative thinking, Edison's account is most likely be taken at face value. Rosanoff's account would be reinterpreted in accordance with thinking processes depicted in models of problem solving.

The "Edison-style" is akin to the scientific method itself, particularly as it pertains to laboratory-based research. Thus, Edison's style of working nicely lends itself to experimental investigation. The "Rosanoff-style" is a different matter. Rosanoff's description of problem-solving is a case of the classic experience of insight. The long-elusive solution comes about "like a flash of lightning," and by all appearances, through a quite different cognitive route than that of a consciously controlled, deliberative reasoning process. While in a state of reverie, Rosanoff had come to "think waxes" which quickly brought about the solution. Edison's approach was much more arduous. Given Edison's known success rate, however, clearly both methods find successful solutions to problems. One has recourse to wonder though, just

how long Rosanoff would have taken to find the answer if left alone to pursue the matter in his own way.

This incident highlights the dilemma encountered by cognitive psychologists seeking an empirical explanation of creative thinking. If, like Edison, the creative thinker works primarily in the deliberative mode, then explaining how discoveries are made is more straightforward. Edison's thinking processes are clearly traceable and demonstrable by following the series of experiments he conducted. On the other hand, if the creative thinker works primarily in the subliminal mode, then explaining how insights occur is considerably more difficult—unless, of course, it can be shown that insights actually follow the same "Edison-style" reasoning processes, only less obviously so. If this is the case, then the implication is that the *thinking processes* involved are the same. This is just what some cognitive psychologists argue. If their arguments are convincing, then they may provide the rationale (and the methods) to promote the scientific explanation of creative thinking.

This is an exciting idea, but problem solving by insight, at least on the face of it, looks to be difficult to study empirically, particularly experimentally. As typically described in the traditional literature, such experiences are truly unique to the individuals concerned. Because of the sudden and unexpected appearances of insights, these do not appear to be occurrences that can be experimentally induced, observed and then reported, replicated, and so forth. A possible exception to this is the earlier work on insight problems undertaken by Gestalt psychologists who devoted a great deal of time and effort to demonstrating how insights solve problems (see, for example, Duncker, 1935; Luchins & Luchins, 1970; Wertheimer, 1973). These studies looked at the ways people (and animals) solved various problems and puzzles requiring an insight to find the solution. The problems were specifically designed to provide subjects with novel situations that required going beyond prior knowledge and experience in order to solve them. Usually all of the needed ingredients were included in the experiment, but the

subjects had to figure out (insightfully) novel combinations of them in order to meet with success.

Many of these puzzles have been adapted to laboratory experiments by present-day cognitive researchers. The puzzles used, however, such as the "missionary and cannibals" problem, the "candle and wax" problem, and the "nine-dot" problem, though cleverly devised, are trivial in nature compared to the discovery of relativity, Fuchsian functions, or the structure of benzene molecules. Nor do they appear to bear any resemblance to the profound understanding of the nature of man expressed by the likes of Shakespeare or Wordsworth. Whether or not the *thinking* involved is the same, however, is an issue of considerable importance for cognitive psychologists, particularly Perkins (1981, 1988), Weisberg (1986, 1988, 1993) and Holland (1990). They argue that it is, and further, that these processes are the same common, ordinary procedures we use to deal with everyday problems. This belief has led some cognitive psychologists to conclude that there is "nothing special" at all about thinking that produces highly creative outcomes. The purpose of this chapter is to take a close look at why they think so and to assess to what degree their reasons for doing so are convincing.

Finding original, highly creative and useful solutions to complex problems requires the thinker to go beyond current knowledge and practice, often providing entirely new directions of thought. Explaining creative thinking, then, means explaining how knowledge generated from a necessarily simpler conceptual basis of information gets conceptually more complex. To be comprehensive, a theory of human cognition, whether it be based on the assumption that such thinking is ordinary or extraordinary, must be able to explain this phenomenon.

Part II: A Comprehensive Theory of Cognition

For the emerging science of cognition there is a great deal at stake in being able to demonstrate that problem solving processes are ordinary in the sense that they can be construed as common to everyone. Relatedly, cognitive psychologists must also be able to show that these same ordinary thinking processes are sufficient to do the work of creating, inventing, and discovering. The term "problem" is meant to be understood in the widest possible sense; it is inclusive of the discovery of black holes, creating new art forms, or fixing a broken dishwasher. In each case the individual has solved a problem, and though the outcomes may be quite different in terms of perceived importance and value from a socio-cultural point of view, the cognitive processes involved, nonetheless, are claimed to be the same.

Reconstruing something traditionally perceived to be uniquely creative thinking into thinking that is ordinary, common, and demonstrable, nicely dispels the difficulty of having to deal with elusive phenomena like insights and unconscious thinking processes in other than rational terms; particularly as these are generally held to be the unique mental properties of a very few highly gifted individuals. Although none of this altogether precludes scientific investigation of a particular phenomenon called "creative" thinking, generalizable to a specifiable category of thinkers possessing certain definable and measurable attributes and/or characteristics designated as "creative" (see, for example, Torrance, 1966; 1988), it does pose serious problems for the development of a *comprehensive* scientific theory of human cognition. The challenge for a science of cognition lies in how to explain how new ideas or concepts are formed. Without the ability to explain this phenomenon, it is doubtful that models of problem solving currently in vogue can explain how new, more complex knowledge and practices are generated from the ordinary thinking processes associated with problem solving.

According to Pascual-Leone (1976, p. 90), a general scientific theory of cognition would have to be a "constructive" theory, that is, one that describes, and ultimately explains, how we make "rational reconstructions" or models

(structural simulations) of the world as we encounter it and the mental operations or "mechanisms" we use to do so. A constructivist theory, then, is comprised of two components, a description of the structure of the human cognitive system itself and a description of how this system, in turn, generates the structures of situations as we construe them, including, of course, the cognitive systems of the theorists/researchers. The cognitive scientist, then, works with two things: a general theory of how the human cognitive system works, and the actual or inferred description of particular situations "as construed by the subject's psychological system." The particular situation is a reconstruction of events that reflects, or is "isomorphic" with, the underlying processes inherent within the general cognitive system. As stated by Pascual-Leone;

> a theory should be called constructive if and only if it aims at rational reconstructions of data on its symbolic medium. Constructivist theories are contrasted . . . with . . . *reductionist theories*, namely theories which aim at empirical prediction of data based on analogic relations assumed to exist between the to-be-explained performance and some other well-known performances of the subject. (1976, p. 90)

Cognitive psychologists have come up with constructivist models that describe creative thinking in terms of problem solving. In short, if you are creating something, then you are problem solving. How you do it is a function of how the general system itself works. Models of problem solving, then, must be able to explain "truly novel behavior." Pascual-Leone offers the following explanation of what this means from the constructivist perspective.

If it is accepted that there is a general cognitive system, then the components of the theory are reflective of a system of "deeper organismic factors organized according to little-known dialectic or context-sensitive laws" (p. 96). Because the "laws" make up a general theory of human cognition, then they would be universally held to apply. Explaining what the laws are is *the* ultimate goal of a constructive learning theory. Piaget's "logical models" or Newell and Simon's computer-simulations of problem solving are good, but

not flawless, examples of constructivist theory at work. The flaws in them may be accounted for by various shortcomings, but the one that cuts across all constructivist theories, to date, is that none can adequately account for the nature of thinking that produces results which are truly novel, original, and of great value to humankind. As such, they fall under the "learning paradox contradiction" (p. 100).

Pascual-Leone, then, makes the important point that in order for a constructivist theory to be truly inclusive, it must be able to account for how we may supersede or transcend currently held knowledge, beliefs, and practices, and thus be able to account for the growth in complexity of human knowledge and understanding which arises from truly novel behavior. In short, Pascual-Leone refers to the need to explain how new concepts are formed by the general cognitive system and by reconstructions of particular events. He notes:

> *A truly general constructive theory which is consistent must be capable of explaining the production of truly novel behavior*—behavior which is neither mere transfer of learning or novel integration of pre-existent learned units, nor innately determined. (p. 94)

> To be considered truly novel means that the behavior in question has never before been produced [and] is complex and improbable enough not to have been produced by "chance." . . . Yet all learning theories agree that a behavior cannot be learned by a subject before he has ever had the opportunity to produce a simple instance of it. To say otherwise . . . is to imply that learning can take place without experience. (p. 94)

Pascual-Leone thus points out the paradoxical nature of how to explain truly novel learning and concludes by making a point critical to the individual experiences of creative thinking reported in the foregoing chapter. That is, that "truly novel behavior does exist and that it is produced by organismic factors different from learning. To be consistent, a general constructive theory must include a representation of organismic-structural

factors other than learning to account for truly novel behavior" (p. 94). "Behavior," of course, refers to thinking behavior.

Thus, what Pascual-Leone means is that such "organismic factors," although they are not specifically cognitive, do impinge on human cognitive processes in significant ways that foster the genesis and development of original ideas. As evidenced by descriptions of creative work in the foregoing chapter, the important place and role of human feeling and emotion in creating is a good example of an organismic factor. The implication is that cognitive scientists are faced with the need to integrate these "organismic" factors into a constructivist theory of problem solving that is built upon a foundation of logical, rational reconstructions of the creative experience.

In sum, at issue for cognitive science is the need to provide a general theory of cognition that includes the means to identify and explain what those factors, or mental "mechanisms" are that account for how new, more complex knowledge is generated in the first place. At the heart of the matter is the issue of how to explain concept formation in human cognition. In short, how is something conceptually more complex generated from a basis of prior knowledge, which, by definition, is necessarily a conceptually simpler basis of knowledge? Bereiter (1985), like Pascual-Leone before him, posed this dilemma as the "learning paradox."

One other important point made by Pascual-Leone (1976, pp. 93–94) based on the prior work of Newell and Simon (1972) should be noted before proceeding; that is, that "humans cannot keep in mind too many ideas or perform too many activities at the same time, their . . . cognitive processes are forced to become serially organized. It follows that constructive theories must adopt . . . language which is capable of representing the step-by-step temporal unfolding of behavior and of the mental processes." The belief in the serial nature of human thinking is a "fixture" in problem solving theory that purports to be inclusive of creative thinking. Although more recently, such thinking is considered in terms of the parallel distribution of thought,

parallel distributed processing itself still takes place within the problem solving framework.

The logical and psychological difficulties posed by the learning paradox for a constructivist theory are the subject of the next chapter. The focus at this point is to describe what problem solving processes are and relatedly, how these can account for our ability to generate knowledge that results in entire shifts in human understanding, beliefs, and practices, that is, "truly novel behavior." If it is true that problem solving thinking processes are the same no matter what the problem might be, then the implication is that though few of us ever manage to achieve at the level of an Einstein, a Beethoven, or a Picasso, we are all, in principle, capable of it.

Part III: Problem Solving

The following description of problem solving covers a number of key issues: first, what is meant by "problem," second, the actual thinking processes involved when problems are solved, and third, how these processes are inclusive of creative thinking. Although the representative cognitive psychologists discussed in this chapter do not give an explicit description of a general theory of cognition, some idea of what it must be can be extrapolated from how models of problem solving are believed to work.

Defining "Problem"

There is a fair degree of consensus among cognitive psychologists as to what constitutes a "problem." According to Voss (1989),

> A problem is said to exist when an individual in a particular situation has a goal but is unable to attain the goal. In addition, it is frequently assumed that there is some type of obstacle or barrier that prevents the solver from reaching the goal. (p. 252)

For something to be a problem means that just how it is to be solved is not at first obvious. Thus, the solver is assumed to be motivated to achieve the goal and is, therefore, willing to deal with the obstacles facing her or him one step at a time.

In a similar manner, Holyoak (1990) notes that "A problem arises when we have a *goal*—a state of affairs that we want to achieve—and it is not immediately apparent how the goal can be attained" (p. 118). Weisberg (1986, pp. 3–4) offers a variant of this theme with respect to specifically creative problem solving. He states that "creative problem solving involves a person's producing a novel response that solves the problem at hand" and Weisberg's definition entails that first, "the solution must be novel for the person," and second, "novelty is not enough; the solution must indeed solve the problem." He assumes that "any solution which is novel for an individual, regardless of how many other individuals arrive at the same solution, is creative" (p. 4). Weisberg further echoes a shared assumption among cognitive psychologists investigating creative thinking which is that no matter what the task to be done is, or which domain of knowledge applies, the task or activity involves solving a problem.

> The view that creative work in science involves problem solving is straightforward, since in most situations scientists are faced with the problem of devising a theory that explains some phenomenon. . . . creative artists—painters, sculptors, poets, and novelists—can be seen as trying to solve problems. For example, we might think of a painter as trying to solve the problem of expressing in a painting some feelings about his or her life. In addition, the painter may also be trying to produce a painting that will move others emotionally; this can be seen as an attempt to solve another problem. (p. 4)

The notion of "problem," then, is meant to be interpreted in the widest possible sense. There are two types of problem: well-defined and ill-defined.

The Well-defined Problem

In the case of a well-defined problem, the task is clearly specified, that is, the starting point, the end point or solution, and obstacles to be overcome are known. The "missionary-cannibal problem" is one example of a well-defined problem. Three missionaries and three cannibals have to cross a river in one boat that only holds two people at a time, and there must never be more cannibals than missionaries on either side of the river at any given time. The solver has to figure out how to get everyone safely across. Well-defined problems are frequently used as experimental tasks in laboratory studies (having students as subjects) from which generalizations are then made about how creative thinkers must also process information. This is justified in two ways: first by arguing that the actual thinking processes involved are the same, and second, that problems requiring novel solutions are comprised of both well- and ill-defined aspects.

The Ill-defined Problem

In the case of ill-defined problems, the problem itself may be more difficult to articulate, the issues to be dealt with may be exceedingly complex and the solution could be difficult, or impossible, to resolve to everyone's satisfaction. How to get more people off welfare, finding a cure for cancer, or how to resolve the ethical and moral issues surrounding abortion, are examples of ill-defined problems. The step-by-step processes undertaken to solve either a well- or ill-defined problem is metaphorically expressed as *search* through a problem *space*, terms which arose from the earlier work of Newell and Simon (1972) researching how people solve chess, cryptarithmic, and logical problems, and which are now generally representative of the current "information processing" appoach to problem solving. Here, relevant information is "processed" in a series of interconnected incremental steps until the goal is reached.

How Problems are Solved

As with the question of what constitutes a problem, there is a good deal of consensus about the basic processes involved in how to solve one. Holland, et al. (1986), closely following Newell and Simon's (1972) and Simon's (1979) seminal accounts, describe the process for solving well-defined problems as

> . . . a process of search through a *state space*. A problem is defined by an *initial state*, one or more *goal states* to be reached, a set of *operators* that can transform one state into another, and *constraints* that an acceptable solution must meet. Problem solving methods are procedures for selecting an appropriate sequence of operators that will succeed in transforming the initial state into a goal state through a series of steps. (p. 10)

The most commonly used problem solving strategy is "means-ends-analysis" which consists of the following four steps (Holland, et al., 1986):

1. Compare the current state to the goal state and identify differences.

2. Select an operator relevant to reducing the difference.

3. Apply the operator if possible. If it cannot be applied, establish a subgoal of transforming the current state into one in which the operator *can* be applied. (Means-ends analysis is then invoked recursively to achieve the subgoal.)

4. Iterate the procedure until all differences have been eliminated (that is, the goal state has been reached) or until some failure criterion is exceeded. (p. 10)

Voss (1989, pp. 256 ff.) uses the example of the "missionaries and cannibals" problem to illustrate this process. The *initial* state refers to the situation where there is one boat and both groups are on one side of the river. The *goal* state is, of course, getting the missionaries to the other side, uneaten. The *constraints* put certain limitations on how the problem can be solved. There are three in this case; one boat, holding two people, and at no time must there be more cannibals than missionaries on a given side of the river. Steps taken to solve the problem are defined by reference to *states* and

operators. The "states" include all possible combinations of missionaries and cannibals and the location of the boat at any given combination point. The "operators" are actions taken by the solver to transform the problem from one state to the next. A first operator, for example, could be to have one cannibal and one missionary cross the river, leaving two of each group on the bank, thereby transforming the problem into the first of a series of intervening states, each transformed by the application of another operator until the goal, or a subgoal, has been reached.

The selection of a particular operator or a series of them requires use of a *strategy*. Using means-ends analysis, for example, the solver uses the goal state to systematically select operators that reduce the difference between it and the initial state (referred to as *working backwards* from the goal). Moving from one transformational state to the next until the problem is solved involves a *search* through a *problem space* where the solver "looks for a path that goes from the initial state to goal" (p. 256). Problem space refers to the knowledge needed to interpret the problem and solve it. Obviously, in well-defined problems not much in the way of interpretation is needed.

The concepts describing steps to problem solving at the level of well-defined problems do not adequately convey the more complex nature of information processing required to solve ill-defined problems. How these are handled is very much determined by how the solver interprets the nature of the problem which is referred to as *problem representation*. According to Voss,

> In order to develop a representation, the solver typically must draw on his or her memory and/or possibly on other sources of information. What the individual knows about the problem, therefore, is quite important . . . not only the person's knowledge, but also how that knowledge is organized, is important to the problem representation. Finally . . . the nature of the representation that is developed is quite important not only because the solver is attempting to isolate the causal factors and constraints of the problem, but also because the solution that is proposed will be based on the particular representation that has been developed. (p. 258)

Understanding how the ill-defined problem is solved requires working out how prior knowledge, memory, and perception may affect the problem representation. Further, there is no one straightforward route to the solution as in the case of well-defined problems; what the solution may be is influenced by what the solver already knows or believes (prior knowledge and how it is remembered and organized) and relatedly, how one initially constructs the problem and subsequently reconstructs it while working through it. Strategies like means-ends analysis are insufficient for working through an ill-defined problem space. Instead, the term "planning" is used to refer to the need now to consider a variety of strategies that may be used, including some evaluation of their potential and actual effectiveness in finding a solution.

In the case of an ill-defined problem, when moving from initial to goal state a number of things may have to be changed, any of which may signal a change in problem representation. In finding a cure for cancer, for example, the goal state is known, but finding the right starting point entails coming up with a series of problem representations based on the ability of each one to add another step toward finding a solution. Even if a workable representation has been found the constraints may be prohibitive, such as the ethical constraints placed on using animals or human subjects for research. Sometimes the goal state is more desirable than achievable. Feeding the world's poor is a goal of great scope but, no doubt, many subgoals will have to be formed and reached first in order to someday realize the broader goal. In these instances, problem finding is just as important as formulating the problem space and constructing representations, as it suggests a willingness to remain open to unexpected turns in events, to change, and to be flexible in one's approach to solving a problem (Perkins, 1981, p. 185).

Problem Solving and Creative Thinking

When it comes to creative thinking the main point of interest lies in trying to understand the mental "operators" or "mechanisms" that come into play when moving from one representation to another. In one sense, this movement can be construed as incremental in nature as it builds upon prior and current knowledge and experience. In this case, a step-by-step progression of thought, or incremental knowledge growth leads to the solution. In another sense, solving some difficult problems may require going beyond current knowledge and experiences. This is where the controversial notion (to cognitive psychologists) of insight, or "mental leaps" comes into play. Rather than view this as an unexpected and dramatic flash of new understanding, their preference is to deal with it as a case of analogical thinking, where two or more different ideas with enough similarities between them link in such a way as to stimulate a change in the direction of thought. The chemist Kekulé's observation that the dream image of a whirling snake biting its tail led him to discover the ring-like shape of benzene molecules is often given as an example of the role analogy plays in discovery (Perkins, 1981, p. 85).

The role of prior knowledge and its organization in memory is critical to planning for solving ill-defined problems for this very much determines how the problem is represented in the first place. Memory is viewed in two ways—short-term or "working" memory, and long-term memory. Working memory has limited capacity such that only a small amount of information is available for use, thus limiting "the number of moves that may be considered at any one time, and in the ability to "backtrack," which leads Voss to conclude that "the solver is thus viewed as a *serial* processor (i.e., the solver considers moves in a step-by-step manner)" (p. 258).

The depiction of problem solving as incremental, serially ordered, step-by-step processing points to a view of human cognition that is primarily algorithmic and computational in nature. The basic algorithmic nature of information processing theories does find expression in the pervasive

influence of the computational metaphor of mind in cognitive science views of human cognition. See, for example, Holland, Holyoak, Nisbet, and Thagard (1986) or Mac Cormac (1988) for a thorough discussion of the computational metaphor of mind. The idea that human information processing is essentially algorithmic and computational in nature points to the framework of what a general theory of cognition would entail. As such, most constructivist theories of creative thinking as problem solving are, to a greater or lesser extent, cast within an algorithmic or computational framework.

The remainder of this chapter presents the views of two prominent cognitive psychologists, Robert Weisberg and David Perkins, who, amongst other things, have done extensive work in the area of creative thinking. They have explored in depth the ways in which the problem solving model offers a viable alternative to traditional, more "romantic" descriptions of creative thinking, in particular, the notion that discoveries come about through great leaps of insight and unconscious thinking processes. Cognitive psychologist's views tend to follow a similar pattern in interpretations of what constitutes creative thinking. Some argue that creative thinkers' self-reports are anecdotal in nature and therefore should not be considered reliable sources of data, that empirical studies undertaken to provide evidence for the presence of insights and the unconscious processes from which they spring can be readily reinterpreted in terms of the quite conscious, well-reasoned, incremental steps taken in the problem solving process. Re-analysis of Gestalt psychology studies on insight and studies done to support Wallas' four stages of creating, are examples of this (Weisberg, 1986, 1993). Thus, there is no "hard data" to support the presence of unconscious incubation and the insights believed to result from it. Conversely, there are properly controlled laboratory studies that do support the contention that creative thinking processes are the same as those used to solve problems (Perkins, 1981). Both Perkins and Weisberg show how the processes involved in a number of famous discoveries and inventions can be understood in terms of the incremental thinking processes in problem solving. Perkins (1981) provides more ordinary terms to account for mental events such as insight.

Both address the role of analogical thinking in situations where solutions to problems require going beyond the current information available to the individual concerned.

Cognitive psychologists have set themselves a difficult task for they must deal with a few basic issues before tradition will graciously give way to science; for example, does the lack of empirical evidence to support something mean, in fact, that it isn't there? Is the notion that every act of creating involves solving a problem much too general to be useful or meaningful? If their arguments are sound, if the proposed constructs are adequate to replace the traditional ones, and if truly novel learning can be accounted for by a process of analogical thinking, then problem solving theory may successfully replace the more popular practice of associating creativity with extraordinary mental abilities belonging to only a few exceptional individuals.

In the following, Weisberg's views of the incremental nature of creative thinking and Perkins' views on the mental mechanisms involved will be discussed in turn. Because the intent of this thesis is to examine whether or not the view of creative thinking as problem solving is adequate to explain, or explain away, descriptions of thinking processes given by creative thinkers, a necessary first task is to restore their credibility. Accordingly, the next section takes a critical look at the arguments given by Weisberg and Perkins for not accepting creative thinkers' self-reports as evidence for how we think creatively.

Part IV: The Credibility Issue

There are a number of different ways that self-report cases of creative thinkers have been used. They have traditionally been sources of information for theoretical descriptions of creativity and creative thinking (see, for example, Hadamard, 1945; Harding, 1967; John-Steiner, 1985; Wallas, 1926). These theories include some or all of the influences of the creative individual's family, mentors, educational and work experiences, as well as creative thinking patterns per se. The cases have also been used as a source of selective quotes to support a variety of theories that extend already developed frameworks to include descriptions or explanations of creativity and creative thinking as well (see, for example, Freud, 1938; Schachtel, 1959, Skinner, 1972). These uses of the self-reports, in the main, do not dispute the credibility of the creative individuals concerned. Conversely, some cognitive psychologists use selective quotes from the self-reports combined with other sources of information to point to discrepancies, possible distortions, inaccuracies, and so forth, in order to cast doubt on their usefulness as a source of data. Both Perkins (1981) and Weisberg (1986; 1993) begin their accounts of creative thinking in this way. Their goal is to demystify creative thinking by placing it within the more pragmatic context of ordinary thinking processes associated with problem solving.

Some initial points should clarify just what Perkins and Weisberg are trying to do. They are not looking at which aspects of creative thinking may be quite ordinary, nor are they necessarily considering which aspects of ordinary thinking may be quite creative. They are juxtaposing traditional, more "romantic" views of creative thinking with ordinary thinking. The intention is to *replace* the former view with the latter. Both Perkins and Weisberg believe there is good reason for doing so. The more romantic views on creative thinking come from relying too much on the "testimonials" of creative thinkers, without questioning whether or not these reports are accurate. In support of this, both Perkins and Weisberg analyze examples from a number of creative thinkers; Coleridge and Poincaré, Mozart, Kekulé, and Poe.

Perkins sets up the credibility issue by using Coleridge's and Poe's very different accounts of how they do the work of creating. Perkin's quotes the parts of Coleridge's account that, according to Coleridge, describe the dreamlike composition of *Kubla Khan*, bereft of "at least . . . the external senses" where "all the images rose up before him as *things*." The images were concurrently accompanied by two or three hundred lines of the poem itself (p. 10). Coleridge reports the experience to have occurred effortlessly. At one point, an external intrusion disrupted the flow and Coleridge was unable to complete the work upon his return to it. Poe's account stresses the rational, deliberative mode of thinking. He composed *The Raven* and other works by stressing the "logical, deductive character of the process," that is, without reference to "accident or intuition . . . the work proceded, step by step, to its completion with the precision . . . of a mathematical problem" (p. 12). These two accounts closely resemble the distinctive thinking styles of Rosanoff and Edison presented earlier.

Perkins notes, however, that examination of Poe's extant manuscripts on *The Raven* shows as much or more trial and error as systematic inferencing, suggesting that Poe's description of his own style of writing was somewhat at odds with the evidence. Apparently, Poe had little use for those who claimed "they compose by a species of fine frenzy—an ecstatic intuition" (p. 11) which, as Perkin's points out, well describes Coleridge's style. Perkins then questions which one of these styles depicts the nature of creating.

> Do we go with the hard-headed Poe? Or do we credit the more romantic image of invention presented by Coleridge . . . whose example has often been taken to be the quintessential example of creating? . . . Such problems as these come up whenever one tries to study the ways of the creative mind by relying on . . . after-the- fact testimonies . . . (p. 13)

Based on Coleridge vs. Poe, Perkins concludes that relying on such reports results in an unresolvable dilemma, suggesting that a better way needs to be found. A little more probing into the unreliability of such reports by both Weisberg and Perkins brings the point home.

Weisberg (1986, 1993) looks at how Poincaré, Mozart, Coleridge, and Kekulé present a case for unconscious processing of information, and whose reported style of working is an example of it. Weisberg's intent is to discredit the notion that their achievements are due to "great leaps of imagination" which arise suddenly and unexpectedly "out of the blue." At issue is the belief that because such "leaps" appear to take the individual by complete surprise, they must be thought up during a period of unconscious information processing or "incubation" which, by definition, the thinker is unaware (1986, p. 17; 1993, p. 45). Weisberg's and Perkin's first example concerns Poincaré's description of how he discovered the proofs for Fuchsian functions.

Weisberg begins by presenting Poincaré's experiences of ideational flow (my term—cognitive psychologists refer to this as "idea association" in a way that assumes conscious control of the event) and the ensuing insights that pointed the way to prove the existence of two sets of Fuchsian functions. Weisberg states that because Poincaré "felt himself to be an inactive participant" during ideational flow, where "ideas rose in crowds," the experience had to be an instance of extraordinary unconscious thinking processes. Poincaré's flashes of insights that followed this experience purportedly arose even though "none of his previous thoughts seemed to lead up to it," and further, that "Poincaré felt certain the idea was correct without having to verify it" (p. 16), thus providing more evidence of the presence of unconscious reasoning processes. Perkins refers to Poincaré's first insight as "one of the most spare" on record. He stepped onto a bus, had the insight, and that was it, noting that if this story is believable, "his insight was truly out of the blue" (p. 43). Perkin's summarizes Poincaré's description as follows:

> Mental leaps usually (1) achieve an insight quickly, without conscious thought; (2) achieve an insight toward which there has been no apparent progress; (3) achieve an insight that otherwise would seem to require considerable ordinary conscious thinking, if ordinary thinking would help at all. . . . Insight . . . is something that happens apart from anything you might do deliberately. Insight experiences point to a powerful mental process which can't be commanded by conscious tactics. If you want to take advantage

> of this process, you can only involve yourself in a problem and then await an idea. (1981, p. 44)

Problem solving, Perkins concludes, "becomes a kind of gambling where people bet on their intuition to find a way" (p. 44).

Relatedly, Weisberg quotes a segment from a letter alleged to be written by Mozart which described how unbidden thoughts "crowd" into his mind bringing theme and melody for a composition. Interpreting Mozart, Weisberg notes that such thoughts came

> into consciousness without any particular work on his part. The creation of a melody was done before Mozart became conscious of anything. He did not have to edit anything; the melodies were not reworked or changed, he simply kept the ones he liked in his head and hummed them. . . . The modern view assumes that the completed melodies were worked out in Mozart's unconscious mind. (1986, p. 17)

Unlike Poincaré, Weisberg notes, Mozart did not even have a period of hard, frustrating conscious work that preceded composition of the final piece.

Following Perkins, Weisberg also refers to Coleridge's description of the composition of *Kubla Khan* as an example of a creative product ensuing from unconscious processes. Like Poincaré's sleeplessness induced by drinking coffee which brought about ideational flow, Coleridge's opium induced dream state purportedly produced a host of visual images without conscious effort. These images appeared, Weisberg claims, with no prior preparation on the part of the poet. He notes that such altered states of ordinary consciousness are commonly believed to "allow unconscious processes to operate freely" (p. 18). In a similar vein, Perkin's notes that Coleridge's report provides a view of creative thinking where "invention appears almost as suddenly and completely as a jack-in-the-box comes out of its cubbyhole" (1981, p. 9).

Finally, Weisberg points to another dream experience, that of Kekulé's description of the discovery of the benzene ring, to further illustrate how we've been led to believe that exceptional results are due to unconscious

thinking processes. In this case, Kekulé's dream image of the snake biting its tail provided an analogical insight into the ring-like shape of benzene molecules. The analogy between the whirling snake biting its tail and the shape of the benzene ring is described as a "far analogy," a term used by Koestler (1964) to illustrate how two apparently dissimilar elements, wiggling snakes and strings of atoms, are related. Weisberg summarizes these experiences as a case where

> postulating unconscious thought seems reasonable when the thought process "jumps a gap," and no external aid to help the thinker across the gap is apparent. If a series of steps are involved . . . then they must have been carried out unconsciously. (1986, p. 19)

Using these reports as suspect examples, Weisberg cautions against adopting creative thinkers' testimonials without question for a number of reasons.

First, self-reports are suspect because they are anecdotal and are believed to have been made long after the time of the occurrences described. As such, they may be subject to poor memory and distorted recall. In reference to Poincaré Weisberg says that

> . . . not only might parts of the event be forgotten, but new information might be recalled that was never part of the original event at all. Also, it is seldom possible to tell if the subjective report is accurate. How would one know whether or not Poincaré actually had that insight while stepping on the omnibus? . . . Since all we have . . . is Poincaré's report, we can go no further. (1986, p. 19)

Second, Weisberg questions the "out of the blue" claim. An observation both Perkins and Weisberg make is that Coleridge and Mozart claimed to have produced completed works with no prior preparation. They refer to the work of one critic, Elizabeth Schneider, to show that Coleridge's account of creating is distorted and untruthful (Weisberg, 1986, pp. 25–26; Perkins, 1981, pp. 14–17). According to Schneider's interpretation, the facts indicate that there was an undated version of *Kubla Khan* written earlier that Coleridge doesn't mention, and in this version, the poem was written in a

"sort of Reverie brought on by two grains of Opium," to quote Coleridge. Perkins points out that Coleridge's "profound sleep, at least of the external senses" was now, a "wakeful reverie," which is a "very different thing." Further, Coleridge was known to be unreliable about dates of composition of another poem which he claimed to have written on Christmas Eve, 1794, when, in fact, the poem had been worked on for two years prior to this. Finally, sixteen years had passed before publication of Coleridge's public version of *Kubla Khan* and the first known existence of the poem. Thus, Weisberg notes, Coleridge had plenty of time to get his recollections wrong.

Weisberg echoes Perkin's observations by also referring to an earlier version of *Kubla Khan*. He notes, first, Coleridge describes it as being composed in a reverie; second, because the poem remained a fragment this indicates that Coleridge was unable to finish it so he made up the opium induced dream sequence in order to make the advent of the poem more "miraculous" and therefore of publishable interest; third, opium could not induce the images Coleridge claims he had; and fourth, that Coleridge was a "notorious" liar about his work. From this report Weisberg concludes that the discovery of another version of *Kubla Khan* shows that Coleridge

> . . . apparently did some editorial work on the poem, indicating that it was not perfect when it "appeared" to him. Also, this other version . . . was accompanied by an introduction that differed slightly from the introduction reported earlier. Most importantly, Coleridge says that the poem was composed in "a sort of reverie," which is different than a *dream* . . . [therefore] . . . Coleridge's . . . report does not support the idea that unconscious processes are important in creativity. (1986, p. 28)

So, it seems that Coleridge was doing little more than making a fanciful case for self-aggrandizement; he exaggerated the role of the dream sequence in the composition of *Kubla Khan*, and either had a very poor memory or knowingly distorted the facts about how his poems were actually written, or both. The problems with Coleridge's credibility is generalized to raise the possibility that other creative thinkers are subject to the same sorts of inaccuracy.

Thus, Weisberg's comments about Coleridge's "dream" convey a similar suspicious attitude toward Kekulé's dream as well.

> . . . the question arises whether Kekulé was imagining snakes at all. . . . Kekulé first talks about rows of atoms "in *snakelike* motion." Kekulé obviously does not think those rows are snakes, because he says *snakelike*. furthermore, when he says that "one of the snakes had seized hold of its own tail," he is probably speaking figuratively. . . . He described the chains of atoms figuratively as snakes for ease of communication, and this later led him to describe a closed ring in a figurative way. . . . All this imagining probably did not take place in a dream. (1986, p. 33)

Weisberg's interpretation of Kekulé's dream that led to the discovery of the benzene ring takes quite a tortuous path, but for all that, it is not at all clear how distinctions between "reverie" and "dream," or between "snakes" and "snakelike" can lead to the conclusion that the unconscious is a myth, or that Coleridge or Kekulé didn't really know what they were talking about. Similarly, with respect to Mozart, Weisberg observes that

> Mozart's notebooks contain compositions that were . . . begun and never completed, or begun, dropped, and then returned to and revised, indicating that things did not always flow as smoothly as the letter implies. Furthermore, Mozart's excellent memory for music might have enabled him to produce completed compositions on paper that had already been more laboriously worked out in his head. (1986, p. 27)

Thus Mozart, like his poetic and scientific counterparts, did not really compose anything unconsciously, nor did he come up with full-blown, perfect compositions with no effort. What was composed in his mind came from various combinations of what he already knew, and remembered, about music.

In sum, armed with the model of thinking as problem solving, the opinions of a few critics, and some reinterpretations of studies that purportedly support the traditional view (Gestalt studies, Wallas' stages), Perkins and Weisberg observe that the testimonials of creative thinkers add

little of value to the study of creative thinking. They are shown to be intentionally or unintentionally inaccurate; subject to poor recall, subject to distortions, and are not verifiable. Finally, at best creative thinkers tend to misunderstand their own experiences, and at worst, deliberately misconstrue them to enhance their own public image. Thus, Perkins and Weisberg conclude, these testimonials need to be replaced with something much more reliable.

Commentary

A number of observations can be made about Perkins' and Weisberg's attempts to discredit the self-reports of creative thinkers. Most obviously, they have used a specious form of argument that sets up the credibility issue by framing the various points of contention in terms of extremes. To wit, either creative thinking is extraordinary or it is ordinary; either it occurs unconsciously or it occurs consciously; either changes in direction of thinking come about in great mental leaps or they occur in small incremental steps; either insights suddenly come from out of the blue or they arise, not unexpectedly from prior knowledge; either insights come effortlessly or they come about from concerted effort. Setting up the problem this way is a fallacious form of argument that allows for no alternative but to reject one extreme and, in doing so, replace it with the other which is, of course, just what Perkins and Weisberg intend to do.

Weisberg's and Perkins' discussion and critique of the testimonials are purported to be about thinking *processes*; but instead of directing criticism to an analysis of process in creative thinkers' testimonials, they redirect attention to focus on oversimplified, dichotomous categories. Indeed, one gets the impression that extraordinary, unconscious, effortless, unbidden great leaps from nowhere belong to the fellows wearing the "black hats" and ordinary, conscious, effortful, small-step, experience-based inferences belong to the "white hatted" good fellows. The simple idea that one might think both

ways is not considered. Unfortunately, this way of arguing does not allow for consideration of other, perhaps more plausible ways to interpret phenomena.

One could consider, for example, that self-awareness includes conscious, unconscious, and subconscious levels; that dreams or reveries are examples of meditative states of mind which do not at all resemble rational thinking processes; that insight may not be a singular phenomenon, but may be of different types, each serving a different function at different points in the creative process, and so forth. But to entertain these ideas requires that one make a shift from categorical classifications of mental events to processes of thinking, and the only thinking processes both Perkins and Weisberg ultimately describe are the rational processes associated with problem solving. As the ensuing discussion on creative thinking as problem solving will show, mental events designated by Perkins and Weisberg as categorical in the "romantic" view of creative thinking are found to be part of a process only when redefined in the rational terms of the problem solving model of thinking.

The self-reports presented in the foregoing chapter clearly show that things are not so simple and straightforwardly dichotomous. Creative thinkers' testimonials can be interpreted quite differently, and in ways that include the extremes and more besides. I will begin with a small reinterpretation of Coleridge, Mozart, Poincaré, and Kekulé, then take another look at insights as Poincaré described them, discuss the most contentious points about insight that Perkins and Weisberg raise, and then conclude with some general observations about creative thinking.

If the examples given of Poincaré, Mozart, Coleridge, and Kekulé are reconsidered regarding the advent of "clouds" and "crowds" of ideas, images, rows of twisting atoms, and the like, occurring in dreams or reveries, then some points not made by Perkins and Weisberg, or made differently, do stand out. Taken as described, these mental events are remarkably similar. In all cases, the individual concerned was conscious of them, albeit in an observant but passive way. It is not correct, then, to claim that the events arose from a

process of incubation, or unconscious reasoning; unconscious is not conscious and therefore means unaware. If the conscious mind is aware of the events, but not actively or intrusively involved in them, then this suggests that some other state of mind, having a different level and kind of awareness, may be operative. It is certainly a state of awareness that produces ideas, but much more prolifically and with either less effort, or a different kind of effort, than that associated with deliberative work. It does appear to access memory stores in a very different way than the deliberative search method advocated by the problem solving model of thinking. In all cases, thinking appears to be subliminal and occurs only when the activities of the conscious mind, the intellect, are suppressed or subordinated to it as, of course, they are in a trance-like, dream-like, reverie, or some other similarly meditational mode of thinking.

Interestingly, these experiences occurred to individuals from such diverse areas as mathematics, music, poetry, and chemistry, taking place over the eighteenth, nineteenth, and twentieth centuries. If the examples used are unreliable, then it is indeed odd that they all appear to be unreliable in much the same way, in a variety of spheres of knowledge, over a time period of some three hundred years. An impressive list of "subliminal" thinkers can be added to those already considered by Perkins and Weisberg: Herschel, Galton, Nichols, Einstein, Wolfe, Housman, Nietzsche, and Beethoven, to name a few. Under these circumstances it might be more valuable to seek consistencies in creative thinkers' testimonials, and not focus exclusively on their verifiability; for as Weisberg himself points out (perhaps in a moment of weakness), no psychologists were present.

The mental event that occupies much of Perkins' and Weisberg's attention is insight. Poincaré's insights, particularly the one that came while stepping into an omnibus are frequently mentioned. The commentary is that it came suddenly, unexpectedly, out of the blue, with no prior preparation, emerging full-blown from a process of incubation or "unconscious reasoning." This is correct, except for the no preparation part. Logically, if there was

unconscious incubation or reasoning, then there must have been preparation. To view insight this way, however, is to take it out of context. Poincaré cycled through various modes of thinking over a period of about three years before finally verifying the existence of two sets of Fuchsian functions. The first mode entailed the kind of deliberative work akin to problem solving. It produced no results. The second mode, following immediately upon the first, entailed the subliminal work described above. During this phase, Poincaré experienced insights in the form of certain "interlocking pairs" of equations which selected out from "clouds" of them. He then was able quickly to verify mathematically, what his aesthetic judgement already "knew" to be correct. Some time later, while away on military duty, he had an insight that classified the newly discovered equations. Subsequent to this, he unsuccessfully worked on a set of problems he did not recognize as related to Fuchsian functions. An insight occurring months later, while on holiday, made clear this connection. Again, Poincaré was sure of its accuracy and verified it some time later upon returning home, except for one last problem. The solution to this remained intransigent and he gave it up. Again later, while hiking, an insight brought the solution. This was a three year process involving the following nine connected steps. The level of awareness in which the thinking processes took place is indicated in brackets.

1. deliberative work on a problem—no results (conscious)
2. subliminal work—insights (subconscious)
3. deliberative work—verification (conscious)
4. insight—classification (intuition)
5. deliberative work on another set of problems—no results (conscious)
6. gestational work on the problem—insight (unconscious)
7. deliberative work verifying the insight—mixed results (conscious)

8. gestational work on the remaining problem—insight (unconscious)

9. deliberative work—verification and closure (conscious)

What is so interesting about Poincaré's experiences is that insights do not appear to come about in the same way in every case. None came from deliberative work, some resulted from subliminal work, some from gestational work which he claimed not to be actively thinking about at the time, but one, the fourth, appears to be truly one of those infamous "leaps" of the imagination. What might that mean?

Perkins admitted that this incident cannot be explained in terms of unconscious thinking if taken the way Poincaré describes it, but concludes that Poincaré must have got it wrong (p. 49). Perhaps some of the confusion clears up if insights are looked at a bit differently. Poincaré's, and others', experiences of insight point to the idea that they do not come from a singular source. Some arise from chance observation (James' "germs" and Fleming's observations of mold are examples of this), some arise from different modes of thinking—subliminal, gestational, or deliberative work (Poincaré reported none from the latter, but Spender certainly did), and those that are truly intuitive. An intuition is a result of direct perception and thus, by definition, intuitive insights would not arise from a process of reasoning, unconscious or otherwise. Looked at in this way, Poincaré got it right and Perkins got it wrong.

The phenomenon of insight may be more complex than either Weisberg or Perkins have considered. If Poincaré's experiences are indicative, it seems certain that insights perform a number of different functions during the process of creative thinking. Those that arose from subliminal ideational flow pointed to the fact that Fuchsian functions did exist when Poincaré had spent weeks trying to prove that they didn't. The second, intuitive insight provided an important new connection between two different classes of equations, indicating there were not one, but two types of Fuchsian function. The third insight equated what Poincaré had first believed to be two discrete series of

problems. The fourth, and final insight resolved the last remaining difficulty by allowing Poincaré to complete the missing step in the final mathematical proof needed to verify that Fuchsian functions exist. Put simply, it looks like some of the functions of insight are to inspire, some to seam-bind, and some to solve problems where other modes of thinking have either been on the wrong track, failed to solve difficulties, or peaked. Given that insights serve specific functions, no insight appears without prior preparation; they are necessarily embedded in all of the concomitant knowledge of a work in progress. The intuitive insight, however, is truly mysterious. One can speculate on the thinking processes that produced the others, but intuiting something is an act of direct perception. It is not known, in cognitive terms, how this might occur.

In terms of more general observations about Perkins' and Weisberg's critique, one minor point should be made. Weisberg claimed there is "strong evidence" that Mozart's letter is a forgery. In fact, the evidence is not all that strong. It would be more accurate to say that the letter was allegedly written by Mozart because one critic noted there may be some doubt about its authenticity (Ghiselin, 1952, p. 44). Comparatively, Mozart's description is not out of keeping with those of other creative thinkers who were able to work extensively in the subliminal mode, if it is granted that new melodies or form, and orchestration were created this way. To claim that whole, complex works were composed like this and needed only to be written out is perhaps a bit fanciful, as evidence of Mozart's edited works do indicate otherwise. It is more likely he worked in both the subliminal and deliberative modes, as did a number of other creative thinkers.

What may be the case with Mozart, and with Coleridge, Kekulé, and others (Nichols, Housman, Nietzsche, Wolfe), is that they are not so much claiming exclusivity for subliminal composition as they are stating a preference for it, or describing how a work or a discovery *originated* in the first place. From their descriptions subliminal work, besides being difficult to describe in "ordinary" terms, is impressively quick, efficient, and effective and is nothing like the slow, rather more arduous and painstaking work

associated with deliberative thinking. Creative thinkers, on the whole, recognized and accepted the importance and place of both modes of thinking in the creative process.

Perkins and Weisberg make much out of the fact that ideational flow results from the use of some inducement to bring about clouds and crowds of ideas, images, and the like, that arose from "unconscious incubation." Coleridge took opium, Poincaré coffee, Mozart and Nietzsche took long rides or walks, and so forth. The critic, Elizabeth Schneider makes mention of the fact that opium, by the nature of the effects it produces, could not have induced the many images and visions from which *Kubla Khan* was constructed. Coleridge himself did not appear to make this claim anymore than Poincaré claimed that his "crowds" of ideas came about because of the intake of caffeine. A number of creative thinkers did, however, refer to strategies they used to blot out external distractions or to keep internal intrusions from the "intellect" at bay. Schiller's affinity for the smell of rotten apples comes to mind; so do Auden's and de la Mare's drinking bottomless cups of tea or coffee, or chain-smoking. Strategies like Nichols' rhythmic repetition of words or phrases that kept him connected to his "subliminal workshop," or the invention of personified friends and editors, like the "artificer," the "collaborator," or "Loplop" also appear to serve the same function. The use of inducements, then, seems more to repress or subsume the deliberative work of the conscious mind than to stimulate the unconscious or subconscious levels of the mind into productivity.

To sum up, creative thinkers' testimonials, considered differently, do not appear to be especially inaccurate or unreliable, though some may be subject to distortions here and there. It does seem inadvisable to look at their reports with a singular focus on thinking processes in mind. Clearly, one creative individual can think in quite different ways and these suit different purposes at various points over the entire phase of the work in progress. Further, focusing on the issue of whether or not there is such a phenomenon as "leaps" of the imagination does not convey the whole picture; insights appear to arise

from different types of thinking and to perform different functions during creative thinking. That they can arise from the level of full conscious awareness where "small steps" systematic inferencing processes take place seems clear; less clear, however, is how insights arise from the subliminal and gestational processes of thinking associated with the subconscious or unconscious levels of awareness.

Subliminal insights come about when thinking, perceiving, and remembering, now freed from the constraints of the conscious state of mind, interact differently. Here, creative thinkers describe how perception, memory, feeling, and emotion converge to play a substantial role in the generative process and selecting insights most likely to solve problems appears to be a function of esthetic judgement, rather than the more serially oriented thinking or "search" processes associated with the exercise of logical judgement. Ultimately, however, it is reason alone that determines or verifies the appropriateness, accuracy, or usefulness of an insight. How insights arise from the gestational or intuitive processes is not known, but it does seem apparent that they do so. Finally, as illustrated in the case of Henri Poincaré, for one, no insights, whatever their genesis, represent a complete break with the past nor do they arise out of the blue. That they can arise over periods of months or years is testimonial to a creative thinker's remarkable memory and ability to sustain high levels of concentration over protracted lengths of time.

Part V: Creative Thinking as Problem Solving

Both Weisberg and Perkins tried to establish a convincing case for not relying on creative thinkers' self-reports as a source of information for understanding creative thinking. Their arguments were framed in terms of extremes, and having eschewed the traditional view of creative thinking at one extreme, they then seek to replace it with its opposite, the problem solving model of thinking. This theme continues throughout their discussions of ordinary

thinking and the mental mechanisms associated with it. Every point made about the systematic inferencing process of rational thinking is presented as the antithesis of the "traditional" point of view with its emphasis on the unique and the extraordinary qualities of creative thinking. Having suggested that the rational thinking associated with problem solving is akin to the deliberative mode of thinking posited in the last chapter, I will focus now on their descriptions of how "creating" comes about in this mode.

There is, of course, agreement between Perkins and Weisberg that the type of thinking employed is that associated with problem solving, but each does make a distinct contribution. Weisberg emphasizes the step-by-step incremental process of problem solving, including case specific retrospective analyses of creating, while Perkins focuses on the mental "operators" involved in rational thinking, trying to establish that these are quite ordinary. On the whole, Perkins presents a much more flexible system of information processing than does Weisberg, but by extension rather than by any fundamental differences. Keeping in mind Pascual-Leone's description of a two part constructivist theory, both Perkins and Weisberg concentrate on situation specific constructions or reconstructions and do not present the structure and process of a "general" cognitive system. Perkins focuses on identifying the particular mental mechanisms associated with ordinary and creative or extraordinary thinking (a difference of degree) and is not concerned with describing the general system within which they operate. As already noted, a concept of mind, if not a description of a general cognitive system, is implicit in their work.

Both theorists have pointed to the importance of analogical thinking in problem solving, which Perkins refers to as "contrary recognition," particularly as it signifies a way of "going beyond" current knowledge and practice to find new directions for thought. Analogy, then, is posited to be *the* mental mechanism that can account for truly novel learning within the confines of the problem solving process of thinking. A closer look at how

effective analogical thinking is as an explanation of concept formation will be provided in Chapter Four.

Weisberg: The Incremental Nature of Creative Thinking

Weisberg's work is focused on the incremental nature of information processing in a problem solving context. He discusses thinking in two distinct ways: logical thinking and analogical thinking. His description of logical thinking is explicitly analytic in nature. Analogical thinking describes the more implicit aspects of thought normally associated with creative thinking.

Logical Thinking

Incremental thinking is logical thinking. To recap, the problem solver moves through an explicit and traceable series of steps that lead from initial premise to conclusion. In problem solving terms, these are considered "move" problems; the premises include the first representation of the problem and any subsequent restructurings of it needed to move from the initial to the goal state within a given problem space. The series of steps taken is called the solution "path" and movement from one step to another consists of the moves or "operators" carried out to reach a sub-goal or a goal state. Because ill-defined problems may have a number of paths, algorithms are methods used to critically examine all possible solution paths in a problem space. The initial representation of a problem is constructed from the elements of a problem along with related prior knowledge already learned. Each subsequent step forward, or backward, in the solution path builds incrementally on the steps that went before. As such, incremental thinking is characterized by its continuous links from the past to the present. For Weisberg, "continuity in thought" is the "cornerstone of all thinking."

> we deal with new situations on the basis of what we have done in similar situations. This belief leads to the expectation that creative works in all domains, even those works that make the most radical breaks with the past, must be based on what was done before. The

> new must begin as a variation on old themes, which may come from the work of others or of the individual in question, depending on the specific knowledge and experience available to that person. (1993, p. 21)

Given enough information about the steps taken to solve a problem, the continuity in its development can be explicitly seen and traced accordingly. Weisberg (1993) cites a number of lab studies that demonstrate the continuity of thought involved in the development of a creative work, if it is assumed "the same thought processes are at work in laboratory problem solving and other examples of creative thinking" (p. 113).

This research includes a number of studies on how various insight problems are solved such as the "nine-dot" problem or Bowers "intuition" problem. In the nine-dots rpoblem, the dots are arranged in three rows of three dots. Subjects are required to connect all nine dots without taking the pencil off the paper and without retracing any steps. They cannot solve the problem without going outside of the dot array and, as such, must transcend the natural tendency to work within the array itself. The Bowers intuition problem requires subjects to read down a list of fifteen words, (times, inch, corner, head, person, math, table, box, and so forth) and try to figure out, that is, "intuit," the one word that each refers to; "square" in this case (1993, p. 55). The Charlie problem is another popular choice for insight studies:

> Dan comes home from work and finds Charlie lying dead on the floor. On the floor is some broken glass and some water. Tom is also in the room. Dan takes one look around and immediately knows how Charlie died. How did Charlie die? (1993, p. 91)

The answer is that Charlie is a fish and Tom is a cat. It was found that subjects (college students) do go through similar processes of step-by-step reasoning, much like hypothesis testing, from Charlie is a person, to Charlie is not a person, to Charlie must, then, be a fish (who, conveniently, had not been eaten by Tom). These are examples of ill-defined problems, particularly the Charlie problem, as it has unspecified operators and a goal state (1993, p. 94).

For demonstrating continuity of thought in analogical reasoning, researchers like to use problems like the "candle problem," where solving it requires drawing on knowledge about how to attach things, or the consistency of wax, and so forth. Subjects are required to "think aloud" while solving it, thereby providing a "problem-solving protocol" for later analysis of the steps involved and how they lead up to the point of analogical transfer of familiar information to the unfamiliar circumstance posed by the problem of figuring out how to attach the candle to the wall with the given objects (1993, p. 98). Whether the subjects use incremental or analogical thinking, or a combination of them, Weisberg concludes that the thinking processes involved do not require anything that could be considered extraordinary thinking.

The task of the cognitive psychologist seeking to understand creative thinking, however, is to explain, in terms of ordinary thinking processes, how something original or novel occurs, that is, how "work based on the past can go beyond it." When this happens it points not to continuities in thought, but to discontinuities where radical shifts in direction take place in the way one thinks and works. According to Weisberg, such shifts can come about in two ways: by some "triggering" event in the environment, or critical examination of a work already done by one's self or perhaps others (1993, p. 22). In either case

> . . . the processes involved are ordinary . . . ordinary thought processes. . . . refer to continuity of thinking as well as to the discontinuity brought about through feedback and through external triggers; ordinary thinking is thus a term covering a family of activities. (1993, p. 22)

Whether continuous or discontinuous, the "basic mechanisms" are the same; assessing the quality of your own work, or assessing the quality of some external "triggering" event that effects it in small or radical ways, requires you to use your critical judgement about its value, potential worth, or effectiveness based on your own knowledge and understanding. Though Weisberg states that triggering events bring about discontinuity of thought,

he argues that in the overall process these are made continuous by the exercise of critical judgement. The use of critical judgement, of course, is an ordinary thought process and, by extension, "creative thinking is based . . . on ordinary thought processes" (1992, p. 23). In all cases, advances in knowledge occur step-by-step; there are no "leaps" forward in incremental thinking, nor is there a complete break with the past. This applies to advances in the arts and fine arts, as well as to those in science and technology. Small steps "accumulate to produce a significant change" (1986, p. 143).

Analogical Thinking

The immediate influence of triggering events on the direction of thought does not necessarily involve explicit reasoning. Whether the triggering event comes from one's memory or externally, its most salient feature is its dissimilarity to the current problem. Relating it to the problem at hand entails a process of analogical thinking where enough "surface" level similarities exist to bring about a reorganization or redirection of thought. Gutenberg, for example, used information gleaned from observing the operation of a wine press to rethink and subsequently figure out how the printing press should be constructed. In terms of analogical thinking, Gutenberg recognized and then was able to "transfer" enough similar elements of the wine press operation to invent the printing press itself (1993, p. 42). It is by use of analogical thinking, then, that the problem solver moves beyond the current state of knowledge, thus enabling discovery or invention of something original and novel. Analogical thinking is posited to follow a particular process, as evidenced by research into the use of analogies in problem solving.

Within the scope of problem solving, analogical thinking involves the transfer of information from a known or familiar similar situation to one that is problematic where it functions to resolve the difficulties. There are two kinds: "near" analogies and "far" analogies. A near analogical relationship

exists between two (or more) objects or situations when they are very similar, that is, their structures and surface features are identical or nearly so. The familiar analogy is called the "base analogue" and the problem is referred to as the "target" problem. Based on the close similarities between them, the solver apprehends the information needed from the base analogue, then transfers it to the target situation, applying it to solve the problem. A far analogical relationship exists when the base analogue is considered to be only remotely related to the target problem. In this case, elements are not obviously similar and the solver must be able to formulate a "schema" of the base analogue abstracted from those elements remotely connected to the problem.

It is the far analogy that traditionally has been considered the hallmark of truly creative thinking. According to Koestler's (1964) theory of bisociation, the creative thinker is able to see abstract and obscure connections between things in ways that most of us cannot. Kekulé's immediate connection between the image of the body and motion of a snake (familiar base analogue) as a configuration for strings of atoms (target) is an example of far analogy and how new understandings arise from the spontaneous apprehension of them. If belief in the function of far analogical thinking is left uncontested, however, then Weisberg's argument for small step incremental thinking based on the continuity of thought could not adequately account for creative thinking and, most importantly, the contention that it is quite ordinary. After noting that imaginative leaps are "difficult if not impossible to demonstrate under controlled conditions" (1986, p. 33), He argues against the use of far analogy in creative thinking by trying to demonstrate that spontaneous transfer does not, in fact, occur.

Weisberg does this by citing lab studies on base and target analogues which show that subjects did not spontaneously abstract schemas from the base analogue, even when it depicted a situation that was reasonably similar, not remote, to the target problem. Some examples of analogies used in these studies are as follows—first the target:

> Suppose you are a doctor faced with a patient who has a malignant inoperable tumor in his stomach. Unless the tumor is destroyed the patient will die. There is a kind of ray that can be used to destroy the tumor. If the rays are directed at the tumor at a sufficiently high intensity the tumor will be destroyed. Unfortunately, at this intensity the healthy tissue that the rays pass through on the way to the tumor will also be destroyed, which will kill the patient. At lower intensities the rays are harmless to the healthy tissue but they will not affect the tumor either. What type of procedure might be used to destroy the tumor with the rays, and at the same time avoid destroying the healthy tissue? (1993, p. 107)

next, the base analogue:

> A general was trying to destroy a fortress which was situated at the center of a country with roads leading in to it, by using his army. He needed to use his army as a complete group in order to destroy the fortress. However, he could not march his army down a road to the fortress because the roads were mined to explode when large groups of men passed over them.
>
> After considerable thought he knew just what to do. He divided his army into small groups of men, and, by sending these groups simultaneously from a number of different directions, they converged on the fortress, making up a sufficiently powerful army to destroy it. (1993, p. 107)

In order to solve the target problem, the subject must first *store* and *retain* the base analogue in memory. Once this is done, it is now "potentially retrievable." When the target problem is presented, the subject first *constructs a representation* of it and then should spontaneously *abstract* the similar elements from the base analogue and *map* them onto the target problem. In this way, the solution to the problem is *transferred* from the base analogue to the target and *guides construction* of the target problem solution. If no spontaneous transfer occurs, then the subject has failed to form an "abstract schema" from the base analogue. The italicized terms represent the mental mechanisms involved in analogical transfer.

According to Weisberg, subjects in these studies did not make a spontaneous connection between the situation portrayed in the target and the

similar one given in the base analogue. This was the case when base and target were presented one after the other or, to rule out overlap, with some intervening time between. In fact, success at transfer appeared to be concomitant with the amount of hinting or explanation received from the researchers about the relationships between the base and target analogues, (1993, pp. 109–112). In other words, the researchers provided aids to schema abstraction. Only in cases where the structures and elements between base and target were identical, or very nearly so, did spontaneous transfer take place. Weisberg concludes from these studies that, by association, the likelihood that creative thinkers made connections from remote analogies is minimal. Hence his pronouncement that Kekulé was probably not dreaming at all; he was imagining strings of atoms "represented in some way, in various configurations, and he used "snakelike" to communicate this to his listeners" (1993, p. 112).

This is another instance of reinterpretation of a creative thinker's account that points to the fact that the person simply did not understand very well their own thinking process. Weisberg doesn't say what he means by "imagining" but Kekulé was quite clear about it. The solution came in a dream-like, meditative state. This issue will be taken up again in the next chapter by taking a closer look at how the poet, Nichols, used analogy to find words to express particular meanings. Nichols' experience presents a clear cases of the use of far analogy.

In sum, Weisberg has argued that there is nothing extraordinary about either logical or analogical thinking. Both can be understood and explained in terms of the incremental thinking processes involved in the continuity of thought. Discontinuities in thought, arising from memories or from triggering events that arise from chance observations or encounters, are made continuous by the process of critical judgement. He claims that the evidence for spontaneous transfer of remote analogies, which could be considered an instance of extraordinary thinking, is exceedingly weak because lab studies have shown that even when two or more analogues are similarly related in

structure or content, or both, little or no spontaneous transfer occurs. Based on this evidence, Weisberg suggests that creative thinkers' descriptions of discoveries coming from remote analogical transfer are unlikely to have happened in the way they were reported to occur. His reinterpretation of Kekulé's dream shows the experience to be quite ordinary.

Comments. It seems inconceivable that Weisberg would overlook the numerous instances of the occurrence of far analogy in creative thinking. Koestler's work on this topic provides so many documented cases of the phenomena that it is highly unlikely that every creative thinker who described it did not experience it as reported. Most importantly, these experiences occurred spontaneously and in periods during or following emotionally and intellectually intense concentration on the work. By comparison, lab studies on base and target analogues are so contrived as to bear little resemblance to how analogical thinking most often comes about in a more natural setting. So little, in fact, it may be just as plausible to conclude that Weisberg's research results could be interpreted to show how to teach students to look for resemblances between things. This may make students more adept at recognizing that something is an analogy or at thinking them up when needed. Further, analogical thinking is defined to be direct apprehension of relationships between two or more things and, as such, would be spontaneous, which would lead one to question whether or not a schema would need to be constructed to aid in the task of "mapping." Unfortunately, Weisberg chose to criticize creative thinkers, in this case Kekulé, instead of questioning the merits of his own and similarly related research on analogical thinking.

Weisberg is aware, of course, of the obvious question that if all we need to be creative is ordinary thinking processes common to everyone, why then are we not all Mozarts, Einsteins, or Picassos? His answer is simply that we do not all possess the same levels of expertise, motivation, and knowledge required to produce a great creative work.

> We all possess . . . various skills to some degree, although usually not to the degree needed to perform at a high level of proficiency in a creative domain. . . . It is probably also true that . . . skills can be improved with work and study, although there are inherited limits set to development. (1993, p. 24)

There is no general set of abilities identifiable as uniquely creative that cuts across various "domains" of knowledge; each has its own special set of requirements. A great mathematician, poet, scientist, or composer is a talented master of his or her own craft. There are common characteristics to be found amongst creative individuals from different domains, but these pertain to high levels of motivation, talent, and productivity rather than to domain specific knowledge and expertise per se. Motivation and talent are necessary, but not sufficient conditions to produce creative work; one must also have acquired great depth of experience and knowledge over many years of hard work before a "masterwork" can be created. Thus, thorough immersion in a chosen field, with the concomitant "deep expertise" that develops, provides the additional sufficient condition that must be in place before "one becomes capable of going beyond what has already been produced" (1993, p. 25). Thus, the differences between "us" and "them" are differences of degree, and are not due to possession of distinct cognitive abilities or personal characteristics that set creative thinkers apart.

It is interesting to note that Weisberg does not follow up on the notion of "inherited limits," as this clearly is an admission into his argument of individual variability which suggests that some differences may be innate and therefore not simply a matter of degree. Lots of people have acquired Weisberg's necessary and sufficient conditions to be truly creative. One only has to think of the disciplinary expertise available at any given, reputable university. Few, however, achieve at the level of the genius.

Although Weisberg doesn't explicitly say so, high levels of talent, motivation, and productivity could be construed as the non-cognitive or other "organic" factors needed to account for occurrences of truly "novel behavior" as Pascual-Leone put it. Nonetheless, to "go beyond" a given situation means,

for Weisberg, reconfigurations of prior knowledge through the action of critical judgement or transfer of closely related knowledge from one situation to another through analogical comparison. Pascual-Leone does point out, however, that truly novel learning is neither a new configuration of something that is already known, nor is it "mere transfer" of knowledge. To be truly novel, the behavior in question would never before have been produced.

Thus, although a radical discovery may enjoy continuity of fit within the overall development of a given cannon of knowledge and is traceable as such, the shift itself represents a complete break with traditional knowledge and practice, signaling a whole new direction of thought. These are the radical changes that occur when current knowledge and practice have reached a stage where they can no longer provide answers to intransigent difficulties imposed and bound by the constraints of the current view. Beethoven's music signalled a shift from the Classic to Romantic periods in music; Wordsworth and the Romantic poets moved poetics beyond the constraints of the Classical period; Faraday discovered (intuited) the presence of mysterious "lines," Clerk Maxwell translated this work into mathematical equations, the ensuing results of Einstein's thought experiments enabled knowledge to transcend the limits of Newtonian physics, and discoveries in quantum mechanics moved thought into the realm of probability, thus enabling the science of physics to once again change and go beyond the limits of relativity itself. In these cases, prior knowledge wasn't merely "mapped" onto a problem, nor was it reconfigured to fit another circumstance, rather, the nature and scope of entire cannons of knowledge and practices were completely superseded by each new discovery.

Finally, one should be able to look at Weisberg's description of thinking associated with the problem solving model and be able to do more than just point to the mental mechanisms or "operators" that account for a range of cognitive activity in this model. These are the mental activities responsible for the step-by-step constructions and reconstructions that occur while

moving through the problem space from initial to goal states. Such terms as "store," "retain," "retrieve," "abstract," "construct (representations)," "transfer," and "map," for example, need further explanation about how they actually *work* in the discovery process. While Weisberg identifies such terms when talking about reconstructions of information in the context of problem solving, he does not actually explain them. In order to do so, he would have to provide a theory of how the mind works, that is, of the general cognitive system, to use Pascual-Leone's term for it. Piaget, for example, looked for the presence of universal "operators" in children's interactions with experiences that moved the developing child from one stage to the next. Each experiment was meant to demonstrate the presence or not of such operators at a given stage and provide concrete evidence of how they worked. From this work, Piaget was able to come up with a general description of how the mind works and develops. In the absence of such a general explanation of mind for the problem solving model, it is unclear just what "ordinary thinking" means beyond the rather vague notion that we all do it because we all solve problems (in a particular way), and sometimes creatively to a greater or lesser extent.

Perkins, on the other hand, makes a concerted effort to specify and explain the mental operators involved in "ordinary" thinking processes. Perkin's overall goal is to "make the strange familiar" and to "show how creating in the arts and sciences is a natural comprehensible extension and orchestration of ordinary everyday abilities . . ." (1981, p. 4). He does this by identifying and describing the ordinary "operating characteristics" of various mechanisms of thinking, claiming that these are sufficient to understand acts of creative thinking as well. Viewed this way, creative thinking is not a unique species of thinking, rather, it is an extension of those ordinary thinking processes used in everyday practice. Perkins does not provide a description of a general cognitive system either. But, unlike Weisberg, he is at least aware that one is implied, as he claims it is not necessary to know how mental operators actually do the work that he (and Weisberg) ascribes to them (1981, p. 5).

Perkins: Mental Mechanisms of Creating

When Perkins talks about something being "creative" he means that it is "original and of high quality," which he distinguishes from "creating" which "means explaining how the originality and quality "get into" or "get put into" the developing creative outcome during the making process" (p. 6). Of concern is how he explains the thinking processes associated with the work of creating. As already discussed, Perkins begins by discrediting creative thinker's testimonials, looks at other kinds of research that purport to support the more "extraordinary" features of creative thinking in terms of its inadequacies, and then puts forward an argument for ordinary thinking processes generally organized around the problem solving model and the laboratory studies that support it. The empirical data derived from laboratory studies include the uses of "think-aloud protocols" and "reflective reasoning" in problem solving tasks. As he makes reference to some of these studies to make various critical points throughout the book it may be helpful to know what they are like.

There are two methods for gathering data on the steps involved in problem solving, think-aloud protocols and reflective reasoning. A think-aloud protocol is a written or taped record of what the problem solver is saying while talking out loud about the problem (not about thinking) over the course of solving it. Some prior training and practice in how to do this is generally given before proceeding with the study. Reflective reasoning refers to the "retrospective report" given immediately upon completing a task. It too is a written record of what the problem solver did to find the solution to a problem. In this case, the researcher asks questions about each of the steps taken from initial to goal state, such as, "was the person sure of remembering it? Could anything else be added? Did any mental imagery accompany a step?" (p. 45). The "bronze coin" problem is one example of such a task. In this case, data are gathered by recording responses to a series of questions requiring reflective reasoning. Another example concerns demonstrating, via poetry composition, how insights can come about through a process of

reasoning. In this case the subjects provide think-aloud protocols in the presence of the researcher. In the bronze coin problem

> A stranger approached a museum curator and offered him an ancient bronze coin. The coin had an authentic appearance and was marked with the date 544 BC. The curator had happily made acquisitions from suspicious sources before, but this time he promptly called the police and had the stranger arrested. Why? (1981, p. 45)

Perkins gives two examples of how subjects solved this problem. In the first instance, "Abbot" solved the problem via insight, and in the second, "Binet" reasoned through to the solution (p. 46). In the first case as well though, the subject did make a few steps in reasoning before achieving the insight. The answer, of course, is that since BC means Before Christ, the coin could not have been dated prior to the as yet unknown date of Christ's birth. Thus, the solution to the problem requires that subjects detect a logical inconsistency in order to find the answer.

The experiment on poetry writing was designed to show how insights can emerge from a process of reasoning with no other "special mental activity" involved. In this example, a professional poet was asked to draft a poem in a special lab session. She came in with a particular idea, namely, "the day proceeds like an air raid drill," based on her thoughts about how her children sound. Using the metaphor between air raids and her children she then constructed the poem line by line without direct reference to the babies. At a certain point she realized that she needed to find a deeper level of the metaphor to get beyond the superficiality of the poem. As Perkins reports,

> The poet thought about this without making much progress. Then she read the poem through from the start, ending with the lines *I am still fighting that cold war / alone. The wailing babies . . .*" Then she said, still thinking aloud, "Aha! It has to do with . . . preserving your own life first. I think that's what this has to do with actually. Maybe I'll call this poem "self-preservation." (p. 67)

Perkins followed the insight experience from the think-aloud protocol with some reflective reasoning questions to get at the actual process the poet might have followed prior to the appearance of the insight. She said:

> Well, I was thinking, (reads) and I am still fighting that cold war alone. The wailing babies—what did they signal me to do? What is it a signal for me to do? And actually, (pause) why do you hide? It's because you're trying to preserve yourself, and that's what the babies are signaling me to do too, because basically I can't, I don't tolerate them very well, and it does me in so much that I have to leave them and go into silence, someplace that's silent so I can preserve myself. (pp. 67–68)

Perkins is satisfied that, though the insight occurred from a spontaneous chain of thought, this account demonstrates the step-by-step logic that went into it, "spontaneous or not." This experience does bear some similarities to Spender's description of the "plodding" poet. It will be recalled that Spender first felt a strong sense of disgust and despair at the ugliness of the Black Country he observed from the train window. His thoughts then followed along a sequential chain to produce the insight "a language of flesh and roses," giving him a fragment for a new poem. Although, unlike Perkins' subject, Spender clearly knew what the poem was about *before* he began the work of line by line construction. What was most important for him and for the other poets reviewed earlier was the need to preserve the inspirational meaning throughout the work, no matter how the poem is composed. This point will be revisited below when discussing Perkin's views on the role of "purpose" in creating.

Comments. Perkins does ask, "Could the poet be rationalizing her report? Was the real process more haphazard? There's no way of determining for sure. All that can be said is that the poet reported as she did, and her report gives a plausible explanation of her insight. All in all, I'm inclined to take her report seriously" (pp. 68–69). Given the nature of the questions Perkins raises, one can't help but wonder why this poet's report is more credible than that of a Housman, Nichols, Lowell, or Coleridge? The only plausible reason, and one I think Perkins would give, is that he was there to observe and

record what she said under "controlled" conditions. The presence of a psychologist, however, does not allay the possibility that reflective reporting will include post hoc rationalizations, distortions, and the like, any more than his absence will encourage it. Accepting this poet's report as credible seems just as much an act of faith as accepting those of acknowledged creative thinkers.

Could it also be the case that "subliminal" thinkers are more suspect simply because the way they work bears little resemblance to the kinds of descriptive terms and thinking processes amenable to the design and methods of psychologists' studies of problem solving? This is, of course, a critical question and Perkins' response to it is to show how subliminal work is not subliminal, but deliberative (to use my borrowed terms for these processes). He includes the feeling tone in this as well. Perkins allows that his studies are quite unlike the insights experienced by the likes of Einstein or Poincaré, but he does claim that

> . . . the feeling of the experience seems much the same, and . . . much the same psychological mechanisms appear to be at work. Accordingly, insight problems provide a way of manufacturing in the laboratory experiences of insight for study. (p. 44)

I will subsequently argue that the felt experiences are not at all the same, but for the present it is important to get a clear idea of how Perkins sees ordinary mental mechanisms operating in creative thinking. Following are Perkins' views on the mental mechanisms associated with ordinary thinking and how he sees these as operative, by extension, in creative thinking.

Mental Mechanisms

The mental mechanisms associated with ordinary thinking put forward by Perkins are meant to replace the more exotic notions traditionally associated with insight and unconscious "incubation." The question of whether or not insights occur at all is not at issue, nor is the question of whether or not we

use the unconscious mind for doing mental work. He suggests that we do both, and they operate in the service of ordinary and creative thinking. Thus, for Perkins, both insight and unconscious processing are legitimate cognitive phenomena, but they need to be understood in rational terms. To this end, he introduces as concepts for ordinary thinking those of recognizing, realizing, noticing, reasoning, directed memory search, contrary recognition, and feelings and emotions as they are posited to operate in perceiving, remembering, and understanding in both ordinary and creative mental acts. The following descriptions are taken from Perkins' (1981) book, *The Mind's Best Work*.

Recognizing

Perkins uses the term "recognizing" to illustrate one way to account for occurrences of insight. He states that the traditional view of insight holds that "mental leaps are explained by an accelerated thought process special to insight which compresses considerable normal mental effort into a couple of seconds" (p. 58), and further, it is held that "what normally happened in a plodding way sometimes occurred much faster" (p. 59). Perkins views this as straightforwardly false, noting that there is no evidence to support the idea that some "high gear" process can do "the work of hours in seconds." Nothing here in terms of the quality of thinking has changed, only the rate and compressed volume of it. Using the example of Darwin, who arrived at the theory of natural selection by insight, and Wallace, who achieved the same thing by an incremental reasoning process, Perkins draws attention to the fact that, for some, thought occurs more rapidly than for others, a "deftness that deserves attention." This, however, is not the total picture. He also notes the gains made in efficiency of thinking when one has had a great deal of experience with something, thus being more able to quickly identify nuances of style, presentation, and the like. He says, "with experience, acts of recognition take over from acts of analytical identification, a dramatic gain in efficiency" (p. 59). In short, recognizing is a case of "abrupt identification" and constitutes the "reality" of rapid mental processing. Perkins concludes that,

in the case of the traditional view, nothing changes, "everything happens in the same way only faster"; by contrast, in his reinterpretation of such claims, the individual has made qualitatively better gains in efficiency. Recognizing is, of course, a quite ordinary mental activity, being a constant in all sorts of commonplace, everyday mental events. Thus, if "recognition is important to insight, it certainly isn't special to insight" (p. 59).

Comments. Perkins' observations about "recognizing" as a form of "abrupt identification" are intended to explain how some insights occur. His view focuses on the relationship between efficiency of thought and cumulative experiences. Likely no one would deny that a great deal of experience and expertise in a certain area makes for more efficient thinking habits, but this way of looking at it shows that Perkins may not have understood the phenomenon as it relates to creative thinking in two ways: first in terms of his example, and second, what it is that creative thinkers are trying to describe.

In Perkins' example, Darwin used insight and Wallace used incremental reasoning to achieve the same end. Does this mean, then, that Darwin had more experience than Wallace and therefore could think more efficiently? It is doubtful that either Edison or Rosanoff would agree with this claim as each was "efficient" in the way that suited his own preferred mode of thinking. In the second instance, creative thinkers who experienced ideational flow during periods of subliminal thinking equate the efficiency of it to the ability to tap into their own store of accumulated knowledge. This knowledge is not labouriously sought for; it is described to "come" in rapid and voluminous flow and the selectivity of certain parts of it also "comes" forward from it powered by the felt experience of knowing. The experience then, is, involuntary. As such, it bears only a superficial resemblance to Perkins' idea that such descriptions merely depict speedier thinking with no gain in efficiency.

Realizing

Realizing is another component of insight. It is related to recognizing, but in this case it refers to "abrupt understanding." According to Perkins, "we simply realize what we instead might have had to work out" when "things fall into place" (p. 60). Like recognizing, realizing is effortless and functions primarily as a process of "filling in" situations where information is given in such a way that meaning is implicit and must be inferred from the context. Perkins notes that "this talent for filling in is a pervasive characteristic of human thought and perception" (p. 61). Thus, realizing is another ordinary thing that we do in the course of everyday experiences.

While Perkins acknowledges that a "heady sense of discovery" to insight, which feels subjectively different from ordinary acts of realizing, is frequently reported to be part of the experience, it is, in fact, not different in kind. The mind work for both is identical. The so-called "Aha!" experience is something keenly felt by a particular individual and the strength of the feeling is relative to the meaning of the achievement for that person. This gives it a "quality of significant discovery that colors the experience" (p. 62). What Perkins is stressing here is the tie between the feeling of achievement as it relates to the product and not the process itself. In sum,

> Recognizing and realizing routinely involve filling in, but we reserve the names mental leap and insight for those occasions when (1) the pattern or understanding arrived at makes significant sense of previously less organized or differently organized information; and (2) the person fills in more than would ordinarily be expected. (1981, p. 65)

Looking at recognizing and realizing in terms of creative thinking means, in this case, that first, incremental inferencing takes place when meanings in context are implicit, and second, that prior knowledge is organized or reorganized in some significant way. Thus, "realizing" changes from routine "filling in" pertaining to rationally ordered incremental

inferencing to leaps of insight where prior knowledge is reorganized in a more meaningful way.

Comments. Certainly, some insights function to reorganize knowledge in routine or in more significantly meaningful ways, but some do not. Some function to generate new meaning in the first place. The inspirations experienced by composers, poets, and writers bear testimony to this experience. In these instances, the insights are, again, known and strongly felt to contain the kernel or "germ" of a new understanding, forms of expression, or melody —one that has yet to be made manifest in the medium of expression concerned. In fact, the import of the new understanding is so powerful that great care is taken to preserve it in all its pristine beauty and form over the course of development of the work. The failure to do so often led to setting the work aside for a time or abandoning it altogether. Insight as inspiration could be seen as "recognizing" or "realizing" that you are onto something new, but to consider it in such a superficial manner overlooks or obscures the powerful emotional import of those *initial* experiences from which new meanings spring. To equate the felt part of such experiences with what individuals personally feel about their achievements is, perhaps, to put the cart before the horse.

Noticing

Noticing refers to "out of place" recognitions that arise from "unfocused attention." What Perkins means by this is that rather than examining a work by focusing on it one part at a time, we tend to scan it and notice difficulties or any elements that may be amiss. "Noticing in such cases is supported by the context: the maker notices things relevant to the activity underway" (p. 82). Thus defined, noticing is much more efficient than having constantly to search for discrepancies, errors, and the like. In situations where intense work on a problem has taken up a great deal of attention, for example, we are more likely to notice the solution in unusual or unrelated circumstances. Archimedes' discovery of how to weigh the gold in the crown while noticing that his bathwater was displaced when he stepped into it is one instance of

noticing that had very important consequences. There is more to noticing than those experiences pertaining to external events, however. According to Perkins,

> . . . we miss the full importance of noticing and recognition in general if we only consider recognizing things in the world. Our thoughts too, are events of a sort and we can notice in them patterns and concepts leading to insights about other contexts. (p. 82)

In creative thinking, noticing in external contexts would be more akin to acquiring insight by a chance observation, while noticing in an internal context brings to mind particular thought patterns or concepts which would be insights based on information already acquired. Noticing, like recognizing and realizing, is active in the more mundane acts of cognition as well as in creative thinking.

Comments. Although Perkins presents recognizing, noticing, and realizing as specific concepts, it is not altogether clear just how distinct their functions are. Archimedes, for example, could have recognized that bathwater rises when an object, namely himself, is submersed in it, perhaps by observing two different ring levels in the tub, or he could have realized that that is what water does when you submerge yourself in it, or he could simply have chanced to notice that his bathwater was displaced while busy splashing about looking for some soap. Generally, the terms are not clearly distinguishable and this is further complicated by Perkins' claim that recognizing, realizing, and noticing are done mundanely or creatively. The difference is a matter of degree. It is also not clear what the demarcation point would be on the scale from mundane to creative, and the specific attributes that would need to be in place to signal the change from one level to the next are unknown.

Directed Remembering

According to Perkins', remembering, although a pretty ordinary experience, can also do the work of creating just as do recognizing, realizing, and noticing. Inventors or "makers" like artists, poets, and scientists, seek to express the unusual in the quest for freshness and originality, or seek to solve the most difficult problems. Directed remembering plays a role in such activity because it is the means we use to probe stores of prior knowledge in order to bring forward information pertinent to the purpose or task at hand. Perkins states that "it's profoundly important that you can ask your mind for something—even when unusualness is a desired property—and, at least some of the time, expect to get it" (p. 77). A poet, for example, searches for just the right phrase or word to express a particular meaning. From Perkins' description it is clear that directed remembering is focused, but he notes there may be a "penumbra" of elements that surround the particular case which could readily move into the search space if recognized to be relevant. Accordingly, "the way people direct their remembering—and thinking in general—involves a curious mix of the explicit and the tacit" (p. 78).

Comments. Perkins idea of the penumbra bears some resemblance to Galton's notion of the "antechamber" of consciousness. In Galton's case, however, the antechamber "thronged" with myriads of ideas logically related to those occupying full consciousness, from which some were "summoned." His account is more akin to similar descriptions given by Wolfe, Poincaré, and others who describe the experience as wholly involuntary, an event over which reason has little control. Perkins has touched upon something important to creative thinking but he does not discuss what he means by penumbra. Given that the individual is understood by Perkins to be deliberately seeking the unusual or the most difficult, penumbra likely refers to the "fuzzy edges" of the ideas or concepts on which the person is focusing with the outcome that the person recognizes or realizes or notices that some things, heretofore unsuspected, are connected? Perkins' idea of the penumbra is governed by the notion of directed, deliberative "search" and under this

constraint, precludes entertaining the possibility for occurrences of the involuntary free flow of ideas that may, in fact, be triggered by search, but not controlled by it, as in the example given by Poincaré.

Reasoning

For Perkins, a process of reasoning takes place "when each thought can be considered an inference from prior thoughts. . . . reasoning has to do with the pattern or structure of thought, regardless of pace" (p. 71). While realizing involves rapid mental activity, reasoning occurs at a much slower pace, following incremental patterns of step-by-step logical analyses. In the descriptions given above, reasoning is cast somewhat differently in each of recognizing, realizing, noticing, and directed remembering. So too with reasoning, as Perkins casts the incremental reasoning process as acts of evaluative judgement. As much of the incremental nature of creative thinking involves ongoing assessment of one's progress over the course of producing a work (as Weisberg has certainly argued), critical judgements are more typically considered analytical in nature. Perkins, however, claims that evaluative judgements are really a cross between intuitive and analytical judgements.

Perkins argues that the general tendency is to juxtapose reasoning with its opposite, which is intuition. But, he says, even intuitions come from having reasons, although in this case, a process of "reasoning out" is not involved. According to Perkins "a judgement is intuitive when there are no conscious reasons for it" (p. 105), and he gives as a lighthearted example, the fact that we associate villains with those who wear black hats. So, when someone wearing a black hat comes on stage we intuitively know that person to be the villain—"there was just something about him"—though we may not particularly reason it out. The point is there is a reason, it is just not arrived at consciously. Using this example, Perkins is trying to show how judgements are really neither intuitive nor analytical; they are somewhere in between, and "just there . . . much of critical response occurs" (p. 105). Judgements,

then, are a cross between past reasoning out and current evaluative responses to a work. In reference to his research on the matter, Perkins concludes:

> All the results support the suggestion that critical response involves judgments neither intuitive nor analytical in character. Rather than reasons not accompanying judgments at all, or judgements resulting from applications of explicit standards or other sorts of extended reasoning, or reasons for judgement deriving from an extended effort to reason out the causes of one's likings and dislikings, rather than any of these, for the most part reasons come spontaneously right along with one's pro and con reactions. (p. 107)

These judgements result, then, from the "fused nature" of evaluative responses—"free of overt reasoning and intentional analysis but full of reasons" (p. 109). To regard them as straightforwardly intuitive is in error; critical responses are neither analytical nor intuitive, but a mix of both. In short, reasoning does not occur spontaneously, but reasons certainly do.

Perkins also attacks another common belief about how creative individuals evaluate their work. He refers to the labourious process of making analytical judgements. Perkins calls this "looking harder" and it involves two strategies: "looking at" particular parts of the thing to be assessed, and "looking for" particular features or kinds of features" (p. 110). In these cases, attention is consciously and deliberately focused on the task at hand in order to scrutinize either positive or negative features of a work. Perkins suggests that examining a work in this manner would be too time consuming, tedious, and possibly very discouraging. He thinks that a work seldom undergoes such "piecemeal" examination. Instead, it is examined all at once. A "maker" doesn't look for problems and difficulties, she or he notices them.

> . . . the maker expecting to notice whatever needs attention stays open to everything at once. In the long term of months and years, the trade of more sensitive evaluation for more time spent may not be worthwhile: the maker could gain more by doing more projects faster and by becoming a better and better noticer. (p. 113)

Critical judgements then, are made much more reflexively than is normally supposed, which suggests that a process of unfocused scrutiny is involved rather than deliberate step-by-step reasoning. As with noticing, reasoning, understood to be unfocused scrutiny, is much more efficient than setting out to do a series of painstaking and deliberate, small-scale evaluations of a work in progress. In this way, Perkins extends his description of how critical judgements are made in creative as well as more mundane thinking.

Comments. In his description of reasoning, Perkins is once more trying to show how mental activities traditionally considered mysterious and unknowable are straightforwardly understandable in rational terms. An intuition, he states, is a judgement made without conscious reasons. It is unlike an analytical judgement which is arrived at by a conscious process of reasoning. The former comes from "past reasoning out" and the latter is reasoned out in the present. According to Perkins, critical judgements are a mix of both. A standard dictionary definition of an intuition, however, defines it to be the direct perception of a truth or facts *without* reasoning, including, one would suppose, the past reasoning out of something. One can, of course, remember intuitions made in the past, but that is straightforward recall, not reasoning. Judgements that spring from a combination of present and past reasoning out, whatever else they may be, do not come from intuitions. Rather, in Perkins case, they appear to be more like stereotypes, already established beliefs, or routine patterns of thinking about things applied and adapted to present circumstances. By his own definition Perkins can say that judgements are a blend of present and past reasonings but he cannot make the claim that intuition has anything to do with it.

Contrary Recognition and Bisociation

Contrary recognition refers to acts of perception that allow us to create patterns of analogical and metaphorical thought. Perkins defines this as "the process of coming to "see as," that act of mind and eye by which we discover counterfactual appearances" (p. 84). A thing is perceived in more than one way, that is, it is "noticed" in other than its literal sense, or it can be "deliberately apprehended" to be something other than what it is. The mind performs this feat with ease whether seeing actual objects or with sensory stimuli within the mind itself—images, sounds, or ideas. Perkins mentions Kekulé's by now oft-quoted metaphor of atoms as snakes as an example of contrary recognition in scientific discovery. Unlike Weisberg, he acknowledges that this is an example of remote analogy, or bisociative thinking in Koestler's terms, but argues that this more dramatic kind of analogical thinking is a rare occurrence in creative thinking.

Perkins has argued instead that sudden, spontaneous insights are more commonly due to recognition (abrupt identification), realizing (abrupt understanding), directed remembering (deliberate search; penumbra), reasoning (making critical judgements), contrary recognition (analogy), or noticing (unfocused scanning) than to incidences of remote analogy. "All these mental resources function routinely in everyday matters, but also on some occasions do the work of invention. Such resources are parts of a case against the need to posit special mental faculties to account for creating" (p. 91). Of course Koestler's biggest claim is that the work of connecting in remote analogy is done by the unconscious mind. Perkins has argued strenuously against just such an idea throughout his book. He sums it up as follows:

> First, people aren't all that unconscious during the process of creating, as the think aloud methods I have discussed show. Second, I've argued that there is no evidence at all for extended unconscious thinking. Third, clearly the work of the unconscious usually concerns routine, entirely uninventive matters. . . . Fourth, thinking that breaks the rules is easy to do quite consciously and deliberately. . . . *Significant* rule breaking is rare, of course, but rare whether conscious or unconscious. (p. 94)

Perkins notes that whether rules are kept or broken has little to do with the "degree of consciousness" involved. But, in fact, he doesn't really talk about consciousness in terms of degrees of awareness as most of his arguments are organized around the idea that thinking is either conscious, or it is unconscious but nonetheless directed by a process of reasoning. In either case, ordinary thought processes do the work of creating.

The idea of bisociation, on the other hand, points to the presence of an extraordinary thought process and, Perkins notes, because Koestler has documented so many cases of it in creative thinking, instances of far analogy must somehow be accounted for. He does this by arguing that ordinary acts of mind such as noticing, contrary recognition, recognizing, realizing, and directed remembering are small-scale bisociations. He notes that

> . . . most of the time such bisociations don't achieve much originality . . . However, sometimes the yield is richer: a truly creative synthesis of remote frames of reference to achieve a revealing insight. When this occurs, there's no reason to suggest that fundamentally different processes are at work. The contrast between dramatic and mundane rememberings, noticings, and contrary recognitions is of degree and good fortune, not of kind. (p. 97)

Thus, there are shades of bisociation from near to far, and the line between what is truly creative, and what is perhaps interesting but still ordinary is rather more continuous than discrete.

Comments. Some things are unclear about Perkins' claim that most bisociations consist of small-scale noticing, recognizing, realizing, directed remembering, and reasoning, and are not just contrary recognitions (analogy, metaphor) or bisociations (far analogy). First, in each case, Perkins is saying that these mental acts operate in ordinary thinking and also in more extraordinary thinking considered to be creative, and second, that they are all understandable in rational terms. First, it is unclear whether or not mundane recognizing or noticing, and realizing, considered in terms of the ordinary acts of taking notice of, attending to, heeding, or observing, or being fully aware of, none of which are necessarily insights, occur abruptly. Under

what conditions would any one of these be considered an insight? Is it the case that abrupt identification and abrupt understanding refer only to the more dramatic insights and "aha!" experiences? In short, is the difference due to the abruptness with which these events occur? If so, then abruptness would be an attribute of specifically creative thinking, the very thing Perkins is arguing against. The idea of "small-scale bisociations" suggests that some, probably most, insights are mundane. On what grounds is an insight judged to be mundane as opposed to creative?

Second, there are two distinct types of mental activity represented by the concepts put forward by Perkins—rational thinking processes and direct acts of perception, referring to direct apprehension of relationships between facts, things, or ideas. Contrary recognition and bisociation cannot be understood exclusively in rational terms because they are not necessarily products of "reasoning out"; they are also acts of perception. Conversely, noticing, recognizing, realizing, reasoning as in making critical judgements, and directed remembering, in the way Perkins has described them, are rational processes or at least are connected or governed by reason. Thus, to claim they are all small-scale bisociations is to confuse the difference between logical thinking and analogical perceiving.

Analogy points to perceived similarities between two or more things in terms of some of their attributes, relations, or effects, like the analogy between sleep and death, for example, where repose, cessation of activity, cessation of conscious awareness, and the like, are understood to be related. Analogy in creative thinking frequently concerns correspondences made between appearance and reality or between the sensible world and the spiritual realm. Creative thinkers having these experiences are unanimous in their assertions that these are not "thought out." Instead, they are directly apprehended by the senses, by insight or by intuition.

A Teleological View of Inventing

Perkins has a small section in his book where he addresses the "essence" of inventing. He is looking for the one, overall element that ties together all the various aspects of ordinary thinking. What is it, for Perkins, that makes thinking creative? It is "purpose," and purpose includes both striving to be original and trying to do something difficult.

> Purpose is what organizes the diverse means of the mind to creative ends. First and most simply, on many occasions people try to be inventive *as such*. Scientists seek new phenomena and theories, artists strive to develop fresh styles. It's odd that this has been so overlooked as an important explanation for creative accomplishment. (p. 100)

If particularly creative individuals are willing to attempt the difficult and strive to be original then they put inordinate demands upon themselves in terms of motivation and commitment to the work. Such self imposed pressure can literally "force invention . . . by excluding conventional solutions and requiring the maker to search beyond them" (p. 100). Of course, discovery itself need not be purposeful as many chance discoveries have shown; rather the mind is so keenly attuned to the given project that one is sensitized to receive the chance opportunity. According to Perkins,

> To say as much is to take what might be called a *teleological* view of creating. The term teleology implies that the ends govern the means. What makes creating special is not so much its component processes but their organization and direction, and that organization and direction derives from an end in view, however broadly characterized and vaguely grasped. (p. 101)

Discovery, then, is primarily a function of purpose. Process is a means to an end.

Comments. Whether or not purpose is firm and clear or broad and vague, however, says little about where purpose comes from in the first place. Inspiration, for example, provides the purpose for writing, painting, or composing. What is truly creative about it is first, how it comes about—the felt experience of knowing, second, the "swarm" of ideas it frequently unleashes, third, the complex meanings inspiration enfolds, and finally, the relentless need to preserve the import of the meaning within and throughout the medium of expressing it. Perhaps it is the latter that Perkins refers to when he says some individuals strive to be original or to attempt the difficult. Though purpose may be decided upon in the way that Perkins describes, in many reported cases purpose springs from an unsolicited and sudden apprehension of a particular circumstance. As in the case of insight, he treats "purpose," in an overly simple manner. For Perkins, it serves to establish the goal state in problem solving, but for the creative thinker, purpose, or rather, inspiration, is complex and multi-functional both in its appearance and in the preservation of its import.

Feeling and Emotion

Like the other acts of cognition Perkins describes, feeling and emotion are regarded by him as means to an end. Put most simply, they represent a different way of knowing. According to Perkins, there are three different ways that feeling and emotion act as "sources" of knowledge: felt emotions, cognitive emotions, and expressed emotions. As expressed emotions refer exclusively to the product, I will concentrate on felt and cognitive emotions.

Felt emotions are responses to the facts of a given situation and change as knowledge of the situation changes. In this sense, feelings may be appropriate or inappropriate as the case may be. You may feel angry because your friend is late for dinner, but that changes when you've found out she has been in an accident. Feeling, in short, is closely related to understanding.

> Because feelings involve understandings, feelings toward a developing work of science or art may carry important insights about the work and its potentials. . . . Because feelings may be inappropriate, the maker must learn when to trust them. (p. 117)

Perkins ties in this view of feelings with his description of how we make evaluative judgements. These "aren't cool assessments, but felt reactions" (p. 117). The "felt reactions" are fused with the more efficient means of evaluating associated with noticing. Any irregularities, anomalies, discrepancies, or curious chance events, for example, would certainly be noticed and simultaneously felt to be important in the development of a work if the "maker" recognized their potential importance. According to Perkins,

> The emotions are not merely incidental additions to the understanding. They draw attention to it, a very important function. They also measure the degree of a problem, which amounts to further understanding. . . . Furthermore, felt emotions themselves sustain the understanding of a situation. (p. 118)

While felt emotions are associated with knowledge, cognitive emotions are associated with cognitive process. When speaking of cognitive emotions, Perkins uses Scheffler's notion of "rational passions." As quoted by Perkins, Scheffler refers to "a love of truth and a contempt of lying, a concern for accuracy in observation and inference, and a corresponding repugnance of error in logic or fact. It demands revulsion at distortion, disgust at evasion, admiration of theoretical achievement, respect for the considered arguments of others" (p. 118). Perkins identifies two emotions in particular that are specific to "coming to know"—the "joy of verification" and "simple everyday surprise." The former refers to the feeling of immense pleasure at verification and the latter to contradiction of expectations for good or ill. Together, "joy of verification and surprise are emotional responses to success and failure at prediction" (p. 119).

Comments. For Perkins, emotions are another means to provide insights and also to act as something of a "checks and balances" support system for cognitive processes, including making critical judgements. Any of the creative thinkers considered so far would find little to disagree with here, at least at the level of rational knowing and information processing to which Perkins refers. But Perkins quickly reduces what promised to be a comprehensive and more encompassing view of the emotions to the more restricted notions of fusion with efficiency of evaluation, "simple everyday surprise," and the "joy of verification." These are felt reactions, feelings of pleasure, and satisfaction, all of which react *to* something already in place. Despite the promising start, in the final analysis, Perkins greatly underestimates the place and depth of emotion in creating by not fully recognizing its generative power in the role of creating in the first place.

Cognitive Process

Within the framework of problem solving, cognitive information processing refers to active searching. When Perkins discusses the key elements of cognitive processing, he emphasizes the ways in which they work much more efficiently than the effortful and arduous piecemeal activity normally supposed to be involved in making and evaluating a work. Unlike Weisberg, however, Perkins' discussion of search moves a good distance away from the notion of step-by-step, incremental, and serial processing. He describes four kinds of search: search not done, done on the side, done in parallel, and search done by scanning. In the first instance, an individual would not take the time or trouble to conduct searches in places where nothing is likely to be found. This is a variant of "knowing where to look." Search done on the side is akin to doing something else while the mind continues to work on a problem. One may then notice something while busy with another activity (p. 133). Parallel search means that we are quite capable of searching for a number of different items simultaneously. Perkins gives the example of editing a paper where we notice a number of different problems pertaining to punctuation, spelling, grammar errors, shifts in style, and so forth. When testing for or evaluating

an item or a response, search by scanning is very efficient in that we are able to scan for a number of desired items at once, in the same amount of time it takes to scan for a single item.

Comments. In keeping with the problem solving model of thinking, these searches are conducted within a problem space from initial to goal states. The kinds of searching Perkins describes allow for a much more flexible approach to problem solving than does the strictly incremental processing advocated by Weisberg. First, search on the side means that more than one problem space can be running at a given time. Second, parallel search and search by scanning mean that simultaneous rather than just serial step-by-step processing can be done. Though more flexible than Weisberg, Perkins' description of search activities are, as with Weisberg, still confined to the activities involved in the rational reconstructions of a problem space from initial to goal state. This holds whether search is serial or parallel, singular or simultaneous, labourious or scanned.

Part VI: Conclusion

In conclusion, some observations of a more general nature can be made about Perkins' and Weisberg's views on creative thinking that raise serious questions about the viability of a problem solving view of creative thinking, including the data that support it. The viability of their arguments rests upon how successfully Perkins and Weisberg have been able to explain away the need to posit a special kind of thinking that is specifically creative in nature. Of course, people do think creatively and knowledge does get more complex, so Perkins and Weisberg have tried to come up with what they view as a more realistic (as opposed to romantic) explanation of how such phenomena occur. The fundamental claim is that such thinking is really quite ordinary; how extraordinary or creative something might be is due to some pretty high quality ordinary thinking combined with good fortune and particular non-cognitive factors associated with how an individual works. There are some

problems with their explanation of creative thinking, however, which are difficult to reconcile within the constraints of the rationally ordered problem solving framework.

Both Perkins and Weisberg often refer to the lack of "hard data" needed to support the more traditional interpretations of creative thinking, specifically "mental leaps" and unconscious reasoning processes. If there is no data to support such ideas then this is reason enough to conclude that some processes do not occur, at least not in the way creative thinkers claim they do. Both Perkins and Weisberg rely heavily upon the appropriateness of laboratory studies in problem solving to be representative of truly creative thinking. This, I think, requires an act of faith that few would make outside the bounds of a scientific cognitive psychology, and for a most obvious reason. In their design and execution, laboratory studies represent the very antithesis of how creative thinking comes about as reported by creative thinkers. These studies take place in an artificial setting, what subjects do is planned, orchestrated, and controlled by others, and the tasks are contrived, trivial, and typically very short. Research subjects, on the whole, are students. If "hard data" are to be obtained on traditional interpretations of creative thinking as reported by highly creative people, it would be quite impossible to gather them in this way. Unfortunately, the corollary may very well be that if data are not gathered in this way, then they are unlikely to be viewed as acceptable data, in a "scientific" sense.

Unquestioned adoption of the problem solving model to explain creative thinking, with its focus on rational methods of "search" through a problem space, provides a tight and orderly perspective from which to view creative thinking. To explain it this way, Perkins and Weisberg must reduce the traditionally more complex aspects of creative thinking to a single dimension—one governed by reason—in order to make them fit the problem solving framework. Reduction of complex concepts to a simpler construct, one ostensibly still representative of the original concept in some important way, is, of course, essential to the operationalization of the construct for purposes

of research. But when terms like recognizing, noticing, realizing, reasoning, and directed remembering are used to describe acts of direct perception like analogy, insights, and intuition, they turn out to represent only very superficial aspects of the such mental acts. Further, I think it would not be too difficult to examine think-aloud or reflective protocols derived from laboratory tasks for evidence of noticing, recognizing, or realizing, given that those are everyday terms that people use, just as Weisberg and Perkins claim. But these terms are largely denotative; they name *what* subjects are doing, but say little about *how* they do it.

Perkins and Weisberg do not entertain the idea that some mental events may just not be amenable to psychologists' investigation. Acts of direct perception, whether they signal inspiration, insights, intuitions, or the import of chance observations, are highly individual events. By definition, they could not be otherwise. Such experiences do, in fact, make critical contributions toward the making of a beautiful creation or an important discovery. Ideational flow, for example, is one very complex form of direct perception which, by all accounts, appears to be the antithesis of search through a problem space. It arises unbidden, is involuntary, does not take place under conscious control mechanisms, that is, it is not amenable to directed memory search, and possesses a powerful emotional component that allows for the aesthetic or felt experience of knowing to select out what is most important from the flow.

The ability to experience ideational flow, along with its importance in the creative process could very well make it the heart of creative thinking. Examples of it, like those experienced by Poincaré, Beethoven, James, or Wolfe, as described by them, provide an exceedingly rich ground for the emergence of inspiration and insights. Creative thinkers have acquired great depths of knowledge and experiences; and thus, ideational free fall, taken as given, represents an extremely efficient method of "reviewing" it all at once when occasion demands. Aesthetic, rather than rational, judgement does the work of selecting at these times, which precludes the need to laboriously

examine every item one at a time, or to do parallel scanning under the rational constraints imposed by methods of "search." Besides, deliberative "search" methods are the means to work through something already in place. They do not address how the impetus for a work arose in the first place, beyond recognizing or being told that there is a problem to solve. This raises the question of how well Perkins' and Weisberg's ordinary, commonplace concepts can explain how something original is generated, which leads to the next point.

Perkins and Weisberg, repeatedly claim that creative thinking is an extension of ordinary thought processes. Perkins, in particular, argues that it is a matter of degree and "good fortune," not extraordinary thought processes themselves. The highest degree, then, of ordinary thinking is variously described as creative, unusual, extraordinary, significant, or dramatic. It is never, or rarely, described as original. Terms like unusual, extraordinary, dramatic, and the like, are not synonyms with "original," though they may be used as descriptors to indicate originality. This leaves Perkins and Weisberg in the situation of looking for how creativity "gets put into" something thereby making it unique. They both turn to individual characteristics, or to the product to account for this. They argue that the person who produces something undeniably, uniquely creative is deeply knowledgeable and experienced, is highly motivated and committed to his or her work and is highly productive. The product is judged to be creative, not by the thinking that produced it, but by the community who rates or evaluates its worth. Obviously, not all persons with these characteristics produce something that is original and of great value, and community appraisals of a creative work are frequently subject to the exigencies of changing times and tastes.

Perkins and Weisberg are still left with the problem of how to explain originality, that is, in the sense of how we can go beyond current understanding and practices in ways that are neither novel reorganizations of prior knowledge and understanding, nor "mere transfer of learning." Indeed, as Pascual-Leone has pointed out, a comprehensive theory of cognition

requires that such "novel" events be accounted for. Unfortunately, by reducing the key aspects of creative thinking to ordinary thinking, Perkins and Weisberg have not explained it, they have explained it away as ordinary problem solving, almost. I say almost, because the door to originality has been nudged open a bit by Weisberg's, and especially Perkins' discussion about discontinuities in thought, most importantly, about bisociation and contrary recognition. Unfortunately, in Perkins' and Weisberg's hands, even these are reduced to base and target analogues that are so remarkably similar that spontaneity is precluded. "Small-scale" bisociations have more to do with rational thinking processes than with direct perception or apprehension of relations between things as depicted in intuition and for analogy. Thus, even this opening toward explaining originality suffers from the severe constraints of the rational framework in which the problem solving model of thinking is embedded.

Further to the problem solving model, is it necessarily the case that when you make, discover, or invent something, you are solving a problem? This question, unfortunately, is unanswerable, for if the definition of problem solving is so broadly construed as to include all such acts, then it is not refutable. If the declaration that all creative thinking is problem solving is accepted, this makes the question of how problem solvers think relatively easy to answer. Come up with some small scale problem solving tasks that embody making something (writing a poem), discovering something (how Charlie died), or inventing something (ways to attach candles to walls), then give them to groups of people to solve, and when they've solved them, or while they are solving them, ask how they did it. One important finding clearly emerges: their thinking is of the kind pertinent to solving the problems they were given. Delineating the processes follows easily from examining the think-aloud or reflective protocols. First, they figure out what is supposed to be done (problem representation at initial state, and sometimes subsequent representations), then they figure out how to do it (make strategic moves) then they do it (solution at goal state). Some subjects solve problems in fewer steps than others, but they all solve problems by essentially the same

processes. By extrapolation, Perkins and Weisberg claim that we all solve problems in more or less the same way and the thinking processes we use to do so are commonplace and ordinary. So pervasively common, in fact, that the problem solving model of thinking extends far beyond the realm of human cognition. As it turns out, even the lowly octopus can manage it.

An article appearing in the April 25, 1992 edition of the *San Francisco Chronicle* headlined "Octopuses Found to be Smart Suckers," reports how some pretty smart octopuses solved a difficult problem. It seems that scientists successfully trained thirty octopuses to distinguish between a red ball and a white ball suspended in the octopuses' tanks. Octopuses are colour blind. One ball was wired with a mild electric shock and the other contained a tasty bit of fish. If an octopus attacked the red ball, it got a reward; if the white ball, a punishment. Within 17 trials, all the octopuses learned to attack the red ball and remembered which was which for days afterward. This isn't the interesting part.

These thirty octopuses were now considered to be deeply knowledgeable and expert in this area. Thirty novice octopuses were placed in tanks next to the experts where they could observe them successfully attack the red balls every time and, by now, without reward or punishment. In very short order, the novices learned to attack the red balls too just by observing the experts. This amazed the scientists. Put in Perkins' and Weisberg's terms, the novices recognized (abrupt identification) or figured out (constructed a problem representation, reasoned out) what the experts were doing, and then moved through the problem space themselves (by trial and error, or incremental inferencing, or noticing, or remembering) or more quickly realized (abrupt understanding, insight) what they had to do. Unless they all figured it out at the same time, some of the novice octopuses presumably learned more quickly by thinking faster with attendant gains in efficiency, than did other novice octopuses. Of course, the supposed "think-faster" novices may have just smelled the fish, which is a case of direct sense perception. Given that most species only get together from time to time to mate or eat one another,

octopuses are obviously very sociable little invertebrates who learn from each other and problem solve through observation. This example neatly shows how readily inclusive the notion of creative thinking as problem solving really is. Under these circumstances sorting out what may or may not be thinking in its creative mode is difficult to do.

I began this chapter with an anecdote about two different styles of problem solving, Rosanoff's and Edison's. While Rosanoff could apply the solution found by "thinking waxes" in a rational manner, he did not actually find it that way. Conversely, Edison could both find and apply solutions to problems by a process of incremental reasoning that probably took the form of step-by-step inferencing or perhaps trial and error, or both. Both Perkins and Weisberg give detailed examples of the constructs and processes involved in "Edison-style" problem solving. They include, for example, explanations of the rational construction of Picasso's *Guernica*, Darwin's theory of natural selection, Witney's inventions of the cotton gin, Orville and Wilbur Wright's invention of the flying machine, Watson and Crick's discovery of DNA, and the like. Having looked at these carefully, I notice that each one of them has a strong deliberative component to it, at least as Weisberg and Perkins construe them, and I am of the opinion that Weisberg and Perkins give a very thorough description of that particular mode of thinking. Only one counter-example is needed, however, to show the limiting nature of this view of creative thinking. I will defer this discussion to the next chapter.

Weisberg (1993) has gone so far as to make the claim that when enough information is available about how something was invented, made, or discovered, including other's reconstruction and commentaries, all creative thinking can be understood in rational, problem solving terms, each step being built from its antecedent condition or from some triggering event. This raises the question of just what would be considered enough information? Certainly Nichols composition of the *Sunrise Poem* provides a great deal of detail, very little of which bears much resemblance to the standard view of problem solving processes. Perhaps Weisberg's description of analogical

"mapping" comes closest when looking at Nichols' remembrance of the two postcards. They were not mapped onto anything however; these images brought meanings, and once the meanings were understood, the needed words were carried with them. Nichols was emphatic that none of this had been "reasoned out." He just didn't work that way. Poincaré's discovery of Fuchsian functions contains "steps" in the process that also do not accord with the concepts and processes of the problem solving model as does the work of Beethoven, Tchaikovsky, and others. Wolfe was so inept at deliberative, that is, rational thinking, he had to rely on someone else to do the "brutal" work of cutting. There are just too many examples of this nature to rest easily with the dismissive claim that these experiences did not occur as reported. The different styles of thinking and working reported by creative thinkers suggest a much richer concept of how the mind works than that implied in the work of cognitive psychologists.

Finally, there is a concept of mind implicit in the problem solving model of creative thinking that points to an underlying, general model of cognition. To recap, Perkins and Weisberg describe thinking almost exclusively in rational terms, the mind is conscious mind, and awareness exists primarily at that level. Perkins does allow for an unconscious component to thinking, but this is quickly subverted to conscious ends as his descriptions of the different kinds of search clearly show. Reason dictates how thought "moves" or processes information within a problem space, though movement from one step to another may result in new representations of the problem due to chance events or analogies, or the detection of anomalies arising from direct search. The non-cognitive elements that impinge on cognition are said to be varying degrees of motivation and commitment. Feeling is equated with passion for the work or with the feeling of satisfaction gained at successful solution of problems, or surprise at chance noticing. The movement of thought is described in terms of serial or parallel processing and is thus algorithmic in nature because the impetus for movement is directed search. Search procedures consist, for example, of hill climbing or means-end analysis, algorithms used to move from initial problem statement to final

problem solution. This implies that the way the mind actually works is computational in nature.

If Perkins or Weisberg had come up with a general theory of human cognition as it pertains to creative thinking, then, it likely would bear close resemblance to the computational metaphor that characterizes the rule-bound models of thought originally proposed by Newell and Simon (1972) and Simon (1979, 1981, 1989), which now forms one mainstream basis for research in human cognition. Researchers like Holland, Holyoak, Nisbett, and Thagard (1986) and Roger Schank (1988), for example, have devoted much work to developing standardized formulae devised to depict the rule-based movement of inductive reasoning, particularly in analogical thinking in problem solving, and in the ability of AI research to model creative thinking respectively. The mathematical and logical precision associated with thinking embedded in these models is, I think, intended to demonstrate how well human cognition and its AI counterpart, machine cognition, is amenable to the scientific study of cognition.

By contrast, the concept of mind implied in the self-reports of creative thinkers is multi-dimensional in nature, encompassing what appear to be discrete states of mind with accompanying variable levels of awareness. Thinking is deliberative (rational, effortful, and under voluntary conscious control), subliminal (involuntary, effortless, and free of conscious control), gestational, and intuitive in nature (involving thinking processes the thinker is not aware of, and acts of direct perception), with shades of overlap between these characteristics. Non-cognitive elements that impinge on thinking and knowing work primarily in the subliminal mode. These are described to encompass intellectual stillness, trance, reverie, or some other type of self-hypnotic or meditative state; powerful emotion and feeling, particularly as these relate to inspiration, insight and aesthetic judgement; heightened sensual perception of the external world or the internal world of the mind; and intense pressure to work. Movement of thought is different in each of the conscious and subconscious states of mind and gestational movement of

thought and intuitive acts are known only by the insights or parts of a work that spring from them.

The metaphor of mind that best captures how the creative mind works, and one frequently invoked by creative thinkers themselves, is that of the multi-directional development, growth and nurturing of a plant. If one were to accept the plant metaphor, rather than the computational metaphor, of mind, then the degree to which it is amenable to an algorithmic, rule-based science of cognition is unknown. However, one could easily infer that it is not. One thing that the plant metaphor can do is both include and supersede the rational processes so highly valued by Perkins and Weisberg. As such, the reduction of thinking processes to a specifically rational framework severely curtails the ability of the problem solving model of thinking to explain away creative thinking, particularly as it concerns how ideas, works, and discoveries originate in the first place. This is the subject of the next, and final chapter.

Chapter Four: Going Beyond

Part I: Introduction

According to Perkins and Weisberg, thinking takes place within the structures and processes of a "problem space." In the procedural sense, movement through the problem space involves the rational processing of information from initial to goal states. Rational processing begins with the representation of a problem and ends with its solution. In between, any number of events may occur that would cause the solver to rethink the problem and thus require a new representation of it, or a series of them, until the solution is found. In order to find the solution, the solver may use various search methods or algorithms depending upon the nature of the problem. In the structural sense, the problem space consists of the knowledge needed from memory (prior knowledge) or from other sources to represent and solve the problem.

Ideally, the entire process is depicted to move smoothly, in a logical, incremental fashion—each step in the acquisition and subsequent organization or reorganization of knowledge building upon the one prior—just as one would expect when solving logical puzzles, arithmetic problems, or when playing chess, for example. On the face of it, the structures and processes of the problem solving model appear to provide a sound theoretical framework in which to cast explanations of how the most important human creations, discoveries, and inventions have been made. It is just here, however, where things start to get complicated. In order to develop an inclusive problem solving framework, Perkins and Weisberg had to take mental acts, traditionally considered to be associated with creative thinking as described by creative thinkers, and redefine them into terms they believed more suited to a rational view of how we think creatively. A fundamental question arises,

then, concerning how well a theory constructed in rational terms can explain the emergence or genesis of creations that are new, novel, and original, particularly those of great worth and social value?

Pascual-Leone stipulated that truly novel learning is something more than just reorganization of prior knowledge or transfer of learning, or chance. It is learning that has "never before been produced." I have taken this to mean that it incorporates and supersedes, or completely transcends in some way the familiar ground of accepted knowledge, beliefs, practices, or understanding. In Pascual-Leone's estimation, such a theory would have to include non-cognitive factors other than learning to account for this phenomenon, although he did not discuss what these factors might be or how they may affect cognitive processes. One point is clear, however, the focus for a constructivist theory is on those mental mechanisms we use to make rational reconstructions of situations we encounter. To this end, Weisberg and Perkins have subverted factors traditionally considered to operate outside the range of reason to better serve the process of rational constructions of experience itself. Interestingly, these are the factors that acknowledged creative thinkers claim have little to do with reason and the voluntary control of the conscious mind associated with it. I have argued that Perkins and Weisberg were not successful in their efforts to explain, or rather to explain away, factors traditionally associated with creative thinking in rational terms.

Looked at now, from the perspective of Pascual-Leone's comments, Perkins' and Weisberg's explanations of "going beyond" rest not only upon explaining that reorganization of knowledge and understanding, transfer of learning, and chance events, and the like, are the means by which we go beyond prior knowledge and understanding. Their explanations clearly rest on showing that the mechanisms involved in bringing these about are perfectly understandable in rational terms. Perkins and Weisberg were unsuccessful in their efforts to convert intuition, insight, far analogy, bisociation, and ideational flow into rational terms because, in themselves, they are not acts of reason. They are involuntary acts of direct perception or

apprehension of events and, as such, do not take place under the voluntary control of reason, even indirectly as Perkins' argument seems to imply.

This raises another problem, however, because before being able to go beyond a given basis of knowledge by use of particular mental mechanisms, it must also be shown that it either is, or is not, possible to make a partial or complete break with prior knowledge in the first place. There is no compelling reason to believe that the exercise of different mental mechanisms would necessarily result in changes in knowledge itself, even though Perkins and Weisberg appear to assume that this is the case. To explain how this occurs is a logical problem, and it is tied to the debate on what constitutes a logical, theoretically sound justification for accepting judgements based on inductive reasoning. I will first consider how this particular logical problem affects Perkins' and Weisberg's arguments and then, to conclude, take another look at how the psychological assumptions that inhere in their arguments in support of using commonplace concepts of thinking, particularly near and far analogies, are questionable. Robert Nichols' description of the creation of the *Sunrise Poem* provides a good basis for "trying out" some of Perkins' and Weisberg's "ordinary" terms.

The Logical Problem

Trying to find ways to redefine perceptual acts that are not rational into rational terms is one problem that Perkins and Weisberg have to contend with, but as I have just noted, it is not the only one. There is another problem that arises when they undertake to subsume all mental acts into thinking processes that "move" in the continuous, small-step, inferential manner associated with logical-analytical thought patterns.

Such a postulated movement of thought implies that knowledge growth itself proceeds in the same logical, incremental manner that is reflective of the rational continuity of thought processes. Thus, the way in which Perkins and Weisberg depict thinking processes in the problem solving model are

isomorphic with the way the growth of knowledge itself is postulated by them to proceed. Discontinuities of thought, like chance observations, insights, and analogical apprehension, though they may influence the direction of thought, are nonetheless evaluated or judged to be accepted into the knowledge base, or to be rejected, according to the dictates of analytical or critical judgement (reasoning and past reasoning out). Within this perspective, every development in knowledge and understanding is judged against the ground of related knowledge, beliefs, and understanding that came before it. In this way, the rational, incremental growth of knowledge, based on a process of small-step incremental reasoning, is sustained and, by implication, so is the isomorphic relationship between the logic of thinking and the logic of knowledge growth. Put in its simplest terms, if knowledge growth itself proceeds in a logical, small-step, inferential manner, then Perkins' and Weisberg have put forward a learning theory of small-step hypothesis formation and confirmation that would be based on the method of inductive reasoning. As such, Perkins and Weisberg inadequately address the learning paradox.

The term "learning paradox" refers to the logical and psychological problem of how to explain how more conceptually complex knowledge is generated from a simpler conceptual base of information. The psychological problem addresses the question of just what the cognitive mechanisms involved in the restructuring of knowledge might be and how they may be identified and described. The logical problem addresses the issue of how to explain the origin of knowledge in the first place. Thus, trying to solve the learning paradox on psychological ground involves looking for the mental "bootstraps" responsible for generating new configurations of understanding in given spheres of knowledge. Trying to solve it on logical grounds requires coming to terms with the problems associated with inductive reasoning. The relationship between the two problems is not necessarily isomorphic, as Pascual-Leone most certainly recognized when he suggested that the search for a cognitive explanation of how novel learning comes about must include non-cognitive as well as cognitive factors.

Because scientific explanations are generally arrived at by a process of induction, the rational basis of inductive reasoning should be logically sound. By association, if cognitive psychologists want to find scientific explanations of how original, new, or novel learning comes about in cognitive terms, then these too should be rational explanations that also will stand or fall on the basis of a sound logic. And that is the heart of the problem. There is as yet no widely accepted explanation of the origin of knowledge that is wholly immune from the devastating critique of inductive reasoning put forward by the philosopher, David Hume, over two centuries ago.

Hume's Critique

Hume in "An Enquiry Concerning Human Understanding," was searching for a logical way to establish the rational and empirical foundations that justify knowledge or belief. In the process, he made clear the intricate relationship between the psychological and logical issues that arise when trying to justify the origins of knowledge on inductive grounds (Solomon, 1985). Hume first argued that every justifiable belief must be either a "relation of ideas" or a "matter of fact," that is, justification comes about by reason or by experience. Confirmation by reason resides in the truth of mathematical or logical statements or conceptual truths, and confirmation of fact occurs by an appeal to experience. Hume claimed that all knowledge begins with "impressions," that is, sense-data, derived from experience. These, in turn, make up ideas and ideas are images of impressions. Separate ideas connect to become beliefs and human reason is the connecting process. Hume further argued that the physical world exists independently of us and "causes" ideas to arise in us from the external "impressions" we receive. This is his causal theory of perception which asserts that what we believe to be existent is no different from "the idea of what we conceive to be existent." Thus, there is a logical connection between the experiences we have and the ideas we make from them which paves the way to posit cause and effect as the basis of all human perception and reasoning.

Hume argues that we cannot arrive at knowledge about how something works by reasoning about it. He notes, for example, that all the thinking about gunpowder we can muster will not tell us that it explodes when ignited by fire. We can only know this by having first-hand experience of it. As Hume puts it,

> Were any object presented to us, and were we required to pronounce concerning the effect, which will result from it, without consulting past observation; after what manner, I beseech you, must the mind proceed in this operation? (Hume, II, 4–5, Hendel, p. 119)

For Hume, causation is presupposed and it is universal, and thus is invoked every time something is explained. Believing that every event has a cause allows us to look beyond the present either to explain the past or to predict the future. Future predictions are made by a process of inductive inference based on our belief in related present observations; in other words, valid inductive generalizations are drawn from experience.

Having established that all knowledge must be either a relation of ideas or matters of fact, and how all reasoning about it is based in cause and effect determined from experience, Hume then proceeds to reverse his own argument by showing that inductive reasoning is neither a relation of ideas nor a matter of fact. According to Hume, experience is explained by appealing to other experiences, thus knowledge of cause and effect derives from experience and not from reason. He states that

> No object ever discovers, by the qualities which appear to the senses, either the causes which produced it, or the effects which will arise from it; nor can our reason, unassisted by experience, ever draw any inference concerning real existence and matters of fact. (Hume, II, 4–5, Hendel, p. 119)

By itself then, reasoning cannot discern effects or causes of a given event, nor is cause and effect discovered through perception for the same reasons. Although we may be able to perceive qualities of a thing, we cannot perceive what it will do with respect to encounters with other objects or

events. Cause and effect is derived from experiencing the "constant conjunction" of two or more events, and from this experience we predict that much the same will happen in the future. That is, we arrive at cause by a process of induction from past experience. Hume then enquires about what the foundations of experience might be; in other words, how can inductive reasoning be justified?

At this point in his argument, Hume provides an explanation that has upset attempts to establish an empirical basis for knowledge. He has already shown that the basis of expectation does not reside in the ability to perceive or to reason about the nature of events; certainty comes from direct past experience of the "constant conjunction" of events. Accordingly, Hume then asks,

> . . . but why this experience should be extended to future times, and to other objects, which for aught we know, may be only in appearance similar; this is the main question on which I would insist. (Hume, II, 4–5, Hendel, p. 125)

Thus, to know something based upon experience of it gives no assurance that such a thing holds for the future. We reason that it will because we believe in regularity which is established by repetition of experiences, that is, by force of custom or habit as Hume put it. But Hume has shown that there is no demonstrative reasoning available that allows any justification for believing the future will be the same as the past. Custom or habit have no power in terms of logical argument; they are grounded in a commonsense understanding of the world. It was the philosopher, Immanuel Kant, who pointed to a new direction and, in doing so, managed to reclaim certainty from Hume's doubt, but not on empirical grounds.

Kant's Response

Hume's unquestioned assumption is that what we know, what can be rightfully called knowledge, corresponds to our experience; this is his correspondence theory of truth. According to Solomon (1985), Kant saw that

for science to know anything, the correspondence theory, with its concentration on reason and experience alone, had to be extended to include the workings of the mind itself. Like Hume, he believed that knowledge originates in experience, but he also claimed that it need not necessarily arise from it. Rather than viewing the external world as something entirely separate and external to us, Kant argued that our own "ideas" structure or "constitute" our experiences. As he put it in the introduction to the *Critique of Pure Reason*,

> But though all our knowledge begins with experience, it does not follow that it all arises out of experience. For it may well be that even our empirical knowledge is made up of what we receive through impressions and of what our own faculty of knowledge (sensible impressions serving merely as the occasion) supplies from itself. (p. 42)

Thus, knowledge is, at least in part, shaped by ideas imposed on it by the mind. These basic ideas (the transcendental categories) endow us with a natural capacity to impose shape upon knowledge and the external world. The source of cause and effect, then, is now no longer necessarily grounded in experience because what we come to know is reality constituted through our own "concepts of understanding." In this way, Kant found a basis for knowledge independent of experience and added a new dimension to Hume's argument. For according to Kant, our understanding of experience is compounded of information received both from sense-data (impressions) and from information supplied by our own faculty of knowledge.

Kant argued that information from our own faculty of knowledge consists of "synthetic" judgements; those that are neither analytically nor empirically true, but intuitively true, and thus precede experience and are independent of it. These Kant referred to as "synthetic *a priori* judgements" which he regarded to be "essential structures" of the mind. They provide the forms, the innate blueprints, by which we intuitively organize incoming perceptions of experience. In sum, Kant argued that we possess a set of constitutive concepts, or rules, by which we will naturally organize experience.

Because these are innate, they precede experience. Rather than just being passive recipients of sense impressions, we are naturally endowed with the intellectual capacity to create and shape our understanding of the world. New configurations of knowledge, new understandings originate from the interaction of these conceptual "forms" with experience. Both Hume's critique of induction and Kant's argument for the presence of innate constitutive concepts provided the backdrop for Jerry Fodor's more recent argument about the difficulties the problem of induction poses for constructivist learning theories.

Fodor

The purpose of Fodor's argument was to show how constructivist claims for the role of experience in human learning were logically flawed. The occasion was the debate between innatists and constructivists held in 1975 at Royaumont, France. (See Piatelli-Palmarini's 1976 proceedings of this debate.) Speaking much too generally, the argument is as follows. The innatists, in this case Chomsky and Fodor, hold that we are already preprogrammed at birth to construct knowledge in particular ways. The brain contains certain distinct components that provide all of the necessary structures needed to acquire increasingly complex knowledge in keeping with the human maturational process. Environmental "triggers" play a minimal or very modest role in development. The constructivists hold that the increasing complexity of cognitive development derives from ongoing interactions between the individual and objects and events encountered in the environment. As Gardner (1980) put it, the mind is considered to be "an active, constructive agent that slowly inches forward in a perpetual bootstrap operation" (p. xxiii). Fodor argued that any attempt to explain mental "bootstrapping" in psychological terms was doomed to failure.

According to Fodor, there is only one learning theory that has ever been put forward that purports to explain mental bootstrapping and that is one of hypothesis formation and confirmation by a method of "nondemonstrative inference" (p. 145). And this theory, tells us nothing about how concepts

originate in the first place. This is because the conclusion of an inductive argument is an hypothesis that was formulated from data collected to confirm (or disconfirm) a prior hypothesis, itself based on prior experiences, and so on, into an infinite regress. Thus, the hypotheses themselves presuppose, in Fodor's words, "the field of concepts on which the inductive logic operates" (p. 147). Fodor echoes Hume when he claims that inductive reasoning tells us something quite else; that is, how "beliefs" are fixed by experiences" (p. 146). Fodor concludes that it is not possible to explain how knowledge gets more complex in other than primarily innatist terms because "it is *never* possible to learn a richer logic on the basis of a weaker logic, if what you mean by learning is hypothesis formation and confirmation" (p. 148). Fodor's (and Hume's) argument about induction was not satisfactorily refuted at Royaumont. Subsequently, Bereiter (1985), in a response to Fodor's critique, took up his challenge by arguing that a constructivist solution to the problem may be found in research on problem solving. Bereiter, unlike either Perkins or Weisberg, at least recognized that there is a logical problem that lies at the heart of the constructivist argument. He does, however, put the argument forward a shade differently than did Fodor.

Bereiter

Bereiter asks, when faced with a difficult problem to solve, one requiring new insight and understanding, what happens in the human mind that *generates* the new level of knowledge and understanding required for its solution? Accordingly, "the paradox is that if one tries to account for learning by means of mental actions carried out by the learner, then it is necessary to attribute to the learner a prior cognitive structure that is as advanced or complex as the one to be acquired" (p. 202). "Prior cognitive structure," of course, refers to prior knowledge. According to Bereiter, the problem for constructivist cognitive psychologists is paradoxical; they must show how prior learning can be as complex as the more complex concepts that may be generated from it, without invoking an innatist explanation. Thus, the argument no longer concerns just the problem of infinite regress. Here, it becomes a matter of

demonstrating that prior knowledge itself is as complex as the new knowledge it generates. Bereiter doesn't explain in a logical sense how something already known to be as "advanced or complex" as the new learning "to be acquired" could plausibly result in more complex new learning. To put it simply, if A is as advanced and complex as B, how can B be more complex than A?

In a practical sense, however, Bereiter describes a piece of research believed to demonstrate that we do have prior knowledge which is as complex as that required to facilitate new, more complex learning. This example was drawn from the work of Groen and Resnick (1977). The researchers gave preschool children the problem 4 + 3 = ?. The children were first taught an initial algorithm where they counted out four blocks, then counted out three blocks, and finished by counting out all the blocks to get 7 for the answer. Apparently without instruction, the children spontaneously eliminated the process of counting out the first addend thus applying the more advanced procedure of starting with four and then adding three more. Thus, the children appeared to "recognize" that counting out the first addend was redundant (the number 4 was no longer seen as the last number in a series; it had become representative of a set). Bereiter argues that unless mathematical knowledge is believed to be innate, one would have to credit the children with having "prior knowledge of cardinality . . . as well as some notion corresponding to the joining of sets." He observes that "such prior knowledge, it seems obvious, is more complex than the new knowledge whose construction is being explained. Hence the paradox" (p. 203).

Unfortunately, these outcomes may be explained without invoking the learning paradox. There are potential confounds in this research that are not mentioned by Bereiter. First, the children had extended practise of addends 0 to 9 to the point of complete mastery; numeracy was thus ensconced as part of their prior working knowledge. Second, working without the blocks was "phased in" by the researchers. The children had opportunities to practice addition problems under different conditions "engineered" by the researchers.

They could conceivably have *memorized* either the procedures or the answers, or both. If the purpose of this example was to provide a counter argument to Fodor's innatism, it certainly fails. Even if the preschoolers could be credited with having prior knowledge of cardinality and sets that is not innate nor learned during the process of the research study, how did it get there in the first place? Bereiter doesn't raise this question. If he did, trying to provide a cognitive answer to it would lead him into the logical difficulties raised by Fodor and Hume. Bereiter is of course acutely aware of this possibility. Inevitably, he winds up doing what everyone else has done, that is, to somehow find a way to bail himself out of Hume's dilemma. He tries to deal with the difficulty by a redefinition of the paradox problem.

Bereiter divides the paradox issue into two questions—the "metatheoretical" and the "theoretical." The metatheoretical question asks how one cognitive structure can generate another structure that is more complex than itself? This is, of course, the problem Fodor raised. Bereiter compares the nature of this question to that of a "Gordian knot," one impossible to disentangle and therefore unworkable. In other words, he isn't about to deal with the problem on logical grounds. The theoretical question, not surprisingly, shifts the problem from the logical to the psychological ground. It asks how complex structures can be derived from "mechanisms that are not themselves highly intelligent or richly endowed with knowledge?" Bereiter apparently means that there must be some psychological or other mechanisms not yet accounted for that could provide the missing "ropes and ladders" responsible for mentally "bootstrapped" increases in levels of cognitive complexity. It appears that he is laying the groundwork for bringing non-cognitive factors into play that may resolve the paradox, although this is not entirely clear.

For Perkins and Weisberg, the non-cognitive factors involved in creative thinking include the possession of deep knowledge and expertise, talent, and high levels of motivation, commitment and productivity. In something of a similar spirit, Bereiter puts forward a number of both cognitive and non-

cognitive factors that research may show to influence mental bootstrapping. He specifically mentions our ability to adapt innate or already developed perceptual systems to new uses (piggy-backing), occurrences of fortuitous chance events (chance plus selection), affective engagement that regulates attention, use of the perceptual field to assist learning, imitating the behaviour of others, providing learning support systems, upsetting biases, using spare mental capacities once a given task has been mastered to the point of automaticity, seeking to maintain equilibrium when faced with something new, and finally, the gradual and implicit accumulation of information, usually by repeated exposure (osmosis). Bereiter believes that research efforts in these areas should eventually lead to a better understanding of how we bootstrap into more complex levels of knowledge and understanding. It seems that between Perkins, Weisberg, and Bereiter, very little has been left out of consideration for resolving the learning paradox, but not much can be said about how any of these elements, singly or combined, may either resolve the logical problem or bring about novel learning.

Bereiter concludes that all of these "principles" initially operate as events in "concrete behavior settings" and then become internalized over time, which allows for a process of cognitive reworking of them, independently of their environmental settings of origin. The question he doesn't ask is how to account for the "internalizing" process itself? Given that Bereiter is writing from a specifically constructivist point of view concerned with the rational reconstructions of experience, however, "cognitive reworking" could only refer to the mental mechanisms or "bootstraps" involved in processes of rational reconstructions of knowledge and understanding. Further, Bereiter believes that ultimately the paradox will be explained by cognitive models of human problem solving. Thus, like Perkins and Weisberg, Bereiter's version of how knowledge and understanding may get more complex is also to be explained by an information processing theory, ostensibly supported by empirical research, that depicts rationally ordered incremental systems of problem solving, consisting of hypothesis formation and confirmation by a method of inductive reasoning. The logical problem remains unresolved.

The Psychological Problem

Weisberg and Perkins both have concluded that there are no mechanisms of thinking that can be identified as distinctively creative. They do, however, try to address the question of how the mental mechanisms associated with ordinary thinking can also encompass the more extraordinary thinking associated with the production of a creative work, invention, or discovery. For Weisberg, these were identified to be certain discontinuities of thought such as triggering events that occur as chance events or that arise externally or from memory, and analogy. For Perkins, ordinary mental events such as noticing, recognizing, realizing, directed remembering, contrary recognition, and small-scale bisociation used in the course of ordinary problem solving, can also do the work of creating.

Although I have made extensive comments on each of these mental acts, more needs to be said about far analogy itself. Weisberg dismissed the notion of far analogical transfer of meaning by claiming that research results did not demonstrate the presence of transfer in near, let alone far, analogy. From these results, he concluded that Kekulé, for example, misunderstood the phenomenon and, by implication, so must other creative thinkers who reported having similar experiences. Perkins allows that there may be cases of far analogy, but its occurrence is extremely rare. He claims that the mental mechanisms that influence change in the direction of thought are normally the "small-scale bisociations" associated with ordinary acts of noticing, recognizing, realizing, and the like. The fact remains though, that far analogy is the particular mental event that both Weisberg and Perkins found the most difficult to subsume into patterns of rational thought. I will try to show that the desire to reduce all mental phenomena to rational terms has prevented Weisberg and Perkins from fully understanding far analogy, particularly with respect to the significant role it plays in the ability to generate new meaning.

Weisberg focused attention on how successful students are in transferring information from a "base" analogue to a comparable "target" problem.

He used the examples of a general trying to destroy a fortress (base) and a doctor trying to remove an inoperable stomach tumour (target). Weisberg found that very few students spontaneously transferred information from base to target to solve the problem (the point could be made that these are not very engaging analogies). More students made the connection when the researcher pointed out the similarities or when the target and base analogues themselves were identical or almost identical. He reasoned that if so few people made use of analogy in near transfer, then far transfer is unlikely to occur at all. This conclusion is hardly justifiable for the following reasons.

First, and most obviously, if one takes the trouble to point out just what the similarities are between base and target analogues, either by explanation or by making them identical, then the very act of providing such a literal paraphrase would not give the insight that an analogy would give. Though, of course, it may be helpful. Second, and less obviously, there is no reason, in principle, why analogies should be understood exclusively in comparative terms. Perhaps some analogies are not at all amenable to literal paraphrasing. An analogy is a form of metaphor and Max Black (1962), for one, has described different types of metaphor; the "substitute" and "comparison" views, and the "interaction" view of metaphor. The first two are arguably applicable to Weisberg's and Perkins' discussion of analogy, but the latter is not. I will discuss the "interaction" metaphor as more appropriate to far analogy.

Near Analogy

Weisberg's observation that transfer takes place when analogies are identical, or nearly so, closely resembles Black's descriptions of the substitution and comparison views of metaphor. The substitution view means that "a metaphorical expression is used in place of some equivalent *literal* expression" (p. 31). The comparison view, which is a special case of the substitution view, holds that "a metaphor consists in the *presentation* of the underlying analogy or similarity" (p. 35). Clearly, the base analogue used by

Weisberg is translatable into literal terms which is just what he wound up doing with it when spontaneous transfer failed to occur, that is, he had to tell subjects that the base and target portray the same sort of situation. Put another way, the base analogue could have been expressed literally in the first place. The base also acted as an underlying analogy to be used in solving the target problem, but, of course, some other comparison view could just as easily be substituted for it. In this case, the base analogue is structurally like the target problem in that both portray an identical situation but in different "stories." Black likens this view of metaphor to "deciphering a code or unraveling a riddle" (p. 32), in other words, problem solving.

The same can be said for Perkins' description of contrary recognition where "things are recognized for what they are not, and indeed obviously are not" (p. 83). Seeing a cloud to be shaped like a camel is one example Perkins gives. Seeing something to be like something else is known to most of us as "simile" and, as such, contrary recognition is a type of substitution metaphor.

The important point to be made is that because these are substitution metaphors and substitution metaphors can be translated into literal terms, they do not add anything *new* to a given situation. It is, therefore, erroneous to put them forward, as Weisberg does, as ways of demonstrating that far analogy is unlikely to occur. Far, or remote, analogies are much more complex in nature than the simpler substitution or comparison metaphors which characterize the base and target analogues that Weisberg used in his research.

Perkins "converts" far analogy into small-scale bisociations that he acknowledges sometimes "yield . . . a truly creative synthesis of remote frames of reference to achieve a revealing insight" (p. 97), though rarely so. He insists that even these are dramatic instances of the more mundane incidences of remembering, noticing, contrary recognition, and so forth. I had earlier pointed out that it is unclear where "mundane" ends and "dramatic" begins and have just noted above that contrary recognition is a case of substitution metaphor. Clearly, if far analogy is to be seen to be something

that generates new meanings, then one of its attributes must be that it cannot be restated in literal terms. Max Black's discussion on the "interaction view" of metaphor is most helpful in clarifying the role of far analogy in creative thinking. But before looking into interaction metaphors, it may be useful to first provide some examples of far analogy and how they come about.

Far Analogy

Both Perkins and Weisberg used Kekulé's experience as an example of far analogy and drew somewhat different conclusions from it; in Perkins' estimation insights of this nature seldom occur and, for Weisberg, far analogy does not occur in the way creative thinkers tend to portray it. They both agree on what a far analogy is, however. But to define far analogy as consisting of two distinct, but abstractly connected, frames of reference says little about how they connect and how they may arise in the first place.

Taking a look at some fresh examples of far analogy in the context of creating a poem provides another opportunity to take a closer look at this phenomenon as reported by the poet himself. Robert Nichols provides a clear case of it in his description of creating the *Sunrise Poem*. The subsidiary subjects of the metaphor, to use Black's apt term for it, consisted of three images; an Arabic holy book, a picture-postcard of an ancient, Persian style poet, and another picture-postcard of Blake's figure from "Ancient of Days." The key words embedded in them were "hieroglyphics," "ancient," "holy being," "stoops," and "poet." The sun rising over the sea forms the principal subject of the metaphor. A cursory glance at the elements of both the subsidiary and principal components shows that they possess no surface level similarities whatsoever. The question of how these particular images arose can only be answered by looking at the context in which they occurred. The following is a recap of some aspects of my earlier discussion of Nichols' creation of the *Sunrise Poem*.

Nichols was on a ship slowly moving through the Caribbean Islands. While observing the terrain, he slipped into a reverie-like state of mind that admitted a profusion of sensations from the natural surroundings that he could see, hear, and strongly feel. The feelings aroused brought an insistent sense of the presence of inherent meanings somehow contained within the surrounding environment itself. The press of feeling immediately aroused in him a state of heightened sensitivity to the possibility of discovering the implicit, deeper, and more profound layers of meaning being conveyed to him, along with an urgent need to begin the poem that would express them. The sensations came involuntarily, in a rush, and were difficult to constrain. These initially brought a rush of fragments of poems as well, all of which began to subside as Nichols focused on the feeling tone of the drumming sound of the waves along with the emergence of the rays of the rising sun. These feelings had the effect of stilling the chaos of sensations he had been trying to constrain, both within and from without. Now, he was "merely being," and in this quiescent state, the waves and rays of the rising sun were the elements that "stuck" and thus initially inspired the *Sunrise Poem.* Nichols remained in this reverie-like state of mind throughout the composition of the poem. His fixed point of concentration was on the rays of the rising sun on the water. The meanings felt and sensed to be inherent within the sun became the principal subject of the poem.

While watching the zigzagging movement from the play of light of the sun's rays on the waves, he "saw" the first image, an ancient holy book written in an Arabic hieroglyphic script, while simultaneously he physically felt the hieroglyphs "flash" through him, which he also simultaneously perceived to be literally "written on the sea by the sun." The convergence of image, feeling, and perception brought forth a powerful emotion that Nichols described as "immense" and "pure" and that was "the reflection" of what he was seeing. From this, he experienced a sense of growing excitement that he was about to be "told something" by the sun. Thus, the sun itself had now acquired new meaning; it was perceived to be an "august presence," a poetic and holy being that signalled entry into the spiritual plane of existence. Thus

personified, the sun now held the promise of imparting a profound and still hidden meaning. At this point, there were as yet no words or phrases to describe these experiences with which to begin composing the poem. They quickly came, however.

At once, an image seen on a postcard of an ancient Persian poet was next "presented" to consciousness, simultaneously bringing with it the first line of the poem. Nichols now focused on the word "ancient" by repeating it in his mind—an act that "stepped up" emotion which, in turn, heightened sensation, feeling, and perception. The feeling was that of "ancientness . . . august, mysterious, and full of power," which was also a reflection of Nichols' emotional response to his surroundings. It brought the next image, that of the figure in Blake's "Ancient of Days." As in the first image, this figure is also ancient, as is the holy book and the Persian poet. The figure "stooped" over a little, just as the rising sun would have to do to continue writing on the waves. "Stoop" was reinforced enough now to bring the word "stoops" and with it the next line of the poem. None of this came about by any kind of reasoning process. Nichols described the experience as occurring by "instinct."

Clearly, heightened sensitivity, perception, image, and feeling simultaneously interact in Nichols' experiences. Taken together, the images themselves portray a set of meanings from experiences exclusive to the poet alone. Interestingly, the first image of the holy book brought order to the profusion of feelings by galvanizing them into a single, powerful emotion, the meaning of which still needed to be expressed verbally in the poem. The same elements interacted again to *generate* particular images that "brought" the needed words and phrases with them. Images then, can compress sensation, perception, and feelings into emotion, and emotion, perception, and sensation into words. Images appear to function as intermediaries between the onslaught of feelings, sensations, and perceptions and their compression into emotional expression; and then, again, between emotion and perception, and verbal expression in the process of bringing hidden meanings to light. The important point is that metaphoric images of this nature are devices that act to *compress* meaning.

Aspects of images that contain particular meanings, in this case, ancient, poet, holy being, hieroglyphs, stoops, are emphasized and selected while other aspects recede into the background, for example, Persian, postcard, and book. Meaning itself appears to *originate* in the interactions of feeling, heightened sensitivity, sensation, and perception and then is compressed into images that convey particular meanings. It should be noted that the images and the words they bring to express meanings, that is the subsidiary subjects, do not themselves undergo shifts in meaning in the process of transfer to the principal subject. In this poem, it is only the sun itself which is transfigured, changing from Nichols' first perception of it as an "august being" holding incipient meaning, into the personification of ancient holiness and wisdom itself, writing the meaning on the waves. The particular images that arose in the making of the *Sunrise Poem* "work" together and appear to be "made-to-measure" for the occasion. They are "interaction metaphors" that organize the meaning and character of the sun and illuminate the importance of what the sun is meant to say. As such, as subsidiary subjects, they are distinct from the principal subject, non-trivial, not replaceable with substitutions, and exceedingly difficult to replace in literal terms without engendering serious loss of meaning. In the words of Max Black,

> . . . "interaction metaphors" are not expendable. Their mode of operation requires . . . use [of] a system of implications . . . as a means for selecting, emphasizing, and organizing relations in a different field. This use of the "subsidiary subject" to foster insight into a "principal subject" is a distinctive . . . operation . . . demanding simultaneous awareness of both subjects but not reducible to any comparison between the two. (p. 46)

Most importantly, the translation of meaning from feeling, sensation, and perception by image into emotion, and the subsequent translation of emotion, sensation, and perception into other images is not a conceptual exercise. No words or phrases appeared until the images themselves transferred meaning to the principal subject, in this case, the sun. The sun's meaning could not be expressed verbally until this happened. New meaning,

then, is generated from the raw stock, so to speak, of elements other than symbolic forms of expression. From these, Nichols created a mystical poet infused with an ancient wisdom that must be discovered, known, and recorded. It appears that new meaning is initially engendered from the "non-cognitive" factors associated with creative thinking.

Cassirer (1946) made a poignant observation about the temporal nature of this kind of metaphor, which he called "mythic metaphors" or "primitive mythic and linguistic conception." There is, he states, no "before and after." Using the example from Nichols' experience, right from the beginning the sun was not taken in any literal sense of the word. Instead, it was perceived to be something profoundly suffused with latent meaning, which subsequently transformed the sun into a mystic being. Nor could Nichols "predict" the form and substance that it would take from the array of feelings, sensations, and perceptions that initially signalled its importance. He knew only that he was "being told something." It was the images themselves that subsequently arose to convert meaning first into a single powerful emotion, and then into language. Thus, there was no prevailing backdrop of experience or conceptual basis of understanding from which the meaning of this poem was "constructed" or from which it could "go beyond" prior knowledge and understanding. Here, meaning itself had first to be discovered, understood, and then expressed in symbolic language.

Further, and finally, as Cassirer observed (p. 89 ff.), logic and metaphor "represent entirely different *tendencies* of thought." Metaphor represents a way of compressing meaning, that is, it can act to establish the original point or ground of meaning. Rationally ordered incremental thinking, on the other hand, expands meaning beyond its original bounds; it is directed toward the extension or expansion of already existing concepts, not on generating them in the first place. "Going beyond," then, has two meanings. It can refer to the expansion of conceptual understanding, and it can refer to the genesis of new, original understanding in the first place. Creative works could conceivably come from either "tendency" of thought. Neither Perkins nor Weisberg have made this important distinction.

Conclusion

Although I have used only one example drawn from the work of a single poet, other cases of creative thinking given in chapter two bear a good deal of similarity to Nichols' description of inspiration for the *Sunrise Poem*. Beethoven's, Tchaikovsky's, Wolfe's, James' and Spender's descriptions of their experiences come easily to mind, which gives some encouragement for making the claim that the origin of meaning itself begins as a non-conceptual, non-cognitive, affair. If this is the case, and it appears to be so, then those who generate new meaning do so on the basis of their own unique experiences and creative responses to the nature of things as they perceive them to be.

I had earlier made the points that acknowledged creative thinkers' self-descriptions have much in the way of theoretical worth in their own right and that a better understanding of creative thinking could be gained from looking at them from the point of view of the commonalities they contained. The most interesting observation that came from adopting this point of view was that many creative thinkers are adept at using and combining quite different modes of thinking, along with perceiving and feeling, depending upon where they are in the creative process, their purpose at that point, and the factors that inevitably influence the direction of creating, discovering, or inventing. Their ability to do so crosses the span of time periods in which they lived and the disciplinary boundaries in which they made their greatest achievements. This may, of course, surprise no one but the cognitive psychologists I've critiqued here.

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