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Environmental Restriction and "Stimulus Hunger"

Theories and Applications

PETER SUEDFELD

Throughout much of the history of psychology, theorists concerned with motivation have focused on constructs having to do with internal states. Certainly toward the middle of the twentieth century most professional psychologists agreed that the major sources of motivation lay either in tissue deficits (drive-reduction theory) or in the combination of physiological and psychic needs for various kinds of gratification (psychodynamic theory). In both instances, the basic thrust was that a variety of physiological processes gives rise to sets of intense stimuli that, monitored and interpreted within the body, engage some sort of behavioral regulator which leads to the emission of appropriate responses. To a degree, the stimuli are unpleasant; behavior is directed toward their elimination, which is reinforcing. Biological concepts of instincts, homeostasis, and general drive (D) all share this basic underlying orientation (Cannon, 1932; Freud, 1915; Hull, 1943).

Of course, most people recognized that this picture is oversimplified. Theorists realized that intensification of stimuli is not necessarily aversive, and that certain events are reinforcing even though they have no clearly discernible drive-reducing consequences. Among such events are sexual arousal even without subsequent copulation (Sheffield, Wulff, & Backer, 1951), the ingestion of sweet but nonnutritive substances (Sheffield & Roby, 1950), and the exploration and manipulation of novel stimulus environments and objects (Harlow, 1950). It was at this point

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that research on "perceptual isolation" conducted at McGill University under the direction of Donald O. Hebb introduced a new point of view (Bexton, Heron, & Scott, 1954), and Daniel Berlyne's theoretical contributions began to elucidate a dramatic set of findings.

MOTIVATIONAL EFFECTS OF STIMULUS RESTRICTION

In the McGill work on perceptual isolation, internal stimulation was presumably maintained by the satisfaction of identifiable physiological needs. At the same time, external stimulation was supposedly reduced through the use of immobilization, constant white noise and diffuse light, and coverings over the hands and the body. As is well known, the consequences of this situation during the course of two or three days included intense negative affect, performance decrements on many kinds of cognitive and perceptual/motor tasks, reported visual and auditory sensations without identifiable external cause, increased desire to be exposed to even boring and repetitive stimuli, greater persuasibility in response to propaganda messages, and changes in psychophysiological functioning (see Heron, 1961). Thus, the data appeared to indicate that a lowering of both internal (drive) and external stimuli did not lead to the quiescent, inactive state predicted by previous theories.

According to Berlyne (1960), these symptoms could be explained by the concept of arousal potential. The argument was that the unpleasantness of low stimulus levels is based on the curvilinear relationship between arousal potential, which is a function of stimulus complexity (cf. deCharms, 1968), and the level of reticular arousal. The latter in turn is negatively related to the hedonic positiveness of the situation. Both low and high levels of stimulus complexity lead to increases in the state of arousal of the reticular activating system (see Lindsley, 1961). Such increases are experienced as unpleasant, and motivate the organism to initiate attempts to restore more acceptable arousal levels. The tactic for achieving this goal may be to move the collative properties of environmental stimuli (novelty, surprisingness, change, ambiguity, incongruity, blurredness, and power to induce uncertainty—Berlyne, 1963) toward such moderate levels.

Naturally, this explanation was not unchallenged. Fiske and Maddi (1961) argued that monotonous environments, both in natural situations and in the laboratory, result in low levels of activation, which the individual attempts to raise by seeking change and action. These authors also emphasized the variability of arousal level over time, and suggested that future research pay attention to such fluctuations. This formulation is quite compatible with that of Hebb (1955), who also explained the pur-

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ported aversiveness of monotonous environments by the argument that such environments lead to low arousal, which is affectively unpleasant, at least until it becomes low enough to produce sleep. Schultz (1965) agreed that low levels of stimulation lead to low arousal, which motivates the organism to try to restore "sensoristasis" —a term analogous to homeostasis, but related to a drive state of cortical arousal rather than one of physiological need. One problem, of course, is that almost any behavioral phenomenon may be interpreted in either direction. For example, increased activity may be viewed as a sign that arousal is high and expresses itself in the expenditure of muscular energy, just as it does when an anxious or hungry person or animal paces back and forth. On the other hand, the same behavior can be interpreted as a sign that the arousal level is low, and that the behavior is being emitted in order to raise it, as when a drowsy individual deliberately stimulates himself by fidgeting.

Compared to its rivals, Berlyne's explanation of the phenomena emerging from research with what is now usually called the restricted environmental stimulation technique (REST) seems to have held up quite well. In fact, it has held up better than the original data themselves. Many of the latter have been nonreplicable, or at best inconsistently replicable, and may in fact have been to some unknown degree the consequences of procedural details and of experimenter or subject expectancy rather than of any intrinsic aspect of stimulus reduction itself (Zubek, 1973). Recent studies have demonstrated that REST is frequently perceived as a relaxing, calming, and enjoyable environment. There is even some question as to whether the original perceptual isolation technique used at McGill in fact leads to any reduction in stimulus level (Suedfeld, 1980). Of course, a reduction in the collative properties of stimuli did occur beyond any reasonable doubt, so that the variables upon which Berlyne rested his theoretical case were indeed appropriate. They remain appropriate throughout the entire REST literature, which has expanded to include such widely differing methodologies as confinement in a dark, soundproof room, immersion in a tank of water, floating in a gel-like liquid, immobilization in an iron lung respirator or a wooden box, and so on (Zubek, 1969a).

The Effects of REST

Research performed in stimulus-poor environments after the early McGill studies has shown a more complex picture than was painted at first. It appears that many of the bizarre phenomena reported in the early days may have been the consequences of some now unclarifiable combination of specific procedural, experimenter, and subject variables (see

Zubek, 1973). For example, the occurrence of hallucinations, in the sense of a clinically defined perceptual disturbance, is extremely rare; and certain types of performance, including some aspects of cognitive process, show improvements rather than decrements (Suedfeld, 1980; Zubek, 1969a).

Even what has been considered the most reliable characteristic of "sensory deprivation," its aversive and unpleasant nature, has been challenged by recent evidence. This was perhaps the issue on which most people agreed in the earlier literature. Stimulus restriction was supposedly experienced as stressful, tolerable for relatively short periods at best, and a source of anxiety, boredom, and other unpleasant emotions. In one early review, for example, this aspect of the effects was summed up as follows:

> In general, the affective response to sensory deprivation includes boredom, restlessness, irritability, and occasionally anxiety and fear of panic proportions. Descriptions of post-isolation affective states have referred to fatigue, drowsiness, and feelings of being dazed, confused and disoriented. (Kubzansky & Leiderman, 1961, p. 229)

This general picture was accepted and widely transmitted by secondary sources, and is still the modal description of the effects in the vast majority of undergraduate-level psychology textbooks (Adams, 1979). It is in fact the case that many studies have reported subjects terminating the experiment before its scheduled end (Myers, 1969), that confined subjects have often said that the experience was relatively unpleasant compared to the ratings of control subjects (Myers, 1969), and that subjects in REST have been shown to emit operant responses not only to obtain stimulation but also to shorten the period of confinement (Jones, 1969; Rossi & Solomon, 1964).

But the findings are not so monolithic as they appear on the surface. To begin with, there are significant differences among subjects, procedures, and measures. Myers (1969) has shown that tolerance for REST is very much a function of such variables as whether the dependent variable is time spent in the condition, an operant response to modify this situation, or one of several affect scales; whether the programmed (expected) duration is known or unknown, short or long; whether the subject is immersed in water, immobilized, or put into a dark and silent room as opposed to a homogeneously stimulating environment; and so on.

Subject set seems to be extremely important (e.g., see Jackson & Pollard, 1962); and the procedures that in the early years surrounded REST experimentation without at all being substantively related to it (e.g., panic buttons, mysterious equipment, legal release forms) were certainly sufficient in themselves to lead to the anxiety-laden affective responses that were so widely interpreted as showing the effects of REST

itself (Orne & Scheibe, 1964; Suedfeld, 1977). By the same token, more neutral procedures lead to a great reduction in the level of stress and anxiety expressed by participants, frequently to the point of evaluations that are indistinguishable from those of control subjects, and evidence for any kind of serious disturbance is minimal (Suedfeld, 1977; Tarjan, 1970). The monotonous stimulation (homogeneous light and white noise) procedure appears to be reliably less pleasant and also less therapeutically effective than the stimulus-reduction methods of darkness and silence. Even the most extreme version of the latter—water immersion—has frequently been perceived as beneficial and enjoyable by participants with the appropriate set of expectations and orientations (Lilly, 1977).

Evidence Concerning Arousal

One aspect of this newly recognized complexity is that it turns our attention to the issue of differential effects and responses. It has become clear that the various techniques of implementing stimulus restriction are not in fact interchangeable. Some of the parametric work reported in Zubek's (1969a) book demonstrates the range of effects that can be obtained to a greater or lesser degree by using different combinations of reduced or monotonous stimulus arrays in the sensory modalities, as well as by varying the extent of output restriction (e.g., by immobilizing the subject). In the argument as to what the arousal effects of sensory restriction really are, the empirical evidence is inconclusive.

Performance on intellectual tasks is compatible with Berlyne's theory of relatively high activation level. Complex cognitive processes reliably deteriorate, whereas simple ones frequently improve in efficiency. This finding is compatible with data using more traditional arousal-increasing procedures, such as electric shock and food deprivation: when arousal is high, responses that are dominant in the subject's learned hierarchy become even more likely to be emitted. This phenomenon should lead to improved efficiency on simple tasks, such as memorization and recall, where the appropriate solution modes have been overlearned, so that the correct approach is likely to be the dominant one. In contrast, complex tasks (such as telling a story integrating several prescribed elements) are not so familiar, and the lack of a clear-cut dominant solution leads to response competition and reduced performance effectiveness when arousal is too high (Landon & Suedfeld, 1972, 1977; Suedfeld, 1969).

One problem with this literature is that most studies draw conclusions based on two, or at most three, points along the two axes (task complexity and arousal level). For example, the effects of stimulus restriction on high-level creative activity have never been adequately tested,

since most experiments use tasks that cover only a small segment of the complexity continuum. We do have subjective reports that the environment is conducive to vivid fantasy and imagery, and that some creative artists and scientists have used the technique to generate new ideas and cognitively explore older ones (Lilly, 1977). Whether these anecdotal instances would be supported by systematic, objective studies, and what implications such studies might have for the relationship between stimulus reduction and arousal, are questions that await further research.

Along the dimension of arousal most researchers have used only a control and a confinement condition. Obviously, in such cases no curvilinear function could possibly be demonstrated to exist. A few other studies have incorporated social-isolation groups without global environmental restriction, but it is difficult to place these along the continuum. Only a few experiments have involved other manipulations, such as combining REST with other motivational factors, or using different durations of confinement as a parametric variable. Another flaw in this regard is that the level of arousal is almost never directly measured. This is understandable in view of the difficulty of identifying an appropriate index of arousal, but obviously critically damaging to the effort to establish whether arousal is in fact a mediating variable between stimulus reduction and cognitive performance.

Noncognitive data have been quite inconsistent. For example, it appears that subjects sleep less as time in REST increases, which may again show increasing arousal; but this may be a function of the type and duration of confinement as well as of individual differences, and it is also mediated by diurnal cycles. Myers, Murphy, Smith and Goffard (1966) reported that motor movement, obviously related to wakefulness, showed similar variability. Restlessness went up across several days of confinement, remaining high during the daytime but dipping at night. Subjects who eventually quit the experiment before the scheduled end of the session were considerably more restless than those who managed to stay throughout the planned period. This last datum reminds us of the finding of Vernon and McGill (1960) that eventual quitters were significantly higher than stayers in the rate of button-pressing to view an unstructured visual stimulus. Zuckerman and Haber (1965) also showed that tolerance for reduced stimulation, this time measured by GSR responsivity, was negatively related to operant responding for stimulation.

Psychophysiological measures also fail to answer this basic question. Although there is evidence that boredom leads to high arousal (London, Schubert, & Washburn, 1978), such data do not serve to identify direct environment–arousal links. For instance, many subjects find the REST experience to be anything but boring. A review of the relevant studies leads to the conclusion that REST appears to cause cortical deactivation coupled with high peripheral arousal (Zuckerman, 1969). One of the most

stable findings is a progressive decrease in mean alpha frequency as confinement time goes on, but there are great individual differences in the pattern. Furthermore, the change is not found consistently when EEG is measured cross-sectionally rather than longitudinally, and the magnitude of change varies greatly as a function of the type of sensory restriction being employed. Studies using GSR as the dependent variable typically show decreases in skin resistance (indicating high peripheral arousal), but other measures, such as skin temperature, blood pressure, metabolic rate, and a number of biochemical analyses, show no consistent significant changes (Zubek, 1973).

These reports point to a more complicated explanation of what may erroneously be considered a REST–arousal relationship. One possibility is that many of the arousal data are unduly affected by whatever proportion of subjects finds stimulus reduction particularly stressful. It may be that changes in arousal are found only among this subgroup, and that such changes are a direct result of stress. This would explain the finding that the adverse behavioral effects of stimulus restriction are more consistently related to indices of relatively high arousal than to low or normal activation levels (e.g., Zuckerman, 1969). As we know (Suedfeld, 1980), a negative reaction to environmental restriction may be owing to a wide number of sources, including subject expectancy, personality variables (e.g., sensation-seeking), and aspects of the experimental procedure other than the reduction of stimuli. Even a relatively few highly reactive subjects may exhibit enough change for a significant intergroup difference in arousal to be found; but any conclusion that REST itself has a reliable affect on arousal would be unwarranted from such data.

The specific question of the arousal effects of REST cannot be answered. Both behavioral and physiological measures show inconsistent results, which is perhaps not surprising. After all, stimulus restriction covers a great variety of specific experimental environments, durations, manipulations, types of orientation, subject and experimenter expectancies, and personality differences; and the term arousal stands for almost as wide a variety of measures (Lacey, 1967). Although it is true that the global relationship being sought would be a very useful one if we could find it, the failure of the search is understandable. Perhaps the best tactic, then, is to turn to a more focused, and possibly more useful, line of inquiry.

The Motivational Consequences of REST

Because of the confusion about the most appropriate measure of arousal, and in fact about whether arousal is in any meaningful sense a

unitary concept, it seems better at least for the time being to lay the issue aside. Instead, attention should be paid to the consequences of REST for motivation. We may accept the principles of sensoristasis (Schultz, 1965) and optimal levels of stimulation (Zuckerman, 1969), that there is some moderate stimulation range or level. Deviations from this level result in behavioral changes tending to rectify the situation. When stimulus level is excessively low, the individual may seek several ways to increase it. One way is to change environments. Another is to produce actual stimulation in any of the sensory modalities (by talking to oneself, making noise, moving about, etc.). A third is to exploit the residual stimulation in the environment more effectively. This can be accomplished by lowering sensory thresholds, by focusing more intensely on stimuli that might normally be processed only superficially and casually, or conversely by scanning the stimulus array more widely to attend to aspects that would normally be filtered out. Another class of solutions is to attend to and/or generate more of the total stimulus load internally. That is, the individual may become aware of thoughts, emotions, and physical processes that are normally unconscious, or intensify the level of fantasizing, intense dreaming, concentrated thought, and emotional experience above that characterizing processing in the normal environment (Budzynski, 1976; Lilly, 1977; Suedfeld, 1979, 1980).

Considerable research has been performed on the motivational aspects of stimulus reduction. Perhaps the most widely accepted concept is that of "stimulus-action hunger" (Lilly, 1956). The need for "action" arises from the restriction of movement involved in most REST situations, and probably also from the interference with feedback from one's own behavior which the situation imposes (Miller, Galanter, & Pribram, 1960; Suedfeld, 1980). As has been mentioned, motor behavior tends to increase over time in REST, and individuals who are the most stressed by the reduced-stimulation environment tend to move the most (Myers *et al.*, 1966). These findings imply that response restriction is one of the contributors to the motivational consequences of REST. This hypothesis is supported by evidence that extreme immobilization even when there is no interference with input modalities has the same effect as global stimulus reduction (Zubek, 1969b), and that physical exercise can counteract some of the negative effects of REST (Zubek, 1973).

However, most of the evidence is concerned with the stimulus-hunger aspect of motivation. The evidence is overwhelming that REST does increase the desire for stimulation. In the very first studies (Scott, Bexton, Heron, & Doane, 1959), confined subjects continued to request repetitious presentations of extremely boring material, such as excerpts from children's primers and old stock market reports. Such material was avoided by control subjects. More recently, Leckart and his colleagues

have shown that even a brief period of stimulus deprivation in a given modality increases the subject's operant rate for prolonging stimulation in that modality. Leckart's team established this phenomenon with auditory (Levine, Pettit, & Leckart, 1973) and tactile (Yaremko, Glanville, Rofer, & Leckart, 1972) deprivation and stimulation. Several studies, both by this group and by others, have demonstrated the same phenomenon in the visual modality (Bearwald, 1976; Drake & Herzog, 1974; Leckart, Glanville, Hootstein, Keleman, & Yaremko, 1972; Leckart, Levine, Goscinski, & Brayman, 1970).

In contrast with Leckart, who used complex visual stimuli, a series of experiments by Jones and others (reviewed in Jones, 1969) used sequences of lights varying in color and tones varying in pitch. Once again, the subjects' desire to see a light sequence was a function of preexposure REST duration. But Jones and his colleagues went beyond this to look at specific stimulus variables affecting the motivational consequences of REST. After several experiments, they drew the conclusion that the most important variable is predictability. Maximum incentive value was associated with the least predictable sequences. Furthermore, high levels of exposure to unpredictable sequences resulted in greater preference for predictable ones, another finding that was constant in various modalities (Jones, 1969; Rogers, 1975). Evidence for central mediation also appeared. For example, satiation with visual information reduced the desire for auditory information, and the converse was true as well. Jones's definition of information value as the inverse of predictability has become standard in the field. Unfortunately, the incentive value of other collative variables was not investigated.

However, the term "information" is perhaps even more useful in thinking about the response to meaningful inputs than in the purely formal sense used by Jones. I have already referred to the early McGill findings concerning information deprivation and consequent desire for information; later research has shown that the incentive values and positive ratings of stimuli are related to predictability and meaningfulness in somewhat complex ways. There was one study using only two hours of stimulus restriction, in which the relationship was the same as with Jones's meaningless stimuli (Rossi, Nathan, Harrison, & Solomon, 1969). In an experiment lasting 24 hours, scrambled words that presented a challenging cognitive puzzle were preferred to both standard meaningful phrases and highly randomized assortments of letters (Landon & Suedfeld, 1969). In studies of individual differences, personality variables related to global stimulus need (Gale, 1969; Lambert & Levy, 1972) and to more specific information orientation (Levin & Brody, 1974; Suedfeld, 1964; Suedfeld & Vernon, 1966) significantly mediated the motivational consequences of stimulus reduction.

Nonexperimental Stimulus Restriction

In environments of monotonous and/or reduced stimulation other than experimental settings, such as long-duration confinement in prison cells, hospitals, submarines, polar stations, or spacecraft, or in such less dramatic circumstances as performing a boring and repetitious job (e.g., on an assembly line), performance decrements may result from stimulus hunger (which may be conceptualized in these cases as the need for variation, challenge, and novelty). It has been argued that impaired task performance, interpersonal conflict, and even deliberate violence, sabotage, and malingering may result (Frankenhaeuser & Johansson, 1974; Suedfeld, 1978). Job enrichment, task rotation, work teams, and the introduction of new and varied stimuli into the working and off-duty environment are all methods whose goal is to avoid such adverse affects. This can be done by introducing new social and physical configurations, by providing higher levels of stimulation in off-duty facilities, by making the diet and other ancillary factors more varied, or by coupling more optimal stimulation levels with improved performance. However, most people even in total institutions or other generally restricted environments are probably able to restore approximately optimal levels of stimulation through their own efforts.

APPLICATIONS OF REST: THE USES OF STIMULUS HUNGER

Information need has been invoked in a number of studies that explored the effects of REST on persuasibility, and more recently in research testing the usefulness of environmental restriction as a therapeutic technique.

Effects on Persuasion

Besides the willingness to listen to normally boring and aversive material, the earliest McGill studies demonstrated that confined subjects, who requested to hear propaganda messages about the reality of psychic phenomena more frequently than controls, also came to accept the arguments presented in those messages (Bexton, 1953). Similar data were obtained by a number of other researchers (reviewed in Suedfeld, 1969, 1980). For example, Myers, Murphy, and Smith (1963) found a generally greater desire for hearing persuasive messages (in this case concerning

Turkey) on the part of restricted subjects. However, only the less intelligent members of this group showed increased persuasibility. Suedfeld and Vernon (1966) presented each of their messages only once, but made the presentation of the next message contingent on stated agreement with the previous one. REST subjects showed more compliance than controls. Among the experimental group, subjects who were relatively high in information orientation (conceptual complexity) were particularly compliant, but showed no more actual attitude change than their less information-directed fellows.

Therapeutic Uses

A large number of other studies have presented various types of messages to patients in stimulus-impoverished environments and have reported positive results. Improved self-concept, lower scores on clinical scales of the MMPI, and similar changes among psychiatric patients have been found (Adams, 1980). More successful smoking cessation, greater adherence to dieting and exercise, better rapport and communication with therapists, more adaptive social interaction and learning among autistic children, and other such phenomena, have been reliably observed (Suedfeld, 1980). Some of the researcher–therapists involved in this work have proceeded explicitly from the hypothesis that clinical progress would result as a function of stimulus hunger arising from sensory reduction (e.g., Adams, 1980; Gibby, Adams, & Carrera, 1960). However, the hypothesis that the therapeutic effect is in fact mediated by this particular type of motivational arousal has not been unequivocally upheld (Suedfeld, 1972).

There is, however, one series of studies clearly supporting the view that stimulus hunger facilitates therapy. Here, rather than verbal messages, slides depicting snakes were shown to snake-phobic subjects. Not only did the REST participants emit operant responses in order to see the slides (which in the normal environment tended to be aversive), but both verbal and behavior signs of snake fear and aversion showed significant reductions at the end of the session. These reductions were accompanied by appropriate psychophysiological changes (Suedfeld & Hare, 1977). Furthermore, in agreement with Jones's (1969) theory, positive effects were significantly greater when the slides were presented in a random order of verisimilitude. In contrast, increasing realism was more effective among control subjects, in accordance with the general procedure used by behavior therapists using desensitization (Suedfeld & Buchanan, 1974).

Arousal and the Applications of REST

To bring the discussion full circle, alternative explanations of therapeutic effects of REST include the proposition that increased arousal is the, or at least one, crucial mediating variable. The argument is that superoptimal arousal leads to the impairment of cognitive performance, as has already been discussed; that resistance to persuasion is one kind of complex cognitive task; and that such resistance is therefore impaired by REST, leading to greater persuasibility both in purely experimental and in therapeutic settings (Suedfeld, 1972).

This hypothesis is supported by data that other sources of high arousal increase openness to therapeutic intervention (e.g., Hoehn-Saric, Liberman, Imber, Stone, Pande, & Frank, 1972). As usual, however, other workers have argued that the potency of clinical techniques is increased by low arousal (Wickramasekera, 1978). Once again we may resurrect the familiar U-shaped function, a tactic that leaves the question of the relationship between REST and arousal level still unanswered; or, from a more pragmatic point of view, we may suspend the debate and carry on with the empirical research.

SUMMARY

There is no doubt that environments that are either monotonous or low in stimulation lead to important motivational changes in human beings. Under some circumstances, these phenomena may have undesirable consequences. These changes may be summarized by the term "stimulus–action hunger." Alterations of arousal level may be a mediating variable. However, the data are mixed as to the direction of such alterations, and different indices of arousal show inconsistent results.

Researchers have found that changes in the reaction to various kinds of stimuli, and resultant effects on cognitive processes and persuasibility, can be put to use in improving the effectiveness of therapeutic interventions. A wide variety of such applications has been reported with both children and adults, ranging from the treatment of psychotic inpatients to facilitating self-management of behavior patterns that affect health maintenance (Suedfeld, 1980). It is probable that the motivational shifts caused by environmental restriction play a crucial role in such changes. At this moment, the actual scope and potency of this technique have not yet been established. Nor has there been any theoretical formulation that comes even close to giving an adequate explanation of the motivational changes mediating the findings. A more specific elucidation of the con-

cepts of arousal and arousal potential, and the application of some of Berlyne's ideas about these variables and about collative stimulus factors, may be one promising step in this direction.

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