

## The Hypnagogic State: A Critical Review of the Literature

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In this paper, literature concerned with the hypnagogic state is reviewed. The term *hypnagogic state* is used in a descriptive sense to emphasize that numerous phenomena characterize the drowsy interval between waking and sleeping. Major methodological issues are considered, psychological and physiological aspects of the hypnagogic state are reviewed, and theories concerned with the genesis and function of hypnagogic phenomena are critically evaluated. Possible directions for future research are outlined, with emphasis placed on elucidating the patterns of psychological and physiological phenomena which characterize the hypnagogic state.

Leaning (1926) prefaced her review on the hypnagogic state by noting that no systematic treatment of the topic had yet surfaced. She felt that investigation of the hypnagogic state would be fruitful for psychologists and urged researchers to systematically explore "this little cultivated area" (p. 290). The 40 years following Leaning's study showed less research on the subject than had the years previous to its publication. Holt (1964), in his paper concerning the banishment and subsequent return of imagery research, pointed out that no information was likely to be found concerning the hypnagogic state in either introductory or advanced psychology textbooks.

The appearance in the last few years of experimental studies exploring the hypnagogic state indicates that widespread interest in hypnagogic processes is beginning to emerge. Unfortunately, information regarding hypnagogic phenomena is widely scattered and unknown to most psychologists. For instance, my own search of the literature has uncovered only four authors (Freedman, Grunebaum,

Stare, & Greenblatt, 1962; McKellar & Simpson, 1954; Oswald, 1962; Tart, 1969) who cited the Leaning (1926) study, which stands as one of the most thorough phenomenological treatments of the hypnagogic state available today. Indeed, if one constant can be identified in the hypnagogic literature, it is that most investigators have worked in ignorance of one another's efforts. The present paper is an attempt to at least partially rectify this discouraging situation by providing a systematic review of the existing literature on the hypnagogic state.

The hypnagogic area differs from most topics addressed in contemporary psychology. There are no standard experimental procedures, comprehensive theoretical systems, or well-known empirical controversies. Accordingly, I have organized this review with two principal goals in mind: (a) to group the myriad topics considered in the hypnagogic literature such that the issues and trends which do exist are clearly exposed, and (b) to preserve maximal informational value within the context of the groupings—that is, not *all* points in the literature can be touched upon, but an effort has been made to eliminate only those findings which appear least related to the body of observations.

### *Definition of Terms and Discussion of Criteria*

To what exactly do we refer when we invoke the phrase *hypnagogic state*? The literature to be reviewed shows that a variety of psychological phenomena have been labeled

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*hypnagogic*: spontaneously appearing visual, auditory, and kinesthetic images; qualitatively unusual thought processes and verbal constructions; tendencies toward extreme suggestibility; symbolic representation of ongoing mental and physiological processes; and so on. Additionally, specific physiological indexes have been observed in conjunction with these phenomena: A slowing of frequency and depression of amplitude of the electroencephalogram (EEG) and the appearance of slow eye movements are fairly well documented; and recent studies suggest that a low rate of frontalis muscle activity and changes in respiratory patterns may accompany the above psychological phenomena.

The factor common to these various psychological and physiological phenomena is that they occur in a similar *context*, the drowsy interval between waking and sleeping. In the present paper, the term *hypnagogic state* is used to refer to that period between waking and sleeping when some or all of these phenomena occur conjointly. It should be noted that the state concept is invoked here in a *descriptive* rather than an *explanatory* sense (Hilgard, 1969); the point to be emphasized is that a multiplicity of phenomena should be considered when discussing the hypnagogic state.

Considering the concept of the hypnagogic state in a descriptive sense, we must clarify some fundamental issues. Specifically, the individual criteria which are relevant to a description of the hypnagogic state need to be identified. The literature as it exists provides a general description of the hypnagogic state in terms of the psychological and physiological criteria listed above, but these parameters require a more precise formulation, and they are only a few of the important parameters which require study. For instance, little is known about the nature of memory storage and retrieval processes in the hypnagogic state; about the response capacity of physiological systems in the hypnagogic state (see Johnson (1970) and Williams, Hammack, Daly, Dement, and Lubin (1964) for discussions of the importance of this parameter for describing a state of consciousness); about the relative contributions of the left and right

hemispheres to hypnagogic mentation; and so on. Moreover, the problem of elucidating the precise *patterns* of these criteria which converge to describe the hypnagogic state, and the degree to which these criteria maintain a consistent relation to one another is of critical importance and has not yet been adequately confronted. There is some evidence which suggests that there are a succession of temporally ordered stages within the hypnagogic interval that can be described by different patterns of psychophysiological criteria (Foulkes & Vogel, 1965; Vogel, Foulkes, & Trosman, 1966); further work on this problem is needed before the patterns of criteria which adequately describe the hypnagogic state become clear.

In the literature, the problem of criteria has largely been addressed in the context of differentiating the waking state from the onset of the hypnagogic state and differentiating the dream state from the termination of the hypnagogic state.

Vihvelin (1948) distinguished between the internal and external methods of differentiating the hypnagogic state from the dream state. The internal view is espoused by Leroy (1926) and Burdach (cited in Vihvelin), who hold that an analysis of the phenomenon itself is sufficient to decide whether the episode is hypnagogic. The external view is advocated by Schultz and Weygandt (both cited in Vihvelin), who argue that the subject's degree of awareness of the external world is decisive. Weygandt's principal criterion is that the person must show continuing consciousness of the environment if the episode is to be considered hypnagogic. Another way of making this distinction is through use of the EEG. Davis, Davis, Loomis, Harvey, and Hobart (1937), Dement and Kleitman (1957), and Liberson and Liberson (1965) all reported that the appearance of 12-14-Hz spindles in the EEG is generally a reliable indication that a person has lost consciousness of the external situation.

Considering the problem of ascertaining the onset of the hypnagogic state, Vihvelin posited that two stages characterize its initiation. First, there is a stage of increasing fatigue, marked by a quantitative reduction of thought

processes; next, the proper hypnagogic state, characterized by qualitative changes in mental content. Davis et al. (1937), Foulkes and Vogel (1965), Green, Green, and Walters (Note 1), and Liberson and Liberson (1965) suggested that the onset of occipital alpha blocking and the appearance of low-voltage, 4-7-Hz theta waves in the EEG signal the beginning of the hypnagogic state.

Although little systematic research has been directed toward this problem, it is clear that specification of *the* moment of hypnagogic onset or termination is impossible. Rapaport (1967b) has noted that "we are dealing with continuous transitions where one cannot draw any hard and fast dividing lines. I cannot say that up to here these are the hypnagogic hallucinations and here begin the daydreams . . ." (p. 395). We can only say that a particular phenomenon is more or less in correspondence with the general criteria of the hypnagogic state. What future research can do is to elucidate the patterns of psychological and physiological phenomena arising within the general borders of the hypnagogic state. Then this more refined information can be fed back into the construction of a more precise definition of the limits of the state.

### *Historical Background*

One of the earliest printed references to hypnagogic phenomena is found in the autobiography of astrologer Simon Forman, written in 1600 (cited in Ellis, 1911). As a child Forman noted, "So soon as he was always laid down to sleep he should see in his visions always many mountains and hills come rolling against him, as though they would overrun him . . ." (p. 30). Forman believed that these presleep visions were sent to him from heavenly sources as a harbinger of later difficulties. Similarly, Emanuel Swedenborg, the 18th century scientist-turned-mystic is alleged to have reported encounters with angels upon entering the hypnagogic state (Van Dusen, 1972, p. 94). Another early reference to hypnagogic occurrences is found in Hobbes' (1651) *Leviathan*: "A man shall in the dark, though awake, have the images of lines and angles before his eyes; which kind of fancy

hath no particular name, as being a thing that doth not commonly fall into mens discourse" (p. 6).

The formal study of the hypnagogic state appears to have commenced with Baillarger (cited by Vihvelin, 1948), who published an account in 1846. Soon after, Maury (1848) invoked the term *hypnagogic*, derived from the terms *hypno* (sleep) and *agogos* (induce). The term *hypnopompic* was coined some years later by Myers (1904) in reference to those phenomena which appear as one makes the transition from sleep to wakefulness. Hypnopompic phenomena are not dealt with here.

A large number of the early studies concerned themselves with the question of how many people have experienced at least one hypnagogic image. Müller (1848), the renowned physiologist, concluded from questionnaires completed by groups of medical students that the images were extremely rare; however, Leaning (1926), Maury (1848), and Taine (1883) all concluded that hypnagogic phenomena are relatively common. The scanty available figures, derived from questionnaire studies, support the latter conclusion. McKellar (1972) reported that his own investigations using students yielded an incidence of 76% and that the investigation of Owens (Note 2) placed the figure at 77%; Buck and Geers (1967) offered an estimate of 72%.

Figures representing the percentage of people who have experienced at least one hypnagogic image are likely to be misleading. If one replies negatively when queried as to personal experience with hypnagogic images, this does not necessarily indicate that they do not occur. As Galton (1883) pointed out, people are characteristically reluctant to admit that they experience visions or hallucinations of any sort, due to the negative connotations which society attaches to such episodes. Holt (1964) offered an identical observation:

In interviewing our subjects about their hypnagogic imagery, I was struck by the discomfort some of them showed in confessing that they experienced it; one of them commented on his nocturnal visualizations, "If they were any more real, I'd know I was crazy." (p. 262)

McKellar (1972) has pointed out that the tendency toward "false negatives" in hypnagogic recall is common:

it [hypnagogic imagery] can be overlooked for a very long time even by those who subsequently come to realize that they have the experience frequently. . . . False negatives seem to occur by a process of ignoring what one is not alerted to notice, as well as from emotional blockage. (p. 43)

An anecdotal remark which appears consistently in the early literature is that hypnagogic images surface often in childhood and decline in frequency as a function of age. Some early data pertaining to this observation, though not extremely dependable, support the anecdotal record. Partridge (1898) asked 826 children to describe what they saw at night after their eyes were closed but before they fell asleep. Hypnagogic imagery was reported most frequently by the younger children. De Manaceine (1897) found that hypnagogic images occurred in 8 out of 10 of the 6-year-olds she studied, in 4 out of 10 of the 8-15-year-olds, and still less frequently in adulthood. More recently, Foulkes (1971), as part of a longitudinal study of childrens' dreaming, found recall of hypnagogic phenomena on 61% of the interruptions of 9-10-year-olds and on only 18% of the interruptions of 3-4-year-olds. These data would appear to cast some doubt on the earlier speculations.

De Manaceine (1897) was also the first investigator to suggest that cultural differences might influence the hypnagogic state. One third of her subjects were Finnish, and she claimed to have uncovered a propensity for hypnagogic phenomena among them:

as all of them presented a very marked and a very long state of half-awakening, I cannot look on this as a pure accident, but I think we have here a national peculiarity. Perhaps this liability to the state of half-awakening is explained by the fact that amongst the natives of Finland it is nearly impossible to find a person of sanguine temperment. (p. 204)

The possibility of cultural factors influencing the hypnagogic state has not yet received serious treatment. The point raised by Galton (1883), that the demands of society may serve to either inhibit or encourage the emer-

gence of hypnagogiclike material, might be profitably researched in a cross-cultural context.

Before leaving the topic of historical background, it should be noted that the latter half of the 19th century can be characterized as the heyday of reports of hypnagogic phenomena. A list of the scientists and philosophers who considered aspects of the hypnagogic state is impressive: Ellis (1897, 1911), James (1890), Galton (1883), Kekule (cited by Koestler, 1964, p. 118), Ladd (1892), Müller (1848), Titchener (1909), and Wundt (cited by Leaning, 1926); all offered observations concerning hypnagogic processes. Historically, this is understandable, as the introspective method was practiced widely during this period, and Watsonian behaviorism had not yet begun its rise to paradigmatic stature.

### *Methodology*

In this section, two major issues are addressed. First, the methods which have been used to collect data from the hypnagogic state are critically evaluated; second, the techniques which have been developed for inducing and prolonging the hypnagogic state are discussed.

*Data collection.* Four major modes of obtaining data from the hypnagogic state are found in the literature: spontaneous self-observation, systematic self-observation, questionnaire sampling, and controlled experimental investigation. These methods vary widely in the degree to which they yield reliable data, and the present discussion attempts to expose the strengths and weaknesses of each.

Spontaneous self-observation refers to those reports of hypnagogic phenomena offered retrospectively by a person who did not specifically intend to systematically observe the phenomena. Leaning (1926) presented the hypnagogic experiences of numerous people which are of this sort; similarly, Hanawalt (1954), Hebb (1968), Hollingworth (1911), Slight (1924), Varendonck (1921), and Warren (1921) offered discussions of the hypnagogic state based largely on their own spontaneous experience of the phenomena.

One advantage of the spontaneous method is that it may produce relatively "pure" hypnagogic phenomena. It can be argued that methods such as systematic self-observation or experimental investigation may significantly affect the type of phenomena which are observed, through processes of self-fulfilling prophecy, experimental demand, and the like. Thus, a positive aspect of the spontaneous phenomena is that they may be relatively unaffected by these influences.

However, the spontaneous method has a major flaw. It is difficult to know how thorough the observer has been in reporting his own hypnagogic experiences. Although there currently exists no systematic study regarding memory of hypnagogic experiences, it has consistently been noted that hypnagogic phenomena are extremely difficult to remember if they are not recorded immediately after they occur. The possibility is raised that the reported spontaneous phenomena are only those most impressive to the observer. Thus, the validity of spontaneous experiences as evidential data is lessened in the absence of a more complete sample of the observer's hypnagogic experiences.

Several sources in the literature have used the method of systematic self-observation in exploring the hypnagogic state. The major difference between this and the spontaneous method is that here the observer has decided before entering the hypnagogic state that he will systematically scrutinize his hypnagogic processes upon entering it. Two kinds of systematic self-observation are found: one in which the author reports on his own hypnagogic experiences (Maury, 1848; Rapaport, 1967a, 1967b; Sartre, 1972; Silberer, 1951; Van Dusen, 1972), and one in which a small group of people are trained to observe their own hypnagogic processes (Leroy, 1926; Vihvelin, 1948). In each case, the observer acts both as subject and experimenter.

The major value of this method is that an in-depth look at these individuals' hypnagogic processes is made possible. As Singer (1966) has pointed out, the trends and consistencies which are observed on an individual basis can then be investigated with larger numbers of subjects. Singer has also recog-

nized the major problem with such an approach:

The execution of such a fairly complex experiment with oneself as subject proved difficult, if engrossing. It seems impossible, of course, to avoid biases and great self-consciousness, which necessarily alter results from what they might be if there were no awareness of an ongoing experiment. (p. 40)

Thus, the major drawback of the systematic self-observation method concerns the questionable validity of the introspective account.

The questionnaire method of investigating hypnagogic phenomena has been used from time to time in the literature. As noted earlier, several investigators have attempted to specify the percentage of people who have experienced at least one hypnagogic image through the use of a questionnaire (Buck & Geers, 1967; McKellar, 1972; Müller, 1848). The questionnaire has also been used to assess the relative importance of each sensory modality in hypnagogic experience (McKellar, 1957) and to correlate the incidence of hypnagogic phenomena with the incidence of other cognitive phenomena, for example, dreams, waking imagery, and the like (Buck & Geers, 1967; Holt, 1972).

The major difficulty with the questionnaire method concerns the latency between the time of the hypnagogic experience and the time that the experience is assessed. Due to the problems mentioned earlier concerning the difficulties in remembering hypnagogic phenomena, which would appear to be accentuated when using the questionnaire, data generated by the questionnaire method should be viewed cautiously. However, the questionnaire may prove useful in either of two ways. First, a questionnaire which assesses the major dimensions of hypnagogic experience can be used to identify subjects suitable for research purposes. Second, such a questionnaire might be used to generate hypotheses which could then be more specifically investigated experimentally.

Systematic experimental investigation of hypnagogic processes has only recently been undertaken. With the exception of early studies by De Manaccine (1897) and Davis et al. (1937) and sleep studies not primarily concerned with the hypnagogic period (Aser-

insky & Kleitman, 1955; Dement & Kleitman, 1957), the first detailed experimental investigations of the hypnagogic state were reported by Bertini, Lewis, and Witkin (1964), Green et al. (1970, Note 1), Liberson and Liberson (1965) and in a series of studies by Foulkes and Vogel and their colleagues (Foulkes, Spear, & Symonds, 1966; Foulkes & Vogel, 1965; Vogel, Barrowclough, & Giesler, 1972; Vogel, Foulkes, & Trosman, 1966). Less detailed investigations have been provided by Braud and Braud (Note 3), Budzynski (1972), Dement (1965), Schacter and Kelly (1975), and Stoyva (1973).

One major advantage accrued by experimental investigation of the hypnagogic state is that the recalling of hypnagogic events over long temporal intervals is minimized by on-the-spot elicitation of internal activity. Additionally, the experimenter is afforded the opportunity to systematically sample the subjects' hypnagogic mentation according to a schedule of interruption based on the criteria he desires.

Another important advantage offered by experimental investigation of hypnagogic processes is the opportunity to address an important methodological issue—the empirical worth of introspective accounts—through the use of converging operations (Stoyva & Kamiya, 1968). Stoyva (1973) argued that by combining verbal reports with physiological indicators, the same type of validity that the discovery of rapid eye movements bestowed upon dream research can be conferred upon hypnagogic work. If specific physiological indicators are consistently linked with reports of certain types of mental content, while other physiological signals are accompanied by systematically different types of content, then the use of these converging operations serves both as a proof of the validity of the introspective account and as a technique for exposing new relationships between psychological and physiological events. The work of Foulkes and Vogel (1965) is the clearest example of the possibilities suggested by the technique of converging operations.

The strategy of converging operations promises to be a fruitful mode of assaying the hypnagogic state. However, there remain

problems in the experimental investigation of hypnagogic processes which have not been solved. For instance, the methodological considerations in obtaining the verbal report must be more adequately worked out. While it has been shown that abrupt interruptions are more effective than gradual ones for obtaining dream reports (Goodenough, Lewis, Shapiro, Jaret, & Sleser, 1965), it is not clear that the same holds true for hypnagogic research. It can easily be seen that an excessively abrupt interruption might prevent a subject from reestablishing the hypnagogic state. Also, the appropriate form and content of the questions posed during interruptions have not yet been adequately formulated. Clearly, questions should be framed so as to unambiguously extract the desired information. However, they should not be so directive as to help the subjects "fill in" missing parts of fleeting and difficult-to-reconstruct hypnagogic episodes.

In sum, it appears that the methods of spontaneous self-observation, systematic self-observation, and questionnaire sampling are of limited value in testing hypotheses concerning the hypnagogic state. Controlled on-the-spot sampling of hypnagogic mentation, though in need of refinement, is clearly the method of choice for hypothesis testing. However, the nonexperimental methods may prove useful in generating hypotheses which can then be experimentally tested.

*Induction and prolongation.* Green et al. (Note 1) and Stoyva (1973) have observed that a delicate balance must be achieved between drowsiness and conscious awareness if the hypnagogic state is to be maintained. One must be relaxed enough to permit the hypnagogic content to emerge spontaneously, yet one must be sufficiently aware to observe what has appeared. If one is excessively drowsy, the transition into sleep will be swift and unaccompanied by hypnagogic phenomena; if one is excessively alert, the hypnagogic material is effectively blocked. Stoyva (1973) has specified five conditions which encourage entry into the hypnagogic state; the first two are adapted from West's (1962) theory of hallucinations: (a) reduction in the level and variety of sensory input to the brain, (b)

maintenance of an arousal state sufficient to permit awareness, (c) reduction of proprioceptive input, (d) ability to shift to a state of "passive volition," and (e) shift from dominance of sympathetic to parasympathetic nervous system, "resetting the hypothalamic balance."

Some recent research has explored the possibility of systematically inducing and prolonging the conditions which are conducive to the maintenance of the hypnagogic state. The first attempt at systematically inducing the hypnagogic state was reported by Kubie (1943), in a clinical setting. He constructed an apparatus which feeds back to the subject his own breath sounds, using a microphone, amplifier, and headphones (see Kubie and Margolin, 1944, for a detailed description). The monotony of the respiratory feedback was successful in helping to induce the hypnagogic state. A more developed version of this strategy has been employed by Bertini et al. (1964). These investigators put subjects in a state of relative sensory isolation, using the ganzfeld procedure, and instructed them to talk continuously. They found that the combination of homogenous visual stimulation and auditory white noise did facilitate the appearance of hypnagogic-like material. Braud and Braud (Note 3) and Honorton and Harper (1974) used similar procedures and found the ganzfeld to be useful in producing hypnagogiclike phenomena. My qualification of the term *hypnagogic* is important, as it points to one of the drawbacks of the ganzfeld procedure: It is not clear that this is specifically hypnagogic material which is surfacing, or anything other than free-associative thought. This point is considered in more detail later in the paper.

Recent research by several investigators has indicated that the technique of biofeedback training can be a powerful tool for inducing and prolonging the hypnagogic state. Green et al. (1970, Note 1) were the first researchers to employ this mode of assay. Green et al. noted that theta rhythms in the EEG are often accompanied by reports of hypnagogic phenomena. They constructed a two-step training procedure designed to improve their subjects' ability to voluntarily in-

duce the hypnagogic state. In part one, biofeedback training is preceded by several minutes of relaxation and breathing exercises. The subject then undergoes 15 minutes of alpha-theta feedback, followed by 30 minutes of theta feedback only. The presence of alpha is signaled by a 900-Hz tone, the presence of theta by a 400-Hz tone. In part two of the training, the same procedure is followed, but now the subject is encouraged to report instances of hypnagogic phenomena. The subject himself may relay hypnagogic episodes as they occur or may be interrupted by the experimenter, on the basis of the EEG, and asked to describe mental content at that moment. The training lasts for 10 weeks, five 45-minute feedback sessions held per week. Although Green et al. have not presented quantitative analyses of their results, they noted that

almost all subjects have been able to consciously increase their alpha production . . . and that theta, though more difficult, has also increased. . . . What is more significant . . . is an increase in reported hypnagogic imagery as alpha-theta practice progresses. (Green et al., Note 1, p. 8)

Green et al. have also introduced several ingenious methods of prolonging the hypnagogic state. For instance, subjects can practice by themselves using "repeat" alarm clocks. At the beginning of the practice session, the subject sets the alarm to ring immediately and then resets it by depressing a bar at the top of the clock. If he remains sufficiently aware during the session to depress the bar every 5 minutes, the alarm will not ring. Each time he resets the clock, or is awakened by it, he records the hypnagogic content that he is able to recall. Another alerting device is a mercury switch finger ring which acts as an omnidirectional tilt detector. If the subject's level of awareness diminishes below a certain critical point, the forearm will begin to tilt. This closes the mercury switch circuit and sounds a chime, which nudges the subject back to above-threshold consciousness.

Budzynski and Stoyva (Budzynski, 1972; Stoyva, 1973) have employed a slightly different mode of hypnagogic-biofeedback training. These investigators first became interested in the hypnagogic state when using an

electromyographic (EMG) feedback technique to treat tension headaches (Budzynski, Stoyva, & Adler, 1970). They observed striking qualitative changes in cognitive processes as their subjects entered states of deep relaxation, and also noted that low levels of frontalis muscle activity were accompanied by an abundance of theta in the EEG. Their outline for a hypnagogic-inducing biofeedback procedure also calls for a two-step process. First, an EMG procedure which feeds back frontalis muscle activity is used to facilitate entry into the desired low-arousal state. Once the subject has experienced some success in achieving a state of deep relaxation, direct theta feedback commences. Although the structure of the training procedure suggested by Budzynski and Stoyva largely parallels that of the Green group, one important difference is that Budzynski and Stoyva used an *analog* auditory feedback procedure, while Green et al. employed a *digital* one. Budzynski and Stoyva (1969) noted that in this manner, the subjects are presented with continual information regarding their state of consciousness; in the digital procedure, the subjects know whether they are in or out of the desired region, but they do not know *how close* they are to their goal. While no large-scale analyses are offered, Budzynski and Stoyva reported positive first results using the above procedure.

The evidence reviewed in this section suggests that a basic methodological framework for inducing and prolonging the hypnagogic state is beginning to emerge. Further development of this methodology appears to be contingent on several variables. More extensive analyses of the biofeedback procedure are called for. It is not apparent in the studies reviewed here precisely what effects were encountered. Also, the design of these studies does not permit one to attribute all of the reported effects specifically to the biofeedback procedure; all of the conditions for hypnagogic activity listed by Stoyva are met by the conditions of quietude and relaxation in which the biofeedback experiments are conducted. Studies comparing "correct feedback," "incorrect feedback," and "no feedback" are needed in order to more critically evaluate the

efficacy of a hypnagogic-inducing biofeedback procedure.<sup>1</sup>

Finally, it should be noted that techniques which intentionally induce or prolong the hypnagogic interval may yield qualitatively different patterns of phenomena than are found in the natural transition to sleep. Research aimed at discriminating between natural and induced or prolonged hypnagogic periods would be highly desirable.

#### PHENOMENOLOGICAL AND PSYCHOLOGICAL ASPECTS OF THE HYPNAGOGIC STATE

Most of the literature dealing with phenomenological and psychological parameters of the hypnagogic state is concerned exclusively with elucidating properties of hypnagogic *imagery*; material on other properties of the hypnagogic state is less abundant. The emphasis in this section is on providing a well-rounded view of the various phenomenological and psychological characteristics of the hypnagogic state.

#### *Hypnagogic Imagery*

*Mode of presentation.* One of the most remarked-upon features of hypnagogic images is their seemingly spontaneous emergence into consciousness. Leroy (1926) noted this, commenting that hypnagogic images appear in an intrusive manner. Maury (1848) first called attention to this quality of hypnagogic images, likening them to suddenly appearing faces in the dark; the images appear "full blown." Numerous observers (Ardis & McKellar, 1956; Leaning, 1926; Leroy, 1926; McKellar & Simpson, 1954; Oswald, 1962; Sartre, 1972) have compared the experiencing of hypnagogic images to being a passive spectator at a play or movie. Alexander (1909), Horowitz (1970), McKellar and Simpson (1954), Müller (1848), Myers (1957), and Richardson (1969) have all argued that the

<sup>1</sup> Budzynski and Stoyva (1969) found that the subjects receiving appropriate EMG feedback reached deeper levels of relaxation than did the subjects receiving either no feedback or irrelevant feedback. However, this study did not directly investigate the effect of feedback on hypnagogic processes.



quality of autonomy is the distinctive feature of hypnagogic images.

Sartre (1972) exposed another feature in the mode of presentation of hypnagogic images similar to the above:

a radical distinction must be drawn between the way a face appears in perception and the manner the same face appears in hypnagogic vision. In the former case something appears which is then identified as a face . . . consciousness must focus on the object. . . .

In hypnagogic vision this discrepancy does not exist. There is no focusing. Suddenly knowledge appears, as vivid as a sensory manifestation: one becomes aware of *being in the act* of seeing a face. (pp. 55-56)

An additional feature of hypnagogic images concerns their localization; that is, are hypnagogic images recognized as appearing in internal space, or are they localized "out there"? Many of the cases cited by Leaning attributed a quality of externality to the images. Such examples appear sporadically throughout the literature (e.g., Lukianowicz, 1959), especially in cases involving children's imagery (McKellar, 1965). Vihvelin (1948) instructed his observers to note whether their images appeared in "external" or "internal" space. Unfortunately, Vihvelin did not present the data pertaining to this distinction. The literature on the whole only rarely shows instances of externally located images, and these are largely of the auditory variety. However, this distinction may be of more than taxonomic import. Liddon (1967), McKellar and Simpson (1954), and Roheim (1952) have noted that the spontaneous experience of seemingly externally located hypnagogic images may have played a significant role in the development of folklore and mythology.

*Content of the images.* While a scan of the literature suggests that the range of subject matter found in hypnagogic images is boundless, most of the reported images can be seen to fall into a limited number of categories. The visual modality is examined first, followed by treatments of the auditory and tactile-kinesthetic variety. Most of the literature derived from spontaneous and systematic self-observation indicates that visual images occur most frequently, followed by auditory and

tactile-kinesthetic.<sup>2</sup> McKellar and Simpson (1954), in their questionnaire sample, found that auditory images were the most frequently experienced. However, Foulkes and Vogel (1965) and Green et al. (Note 1), in experimental studies, reported that visual images occurred most often, in accordance with the self-observational literature. More detailed studies examining the relations between the sensory modalities in the hypnagogic state are called for.

Numerous investigators have noted a consistent pattern of sequential development of visual hypnagogic images: flashes of color, light, and geometric patterns, followed by faces and static objects, followed by landscapes and more complex and prolonged scenes (Critchley, 1955; Foulkes & Vogel, 1965; Gurney, Myers, & Podmore, 1886; Leaning, 1926; Leroy, 1926; Sartre, 1972; Green et al., Note 1).

The light flashes and geometric patterns are often viewed as resulting from entoptic phenomena (phosphenes, intraocular fluid, self-light of the retina, etc.; see Marshall, 1935, for a detailed descriptive treatment of these phenomena). Ladd (1892), McKellar and Simpson (1954), and Sartre (1972) presented thorough discussions of the relationship between the entoptic lights and the formation of visual hypnagogic images. The material gathered in studies of electrically stimulated phosphenes (Knoll, Kugler, Eichmeier, & Hofer, 1962) closely resembles the designs and patterns reported in this stage of the hypnagogic state, thus lending support to the contention that the entoptic phenomena play a major role in generating the geometriclike images.

Several writers have observed that the more formed images of this early stage can be traced to activities pursued during the day (Hanawalt, 1954; Hebb, 1968; Leaning,

<sup>2</sup> Leaning (1926) reported the occurrence of olfactory and gustatory hypnagogic images. McKellar (1957) found evidence for olfactory and thermal imagery. Green et al. (Note 1) also encountered olfactory and gustatory images. However, all of these investigators noted that these types of hypnagogic imagery are extremely rare.

1926; Leroy, 1926; Vihvelin, 1948; Warren, 1921). Thus, Hebb (1968) related:

A day in the woods or a day-long car trip after a sedentary winter sometimes has an extraordinarily vivid aftereffect. As I go to bed and shut my eyes—but not till then, though it may be hours since the conclusion of the special visual stimulation—a path through the bush or a winding highway begins to flow past me and continues to do so till sleep intervenes. (p. 475)

There is some question in the literature concerning the relation of these aftereffects of sensory stimulation to other types of hypnagogic phenomena. Oswald (1962) argued that these experiences occur in relaxed wakefulness and thus should not be considered hypnagogic. To the contrary, Hebb (1968) suggested that true hypnagogic images *are* delayed aftereffects of sensory stimulation. Research exploring this issue would be desirable.

Faces reported in the hypnagogic interval are notorious for their vividness, detail, and novelty (Leaning, 1926; McKellar, 1957; Maury, 1848). One of the observers quoted by Leaning asserted, "The faces I see are *more* vivid than nature . . . absolutely full of life and movement . . . always possess vividness of expression" (p. 317). Remarks similar to the above are abundant in all sectors of the literature. It has been noted by McKellar (1965) that the quality of lifelikeness combined with the tendency for hypnagogic faces to assume a grotesque appearance often results in children's experience of fear in reaction to their hypnagogic imagery. The point to be stressed here is that hypnagogic faces are almost without exception reported as being unrecognizable to the observer. Static objects, conversely, are the images which seem to be the most readily identifiable by the observer.

Landscapes are reported as possessing qualities of unusual grandeur and beauty. Leaning (1926) noted that while landscapes account for a large percentage of the adult images, they are infrequently reported by children. The more complex scenes which arise toward the end of the hypnagogic interval are generally characterized by an abundance of activity and movement. As is the case with hypnagogic faces, the scenes are typically exper-

rienced as foreign and unrelated to personal experience.

McKellar and Simpson (1954) have distinguished between the *perseverative* and *impersonal* varieties of hypnagogic images. The perseverative images are those which are readily explainable in terms of past experience, while the impersonal variety "are not easily explainable in terms of past experience, and may seem interestingly or alarmingly foreign to the personality" (p. 272). Regarding the above content categories in these terms, certain of the geometric and object images may be seen as perseverative, while the scenes and faces can be subsumed under the *impersonal* category.

Auditory hypnagogic images break down into three general areas of content. First, there are the instances in which a person hears his own name "called" (Leaning, 1926; Maury, 1848; Oswald, 1962; Green et al., Note 1). Green et al. provided the example of an experimental subject who, thinking that he had been solicited, unhooked himself from the biofeedback equipment and ran into the hallway, only to realize that he had experienced an auditory hypnagogic image. Also, there are the times the figures in visual hypnagogic images are heard to speak; Leaning offered numerous examples of this. Finally, there are those auditory images in which music and chimelike sounds are heard. McKellar (1957) related that one of his subjects heard distinct auditory hypnagogic images of Rachmaninoff's Second Piano Concerto with a clarity that rivaled the sensory experience.

Tactile-kinesthetic images assume various forms in the hypnagogic state. McKellar (1957) offered an example of kinesthetic imagery from one of his subjects: "I often imagine myself out hunting on horseback and can feel myself bracing to take jumps, check my horse, urge him on, etc." (p. 40). Distortions of the body are experienced as kinesthetic images in the hypnagogic state (Critchley, 1955; Isokower, 1938; Klüver, 1942; McKellar, 1957; Green et al., Note 1). Both Klüver and McKellar have offered examples of polyopia, dysmegalopsia, and dysmorphosia of the somatosensory sphere occurring in the hypnagogic state. Klüver

speculated upon the possible role of the vestibular apparatus in these distortions, but no experimenter has yet empirically evaluated this suggestion.

Isokower noted that the mouth seems to take on great importance in the hypnagogic state: "A hypercathexis of the oral zone is established: 'I am all mouth'" (p. 338). Lewin (1946, 1948) offered similar observations, and both of these psychoanalytically oriented investigators interpreted this form of kinesthetic hypnagogic imagery as evidence of "regressive" tendencies.

A final type of kinesthetic hypnagogic experience is that of "falling" (Bertini et al., 1964; McKellar & Simpson, 1954; Roheim, 1952). Bertini et al. and Roheim have suggested that the experience of falling is symbolic of the descent into sleep, or "sinking into oneself." Oswald (1962) has noted that the experience of falling may be accompanied by sometimes severe involuntary jerks of the body.

#### *Relation of Hypnagogic Imagery to Other Types of Imagery*

*Dream imagery.* An issue which has surfaced continually throughout the hypnagogic literature is the relation between hypnagogic images and dreams. The feature which most consistently differentiates between the two is that one does not hallucinate one's own activities in hypnagogic images, while one is almost always a participant in one's dream imagery (Leaning, 1926; Leroy, 1926; Oswald, 1962; Rapaport, 1967a, 1967b; Sartre, 1972; Taine, 1883). Foulkes and Vogel (1965), in contradistinction to this widely held notion, found that their subjects did hallucinate their own activity in hypnagogic episodes and that participation increased as the subjects moved deeper into the hypnagogic state.

A second difference which consistently emerges concerns mode of presentation: hypnagogic images appear as disconnected "snapshots," while dreams are characteristically longer and better organized (Dement & Kleitman, 1957; Kubie, 1943; Leaning, 1926; Leroy, 1926; Maury, 1848; McKellar & Simp-

son, 1954; Oswald, 1962). Foulkes and Vogel (1965) presented both supporting and conflicting results. They observed that while the time of nocturnal dreams typically mirrors the time course of the events represented in the dreams, hypnagogic episodes tend to occur more quickly than the incidents in the imagery, thus lending support to the previous accounts. However, they also found that hypnagogic episodes are as well organized and complex as dreams; Foulkes (1966) referred to hypnagogic images as "condensed hieroglyphics" (p. 132). Archer (1935), on the basis of self-observation, also stated that hypnagogic imagery can be as complex and well organized as dream imagery.

The results of the Foulkes and Vogel study also suggest that the presence of affect can distinguish hypnagogic images from dream images. They found hypnagogic imagery to be "affectively flat"; in instances in which emotion was manifest it was rarely intense. In contrast, the authors reported a 50% incidence of experienced emotion in a previous study of rapid eye movement (REM) dreaming (Foulkes, 1960).

The most outstanding resemblance between hypnagogic and dream imagery concerns the bizarre and generally fantastic qualities which characterize both (Bertini et al., 1964; Foulkes & Vogel, 1965; Foulkes et al., 1966; Leroy, 1926; Maury, 1848; Oswald, 1962; Varendonck, 1921). Foulkes et al. (1966) had two judges rate hypnagogic and REM dream reports on a 0-7 continuum of Dreamlike Fantasy, where 0 indicates no content, 4 indicates nonhallucinatory content, 7 indicates bizarre content, and so on. Ratings on this scale initially revealed no difference between the quality of hypnagogic and dream content. However, when a "strict" criterion of imagery bizarreness was used (7 by both judges on the Dreamlike Fantasy Scale), it was found that significantly more dream reports met this standard.

Vogel et al. (1972) conducted a detailed study comparing hypnagogic, nonrapid eye movement (NREM), and REM mentation in terms of their "composite regressivity" (degree of bizarre, perceptual, hallucinatory, etc., content). Judges were used in a variety of

tasks in which they attempted to classify the protocols of 28 subjects, which had been obtained from hypnagogic, NREM, and REM periods in two nights of laboratory study, into the correct category based on the content and quality of the protocol. Two additional judges rated protocols on the Dreamlike Fantasy Scale. Ratings on the Dreamlike Fantasy Scale showed NREM reports to be significantly less regressive than hypnagogic reports, which in turn were significantly less regressive than REM reports. In the attempted classification of protocols into the three categories, the judges correctly identified 64.5% of the hypnagogic reports (significantly above chance), 40.3% of the REM reports, and 44.3% of the NREM reports (neither significantly above chance). When discriminations were made between each pair of stages, the hypnagogic-REM pair was correctly discriminated 62.9% of the time, the hypnagogic-NREM pair 61.2%, and the REM-NREM pair 67.1% (all significantly above chance). Thus, the results indicate both difference and overlap in the composite regressivity dimension of the three types of mentation.<sup>3</sup>

The qualitative resemblance between hypnagogic and dream imagery led a number of the early writers (Hicks, 1924; Ladd, 1892; Leroy, 1926; Maury, 1848; Müller, 1848) to a conclusion similar to the one reached by Ellis (1911): "Hypnagogic imagery presents us with the germinal stuff of dreams. If it is not identical with the fully formed dream, it is still the early stage of dreaming" (p. 32). Similarly, Oswald (1962) has argued that hypnagogic images should be characterized as "micro-dreams" (p. 98). The work reviewed here does not support the equatability of hypnagogic and dream imagery. Indeed, it must be pointed out that with the exception of the Foulkes groups (who compared hypnagogic images to REM dreams) and the Vogel et al. study, no distinction is made in the literature between REM and NREM dreams when dreams are compared to hypnagogic images. Given the differences between REM and NREM mentation (Foulkes, 1962; Giora & Elam, 1974), it is clear that a distinction

must be made between REM and NREM dreams in future attempts to investigate hypnagogic versus dream imagery. Investigations of this sort are necessary before a clearer picture of the phenomenological-psychological relation between hypnagogic and dream imagery can be drawn.

*Drug-induced imagery.* Several authors have called attention to the relation between hypnagogic and mescaline imagery (Ardis & McKellar, 1956; Klüver, 1942; McKellar & Simpson, 1954; Mitchell, 1896; Rawcliffe, 1952). Mitchell (1896) was the first writer to expose this similarity, emphasizing the autonomous nature of both imagery types; he also postulated a possible interaction between hypnagogic and mescaline imagery, noting that his mescaline imagery intensified as he neared sleep. Ardis and McKellar (1956, pp. 23-27) offered the most extensive comparison between hypnagogic and mescaline im-

<sup>3</sup> The Vogel et al. (1972) study raises an interesting problem. Their hypnagogic reports were obtained from (a) sleep onset after all-day wakefulness, (b) sleep onset after a brief awakening from REM sleep, and (c) sleep onset after a brief awakening from NREM sleep. DeStrooper and Broughton (1969), Fiss, Klein, and Bokert (1966), Lavie (1974), and Lavie and Giora (1973) have provided evidence that some cognitive and physiological parameters of a sleep stage may persist into the wakefulness immediately following awakening from that sleep stage. Thus, it is possible that hypnagogic episodes which follow a REM awakening may contain characteristics of REM mentation and that hypnagogic episodes which follow an NREM awakening contain characteristics of NREM mentation. Vogel et al. investigated the possible influence of this factor on hypnagogic-REM discrimination. They found that the percentage of errors in hypnagogic-REM discrimination were about the same when the hypnagogic report had been obtained at initial sleep onset or after a REM awakening. However, there were only half as many errors in hypnagogic-REM discrimination when hypnagogic reports followed an NREM awakening.

This finding suggests that there are differences between the hypnagogic state following all-day wakefulness, with which the present paper is concerned, and the transition to sleep following an awakening from a sleep stage. Understanding the nature of the similarities and differences between these hypnagogic intervals would appear to depend on precise specification of the patterns of psychological and physiological phenomena which characterize each.

agery. These authors delineated four principal dimensions of similarity:

1. *Mode of presentation*—autonomy and rapid rate of change are common to both types of imagery.
2. *Quality*—three dimensions of similarity were noted: unusual vividness, brilliant colors, and microscopic clarity of detail.
3. *Content*—some or all of Klüver's "form constants" (see below) are common to both; strange faces and scenes of remarkable grandeur also occur in both forms of imagery.
4. *Synesthesia*—although found more commonly in mescaline imagery, synesthetic episodes are found in hypnagogic imagery.

Ardis and McKellar (1956) speculated that the processes involved in hypnagogic and mescaline imagery are fundamentally alike. A similar position was advocated earlier by Klüver. In attempting to specify hallucinatory constants, Klüver (1942, p. 177) identified the following "form constants": (a) grating, lattice, honeycomb, fretwork, and so on; (b) cobweb; (c) tunnel, funnel, alley, cone or vessel; (d) spiral. Klüver noted that some or all of these form constants are present in both hypnagogic and mescaline experiences. He also posited that polyopia, dysmegalopsia, and dysmorphosia are evident in hypnagogic and mescaline imagery. Klüver emphasized that these number, size, and shape distortions occur in the somatosensory sphere as well as the visual sphere in both cases.

The similarity between hypnagogic imagery and LSD imagery is suggested in a passage from Caldwell (1968); a colleague tells him that hypnagogic imagery is the best way of hallucinating without LSD (p. 109). There is little in the way of empirical evidence on which to test these various observations. Holt (1972) reported a .00 correlation between previous experience with hypnagogic imagery and experienced intensity of experimental LSD imagery in 30 actors. However, this zero correlation does not directly pertain to the phenomenological relation between the

two. Aside from this inconclusive bit of evidence, the literature has nothing specific to offer concerning the phenomenological relation between hypnagogic and drug-induced imagery or the effect of prior experience with one on subsequent production of the other in experimental situations.

*Sensory deprivation imagery.* Several authors have attempted to relate the reported visual sensations (RVSs) of sensory deprivation experiments to hypnagogic imagery. This has been done either by asserting that RVSs essentially *are* hypnagogic images or by suggesting that previous experience with hypnagogic imagery predicts frequency or quality of RVSs in sensory deprivation situations.

Freedman and Greenblatt (1960) and Freedman et al. (1962) hold the position that RVSs are most likely to occur in periods of drowsiness and are thus hypnagogic images. However, the empirical literature militates against accepting this hypothesis. Leiderman (cited in Zuckerman, 1969) presented EEG data which show that RVSs occur in either waking or drowsy states. Bexton, Heron, and Scott (1954) and Short and Oskamp (1965), on the basis of EEG and electrooculogram (EOG) data, concluded that RVSs occur during periods of alertness; Zuckerman and Cohen (1964) reported that RVSs emerge almost exclusively in waking periods. Zuckerman and Hopkins (1966) noted that if the RVS-hypnagogic parallel were valid, then persons who doze and sleep frequently during isolation should have more RVSs than persons who remain alert. Goldberger and Holt (1958) found no correlation between RVSs and time spent sleeping; Holt and Goldberger (1961) found a correlation of  $-.66$  in their actor sample; and Zuckerman, Albright, Marks, and Miller (1962) found a  $-.71$  correlation between sleep ratings and RVS complexity. Murphy, Myers, and Smith (cited in Zuckerman and Cohen, 1964) found that those subjects who reported frequent episodes of drowsiness also reported less complex RVSs than did alert subjects. Clearly, the literature does not support the equatability of hypnagogic and sensory deprivation imagery, hence the qualifying *hypnagogiclike* in reference to the ganzfeld work cited earlier.

Contradictory evidence exists concerning the question of how previous experience with hypnagogic imagery relates to RVSs in experimental situations. Freedman et al. (1962) reported a significant ( $p = .05$ ) correlation between prior history of hypnagogic imagery and subsequent experience of imagery in sensory deprivation.<sup>4</sup> Holt (1972) found an insignificant ( $r = .29$ ) correlation between prior history of hypnagogic imagery and experimental isolation imagery in the actor sample. In a further study with a different sample, he again found extremely low correlations between history of hypnagogic experience and frequency of isolation imagery ( $r = .16$ ) and intensity of isolation imagery ( $r = .01$ ). It should be noted in reference to all of these studies that the questionnaire method of assessing experience with hypnagogic imagery is highly unreliable, for reasons discussed earlier.

The evidence gathered from these varied sensory deprivation researches supports Holt's (1964) statement that "the attempt to refer all the imaginal phenomena from these experiments to hypnagogic imagery was a considerable oversimplification . . ." (p. 261). Sensory deprivation phenomena might be more profitably viewed as a potpourri of various types of thought and ideation, including daydreams, fantasies, hypnagogic images, and dreams. Certainly, hypnagogic images can be a *part* of the sensory deprivation experience, but they do not appear to be a major component.

*Waking imagery.* Although the relationship between hypnagogic imagery and waking imagery has received practically no systematic treatment, interesting speculations are found in the older literature. It should be kept in mind that these observations are largely the result of spontaneous self-observation.

Leaning (1926) presented the cases of several observers who claimed to be exceptionally weak imagers in the waking state, yet experienced extremely vivid hypnagogic imagery. Taine (1883), who experienced feeble imagery while awake found his hypnagogic imagery to be intense, distinct, and lasting. Myers (cited in Leaning, 1926) spoke of "other bad visualizers besides myself deriving from

hypnagogic illusions some notion of the good visualizer's habitual capacity" (p. 304). Hollingworth (1911) noted a similar phenomenon, which he dubbed "the transformation of the imagery type" (p. 104). He suggested that modes of imagery weak in the waking state become dominant while drowsy. He offered himself as an example of an auditory-motor imager while awake and a vivid visual imager while drowsy. Hollingworth additionally noted that E. B. Titchener underwent a transformation from visual-auditory dominant while waking to kinesthetic dominant while drowsy.

Thus, one prediction of this older literature would be that a negative correlation should exist between waking imagery and hypnagogic imagery. However, Holt's (1972) questionnaire data show insignificantly positive correlations between hypnagogic imagery and both waking thought imagery ( $r = .14$ ) and imagery in daydreams ( $r = .19$ ). The earlier literature does not distinguish between different types of waking mental imagery when making comparisons to hypnagogic imagery. Recently, Holt (1972) and Starker (1974) have suggested that a distinction should be made between active, volitional waking imagery of the sort measured by the Betts scale (Sheehan, 1967) and passive, spontaneous waking imagery as found in daydreams. Although the preliminary questionnaire data of Holt do not show differential relations between hypnagogic imagery and these two modes of waking imagery, it does seem clear that experimental investigations aimed at clarifying the relation between waking and hypnagogic imagery should bear the above distinction in mind.

*Eidetic imagery.* The comparisons between eidetic imagery and hypnagogic imagery are sparse. The only apparent similarity is that

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<sup>4</sup> Freedman and Marks (1965), in a photic stimulation experiment, found that the subjects who responded positively to the questionnaire item "Many people see quite vivid images when falling asleep or waking up, usually (but not always) with their eyes closed. Has this ever happened to you?" tended to report a greater variety of visual forms in the photic stimulation situation than did the subjects who answered the question negatively.

both are reported to emerge frequently in childhood. Gray and Gummerman (1975) concluded, after reviewing the literature on eidetic imagery, that "eidetic imagery differs from other types of visual imagery in degree only, not kind . . ." (p. 383). Viewed in this context, there is little reason to expect that hypnagogic imagery would be correlated with eidetic imagery in a manner strikingly different from the way in which it is correlated with normal waking imagery. Holt (1972) reported a correlation of  $-.27$  between hypnagogic imagery and eidetic imagery as a child, which is the only quantitative assessment in the literature relating these two types of imagery.

*Déjà vu experiences.* Though déjà vu is not, strictly speaking, a type of imagery, déjà vu and hypnagogic imagery are linked in several investigations. Buck and Geers (1967), in a questionnaire administered to introductory college students, found significantly positive correlations between frequency of occurrence of hypnagogic imagery and frequency of occurrence of visual ( $r = .35$ ) and auditory ( $r = .27$ ) déjà vu. Similarly, Holt (1972) found a near significant ( $r = .32$ ) correlation between hypnagogic imagery and "miscellaneous experiences"—déjà vu and synesthesia. Ellis (1897), in an article entitled "A note on hypnagogic paramnesia," claimed that the experience of déjà vu is common in the hypnagogic state. Isokower (1938) called attention to the similarity of feelings accompanying déjà vu episodes and feelings arising during the "oral-cathexis" state mentioned earlier: "The subject knows or thinks he knows, exactly what is going to happen" (p. 336). One does not quite know what to make of these observations, but studies exploring this issue are called for.

#### *Quality of Thought in the Hypnagogic State*

Bertini et al. (1964), Critchley (1955), Foulkes and Vogel (1965), Green et al. (Note 1), Hollingworth (1911), Myers (1957), Oswald (1962), Rapaport (1967a, 1967b), and Van Dusen (1972) have all observed that as one moves deeper into the hypnagogic state, thought and ideation become increasingly

bizarre, less amenable to conscious control, and reflect looser patterns of association. Unusual verbal combinations which are "filtered out" of waking awareness appear abundantly in the hypnagogic state. The following illustration from the notebooks of Clark Hull (1962, p. 820) is typical:

"Bill Hembra—Ju [sic] know him?"

Note: A moment ago while passing in a mild lapse of attention, the above came into my mind with great distinctness. It seemed almost as if I were speaking it. . . . I have noticed this just as clearly as the above many times while half asleep in bed but never had paper handy and so never wrote it down . . .

Question: Where in the world could that name have come from? I haven't the slightest recollection of anything like it.

This human machine is a queer thing!

Strikingly similar types of constructions are reported by a number of observers. Archer (1935, p. 33) presented hypnagogic constructions taken from his own experience such as "A savoury pudding—raw in the market" and "A little management of Killiekrankie." Similarly, Oswald (1962) offered examples of hypnagogic thoughts such as "He is as good as cake double" and "The pencil holds well. To the pavement with tell too." Froeschels (1949) studied this aspect of the hypnagogic state and postulated that rules of association radically different from the rules of the waking state govern the formation of thought in the hypnagogic state. He concluded that the unconscious plays a major role in hypnagogic thought:

*similarity* seems to be the term that characterizes best the basis upon which the subconscious works in the state of transition. *But this term evidently does not mean to the subconscious what it means to conscious reasoning.* The latter takes the feeling of similarity . . . for a stepping stone on the way to thorough differentiation and identification. The subconscious on the other hand frequently considers similarity identical with identity, and does not bother with further "research." (p. 24)

Rapaport (1967b), based upon processes observed in his own hypnagogic state, postulated that in the hypnagogically constructed thought, the position normally given to what is syntactically important in a sentence is replaced by what is "psychologically outstanding" (p. 395). Although the phrase

*psychologically outstanding* is a rather vague referent, Rapaport's thesis is similar to Froeschels'; both saw qualitatively unique rules governing the formation of thought in the hypnagogic state.

Singer (1966) studied his own hypnagogic thought processes by setting up for himself specific mental tasks and observing what kinds of intrusive thoughts appeared as he became drowsy. The self-assigned mental tasks varied along three major bipolar dimensions: simple-complex, reminiscent-planful (or theoretical), and personal-impersonal. Thus, a simple-personal-reminiscent task would be to recall personal activities of the past winter; a complex-impersonal-planful task would be to consider the future options of a university program; and so on. Singer (1966) found that "the frequency of intrusive thoughts was by far the greatest for complex, impersonal, and planful or theoretical material. Reminiscing proved to be the easiest task . . ." (p. 41). He also noted that personal reference was predominant in the intrusive thoughts. Further work of this sort in an experimentally controlled context would be useful, as would a comparison of these processes with the same type of task performed in an alert state.

Several authors have noted the similarity between hypnagogic and schizophrenic thought processes (Froeschels, 1949; Hollingworth, 1911; McKellar, 1957, 1972; Mintz, 1948; Oswald, 1962; Vogel et al., 1972). Maury (cited by Oswald, 1962, p. 112) concluded that associations in both cases are based on sound. Oswald paraphrased Kraepelin's conclusion that the disordered thought found in hypnagogic and schizophrenic conditions could be attributed to "the encroachment of associations, the basic thought becoming displaced because of an associated idea replacing an essential link in the normal chain of thinking" (p. 113). Mintz (1948) suggested that schizophrenic speech and sleepy speech are similar in that groupings of elements with only vague relations to one another characterize both modes of construction. Vogel et al. (1972), discussing their finding of the shared regressivity properties of REM and hypnagogic mentation in the con-

text of previously suggested REM-schizophrenia parallels, concluded that "an adequate test of the hypothesis that the physiologic correlates of dreaming are those of schizophrenic mentation requires the use of physiologic correlates of SO [sleep onset] regressive mentation" (p. 449).

Systematic experimental treatment of hypnagogic thought processes has not yet emerged. This may be partially due to the tendency to ascribe all hypnagogic phenomena to the imagery domain. Whatever the reason, further elucidation of the variables contributing to the marked contrast in this mode of cognition between hypnagogic and waking consciousness is needed. A possible strategy for such study is suggested by the work of Salzarulo and Cipolli (1974). These investigators subjected verbal material gathered from dreams in different sleep stages to linguistic analysis and found semantical and syntactical differences between REM and NREM verbal constructions.

#### *The Autosymbolic Phenomenon*

Closely related to the nature of hypnagogic thought processes is the autosymbolic phenomenon, which was first described in a paper by Silberer (1951) appearing in 1911 and has since been reported by numerous observers (Hollingworth, 1911; Isokower, 1938; Lowy, 1946; Neisser, 1967; Rapaport, 1967a; Singer, 1966; Slight, 1924; Van Dusen, 1972; Vihvelin, 1948). The process that Silberer labeled the *autosymbolic phenomenon* consists of a transformation of abstract mental contents into concrete visual images during the hypnagogic state. The phenomenon is occasioned by the struggle of two antagonistic forces: drowsiness and the effort to think.

Silberer delineated three principal varieties of autosymbolic phenomena. The *material* phenomena are representations of the content of thought as hypnagogic images. For instance, Silberer is thinking about advising a friend not to carry out a dangerous resolution; suddenly, he sees "three gruesome riders on black horses storming by over a dusky field under leaden skies" (p. 203). *Functional*



phenomena are autosymbolic representations which reflect the nature of the operations of consciousness at the moment of the representation. Rapaport (1967a) found most of his own autosymbolic transformations to be of this variety, and noted that they often reflected the search for fading thoughts while struggling to remain awake—"watching someone trying to find a way out of a labyrinth; seeing somebody going toward a door only to discover that it is not a door but a shadow; following somebody's increasingly frantic approach toward a door as the door slowly shuts, and so on" (p. 643). Finally, *somatic* phenomena are autosymbolic representations of physiological conditions such as body position, temperature, sensations, and the like. For example, Silberer takes a deep breath, feels his chest expand, and there appears a hypnagogic image of Silberer and another person lifting a table high.

Van Dusen (1972) has argued that autosymbolic representation is a defining characteristic of the hypnagogic state, positing that "the region is naturally autosymbolic, that is, it represents where one is at the moment" (p. 95). He also noted that a degree of familiarity with one's own hypnagogic state may be necessary before one is aware of spontaneously occurring autosymbolic phenomena. Experimental investigation of autosymbolic processes has not yet been undertaken, although the Bertini et al. (1964) study might be viewed as a start in this direction. Foulkes and Vogel (1965) failed to observe autosymbolic processes in their study, but noted that "we did not obtain the second of the two conditions which Silberer felt necessary for its occurrence: drowsiness *and* an effort to think" (p. 242). Clearly, experimental investigation of autosymbolic phenomena poses major methodological difficulties. What types of "stimuli" does one present to the subjects? How and when does one elicit reports of internal activities? Most importantly, how does one discern if a particular stimulus has been autosymbolically transformed? These difficulties notwithstanding, I concur with Neisser (1967) that experimental investigation is sorely needed to clarify the nature of autosymbolic processes.

### *Receptivity and Suggestibility in the Hypnagogic State*

Converging evidence from several lines of investigation indicates that the hypnagogic state may be characterized as an unusually receptive one. De Manaceine (1897) was interested in the degree of suggestibility maintained in the hypnagogic state. She gave her subjects two types of suggestions while they were in transit from waking to sleeping: "intellectual suggestions", for example, two times three equals five, and "emotional suggestions", for example, "The building is burning down" (pp. 195-223). The results show that among children under 15 years of age, the intellectual suggestions were 85% successful and the emotional suggestions 97% successful; among adults, the intellectual variety were 25% successful and the emotional ones 45% successful. A suggestion was considered successful if the person repeated the experimenter's statement or accepted it without protest. No baseline measures were taken (How suggestible are they while awake?), nor was detailed information given regarding the experimental conditions, so these data should be cautiously interpreted. Rosett (1939) posited that the drowsy state is especially conducive to uncritical acceptance of suggestions but did not offer empirical support for his hypothesis. More recently, Barber (1957) suggested that subjects in a drowsy state are just as open to suggestion as are hypnotized subjects.

Several of the early authors have noted that external stimuli are readily incorporated in the hypnagogic state. Hollingworth (1911) offered an example of music being transformed into a hypnagogic image at a concert during which he had become drowsy. Varendonck (1921) implicated external stimuli as being the primary contributors to the genesis of hypnagogic mentation; however, the conditions under which Varendonck made most of his observations—the trenches of World War I—might be seen as biasing factors. Segal (1972), on the basis of her investigations of the Perky phenomenon, has concluded that "any currently available sensory input may be recruited toward the formation of the image" (p. 229). It would be interesting to know if

this phenomenon is accentuated in the hypnagogic state, as would be predicted by this older literature.

In an experimental context, Ornitz, Ritvo, Carr, LaFranchi, and Walter (1967) studied the cortical averaged evoked response (AER) to auditory stimuli during wakefulness, sleep onset, and the nocturnal sleep stages. They found a marked increment in the amplitude of the second negative deflection ( $N_2$ ) of the evoked waveform in the few minutes preceding and just after sleep onset. Ornitz et al. noted that this amplitude increment occurred at the time associated with hypnagogic dreaming, and concluded that there is "increased cerebral responsiveness to auditory stimuli in the environment at this time" (p. 340). Fruhstorfer and Bergström (1969) examined the AER to auditory stimuli at different levels of vigilance. They too reported that the  $N_2$  component of the evoked potential shows a marked amplitude increase just before sleep onset, and further noted that other components of the AER show an amplitude decrease at this time. Fruhstorfer, Partanen, and Lumio (1971) found enhanced  $N_2$  amplitudes in response to auditory stimuli during the hypnagogic interval, and also reported that spontaneous vertex potentials occurring just before sleep onset are systematically related to heart action. Fruhstorfer et al. concluded that "in the transition from wakefulness to sleep there are epochs of enhanced cortical responsiveness during which interoceptor stimulation also may evoke large vertex responses" (p. 616).

The controversial field of hypnopaedia provides an additional source of information regarding the incorporative nature of the hypnagogic state. Several researchers have found that the drowsy state seems to be the most effective period for sleep learning (Rubin, 1968). Simon and Emmons (1956) did not find evidence for sleep learning in the deeper stages of sleep, but did report encouraging results in the drowsy state, and postulated that

it may be in the drowsy state preceding sleep, the individual is more susceptible to suggestion; perhaps one's attitudes or habits can be modified during this presleep period when criticalness is minimized. (p. 96)

For a fuller discussion of the ramifications of this topic, see Budzynski (1972).

An account of the receptive nature of the hypnagogic state would not be complete without reference to the parapsychological literature. Gurney et al. (1886), in their census of hallucinations, found that a disproportionately large number of their veridical cases of telepathy occurred while the percipient was in the "borderland" state between waking and sleeping (Vol. 1, pp. 389-456). They reasoned that since such a small amount of time per day is spent in this state and such a large number of paranormal episodes result from it, further study of the borderland state would prove fruitful for parapsychology. White (1964) reviewed methods of ESP response employed by several gifted percipients. It is evident from a reading of these accounts that a number of these gifted percipients entered a hypnagogic state during their ESP efforts. Recent experimental studies conducted by several investigators have explored the ESP performance of subjects who attempted to enter the hypnagogic state. Honorton and his associates (Honorton, Drucker, & Hermon, 1973; Honorton & Harper, 1974) had their subjects attempt to enter a hypnagogic state by means of ganzfeld procedures while a remotely located agent viewed a randomly selected target slide. The subjects were successful, to a statistically significant degree, in correctly identifying the target out of a pool of slides on the basis of their hypnagogic mentation. Braud and Braud (Note 3), also using the ganzfeld and a similar free-response-forced-choice design, reported significant ESP effects. Schacter and Kelly (1975), in a pilot study, used a biofeedback procedure to induce the hypnagogic state in two percipients. They found statistically significant ( $p < .007$ ) ESP effects in one percipient and nonsignificantly positive results in the other, using a similar design.

The material presented in this section indicates that the hypnagogic state may be characterized by a high degree of suggestibility, receptivity, and responsivity. However, the literature reviewed here leaves important questions open. For instance, there has been no research clarifying the range and form of

individual differences in hypnagogic receptivity, how this is related to personality, cognitive, and perceptual variables, the effect of systematically varied stimuli, and so on. Also, it is not clear from the cited studies which cortical mechanisms underlie the observed changes in the AER. Moreover, much of the evidence which has emerged is tentative and needs more substantial empirical support before a clearer outline of receptivity and suggestibility in the hypnagogic state can be constructed.

#### *Personality Characteristics Associated with the Hypnagogic State*

Until recently, little information was available linking personality traits and the hypnagogic state. Foulkes and Vogel (1965) noted informally that the subjects who manifested large amounts of dreamlike hypnagogic material appeared less anxious and constricted than did the subjects whose mentation was more controlled and thoughtlike. Foulkes et al. (1966) systematically investigated the relation of personality variables to the emergence of hypnagogic dreamlike fantasy in 32 subjects.

Awakenings were made at two points during sleep onset and at three different points during the course of REM sleep. All reports of mentation gathered upon each awakening were rated by judges in terms of aggressive and sexual content, hedonic tone, and depth of sleep. Also, reports were rated on the Dreamlike Fantasy Scale, and all subjects completed the California Psychological Inventory (CPI) and the Thematic Apperception Test (TAT). It was found that hypnagogic Dreamlike Fantasy scores correlated positively and significantly with TAT results. The Dreamlike Fantasy scores of REM episodes did not correlate with waking fantasy as measured by the TAT. Further, it was found that the CPI items which correlated significantly with tightly controlled hypnagogic episodes—rigidity, conventionality, intolerance—closely approximate the standard conception of the authoritarian syndrome. Conversely, those with less controlled hypnagogic ideation tended to be more self-accept-

ing, tolerant, socially poised, and less rigidly conforming.

These correlations led Foulkes et al. to conclude that the emergence of hypnagogic material is associated with healthy, expansive, ego functioning. Budzynski (1972), discussing the Foulkes et al. findings, speculated that extended experience in entering the hypnagogic state might produce positive personality changes in those constricted individuals identified with tightly controlled hypnagogic mentation. Further research is needed to ascertain the generalizability of the Foulkes et al. study and also to investigate the therapeutic possibilities raised by Budzynski.

#### PHYSIOLOGICAL CORRELATES OF THE HYPNAGOGIC STATE

In this section, the discussion is limited to a consideration of those studies which most explicitly link physiological indicators with hypnagogic phenomena. The more extensive literature on physiological parameters of drowsiness are not touched upon here, and the reader is referred to Kamiya (1961) and Kleitman (1963) for excellent discussions of this topic. The results of EEG and EOG work are the focus here, as no other physiological indexes have received extensive systematic treatment in the hypnagogic literature. However, it should be noted that Timmons, Salmey, Kamiya, and Girton (1972) found that EEG patterns characteristic of hypnagogic phenomena were systematically accompanied by specific abdominal-thoracic respiratory patterns, suggesting that further study of this parameter will be useful. Also, the findings of Budzynski (1972) and Stoyva (1973) that a low level of frontalis muscle activity may be related to the onset of the hypnagogic state require more extensive investigation.

#### *EEG Correlates*

Davis et al. (1937) were the earliest investigators to explore the relationship between the EEG and sleep onset mentation. Davis et al. divided the progression from wakefulness to sleep into three stages: the "A" stage, characterized by interrupted alpha patterns;

the "B" stage, characterized by low voltage activity; and the "C" stage, signaled by the appearance of 14-Hz spindles, plus some delta activity. A total of 14 subjects were used in a series of experiments designed to differentiate between these stages. Monopolar recordings were taken from the vertex and occiput, referenced to the mastoid. Sessions were held in the afternoon and at night. The subjects were instructed to relax and to signal by squeezing a bulb when they realized that they had just "drifted" or "floated" for a moment.

Several correlations between EEG patterns and signals from the subjects were specified. The authors noted that the relations were clearest in the subjects with alpha-dominated EEGs, that is, 70% or more alpha in their EEG. In all, 165 episodes of floating were collected from the alpha-dominant subjects; all but 6 of these incidents were preceded by a depression of the alpha wave which lasted from 1.5 to 30 or 40 seconds. The authors did not specify whether this effect is found in both vertex and occipital leads. However, the EEG excerpts presented indicate that the alpha depression is more pronounced in the occipital lead, though present in the vertex.

The subjects agreed on two points concerning the state of consciousness associated with the signals of floating: (a) the episodes were not "real sleep," but an intermediate stage; and (b) when a signal was given, there had been a depression of awareness. It is clear from the few protocols which are presented that the subjects were experiencing hypnagogic phenomena in these periods of floating. One subject noted that "these things are practically dreams, but I am awake enough to catch them" (p. 32). Although little that is precise can be said relating the EEG changes to particular properties of hypnagogic phenomena, the Davis et al. study provides the first general picture of what the EEG looks like in hypnagogic episodes.

Dement and Kleitman (1957) were interested in the type of mental content to be found in the hypnagogic state, largely as it compared to REM dreams. The EEGs were recorded monopolarly from the frontal, parietal, and occipital leads, referenced to the ears. Dement and Kleitman named the sleep onset

period "descending stage one," and noted that "a low voltage, irregular, relatively fast pattern containing slow components in the 4-6 c/sec. range similar to the Loomis et al. 'B' stage characterizes sleep onset EEGs" (p. 678). Reports elicited in the presence of descending stage one EEG contained hypnagogic activity, and the subjects additionally indicated that they were not asleep during these episodes. Reports gathered from ascending stage one (REMs) yielded full dreams and the feeling that the person had emerged from deep sleep.

Foulkes and Vogel (1965) studied the psychophysiology of the hypnagogic state in somewhat more detail. Their study was comprised of nine subjects, who contributed four sessions each. The sessions were scheduled at the subjects' normal bedtime and typically lasted 2-4 hours apiece. Standard Dement and Kleitman (1957) electrode placements were used. Foulkes and Vogel divided the hypnagogic state into four stages: (a) continuous alpha, sporadic rapid eye movements; (b) discontinuous alpha, slow eye movements; (c) low-voltage descending stage one EEG, slow eye movements; and (d) descending stage two EEG.

The experimenter interrupted the subject an approximately equal number of times in each of these stages to obtain a report of mental content. The subject first gave a spontaneous description of what he had experienced, and then responded to questions concerning degree of alertness, volitional control over mental content, awareness of the environment, and the like.

Foulkes and Vogel reported several correlations between EEG-EOG stages and mental content. A steady decline in volitional control over ideation and in awareness of the immediate surroundings was observed over successive EEG-EOG stages. Additionally, an increase in dreamlike content was observed with successive stages. It was also found that while visual imagery was most frequently reported, no consistent association of imagery modality and EEG-EOG stage was observed. (The authors did not look for associations of imagery modality and activity in appropriate EEG leads; this potentially fruitful strategy

has not yet been employed.) In a later re-interpretation of this data, Vogel et al. (1966) further specified the correlations between EEG stages and mental content. Alpha-dominant EEG was associated with nonregressive content (ego intact), descending stage one EEG was associated with regressive content (ego destructuralized), and descending stage two EEG was associated with a return to nonregressive content (restructuralized ego). The authors noted that an ideal psychophysiological parallel was not always observed but that even in cases in which there was a displacement of mental content in relation to EEG stages, the order of progression was preserved.

Liberson and Liberson (1965) defined the onset of drowsiness as corresponding to the onset of EEG occipital alpha blocking. In their study, EEG was recorded both monopolarly and bipolarly from vertex-ear and parieto-occipital leads. Samples of mental content were obtained by asking the subjects to press a key as rapidly as possible when an auditory signal was heard and to report mental content at that time. Liberson and Liberson, much like Davis et al. (1937) and Foulkes and Vogel (1965), found that present oriented reports occur exclusively in alpha-intact segments and that the frequency of vague statements and hypnagogic images reported increases through progressive stages of drowsiness.

Liberson and Liberson also found a delay in the recognition of drowsiness; that is, only 50% of their subjects signaled the presence of hypnagogic images or other indicators of drowsiness during the first 30 seconds after the onset of occipital alpha blocking. They termed this phenomenon "paradoxical drowsiness." However, this finding is paradoxical only if the onset of occipital alpha blocking is taken to be a foolproof indicator of drowsiness. Liberson and Liberson noted that diffuse theta activity, a reliable indicator of drowsiness, often does not appear until well after the onset of occipital alpha blocking. This suggests that the onset of occipital alpha blocking may be a valid indicator of the onset of drowsiness, or the hypnagogic state, in only a limited portion of the population.

Green et al. (Note 1), in the biofeedback study discussed earlier, linked the occurrence of hypnagogic phenomena to the presence of low-voltage theta waves in the EEG. No quantitative analyses clarifying this proposed relationship have yet been presented. Similarly, Budzynski (1972) and Stoyva (1973) reported that the hypnagogic state is characterized by increased theta activity but failed to offer analyses demonstrating the precise relationship between hypnagogic phenomena and the EEG.

The evidence accumulated in the above studies suggests that the gross EEG characteristics of the hypnagogic state are known. It appears reasonable to hypothesize that the low-voltage activity of Davis et al., the descending stage one of Dement and Kleitman, (and Foulkes and Vogel) and the diffuse, low-voltage theta activity of Liberson and Liberson, Green et al., Budzynski, and Stoyva are all descriptively different ways of characterizing a similar phenomenon. In all cases, a loss of amplitude, frequency, and synchronous repetition describe the EEG which accompanies the hypnagogic state. However, it should be pointed out that in addition to the slow activity which is reported to replace the alpha rhythm, Dement and Kleitman (and Foulkes and Vogel) also found that fast components in the beta (14–21 Hz) range accompany hypnagogic episodes. In my own pilot work (Note 4), I have found that a basic wave in the theta range, with considerable low-voltage fast activity superimposed on it, characterizes hypnagogic episodes. The analysis techniques employed in the cited studies do not allow a precise profile of the EEG to be constructed; thus, it is not clear what the proportion of slow to fast components in the hypnagogic EEG signifies.

### *Eye Movements*

The first hypothesis linking eye movements with hypnagogic activity was offered by Ladd (1892), on the basis of systematic self-observation. Miles (1929) reported experimental evidence of slow eye movements occurring in drowsy states. Miles was interested in the ways in which saccadic eye movements differ in waking and drowsy states. The subjects

were instructed to alternately fixate two dots separated by 40 degrees visual angle. Miles then photographed the eye movements and found them to become much slower and less accurate as drowsiness set in. However, most interesting for the purposes of this paper is a phenomenon "accidentally" observed by Miles:

In two records which are reproduced, a subject, although motivated to remain awake, went to sleep during the eye movement test. The eyes remained open for a few seconds, the typical saccadic movements which had been very slow now changed into a rolling movement gliding back and forth as if following a slow pendulum, and all evidence of fixation disappeared. (p. 140)

Although Miles' observation does not specifically relate the eye movements to hypnagogic phenomena, the implication is clear.

The occurrence of slow, rolling eye movements at the onset of sleep was subsequently affirmed by Aserinsky and Kleitman (1955). These investigators used the electrooculograph to record eye movements and found lateral, "pendular" slow eye movements (SEMs) present at sleep onset. These SEMs were typically completed in 3-4 seconds and were frequently binocularly asymmetrical. The SEMs were contrasted to REMs, which are jerky, binocularly symmetrical, and executed in fractions of a second. Dement and Kleitman (1957) specifically noted that no REMs were to be found at sleep onset. (An exception to this general rule is found in narcoleptics, who frequently manifest REMs at sleep onset.<sup>5</sup> See Liddon, 1967, and Rechtschaffen, Wolpert, Dement, Mitchell, and Fisher, 1963.) Foulkes and Vogel (1965), as noted earlier, classified the stages in the transition from wakefulness to sleep on the basis of EEG-EOG characteristics. The REMs (not of the nocturnal variety) accompanied the intact alpha stage; SEMs covered the 20-30 seconds of the record prior to the appearance of discontinuous alpha; SEMs almost always accompanied descending stage one EEG, and were "usually" found in descending stage two episodes.

Liberson and Liberson (1965) linked the SEMs to drowsy episodes as manifest in the EEG. They observed that SEMs started a certain time prior to the onset of occipital

alpha blocking; 50% of their subjects manifest SEMs approximately 5 seconds before alpha blocking, while SEMs appeared in 33% of their subjects 15 seconds prior to blocking. It was also observed that SEMs increased during the first 15 seconds of drowsiness and then gradually subsided until they had disappeared entirely by the time that spindle activity was initiated. Additionally, Liberson and Liberson found that SEM activity persisted between interrupted drowsy episodes, when the EEG indicates an alert state. This suggests that the EOG may be a more sensitive measure of drowsiness than the EEG. However, since subjective accounts are not linked to the persisting SEM periods, this question cannot be answered on the basis of the Liberson and Liberson data.

Dement (1965) has argued that the presence of SEMs is an extremely accurate gauge of the presence or absence of hypnagogic material. Dement interrupted subjects according to the presence or absence of SEMs. When SEMs were absent, the subjects invariably claimed to be awake and "thinking." However, in the presence of SEMs, the subjects consistently reported hypnagogic images and decreased awareness of the environment, though their EEG remained unchanged. This observation lends support to the tentative interpretation of the Liberson and Liberson data offered above. Dement further observed a consistent tendency for greater subjective duration and complexity of hypnagogic imagery to be reflected by a correspondingly longer SEM period. He noted that the slow side-to-side swings found in SEM episodes are unrelated to the reported imagery; unlike REM dreams, appropriate scanning movements are not manifest during SEM hypnagogic activity. Oswald (1962) has suggested that a person experiencing hypnagogic images does not manifest appropriate sequential ocular responses to them "because he quickly and repeatedly re-establishes contact with reality after his brief fantasy creation" (p. 99).

<sup>5</sup> Hypnagogic images are part of the narcoleptic tetrad, which also includes narcolepsy, cataplexy, and sleep paralysis.

The evidence adduced in this section suggests that eye movements may be at least as sensitive an indicator of hypnagogic activity as the EEG. Although most of the studies link SEMs with a general drowsy-hypnagogic state, the Dement work shows that SEMs are potentially useful tools for discriminating between episodes on the basis of content. Additionally, Dement has suggested that the lack of appropriate scanning movements in hypnagogic imagery, in contrast to REM dreams, indicates that eye movements may be helpful in understanding differences between the two modes of ideation.

### *Neurophysiological Mechanisms*

There is little to be found in the literature concerning neurophysiologic mechanisms underlying the hypnagogic state. Oswald postulated that hypnagogic phenomena are attributable to a decline in "cortical vigilance." Bliss and Clark (1962) hypothesized that hypnagogic phenomena "represent the way the mind acts in the twilight zone between alertness and deep sleep, and reflect the dominance of the visual apparatus at that time" (p. 105). Klüver (1942) posited that fundamental mechanisms involving various levels of the nervous system are responsible for hypnagogic, mescaline, and other similar phenomena.

The most ambitious attempt to specify possible neurophysiological underpinnings of the hypnagogic state is found in West's (1962) theory of hallucinations. The "perceptual release" theory of hallucinations rests on two basic assumptions: (a) Life experiences affect the brain in such a manner as to leave permanent neural traces, engrams, templates, and the like, which form circuits that subservise the neurophysiology of memory, thought, and imagination. (b) In normal wakefulness, the interplay of dynamic forces which characterize the individual exert an organizing and integrating force upon these traces.

West cited work on the ascending reticular activating system (ARAS) which implicates this brain stem structure as being responsible for the maintenance of the wakeful state, as well as for exerting the integrating and inhibitory effects on consciousness which enable the

waking organism to reduce the amount of input impinging upon it to a manageable level. He then specified the two conditions necessary for hallucinatory activity: (a) Reduction or impairment of sensory input to the brain, and (b) maintenance of a state of "residual awareness." The crux of the theory is that under conditions of impaired sensory input, the ARAS no longer receives the stimulation necessary to exert inhibitory effects on consciousness; perceptual traces normally inhibited are now released. In order that the person experience these released traces, a minimal degree of awareness must be maintained.

In direct relation to the hypnagogic state, West noted that the transition from wakefulness to sleep is accompanied by a reduction in sensory input, which impairs the inhibitory function of the ARAS and permits the release of perceptual traces. Additionally, a sufficient degree of cortical arousal (descending stage one) is maintained in the hypnagogic state to permit awareness of these traces; thus occur the hypnagogic phenomena. West also observed that the level of stage one cortical arousal occurs in only one other phase of sleep—the REM stage. He posited that one may be "dreaming" throughout sleep but that the degree of cortical arousal needed to permit awareness of released perceptual traces occurs only in descending and ascending stage one episodes. No experimental evidence linking West's theory with hypnagogic phenomena has yet emerged; thus, his postulates must be regarded as tentative at this time.

### THEORETICAL FORMULATIONS

As noted in the introduction, the literature on hypnagogic phenomena is underdeveloped with respect to theoretical systems. Most of the explanations which have been offered, at a psychological level, are typically directed to a small segment of the phenomena. In this section, three ways of explaining the genesis and function of hypnagogic phenomena are presented. These are not the only existing theories, but they do represent the major modes of thinking about hypnagogic phenomena found in the literature.

### *The Entoptic Explanation*

Most writers in the hypnagogic literature have made at least cursory reference to the role of entoptic phenomena in hypnagogic matters. A number of the early writers (Gruithusien, cited in Leaning, 1926; Hicks, 1924; Maury, 1848; Müller, 1848; Purkinje, cited in Leaning, 1926) considered entoptic phenomena to be of paramount importance in the genesis of hypnagogic images. Ladd (1892) and McKellar and Simpson (1954) offered the most developed form of this argument. The main point made by Ladd and McKellar and Simpson is that the background of "retinal dust" which appears upon closing the eyes is colorful, characterized by novel forms and shapes, ever changing, and wholly outside the realm of voluntary control. These properties of the entoptic lights explain three qualities consistently found in hypnagogic images: (a) the seemingly "original" character of the forms, shapes, colors, and so on; (b) their fast rate of change and seemingly voluntary behavior; and (c) the unrecognizability of the images to the observer. Ladd (1892), reflecting upon his own experience, averred that "by far the purest, most brilliant, and most beautiful colors I have ever seen, and the most astonishing combinations of such colors, have appeared to me with closed eyes in a dark room" (p. 300). Ladd went on to say that careful introspection shows that hypnagogic images are no more than combinations of the entoptic lights.

Clearly, entoptic phenomena do play a role in the genesis of *visual* hypnagogic images; at this time the entoptic background furnishes the whole of one's visual field. However, there are myriad phenomena which a totally entoptic theory cannot explain. Alexander (1909) noted that a purely retinal explanation could not account for the existence of auditory images. Similarly, the quality of the verbal constructions, kinesthetic representations, and autosymbolic phenomena discussed earlier do not fit a purely retinal explanation. Finally, a small bit of empirical evidence militates against acceptance of the entoptic theory. Holt (1972) found almost no correlation between awareness of phosphenes and incidence of hypnagogic phenomena in his

sample; an entoptic theory predicts that those most aware of phosphenes should report greater incidences of hypnagogic phenomena.

### *The "Creative Unconscious" Theory*

This notion stands in direct opposition to the entoptic theory and embodies the idea that hypnagogic phenomena are manifestations of processes blocked from awareness in the waking state. Alexander (1909) and Leaning (1926) are the principal exponents of this theory, although the idea is implicit in the work of Froeschels (1949), Green et al. (1970, Note 1), and Van Dusen (1972).

Interestingly, it is precisely those characteristics of hypnagogic mentation (vividness, originality, autonomy) which the entoptic theorists use as a basis for their ideas that the "unconscious" theorists (whose postulates are directly opposite to those of the entoptic group) use as evidence of their formulations. Alexander, noting all of the above qualities of hypnagogic phenomena, posited that "these images are the work of an agent that does not share in my interests, aims, or feelings" (p. 631). Some years earlier, Herschels (cited in Leaning, 1926) had remarked that hypnagogic phenomena are manifestations of "a thought, an intelligence, working within our own organization distinct from that of our own personality" (p. 391). Green et al. (Note 1) recently suggested that "usually 'unheard things' . . . come to consciousness in the form of hypnagogic imagery" (p. 22). Van Dusen (1972) emphasized that a dialogue between conscious and unconscious processes characterizes the hypnagogic state.

Although the concept of the unconscious has fallen on hard times in modern experimental psychology, there is abundant evidence that mechanisms either not operative or not usually manifest in waking consciousness contribute to the formation of hypnagogic phenomena. For instance, in the autosymbolic process discussed earlier, the brain appears to be making qualitatively different responses to internal stimuli than are manifest in waking consciousness. Further, there are numerous reports of creative episodes emerging in the hypnagogic state. The most famous of these concerns the chemist Kekule, who derived the



idea of the benzene ring from a hypnagogic image of a snake biting its own tail which appeared to him while drowsy (in Koestler, 1964, p. 118). Hollingworth (1911) noted that Mark Twain, Edgar Allen Poe, and Robert Louis Stevenson all appear to have capitalized upon the "creative" aspects of spontaneously appearing imagery while drowsy, by incorporating hypnagogic phenomena into their work. He also cited a study by Marsh (1906), who found that artistic-literary types did their most creative work in the early morning and late evening hours, while scientific types worked more during midday hours. Varendonck (1921), commenting on his own experiences, noted that "for years I used to wonder why I seemed cleverer in bed than out of it; the few ideas which I imagine myself to have conceived as my original contribution to science having come just before sleep" (p. 26). Green et al. (Note 1) posited that hypnagogic imagery and creativity are related, and one of the major goals of their research is to enhance creative ability by developing awareness of hypnagogic imagery.

If one insists upon a literal translation of the idea championed by Alexander, that "an agent foreign to the self" is "responsible" for hypnagogic phenomena, then the creative unconscious theory must be regarded with ample skepticism. However, the basic idea of the theory is captured in the argument presented by Leroy (1926) and Rapaport (1967a, 1967b): In the hypnagogic state, there is a qualitatively unique synthesis of mental content. While the mode in which the creative unconscious theory was originally conceptualized does appear to be excessively anthropomorphic, the observations which led to the formulation of the theory are still in need of an adequate explanation.

### *The Ego-Regressive Theory*

The notion that the hypnagogic state is characterized by regressive tendencies of the ego has been espoused by Isokower (1938), Lewin (1949), Rosett (1939), and most systematically by Vogel et al. (1966), whose theory is examined here.

Vogel et al. (1966) averred that in the hypnagogic transition, a person's relation to

the external world can be characterized by two major processes: (a) increasing withdrawal from the external world, marked by loss of volitional control over mentation, and (b) loss of reality testing. Additionally, three ego states were identified based on analysis of mental content: (a) I—intact ego, nonregressive content; (b) D—destructuralized ego, regressive content; and (c) R—restructuralized ego, nonregressive content.

It was observed that regressive content appears only after some degree of withdrawal from the external world has begun and that a return to nonregressive content occurs only after reality testing has been lost. In other words, the D state follows some degree of withdrawal; the R state follows a loss of reality testing. Vogel et al. explained this series of events by first positing that the ego requires sensory input to remain intact. Reduced sensory input results in a withdrawal of ego-cathexes from the external world and a functionally regressed ego. The tendency toward regression threatens the ego, engendering a need for defense. The observation that a loss of reality testing precedes a return to nonregressive content leads the authors to postulate that the loss of reality testing is the ego's needed defense. It is noted that this defense persists into sleep, as the NREM dreams which characterize the interval following the hypnagogic period are typically more thoughtlike than the more bizarre REM dreams. Vogel et al. concluded that

some hypnagogic dreams are instigated by withdrawal from the external world, and from a psychological point of view, they appear to reflect primarily a regressed ego state rather than the rise and disguised fulfillment of unconscious wishes which are expressed by night (REM) dreams. (p. 248)

Support for this theory is found in several sources. Kubie (1943) found that childhood memories not accessible in dreams surface in the hypnagogic state, implying a state of regression. Similarly, Bertini et al. (1964) and Green et al. (Note 1) have commented upon the appearance of archaic childhood memories in their experimental-hypnagogic subjects. Powerful support for an ego-involvement theory is found in the previously mentioned correlations between personality and

hypnagogic dreaming reported by Foulkes et al. (1966). Their findings led them to conclude that hypnagogic experience is a function of waking ego strength and flexibility. However, this does not directly support a regression hypothesis. Finally, it should be noted that this theory is the only one of the three considered here which is based on systematic experimental investigation.

Two criticisms can be leveled at the experimental procedure through which Foulkes and Vogel obtained the data germane to their theory. The first question is the validity of labeling certain material *regressive*. Content was labeled regressive if one or more of six qualities was found: (a) single, isolated images; (b) an incomplete scene or bits and pieces of a scene; (c) bizarre, inappropriate, or distorted images; (d) bizarre sequence or superposition of the images; (e) dissociation of thought and image; (f) magical, omnipotent thinking. Categories a-d (especially a and b) could be just as easily attributed to entoptic phenomena or the inability of untrained observers to fully observe their train of imagery. The point is that the lumping together of myriad qualities under the imprecise heading of regressive might not be justified under closer analysis. A second possible flaw in the Foulkes and Vogel work concerns the interviews conducted after each awakening. The same experimenter who does the wakening also does the interviewing; the possibility of an experimenter effect influencing the course of the interview cannot be excluded (Rosenthal, 1966).

The interpretive approaches presented are characterized by several themes. First, they tend to emphasize one factor to the exclusion of all others. Klüver (1942) exposed this tendency in relation to theories of hallucination:

The theories that have been evolved for an understanding of hallucinatory phenomena frequently stressed one set of factors to the exclusion of others. They have stressed either psychological or physiological factors, "peripheral" or "central" factors, sensory or motor factors, cortical or subcortical mechanisms. In recent years, however, it has been generally recognized that all these factors are of importance. Since all of them are involved in any complex behavioral reaction, it is to be expected that they are involved in hallucinations. (p. 175)

Similar considerations are relevant to hypnagogic phenomena. The one-sidedness of hypnagogic theories reflects how little is known about the phenomena.

A second characteristic of the above approaches is that theoretical biases and antecedent beliefs heavily influence subsequent interpretive strategies. Alexander (1909) and Leaning (1926), writing from a parapsychological perspective, postulated a "disembodied" agent to account for hypnagogic phenomena; Vogel et al. (1966), of a psychoanalytic persuasion, offered an ego-regression hypothesis; and so on. Clearly this criticism is applicable to many sectors of psychological research. However, considering the extremely suggestible and permeable nature of the hypnagogic state, it is entirely conceivable that the type of phenomena which emerge in the hypnagogic state may be a direct function of the matrix of beliefs and expectations which a person holds concerning the anticipated nature of the experience. This point is best displayed in an old criticism of psychoanalytic practice: Freud's patients have Freudian dreams, Jung's patients have Jungian dreams. The possibility of inadvertently influencing subjects to produce the desired phenomena is a problem which future experimental research must face. Indeed, experimental investigation of precisely this parameter of the hypnagogic state would be useful.

#### CONCLUDING REMARKS

In this review, the literature concerning the hypnagogic state has been presented in several perspectives. The theme common to the different approaches is that all are in an early stage of development. Richardson (1969, pp. 95-100) came to a similar conclusion and urged experimenters to get on with systematically investigating the hypnagogic state.

On the basis of this review, several potentially valuable lines of research are suggested. First, further development of experimental techniques which permit systematic exploration of the hypnagogic state is critical to more refined understanding; the major methodological problems were outlined earlier. Second, a more precise phenomenology of the imagery and verbal constructions which emerge in the

hypnagogic state is needed. Can one categorize by content the phenomena which appear in particular individuals? Are the phenomena consistent over time? Can the phenomenological qualities which differentiate hypnagogic mentation from other sorts of imagery and thought be more clearly specified? These are but a few of the phenomenological issues yet to be adequately researched. Third, cognitive processes in the hypnagogic state merit more detailed consideration. What is the organism's capacity for processing environmental information while in the hypnagogic state? How does prehypnagogic state sensory stimulation affect subsequent hypnagogic mentation? Fourth, it is not clear how differences in content and modality of mentation manifested in the hypnagogic state are related to cognitive, perceptual, and personality variables among individuals. What type of person experiences much visual hypnagogic imagery and few verbal constructions? Do more creative individuals tend to exhibit greater amounts of hypnagogic content? Fifth, the psychophysiological approach requires fuller development. Aside from the interest of questions which can be explored psychophysiological (Are there cerebral hemispheric asymmetries related to hypnagogic content? What is the relation between eye movements and the EEG in hypnagogic episodes?), this approach also offers potent methodological advantages for exploring the hypnagogic state. Finally, specification of the conditions under which a person enters the hypnagogic state is critical for future research. As noted earlier, it may be that the "natural" hypnagogic state which spontaneously occurs just before sleep is characterized by patterns of phenomena that are qualitatively different from those that characterize a biofeedback-induced hypnagogic state; and both of these may differ from the hypnagogic interval which follows awakening from a sleep stage. Research which confronts this problem would be extremely valuable.

These possible directions for future research are certainly not exhaustive; but elucidation of these questions may prove useful in understanding the patterns of phenomena which characterize the hypnagogic state.

#### REFERENCE NOTES

1. Green, A., Green, E., & Walters, D. *Brainwave training, imagery, creativity, and integrative experiences*. Unpublished manuscript, The Menninger Foundation, 1973.
2. Owens, C. *A study of imagination*. Unpublished doctoral dissertation, University of Liverpool, 1963.
3. Braud, L. W., & Braud, W. G. *The psi conducive syndrome: Free response GESP performance during an experimental hypnagogic state induced by visual and acoustic ganzfeld technique*. Paper presented at the annual meeting of the Parapsychological Association, Queens, New York, August 1974.
4. Schacter, D. L. Unpublished data, August 1974.

#### REFERENCES

- Alexander, H. E. The subconscious in light of dream imagery. *Proceedings of the Society for Psychical Research*, 1909, 8, 623-634.
- Archer, W. *On dreams*. London: Methuen, 1935.
- Ardis, J., & McKellar, P. Hypnagogic imagery and mescaline. *Journal of Mental Science*, 1956, 102, 22-29.
- Aserinsky, E., & Kleitman, N. Two types of ocular motility occurring in sleep. *Journal of Applied Physiology*, 1955, 8, 1-14.
- Barber, T. X. Experiments in hypnosis. *Scientific American*, 1957, 196(4), 54-61.
- Bertini, M., Lewis, H. B., & Witkin, H. A. Some preliminary observations with an experimental procedure for the study of hypnagogic and related phenomena. *Archivio di Psicologia Neurologia e Psichiatria*, 1964, 6, 493-534. (Also printed, in condensed form, as a chapter in C. T. Tart (Ed.), *Altered states of consciousness*. New York: Wiley, 1969.)
- Bexton, W. H., Heron, W., & Scott, T. H. Effects of decreased variation in the sensory environment. *Canadian Journal of Psychology*, 1954, 8, 70-76.
- Bliss, E. L., & Clark, L. D. Visual hallucinations. In L. J. West (Ed.), *Hallucinations*. New York: Grune & Stratton, 1962.
- Buck, L. A., & Geers, M. B. Varieties of consciousness: I. Intercorrelations. *Journal of Clinical Psychology*, 1967, 23, 151-152.
- Budzynski, T. H. Some applications of biofeedback induced twilight states. *Fields Within Fields Within Fields*, 1972, 5, 105-114.
- Budzynski, T. H., & Stoyva, J. M. An instrument for producing deep muscle relaxation by means of analog information feedback. *Journal of Applied Behavior Analysis*, 1969, 2, 231-237.
- Budzynski, T. H., Stoyva, J. M., & Adler, C. S. Feedback-induced muscle relaxation: Application to tension headache. *Behavior Therapy and Experimental Psychiatry*, 1970, 1, 205-211.
- Caldwell, W. V. *LSD psychotherapy*. New York: Grove Press, 1968.
- Critchley, M. The pre-dormitum. *Revue Neurologique*, 1955, 93, 101-106.

- Davis, H., Davis, P. A., Loomis, A. L., Harvey, E. N., & Hobart, G. Human brain potentials at the onset of sleep. *Journal of Neurophysiology*, 1937, 1, 24-37.
- Dement, W. C. Perception during sleep. In P. M. Hoch & J. Zubin (Eds.), *Psychopathology of perception*. New York: Grune & Stratton, 1965.
- Dement, W. C., & Kleitman, N. Cyclic variations in EEG during sleep and their relation to eye movements, body motility, and dreaming. *Electroencephalography and Clinical Neurophysiology*, 1957, 9, 673-690.
- DeStrooper, J., & Broughton, R. REM awakening latencies and a possible REM breakthrough phenomenon. *Psychophysiology*, 1969, 6, 216.
- Ellis, H. A note on hypnagogic paramnesia. *Mind*, 1897, 6, 283-287.
- Ellis, H. *The world of dreams*. New York: Constable, 1911.
- Fiss, H., Klein, G. S., & Bokert, E. Waking fantasies following interruption of two types of sleep. *Archives of General Psychiatry*, 1966, 14, 543-551.
- Foulkes, D. *Dream reports from different stages of sleep*. Unpublished doctoral dissertation, University of Chicago, 1960.
- Foulkes, D. Dream reports from different stages of sleep. *Journal of Abnormal and Social Psychology*, 1962, 65, 14-25.
- Foulkes, D. *The psychology of sleep*. New York: Scribner's, 1966.
- Foulkes, D. Longitudinal studies of dreams in children. In J. H. Masserman (Ed.), *Science and psychoanalysis*, 1971, 19, 48-71.
- Foulkes, D., Spear, P. S., & Symonds, J. D. Individual differences in mental activity at sleep onset. *Journal of Abnormal Psychology*, 1966, 71, 280-286.
- Foulkes, D., & Vogel, G. Mental activity at sleep onset. *Journal of Abnormal Psychology*, 1965, 70, 231-243.
- Freedman, S. J., & Greenblatt, M. Studies in human isolation: II. Hallucinations and other cognitive findings. *U.S. Armed Forces Medical Journal*, 1960, 11, 1479-1497.
- Freedman, S. J., Grunebaum, S. U., Stare, F. A., & Greenblatt, M. Imagery in sensory deprivation. In L. J. West (Ed.), *Hallucinations*. New York: Grune & Stratton, 1962.
- Freedman, S. J., & Marks, P. A. Visual imagery produced by rhythmic photic stimulation: Personality correlates and phenomenology. *British Journal of Psychology*, 1965, 56, 95-112.
- Froeschels, E. A peculiar intermediary state between waking and sleeping. *American Journal of Psychotherapy*, 1949, 3, 19-25.
- Fruhstorfer, H., & Bergström, R. M. Human vigilance and auditory evoked responses. *Electroencephalography and Clinical Neurophysiology*, 1969, 27, 346-355.
- Fruhstorfer, H., Partanen, J., & Lumio, J. Vertex sharp waves and heart action during the onset of sleep. *Electroencephalography and Clinical Neurophysiology*, 1971, 31, 614-617.
- Galton, F. *Inquiries into the human faculty and its development*. London: Macmillan, 1883.
- Giora, Z., & Elam, Z. What a dream is. *British Journal of Medical Psychology*, 1974, 47, 283-289.
- Goldberger, L., & Holt, R. R. Experimental interference with reality contact (perceptual isolation): Method and group results. *Journal of Nervous and Mental Disease*, 1958, 127, 99-112.
- Goodenough, D. R., Lewis, H. B., Shapiro, A., Jaret, L., & Sleser, I. Dream reporting following abrupt and gradual awakenings from different types of sleep. *Journal of Personality and Social Psychology*, 1965, 2, 170-179.
- Gray, C. R., & Gummerman, K. The enigmatic eidetic image: A critical examination of methods, data, and theories. *Psychological Bulletin*, 1975, 82, 383-407.
- Green, E., Green, A., & Walters, D. Voluntary control of internal states: Psychological and physiological. *Journal of Transpersonal Psychology*, 1970, 1, 1-26.
- Gurney, E., Myers, F. W. H., & Podmore, F. *Phantasms of the living* (Vol. 1). London: Trubner, 1886.
- Hanawalt, N. G. Recurrent images. *American Journal of Psychology*, 1954, 67, 170-174.
- Hebb, D. O. Concerning imagery. *Psychological Review*, 1968, 75, 466-477.
- Hicks, G. D. On the nature of images. *British Journal of Psychology*, 1924, 15, 121-148.
- Hilgard, E. R. Altered states of awareness. *Journal of Nervous and Mental Disease*, 1969, 149, 68-79.
- Hobbes, T. *Leviathan*. London: A. Crooke, 1651.
- Hollingworth, H. L. The psychology of drowsiness. *American Journal of Psychology*, 1911, 22, 99-111.
- Holt, R. R. Imagery: The return of the ostracized. *American Psychologist*, 1964, 19, 254-264.
- Holt, R. R. On the nature and generality of mental imagery. In P. Sheehan (Ed.), *The function and nature of imagery*. New York: Academic Press, 1972.
- Holt, R. R., & Goldberger, L. Assessment of individual resistance to sensory alteration. In B. E. Flaherty (Ed.), *Psychophysiological aspects of space flight*. New York: Columbia University Press, 1961.
- Honorton, C., Drucker, S., & Hermon, H. Shifts in subjective state and ESP under conditions of partial sensory deprivation. *Journal of the American Society for Psychical Research*, 1973, 67, 191-196.
- Honorton, C., & Harper, S. Psi-mediated imagery and ideation in an experimental procedure for regulating perceptual input. *Journal of the American Society for Psychical Research*, 1974, 68, 156-158.
- Horowitz, M. J. *Image formation and cognition*. New York: Appleton-Century-Crofts, 1970.
- Hull, C. L. Psychology of the scientist: IV. Passages from the "idea books" of Clark L. Hull. *Perceptual and Motor Skills*, 1962, 15, 807-822.
- Isokower, O. A contribution to the patho-psychology of phenomena associated with falling asleep. *Inter-*

- national Journal of Psychoanalysis*, 1938, 19, 331-345.
- James, W. *Principles of psychology*. London: Macmillan, 1890.
- Johnson, L. C. A psychophysiology for all states. *Psychophysiology*, 1970, 6, 501-516.
- Kamiya, J. Behavioral, subjective, and physiological aspects of drowsiness and sleep. In D. W. Fiske & S. R. Maddi (Eds.), *Functions of varied experience*. Homewood, Ill.: Dorsey Press, 1961.
- Kleitman, N. *Sleep and wakefulness*. Chicago: University of Chicago Press, 1963.
- Klüver, H. Mechanisms of hallucinations. In Q. McNemar & M. A. Merrill (Eds.), *Studies in personality*. New York: McGraw-Hill, 1942.
- Knoll, M., Kugler, J., Eichmeier, J., & Hofer, O. Note on the spectroscopy of subjective light patterns. *Journal of Analytic Psychology*, 1962, 7, 55-70.
- Koestler, A. *The act of creation*. New York: Macmillan, 1964.
- Kubie, L. S. The use of induced hypnagogic reveries in the recovery of repressed amnesiac data. *Bulletin of the Menninger Clinic*, 1943, 7, 172-182.
- Kubie, L. S., & Margolin, S. An apparatus for the use of breath sounds as a hypnagogic stimulus. *American Journal of Psychiatry*, 1944, 100, 610.
- Ladd, G. T. Contribution to the psychology of visual dreams. *Mind (New Series)*, 1892, 1, 299-304.
- Lavie, P. Differential effects of REM and non-REM awakenings on the spiral aftereffect. *Physiological Psychology*, 1974, 2, 107-108.
- Lavie, P., & Giora, Z. Spiral aftereffect durations following awakening from REM sleep and non-REM sleep. *Perception and Psychophysics*, 1973, 14, 19-20.
- Leaning, F. E. An introductory study of hypnagogic phenomena. *Proceedings of the Society for Psychological Research*, 1926, 35, 289-409.
- Leroy, E. B. *Les visions du demi-sommeil*. Paris: Librairie Felix Alcan, 1926.
- Lewin, B. D. Sleep, the mouth, and the dream screen. *Psychoanalytic Quarterly*, 1946, 15, 419-434.
- Lewin, B. D. Inferences from the dream screen. *International Journal of Psychoanalysis*, 1948, 29, 224-231.
- Liberson, W. T., & Liberson, C. W. EEG records, reaction times, eye movements, respiration, and mental content during drowsiness. *Recent Advances in Biological Psychiatry*, 1965, 8, 295-302.
- Liddon, S. C. Sleep paralysis and hypnagogic hallucinations. *Archives of General Psychiatry*, 1967, 17, 88-96.
- Lowy, S. *Psychological and biological foundations of dream interpretation*. London: Paul, Trench, & Trubner, 1946.
- Lukianowicz, N. Hallucinations à trois. *Archives of General Psychiatry*, 1959, 1, 322-331.
- Manacaine, M. de. *Sleep: Its physiology, pathology, hygiene, and psychology*. New York: Scribner's, 1897.
- Marsh, H. D. Diurnal course of efficiency. *Archives of Psychology*, 1906, 7, 59-69.
- Marshall, C. R. Entoptic phenomena associated with the retina. *British Journal of Ophthalmology*, 1935, 19, 177-201.
- Maury, A. Des hallucinations hypnagogiques ou des erreurs des sens dans l'état intermédiaire entre la veille et le sommeil. *Annales Médico-Psychologiques du Système Nerveux*, 1848, 11, 26-40.
- McKellar, P. *Imagination and thinking*. New York: Basic Books, 1957.
- McKellar, P. Thinking, remembering, and imagining. In J. G. Howells (Ed.), *Modern perspectives in child psychiatry*. Edinburgh: Oliver & Boyd, 1965.
- McKellar, P. Imagery from the standpoint of introspection. In P. Sheehan (Ed.), *The function and nature of imagery*. New York: Academic Press, 1972.
- McKellar, P., & Simpson, L. Between wakefulness and sleep: Hypnagogic imagery. *British Journal of Psychology*, 1954, 45, 266-276.
- Miles, W. R. Horizontal eye movements at the onset of sleep. *Psychological Review*, 1929, 36, 122-141.
- Mintz, A. Schizophrenic speech and sleepy speech. *Journal of Abnormal and Social Psychology*, 1948, 43, 548-549.
- Mitchell, S. W. The effects of Anhalonium Lewinii (The mescal button). *British Medical Journal*, 1896, 2, 1625-1628.
- Müller, J. *The physiology of the senses*. London: Taylor, Walton, & Mayberry, 1848.
- Myers, F. W. H. *Human personality and its survival of bodily death*. London: Longmans, Green, 1904.
- Myers, O. H. Images in the mind. *Journal of the American Society for Psychical Research*, 1957, 51, 62-73.
- Neisser, U. *Cognitive psychology*. New York: Appleton-Century-Crofts, 1967.
- Ornitz, E. M., Ritvo, E. R., Carr, E. M., LaFranchi, S., & Walter, R. D. The effect of sleep onset on the auditory averaged evoked response. *Electroencephalography and Clinical Neurophysiology*, 1967, 23, 335-341.
- Oswald, I. *Sleeping and waking—Physiology and psychology*. New York: Elsevier, 1962.
- Partridge, G. E. Reverie. *Pedagogical Seminary*, 1898, 5, 445-474.
- Rapaport, D. Cognitive structures. In M. M. Gill (Ed.), *The collected papers of David Rapaport*. New York: Basic Books, 1967. (a)
- Rapaport, D. States of consciousness: A psychopathological and psychodynamic view. In M. M. Gill (Ed.), *The collected papers of David Rapaport*. New York: Basic Books, 1967. (b)
- Rawcliffe, D. H. *The psychology of the occult*. London: Ridgeway, 1952.
- Rechtschaffen, A., Wolpert, E. A., Dement, W. C., Mitchell, S. A., & Fisher, C. Nocturnal sleep of narcoleptics. *Electroencephalography and Clinical Neurophysiology*, 1963, 15, 599-609.
- Richardson, A. *Mental imagery*. New York: Springer Publishing, 1969.

- Roheim, G. *The gates of the dream*. New York: International Universities Press, 1952.
- Rosenthal, R. *Experimenter effects in behavioral research*. New York: Appleton-Century-Crofts, 1966.
- Rosett, J. *The mechanism of thought, imagery, and hallucination*. New York: Columbia University Press, 1939.
- Rubin, F. (Ed.) *Current research in hypnopaedia*. London: Macdonald, 1968.
- Salzarulo, P., & Cipolli, C. Spontaneously recalled verbal material and its linguistic organization in relation to different stages of sleep. *Biological Psychology*, 1974, 2, 47-57.
- Sartre, J. P. *The psychology of imagination*. New Jersey: Citadel Press, 1972.
- Schacter, D. L., & Kelly, E. F. ESP in the twilight zone. *Journal of Parapsychology*, 1975, 39, 27-28.
- Segal, S. J. Assimilation of a stimulus in the construction of an image: The Perky effect revisited. In P. Sheehan (Ed.), *The function and nature of imagery*. New York: Academic Press, 1972.
- Sheehan, P. W. A shortened form of Betts' questionnaire upon mental imagery. *Journal of Clinical Psychology*, 1967, 23, 386-389.
- Short, R. R., & Oskamp, S. Lack of suggestion effects on perceptual isolation phenomena. *Journal of Nervous and Mental Disease*, 1965, 141, 190-194.
- Silberer, H. Report on a method of eliciting and observing certain symbolic hallucination phenomena. In D. Rapaport (Ed.), *Organization and pathology of thought*. New York: Columbia University Press, 1951.
- Simon, C., & Emmons, W. Responses to material presented during various levels of sleep. *Journal of Experimental Psychology*, 1956, 51, 89-97.
- Singer, J. L. *Daydreaming*. New York: Random House, 1966.
- Slight, D. Hypnagogic phenomena. *Journal of Abnormal Psychology*, 1924, 19, 274-282.
- Starker, S. Two modes of visual imagery. *Perceptual and Motor Skills*, 1974, 38, 649-650.
- Stoyva, J. Biofeedback techniques and the conditions for hallucinatory activity. In F. J. McGuigan & R. A. Schoonover (Eds.), *The psychophysiology of thinking*. New York: Academic Press, 1973.
- Stoyva, J., & Kamiya, J. Electrophysiological studies of dreaming as the prototype of a new strategy in the study of consciousness. *Psychological Review*, 1968, 75, 192-205.
- Taine, H. A. *De L'intelligence*. Paris: Hachette, 1883.
- Tart, C. T. *Altered states of consciousness*. New York: Wiley, 1969.
- Timmons, B., Salamy, J., Kamiya, J., & Girton, D. Abdominal-thoracic respiratory movements and levels of arousal. *Psychonomic Science*, 1972, 27, 173-175.
- Titchener, E. B. *Lectures on the experimental psychology of the thought processes*. New York: Macmillan, 1909.
- Van Dusen, W. *The natural depth in man*. New York: Harper & Row, 1972.
- Varendonck, J. *The psychology of day-dreams*. New York: Macmillan, 1921.
- Vihvelin, H. On the differentiation of some typical forms of hypnagogic hallucinations. *Acta Psychiatrica et Neurologica*, 1948, 23, 359-389.
- Vogel, G., Barrowclough, B., & Giesler, D. Limited discriminability of REM and sleep onset reports and its psychiatric implications. *Archives of General Psychiatry*, 1972, 26, 449-455.
- Vogel, G., Foulkes, D., & Trosman, H. Ego functions and dreaming during sleep onset. *Archives of General Psychiatry*, 1966, 14, 238-248.
- Warren, H. C. Some unusual visual after-effects. *Psychological Review*, 1921, 28, 453-463.
- West, L. J. A general theory of hallucinations and dreams. In L. J. West (Ed.), *Hallucinations*. New York: Grune & Stratton, 1962.
- White, R. A. A comparison of old and new methods of response to targets in ESP experiments. *Journal of the American Society for Psychical Research*, 1964, 58, 21-56.
- Williams, H. L., Hammack, J. T., Daly, R. L., Dement, W. C., & Lubin, A. Responses to auditory stimulation, sleep loss and the EEG stages of sleep. *Electroencephalography and Clinical Neurophysiology*, 1964, 16, 269-279.
- Zuckerman, M. Hallucinations, reported sensations, and images. In J. P. Zubek (Ed.), *Sensory deprivation: Fifteen years of research*. New York: Appleton-Century-Crofts, 1969.
- Zuckerman, M., Albright, R. J., Marks, C. S., & Miller, G. L. Stress and hallucinatory effects of perceptual isolation and confinement. *Psychological Monographs*, 1962, 76(30, Whole No. 549).
- Zuckerman, M., & Cohen, N. Sources of reports of visual and auditory sensations in perceptual isolation experiments. *Psychological Bulletin*, 1964, 62, 1-20.
- Zuckerman, M., & Hopkins, T. R. Hallucinations or dreams? A study of arousal levels and reported visual sensations during sensory deprivation. *Perceptual and Motor Skills*, 1966, 22, 447-459.

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