

CONCERNING GOETHE'S APPROACH TO THE THEORY OF COLOR

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Now Israel loved Joseph more than all his children . . . and he made him a cloak of many colors. And when his brethren saw [this] . . . they hated him. . . . And it came to pass, when Joseph came unto his brethren, that they stript Joseph out of his cloak of many colors. . . . And Judah said to his brethren: What profit is it if we slay our brother and conceal his blood? Come, let us sell him to the Ishmeelites and let not our hand be upon him. (Genesis 37.)

To most of us the world is cloaked in many colors—colors which bring us calm and colors which rouse us to activity. But our brethren in their white coats consistently strip the world of its many colors and leave us only the dark, dull gray of a lightless room. This violence is done quietly, without the honesty of direct attack—no blood, simply drab theories of color.

Echoes of Goethe. Foreshadowing his work on color, Goethe had Mephistopheles remark to the student (*Faust*, I): "My friend, all theory is gray, But green is life's golden tree." Later in his career, Goethe spent 25 years in experimentation and study, trying to put some color into the gray of theory. This culminated in his publishing *The Doctrine of Colours* (8). With few exceptions, his contemporaries rejected this work. Today, with few exceptions, contemporary psychologists and physiologists continue to reject or to ignore him. It would require a detailed and lengthy effort to reconstruct Goethe's doctrine, to disentangle it from his polemic against Newton's physics, and to evaluate properly (from the point of view of the present paper) his actual and potential contribution to color theory. Such an undertaking would no doubt allow fresh insights into the psycho-biology of color. However, the scope of this paper is limited to demonstrating that the rejection of Goethe's work often is based on a misunderstanding of his mode of research, and a subsequent oversight of the epistemological conceptions at the root of Goethe's approach to color. The attempt focuses on an examination of three critiques of Goethe: by the psychologist E. G. Boring, by the physiologist C. S. Sherrington, and by the psychoanalyst K. R. Eissler.

I. THE CRITIQUES OF BORING AND OF SHERRINGTON

If we study the comments of Boring written on three different occasions, we note a very consistent, negative appraisal of Goethe's work on color:

His [Goethe's] faith in the validity of intuition, an appropriate characteristic for a poet, stamps him more nearly the philosopher by temperament than the scientist In Goethe's *theory of color* . . . observational intuitionism appears at its worst (1, pp. 112-114) An instance of bad egotism that can occur is Goethe's protest against Newton's theory of color: two brilliant volumes of largely incorrect opinionated assertion (3, p. 312) Frustration finally in 1810 produced the 1411 pages of Goethe's *Zur Farbenlehre*, filled with generalizations, speculations, anecdotes and dicta Nowadays no one recalls this episode in Goethe's life except as an example of how personal pride distorts the use of evidence (2, pp. 98-99) His sterile theory of colors was cited during the first half of the nineteenth century, while the fertile theory of Thomas Young remained unknown (1, p. 115).

A similar evaluation was given by Sherrington (29) in his essay on Goethe:

Goethe, though devoted to science, had not at root the scientific temperament [nor] the sublime detachment of the scientific thinkers (p. 30) Goethe held certain views as to what a scientific experiment should be, and the prism experiment did not conform to them Goethe argues too that . . . [one] had but to step into the free daylight to see that [Newton's theory of color] was not so. We encounter here in Goethe what seems an almost willful inability to enter into the physicist's point of view (pp. 8-9) Were it not for Goethe's poetry . . . we should no longer trouble about his science. Such as it was, it is as science not important (p. 29) .

According to the commonly held view, as exemplified in the above statements by Boring and Sherrington, Goethe had an intuitive, poetic, philosophical, and altogether unscientific temperament. Furthermore, it is believed that he eschewed experiments, and relied instead on intuition, speculation, anecdotes, and observations gathered while admiring nature. One supposes these considerations are particularly relevant concerning his work on color, and in this case we are presented further with the suspicion that his work in this field was motivated by frustration, egotism, and willful perversity. Finally, it generally is assumed that Goethe's work on color was sterile and unimportant.

One must grant that a reading of Goethe's work from certain points of view could lead to the above generalizations. However, a close inspection of his work, when considered from other points of view, will reveal the half-truth of these generalizations.

II. TEMPERAMENT

Had Goethe an "intuitive" and "poetic" rather than a "scientific" temperament? It generally is acknowledged that Goethe created great poetry, and this should be sufficient basis for assuming he had a "poetic" temperament. Yet is this sufficient basis for assuming he did not have a "scientific" temperament? It can be sufficient only if one

assumes that these are opposing temperaments, which then makes it a contradiction to assert that both are able to exist in one man. Yet this contradiction faces us in reality.¹ If this creates a problem, the difficulty lies with our notion of temperament. The conception of temperament perhaps may be a useful way of approaching the obvious similarities and consistencies within a person, but it is neither an adequate nor useful way to approach the equally existent incongruities and complexities. In assuming that a person has a particular temperament, we may strive consistently to interpret all of his behavior within the confines of this rubric. This may lead to our misunderstanding or misinterpreting certain important facets of a man's life and work, or it may lead to our overlooking obvious aspects of his accomplishments.

Actually, rather than poetic, the introduction to Goethe's *Doctrine of Colours* (8) seems almost prosaic:

The desire of knowledge is first stimulated in us when remarkable phenomena attract our attention During this process of observation we [note] only a vast variety which press indiscriminately on our view; we are forced to [create] a certain order This requires an unremitting and close application For this reason . . . men prefer substituting a general theoretical view . . . instead of taking the trouble to make themselves first acquainted with cases in detail and then constructing a whole Light, shade, and colour constitute that which to our vision distinguishes object from object From these three . . . we construct the visible world (pp. xxxvii-xxxviii) From the philosopher we believe we merit thanks for having traced the phenomena of colours . . . to the circumstances under which they simply appear and are [In explaining pathological colour, we merit thanks from] the medical practitioner, whose study it is to watch over the organ of sight . . . to cure its disorders We hope by means of our arrangement . . . to bring colour again into credit [with the chemist] [Our theories must convince] the dyer . . . whose attention is constantly and forcibly called to the facts . . . to whom loss of time and money is not indifferent From the side of aesthetic colouring generally . . . we have endeavored to define the effects of colour . . . with a view of making them more available for the purposes of art (pp. xlv-xlviii).

These excerpts from Goethe's introduction certainly do not readily support the notion of an "intuitive" and "poetic" rather than a "scientific" temperament. Goethe noted that problems start with phenomena that attract our attention (light, shade, color). On this level of observation we are faced with an indiscriminate variety (vari-

¹For example, the delightful nonsense verse of Lewis Carroll would lead us to assume its writer had a poetic temperament, until we discover that C. L. Dodgson, the mathematician and logician, was the self-same Lewis Carroll. Boring affords another example of the problems inherent in the temperament approach to understanding the complex activities of a man: In discussing the rise of phenomenological psychology in Germany, Boring noted that Goethe was in this tradition, and that this tradition of "taxonomic description fitted the German temperament It . . . was suited to the painstaking and methodical Germans" (2, pp. 8-9). This description is at variance with the "intuitive" and "poetic" temperament that Boring attributed to Goethe on other occasions.

ous colors, tints, etc.) which forces us to order their manifestations. We do this by becoming acquainted in detail with their many conditions (normal as well as pathological), and on this basis construct our theory. Our theory must allow us to explicate the phenomena in their "natural state" (the visible world), and if such is the case, our theory will be of use to those persons who are faced with the various concrete manifestations of the phenomena (physicians, dyers, artists).

We find here more of the "taxonomic" ("painstaking and methodical") temperament than we do of the "poetic" (see Boring's comment in footnote 1, above). As we shall see below, the assumption of a "taxonomic" temperament, or that of an "intuitive" and "poetic" temperament, interferes with an appropriate interpretation of Goethe's approach, with a proper recognition of important features inherent in his methods and related to his findings, and with an understanding of his purpose.

III. "PHENOMENOLOGY"

Goethe stressed the close observation of "remarkable phenomena" and the detailed acquaintance with their many cases or manifestations. His purpose behind these activities was that of building a "whole" which could enable one to understand the "experienced world." With these views in mind, it is understandable why Goethe has been called a "phenomenologist." As is noted later, this may not be entirely correct; yet, there is much in favor of classifying Goethe within this tradition. However, doing so either on the basis of his "poetic" and "intuitive" temperament or his "taxonomic" temperament leads to a misunderstanding of the basis of Goethe's choice of approach and involves a misunderstanding of the "phenomenological" tradition.

We find an example of this misinterpretation in Boring's discussion:

The whole phenomenological tradition, from Goethe to Wertheimer, is characterized by a belief in the value of direct observation of experience and a mistrust of . . . elaborate experimentation. Thus experimentalism finds itself opposed to phenomenology. The two are not incompatible, for all recent phenomenologists have believed in experimentation and have experimented too. The temper of the two are, nevertheless, opposite . . . Where phenomenology is egoistic . . . experimentalism is diffident, mistrusting individual observation and relying upon controls . . . and the other techniques that have been devised to achieve assurance in the face of the unreliability of human observation (1, pp. 116-117).

If "phenomenology" and "experimentalism" are "not incompatible," how then are their "tempers opposite"? This confusing situation arises because the terms "experimentation" or "experimental"

can have two meanings: they can refer to experiment or experimenting, or they can refer to the *specific procedure adopted by particular men*—the so-called experimentalists. The latter definition often becomes the implicit (and sometimes explicit) standard for deciding what shall be called “scientific” or “experimental.” If we do not allow the meaning of “experiment” to be defined exclusively in terms of the procedures used by a *particular group of men*, then we can understand how, in Goethe's approach, “phenomenology” and “experimentation” can co-exist,² and yet why the approach of the men called “phenomenologists” is indeed different from the approach of the men called “experimentalists.”

And what of these differences? Are the terms “egoistic” and “diffident” true descriptions of the two approaches, or are we again being led astray through an explanation-by-temperament? Rather than egoism, intuition, or taxonomy, Goethe's approach (or that of the phenomenologists) is more likely the logical extension of an epistemological viewpoint. One chooses to study the *individual* and his *experience* because one is convinced that human experience can never be unreliable, *since it is the very datum, with all its variations, that one wishes to understand*. That this method does not yield egoistically unreliable results is attested to by Goethe's own observations, which anyone can repeat and verify. Concerning so-called subjective unreliability, Goethe himself stated: “Optical illusion is optical truth. It is sacrilege to say that there is such a thing as optical fraud.”³ This approach, however, does not vitiate the use of “experimental control,” although it is control of a kind different from that used by the men called “experimentalists.” As Goethe noted in his introduction (see section II above), the control is obtained in the care one takes in thoroughly investigating the phenomenon under study in its *many variations*, including the pathological. “Like all deviations from a constant law, [the pathological] afford a more complete insight into [its] nature” (8, p. 2). For a contemporary elaboration of these views, see Goldstein (9, introduction).

Other misinterpretations of Goethe's phenomenology can arise

²In Goethe's preface we find: “The innumerable cases which present themselves to the observer are collected under certain leading phenomena . . . and here it may be remarked that . . . we have adhered throughout to experiment, and throughout considered it as our basis” (8, p. xx).

³This is not found in the English translation. The statement was made in relation to Goethe's discussion of the importance of investigating and understanding phenomena solely dependent upon the eye's functions, e.g., after-images.

when one employs the term "phenomenology" to refer to anything relating to observation or description. This wider, more popularized usage has little essential relationship to the approach of the "phenomenologists" or to that of Goethe. Its only justification lies in the fact that phenomenological description, as well as any description or observation, refers to the observer's experience—of one kind or another. But greater clarification may result if one makes clearer distinctions between using "phenomenology" as *representing a point of view which involves epistemological as well as psychological considerations*, versus using "phenomenology" simply to refer to any activity vaguely involving observation or description.⁴

When one neglects these distinctions, it is then possible to misinterpret the "phenomenology" of Goethe as being synonymous with poetic intuition, observation, introspection, or taxonomic description. Such an interpretation can result in the grouping together of men whose purposes and modes of approach were entirely different. For example, Boring stated:

It is possible to link Linnaeus with the phenomenology of good observers like Goethe, Purkinje, Hering and the Gestalt psychologists (2, p. 17). Even a hundred years after Goethe . . . there were psychologists like Titchener, who thought that trained observation is more important than carefully devised experiments (1, p. 118).

A rose may be a rose may be a rose, but "observation" by Linnaeus is not "observation" by Titchener, is not "observation" by Goethe. For Titchener, most of Goethe's observations would involve the crime of "stimulus error," while for Goethe, most of Titchener's introspective reports would be an example of what William James later was to call the "psychologist's fallacy *par excellence*" (15, chapter 7).

A similar misinterpretation is seen in Sherrington's essay, where he makes Goethe's approach synonymous with introspection. (By "in-

⁴It is unfortunate that the term "phenomenology" is susceptible to this confusion. Lately some of the Dutch "phenomenologists" have been referring to themselves as "anthropological" psychologists, while some of the Germans, Swiss and French have substituted "existential" (partly independent of *existentialism*). My impression is that neither of these substitutions promises to lessen confusion. Natanson (26) discussed some misinterpretations of the term, while Landsman (21) discussed the similarities and differences between various *phenomenologies*. Since Landsman did not attempt to be all-inclusive, certain contemporary representatives were omitted; for example, Buytendijk, whose article on emotions (4) has particular relevance to this discussion of Goethe's color research. The whole situation is complicated further by the fact that Goethe probably lies closer to the holistic tradition than he does to contemporary "phenomenology." See Goldstein (9, chapter 9; and 12) for observations concerning these two closely allied approaches.

trospction" Sherrington probably meant "observation" rather than the classical introspection of Wundt and Titchener; a change of wording would clarify ambiguity but would not alter the essence of his statement nor the following objection to it.) Sherrington stated: "Goethe was one of those who, relying on introspection, believed that green as perceived contains 'perceived yellow and blue' " (29, p. 13). Quite to the contrary, this assertion of Goethe was not based simply on "introspection" (nor "observation"), but rather was dictated by one aspect of his *theory*, as well as his acquaintance with *mixing paints*, and his *experiments* on "mixing" colored negative after-images on various colored backgrounds (8, p. 227). When Goethe *encountered* the *phenomenon* of green, he had doubts as to whether green indeed is perceived as a blend. He noted that green has a "distinct quality" to the eye and, furthermore, that "the eye and mind repose upon [green] as upon a simple color" (8, p. 316). Goethe did not make this same comment in respect to other blends (e.g., orange).

IV. EXPERIMENT AND EPISTEMOLOGY

As we have seen above, explaining Goethe's approach and its relation to the phenomenological tradition in terms of various assumptions of temperament led to a misinterpretation of both his approach and this particular tradition. But it is not sufficient simply to point out that Goethe's observational approach is different from the introspective or taxonomic approach often attributed to him. Important as these distinctions are, an over-concern with the observational aspects of Goethe's approach lead to one-sided interpretations, such as: Goethe simply was a "pantheist" who naively viewed Nature's manifestations and expressed his resulting intuitions in "poetic rhapsodies" (Sherrington); or, Goethe's work simply consists of "speculations, anecdotes and dicta" (Boring).

Did Goethe not perform experiments? It was noted above that Goethe's "phenomenology" can co-exist with "experimentation" and that Goethe himself felt experiment to be the basis of his work (see footnote 2, above). Why, then, are there implications (and often assertions) that Goethe eschewed experiment?

One reason, briefly mentioned in section II, is that once assuming a particular temperament to be inconsistent with experimentation, it is then easy to overlook contradictory evidence. It is particularly easy in the case of Goethe because his work abounds with the most excellent kind of non-experimental observation. For example, in dis-

cussing the dependence of colored shadows on figure-ground contrast, Goethe described the colored shadows he observed on the snow while he was in the Harz mountains:

During the day, owing to the yellowish hue of the snow, shadows tending to violet had already been observable But as the sun was about to set, and . . . a most beautiful red colour [diffused] over the whole scene around me, the shadow colour turned to a green, in lightness compared to a sea-green, in beauty to the green of the emerald One might have imagined oneself in a fairy world, for every object had clothed itself in the two vivid and so beautifully harmonizing colours, till at last, as the sun went down, the magnificent spectacle was lost in a gray twilight (8, pp. 34-35).

The scenic image evoked by this description is so powerful that it may dull our memory of the pages which preceded it. Therefore, we may be surprised when reminded that five pages before this portrait of the Harz mountains, Goethe presented *experimental* conditions for producing colored shadows:

We may convince ourselves [of the explanation of coloured shadows] by the following experiment. Place two candles . . . on a white surface; hold a thin rod between them . . . so that two shadows be cast Take a coloured glass and hold it before one of the candles so that the white paper appear coloured; at the same moment the shadow cast by the coloured light . . . will exhibit the complementary hue (8, p. 30).

Similarly, throughout Goethe's work, one finds two sets of conditions for observing the phenomena that formed the basis of his theories: one set is encountered in the natural world, and the other set can be arranged in an experiment that creates a situation similar to that encountered in nature.

This brings us to a second reason for overlooking Goethe's experimentation. As mentioned in section III, his definition of "experiment" is at variance with the definition of the "experimentalists." Goethe did not use an "isolating" procedure, nor did he depend upon such experimental "controls" as averaging the results of many observers. In place of experimentally isolating "elements," Goethe substituted experiments that were "miniature situations" based on the conditions under which the phenomena were encountered in nature. Thus, with two candles and a colored glass, Goethe presented the conditions under which we encounter colored shadows in snow-covered mountains at sunset, and thereby substantiated his explanation of this phenomenon. Goethe felt that only this kind of experimentation could "rescue the attractive subject of . . . colour from the atomistic restriction and isolation to which it has been banished, in order to restore it to the general dynamic flow of life and action" (8, p. 298).

Likewise in place of such experimental "controls" as averaging the results of many observers, Goethe substituted the examination of many cases or manifestations of a phenomenon, in both their normal and pathological appearances. He felt that there is a great danger in concentrating on the accumulation of data concerning one manifestation: "We should not confine ourselves to the isolated fact . . . but look around through all nature, to see where something similar . . . appears" (8, p. 94). However, "looking around" nature for Goethe also included a great deal of experimentation, within the meaning discussed above; and this meaning, while differing from the meaning of the "experimentalists," is within the common definition of "experiment" ("an operation for the purpose of discovering something or testing a principle").

Goethe's methods of experiment were different from those of the "experimentalists" because the principles he wished to discover were of a different order. Goethe was searching for the *primordial phenomena* (prototypes) that would render understandable the varying manifestations of "light and darkness." The role that these primordial phenomena played in his experimental and theoretical endeavors was explained by Goethe as follows:

The circumstances which come under our notice . . . admit of being classed under general leading facts. These again [can be arranged] under more comprehensive theoretical rubrics, through which we become better acquainted with certain conditions indispensable [for their] appearance . . . [These conditions] are not to be made intelligible by words and hypotheses to the understanding alone, but, at the same time, by real phenomena to the senses. We call these primordial phenomena, because nothing appreciable by the senses lies beyond them . . . They are . . . the point to which we first ascended . . . and from which we may descend to the commonest case of every-day experience (8, pp. 71-72).⁵

In laying great stress upon the phenomenality of experience, Goethe quite correctly avoided the type of experiment which seeks to isolate the so-called elements of experience, but which themselves may be only "secondary" phenomena, i.e., variations of the primordial phenomena which appear only under the special conditions of the experiment. Likewise, within his view, he is quite right to have avoided the type of experiment and theory dealing with theoretical pro-

⁵It is of interest to note that W. James (15, chapter 17) presented a similar discussion: Only when we experience a "sensational tang [does] consciousness directly encounter . . . a reality . . . The difference between such encounter and all conceptual knowledge is very great . . . The best taught born-blind pupil . . . can never [know] what light is in its 'first intention' . . . Only when you deduce a possible sensation for me from your theory, and give it to me when and where the theory requires, do I begin to be sure that your thought has anything to do with truth."

cesses of a non-phenomenal kind which are presumed to underlie phenomena. Goethe correctly saw that this would create the danger of "substituting the sign for the thing" and that it would be "difficult to keep the essential quality still living before us, and not . . . kill it with a word" (8, p. 302). Furthermore, he questioned whether it is at all advisable to use "expressions and terminologies from all branches of . . . science to embody our views of simple nature. . . . The most desirable principle would be . . . to describe the details of a given province of investigation [with expressions] from the province itself" (8, p. 302).

It is for such reasons as these that Goethe held the view he did toward the introduction of mathematical notions into the theory of color experience:

It will be universally allowed that mathematics . . . has been of the greatest use to the physical sciences [However, progress in] the theory of colours . . . has been incalculably retarded by having been mixed up with optics generally, a science which cannot dispense with mathematics The theory of colours, in strictness, may be investigated quite independently of optics (8, pp. 286-287).⁶

In the preceding paragraphs of discussion, we have touched upon a problem of epistemology that is basic to a correct understanding of Goethe's work, namely, whether conceptual unity among the various sciences is at all a tenable assumption. Goethe questioned this possibility, as can be seen in the above quotations concerning terminology and concerning the theory of color being confounded with the theory of optics. Within more recent times, this possibility has been questioned by (among others) phenomenologically or holistically oriented theorists. For example, Kurt Goldstein, who stands close to the tradition of Goethe, wrote:

As Duhem [French historian of physics] especially has expressed it: There is no direct transition from collecting and ordering of facts . . . to physical knowledge The type of biological knowledge which we here advance, agrees [that] one should not content oneself with a mere ordering of empirical findings In biological, like physical, knowledge, it is necessary [to create symbols] However, in my opinion there remains a difference between the two kinds of knowledge We need symbols which are not as essentially alien to the observed phenomena as is permissible for the symbols of physical science; the latter . . . can content itself with a system of fictitious 'signs' (models). Certainly biological knowledge also remains a set of symbols; and we are also dealing with 'substitutes,' but not with . . . arbitrary 'signs.' We need a more complete image of an *individual concrete character, which as much as possible must match the particulars*

⁶It is unfortunate that Goethe, in his zeal to demonstrate that the world of physical abstractions (light rays) could not explicate the phenomenal experience of color, tried then to explain aspects of optics on the basis of his primordial phenomena, thereby blurring the distinctions so clearly presented in the above quotations.

from which we build it up (9, pp. 411-413). Biological knowledge is the result of the continued extension of our experience . . . [It] can never be satisfied with finding laws of relationship between completely undetermined, theoretically assumed elements. In biology, symbols, theoretical representations, must in principle include quality and individuality in all their determinations . . . From these differences . . . it is understandable that, in spite of their agreement in basic procedure, physical science might find itself in opposition to the method of cognition here proposed (10, pp. 24-29). This contrast has often become apparent, and has led to opposing tendencies within biology, and even to heated controversies between the scientists . . . A classic example . . . is the controversy between Cuvier and Geoffroy Saint-Hilaire, which Goethe has so vividly described (9, p. 413).⁷

V. GOETHE AND NEWTON

Another classic example is Goethe's polemic against Newton. Perhaps this "notorious" aspect of Goethe's work on color can best be understood within the context of the preceding discussion of his experimentation and epistemology. It is surprising how few writers have considered Goethe's attack upon Newton from this point of view. In general, most writers have preferred to interpret this in terms of Goethe's "poetic," "intuitive," or "egoistic" temperament and its shortcomings.⁸ As we have seen in previous sections, the temperament mode of explanation readily leads to an incomplete view of Goethe.

Similarly, in regard to this problem, the experimental basis for some of Goethe's objections to Newton's theory is often overlooked. Thus, Boring (1, p. 115) and Sherrington (29, pp. 7 & 11) note that Goethe said (in reference to Newton's theory): "To think that all the colours mixed together produce white is an absurdity." However, they neglect to mention that Goethe objected not only because this theory was an (obvious) "absurdity," but also because his own experiments did not support it (8, pp. 223-227). Again, partly on the basis of his own experiments, he disputed Newton's assertions concerning refraction (8, pp. 74-90, 100-118, 389-391).

The physiologist Magnus clearly presented this aspect of Goethe's dispute with Newton:

⁷For a current discussion of opposing tendencies within biology see Klein (19). W. James (15, chapter 17) has a discussion of opposing color theories. James called Helmholtz's theory "psychological" and Hering's "physiological"; from his own discussion of these theories, and from Goldstein's distinctions between physical versus biological modes of representation, more appropriate terms perhaps would have been "psychophysical" for Helmholtz and "psychophysiological" for Hering.

⁸One of the notable exceptions is the philosopher Schmid, who wrote: It is of little interest to "simplify the problem in terms of Goethe versus Newton . . . What needs to be clearly recognized is that their theories differ to the very core . . . Goethe's theory of color [was] a pioneer work in [physiology], having nothing whatever to do with physics" (28, p. xiv).

[Goethe claimed] the result of [of mixing colors] could never be white but only gray A correct observation lies at the bottom of Goethe's objection. When several colors are blended . . . gray appears, white being obtained only when extremely brilliant prismatic colors are employed (23, p. 181). Newton had stated that when a single color is isolated . . . and again subjected to refraction . . . the color remains unchanged Goethe . . . did find Newton's assertion to be borne out in the case of red, but not with blue and violet (23, p. 179).

Magnus next pointed out that Goethe repeated Newton's experiments in detail, and that the many discrepancies between the two investigators' claims resulted from Newton drawing *physically* "correct conclusions from his imperfect experiments," while Goethe's contrary claim rested on "careful and precise" experimental observations but they may not have focused on the "essential" (physical) aspects of concern to Newton (23, p. 180).⁹ Many of Newton's assertions were confirmed only when Helmholtz succeeded in refining Newton's experimental techniques.

We see, then, that Goethe's attack upon Newton's theory did not rest solely on his own intuitive disagreement. He performed some of Newton's experiments, and even more of his own. As mentioned previously (section IV), in the performance of his own experiments he followed a different procedure from that used by the physicists (or psychophysicists), *but one no less experimental*. Likewise, we see that Goethe's attack upon Newton's theory could not have been motivated solely by "frustration" or "wounded pride" (Boring), since there is evidence that experiment and empirical data also led (considering his epistemological views) to his opposing conclusions.

However, there may be some truth to the view that the acrimonious aspects of Goethe's *personalized* attack upon Newton had psychopathological roots. Eissler (6) has published an interesting study of the "partial paranoid psychosis" which he felt was involved in Goethe's color controversy. Eissler dates this psychosis as beginning circa 1790, around the time Goethe looked at a white wall through a prism and decided that Newton was wrong.¹⁰ Yet, while granting

⁹This work by Magnus has long been a standard source for investigations into Goethe as a scientist. It is curious that Sherrington was "deeply indebted" to this work (29, p. 15). Yet, he overlooked important points concerning Goethe's color theory which Magnus so carefully presented (quoted above). Sherrington even asserted that Goethe never repeated Newton's experiment of allowing light to pass through a prism!

¹⁰Goethe was in error when he tested Newton's theory of spectral composition by *looking* through a prism, expecting the white wall to dissolve into component colors, instead of letting light *pass* through the prism. However, Goethe then also repeated the experiments where light *passes* through prisms, and, on the basis of these and other experiments (8, pp. 74-150), he confirmed, to his own satisfaction, his initial decision which was based on a misinterpretation of Newton.

some aspects of Eissler's psychoanalytic analysis, the question remains as to whether such a discussion gives us insight into the essential nature of Goethe's color research, or whether it instead gives us insight into the dynamics of the *secondary* role it assumed. A study such as that by Magnus (23) shows that Goethe's *epistemological* considerations were formulated long before his attack on Newton. Likewise, although Goethe's first *published* work on color (colored shadows, 1792) appeared after his decision that Newton was in error (circa 1790), his first *experiments* on color occurred before his involvement with Newton and prisms. For example, during his Italian journey (1786-1788), he had Angelica Kauffmann paint the same landscape with different combinations of color, or in shades of gray with the color glaze overlaid, etc. Goethe's *observations* on color also started long before his Newton involvement, as can be seen in his early poetic imagery. Therefore, while a "partial psychosis" possibly may have had important consequences for Goethe's color publications *involving* an attack upon Newton, Eissler's analysis is less relevant to the prior and (from the approach of this paper) more essential aspect of Goethe's work—namely, his particular epistemological approach.

It would seem that Eissler would agree with this, for he said: "I propose to take Goethe's interest in color for granted and to consider only the circumstances in which he conceived the idea that Newton had been in error" (6, p. 61). Yet, Eissler hinted at the wider implications of his analysis: while the two are not completely unrelated, "one may surmise that Goethe's scientific strivings in Weimar had a different psychological meaning from those of his early years" (6, p. 52). This hint became more explicit when Eissler discussed Goethe's "inability" to engage in experiments that *isolate phenomena in the manner of physical science*; Eissler asked: "What may have caused this disturbance in Goethe?" (6, p. 56). In claiming that a basic epistemological choice represents an "inability" on the part of Goethe, and in asking the cause of this "disturbance," Eissler implies that there are grounds for judging Goethe's choice to be incorrect. What standards can be used in making such decisions as this?

As long as Eissler remained in the area of Goethe's personal attack on Newton, his analysis of pathology (whether one agrees with it or not) was relevant. But when this realm was transcended to bring under the same analysis Goethe's epistemological assumptions, Eissler was no longer concerned with investigating "only the circumstances in which Goethe conceived the idea that Newton had been in error,"

but instead was asserting that Goethe's philosophical inclinations were not in sympathy with his own. This is seen particularly well when, in discussing Goethe's disinclination to externalize human problems, Eissler said:

When Goethe wrote . . . 'in our eye lies the law' — a statement which I think is valid for his whole theory of colors — he was trying to shift the whole problem from physics to physiology, *where it did not belong* (my italics, 6, p. 94).

From the epistemological viewpoint of Goethe, and the tradition which follows from him, this was precisely where it *did* belong. Once recognizing this epistemological assumption underlying Goethe's work, one then can agree with Sherrington when he said that: Goethe had an "almost willful inability to enter into the physicist's point of view" (29, p. 9). But it is equally true that most of Goethe's critics are not able to enter into *his* point of view. This is seen most dramatically in the following quotations from Sherrington:

Helmholtz . . . after furnishing a precis of Goethe's account, writes 'this description of the matter, *if intended for physical*, has no sense' [my italics] . . . [Sherrington then concluded] In other words, Helmholtz declined to accept . . . [Goethe's work] as lying within the province of science at all (29, p. 14).

This is not what Helmholtz said! Only by confusing (equating) *physical* with "science" (and thereby missing a crucial issue in Goethe's color theory) could Sherrington give this as a conclusion.¹¹

The differences, then, that exist between a Newtonian approach to color compared to the approach of Goethe lie in the domain of *epistemology*. Newton approached the study of color from a *physical* view—in his own words, he wished "to subject the phenomena of nature to the laws of mathematics." Goethe approached it from a view similar to the biological approach presented by Goldstein (section IV)—he wished to explicate the nature of color as man *encountered* it. These are different purposes which necessarily lead to different modes of theoretical representation. The Newtonian physico-mathematical mode serves the purpose of producing abstract laws with

¹¹The physicist Le Grand noted a similar confusion with specific regard to color theory: "Throughout the nineteenth century there was almost a complete confusion between the fact that stimuli were trivariant and Young's *theory* which gave this fact a simple interpretation, but which was only one among many possibilities. Likewise, any confirmation of the trivariance seemed, erroneously, to be further support for Young's theory" (22, p. 402). One wonders if Le Grand was unduly optimistic in limiting this confusion to the nineteenth century. One also wonders what new confusion will now arise due to the recent work of Land (19, 20), which disputes the "fact" of trivariance of stimuli; indeed, it raises the question of whether or not the experience of color depends upon *specific* wavelength at all.

which one can dissect nature, and with which one in turn can *create* relationships *between* phenomena. Goethe's bio-phenomenal mode serves the purpose of presenting a prototype of nature with which one can *apprehend* the relationships *experienced in* phenomena. Both modes necessarily utilize symbols, thereby transcending naive experience. However, only the latter will represent what Goldstein calls an *extension* of this experience.¹² The Newtonian mode may be appropriate for physics, but it does not meet Goldstein's requirements for true biological knowledge, nor did it meet Goethe's.

VI. CONCLUDING REMARKS

Only in the light of the above considerations may one approach a proper evaluation of Goethe's work on color. Boring contended that Goethe's "sterile" color theory obscured the more fertile theory of Young, and Sherrington asserted that we should only remember Goethe for his poetry because his science was "not important" (see section I). I hope to show in another paper that when we inquire into the fate of color theory in the realms of "physiognomic" perception, metaphorical usage, affective experience, esthetic appreciation, etc., we find that the Young-Helmholtz theory has obscured the more fruitful insights of Goethe (and Hering).

It is sufficient at this time to note that far from being sterile and unimportant, Goethe's work in color influenced the color research conducted by such men as Purkinje and J. Mueller. In more recent times, his influence can be found in studies such as those by A. Gelb (7), K. Goldstein and his co-workers (9, 11, 13, 14), D. Katz (16), F. Deutsch (5), R. Matthaei (24), E. Schachtel (27), B. Kouwer (18), and M. Minnaert (25).

Likewise, let us merely note here that Goethe (8) *observed* and *experimentally investigated* such diverse subjects as adaptation, color contrast effects and after-images (pp. 2-45), color blindness (pp. 45-49), iridescent colors (pp. 154-162), interference colors (pp. 170-172),

¹²That Goethe was fully aware of the necessity for theory, and of its symbolic character, can be seen in the following: "Mere inspection of a subject can profit us but little. Every act of seeing leads . . . to reflection . . . and thus in every attentive look on nature we already theorize. But in order to guard against the possible abuse of this abstract view, in order that the practical deductions . . . be really useful, we should theorize without forgetting that we are so doing, and . . . with irony" (8, pp. xx-xxi). Thus, what is basic for understanding Goethe is not the superiority of intuition over experiment, nor of observation over theory, but rather, the value a certain *kind* of observation, experiment, and theory has for a *particular epistemological view*.

the chromatic aberration in the lens of the eye (pp. 174-175), atmospherically polarized light (pp. 395-396), etc. He measured the time for retinal recoverability after satiation or light adaptation (p. 3), the discrepancy in phenomenal size observable when a black circle is compared to a white one (p. 6), and the temperature differences caused by different colors (p. 267). He plausibly explained, or interpreted in a manner today accepted as reasonably correct, such phenomena as colored shadows, simultaneous and successive contrasts, positive and negative after-images, esthetics of color contrast and harmony, as well as numerous other aspects of color experience. The *psychologically* complementary color circle, known to every school child, was of his devising (pp. 21 & 318). He recognized that phenomenally "pure" red needed a touch of violet (Goethe called this red "purpur" though it is not to be confused with "purple"—p. 313). He correctly explained as contrast phenomena the colored shadows seen from a diver's bell, which Newton thought to be caused by optical conditions (p. 36).

Many of these accomplishments, which seem commonplace today, were quite unique in their time. But Goethe's significance lies beyond these specific contributions. As important as any single aspect of his color theory was his assertion that isolating the physical aspects of stimuli could never lead to a true understanding of man's experiencing a world of color. For Goethe, color was an event in man's existence. Within such a conception, he correctly saw that only by grasping the *prototypic experiences* (primordial phenomena) could the many manifestations of man's encounter with color be understood.

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