SUBLIMINAL PERCEPTION AND PARAPSYCHOLOGY: POINTS OF CONTACT

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While allowing that appearances may be deceptive, there do appear to be such remarkable similarities between certain parapsychological phenomena and those associated with subliminal perception that it would seem worth considering the possibility that the two sets of phenomena depend at least in part on some of the same underlying processes.

By way of examining this hypothesis, let us consider some ten paradigms which have, as their common denominator, the fact that a physical event, be it a word, a picture or the physiological substrate of a thought, occurring at a certain time and place can evoke a correlated happening, be it a gesture, a dream, a spoken word or some measurable physiological change, occurring at a different time and place, and all this without any awareness by the transmitter or the receiver, or indeed by any external observer, of the intermediate stages in this apparent communication. While all ten of these paradigms involve reception without awareness, culminating in some measurable behavioral or physiological response, nine of them have in common the fact that the causal link between the transmitting sources and the responding receiver is a definable physical stimulus. They also have in common that the overall signal/noise ratio for this stimulus is insufficient to activate cerebral processes which provide for awareness of an incoming stimulus.

The tenth paradigm is that which demonstrates what has, perhaps unjustifiably, been called extrasensory perception. It differs from the other nine in only one obvious respect—there is no known or definable physical stimulus to link events "A" outside the organism with apparently correlated events "B" inside the organism.

By way of trying to account for the data from this last paradigm let us look at the parameters of the other nine. Four of these are described at length in my book (Dixon, 1971). They may be summarized as follows:

Subliminal Determinants of Perceptual Experience

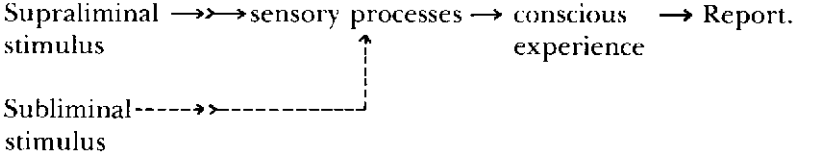
While it is axiomatic that all subjective perceptual phenomena, whether occurring in the waking or sleeping state, whether veridical or hallucinatory, must depend upon preceding preconscious processing by physiological mechanisms, a number of researches (Dixon, 1971; Somekh and Wilding, 1973; Henley and Dixon, 1974; Henley, 1975) have shown that visual or auditory stimuli, at such low energy levels as to prevent consciousness of their presence, may nevertheless influence the way in which a concurrent supraliminal stimulus is perceived. Adaptation level phenomena (e.g. the relative size of the different items in a sequence of stimulus presentations), the "happiness," "angriness," "sadness" etc., of neutral faces, visual illusions, the size/color/duration of After Images and After Effects (Anderson et al., 1970; Smith et al., 1974) visual imagery evoked by supraliminal music (Henley and Dixon, 1974), the meaning of supraliminal auditory homophones (Henley, 1976) and visual content of dreams occurring in REM sleep (Berger, 1966) have all been shown to be determined by the simultaneous presentation of visual or auditory stimuli of which the recipient remains wholly unaware.

Perhaps the most striking and extensively researched of all these effects is that embodied in the Defence Mechanism Test (DMT) developed by Kragh (1962), which, after 15 years of follow-up validation studies, is now part of the standard selection procedure for Swedish Airforce applicants. In this test, the applicants are required to reproduce (by drawing) a briefly exposed picture of a young man (the "Hero" figure). In carrying out this task, they remain unaware of the facts that, in addition to the centrally placed "hero figure," the stimulus card includes in its periphery a small picture of an "old ugly threatening male face." Though subliminal, this peripheral stimulus appears to interfere with their perception of the central figure, and this is a function of the percipient's underlying psychopathology. It is the nature of this interference which has prognostic value. To cut a long story short, those applicants who, in their drawings, demonstrate the operation of such defence mechanisms as "isolation," "denial," "condensation," etc., have been found to have significantly higher accident proneness when flying and also to be significantly more predisposed towards psychosomatic illness, than are those who remain relatively unaffected by the peripheral threatening face. Data from the DMT are, of course, closely akin to those of the Poetzl phenomena wherein unperceived parts of a perceptual display tend to emerge in subsequent dreams or associations.

One other finding from this group of studies which may have some significance for paranormal phenomena is the part played by laterality effects. In the experiment by Henley and Dixon (1974), successfully replicated by Mykel and Daves (1978), it was found that subliminal determination of auditory imagery only occurred when the supraliminal stimulus (orchestral music) was routed to the right hemisphere and the subliminal cue words to the left hemisphere.

Subliminal Determinants of Verbal Behavior

In all the foregoing experiments, subliminal effects were apparently mediated by ongoing conscious perceptual experience, as depicted in the figure.



As many researchers have shown however, a conscious percept is *not* necessary for subliminal effects to occur. Words or pictures too brief, or too weak, to enter conscious experience have been found to influence verbal "guessing" behavior (Dixon 1956, 1958, 1971; Gordon, 1967; Spence and Holland, 1962), and retrieval from long term memory of previously learned material (Spence and Ehrenberg, 1964; Gordon and Spence, 1966).

In these various researches three main effects were found. First, if allowed only a limited ensemble of possible responses (as in a typical card guessing ESP experiment), subjects tend to respond with items conveyed by the subliminal stimulus (see Miller, 1939). If, however, the response ensemble is unlimited (i.e. "the first word that comes to mind"), or includes associations to the stimulus material, then subjects tend to respond with a semantic associate to the stimulus. Often this semantically related response appears to bear a symbolic relationship to the stimulus (e.g. the subliminal stimulus "Penis" evoked the response "Cheroot"). Here again, as with the first category of experiments, interesting laterality effects have been found. Thus, in a recent study, Fonagy (1977) has shown that if a subliminal word is presented to the right ear, the response tends to be a logical secondary process association (e.g. "Grass" → "green"). If, however, the same stimulus is presented to the left ear, the response tends to be of something which *looks like* the stimulus object (e.g. "Grass" → "hair" or "bed of nails,"

and "Arrow" → "hook" or "staple"). This implication of the right hemisphere, in evoking concrete visual symbolic responses, is interesting in the light of the widely held view that, whereas the left hemisphere is concerned with sequential logical linguistic processing, the right hemisphere involves mechanisms for parallel spatial primary processing of incoming information (Ornstein, 1977), whether this be sensory or extrasensory in origin.

Emotional Factors

Running through accounts of parapsychological phenomena is the suggestion that emotion and motivation appear to play a significant part in extrasensory perception. Here again, research on subliminal perception has produced comparable data, the most extensive being that from studies of perceptual defence (Brown, 1962; Dixon, 1971; Erdelyi, 1974). The main findings from this area of investigation may be summarized as follows:

(1) People have significantly longer (defence) or significantly shorter (vigilance) exposure duration thresholds for tachistoscopically exposed emotive material than they have for emotionally neutral stimulus items.

(2) The relationship between threshold and anxiety may be represented by an inverted "U" curve. Whereas low levels of anxiety evoked by the stimulus result in raised thresholds, high levels result in lowered thresholds.

(3) Data from several lines of research (Hardy and Legge, 1968; Broadbent and Gregory, 1967; Dorfman, 1967; Dixon and Lear, 1963; Emrich and Heineman, 1966; Worthington, 1969) suggest that perceptual defence is a sensory phenomenen and involves the following stages of pre-conscious processing: cortical registration and analysis of the input, followed by emotional classification leading to a cortico-reticular interaction whereby the cortex, in-setting its own level of arousal, determines the conscious threshold for awareness of the incident stimulus.

The interaction between the motive state of the subject and the emotional connotations of the stimulus, at a completely unconscious level of cerebral processing, has been shown in various paradigms. In an experiment by Lazarus and McCleary (1951), subjects produced electrodermal responses to shock-associated nonsense syllables even when unable to report the critical stimuli. This so called subception effect has also been found in dichotic listening.

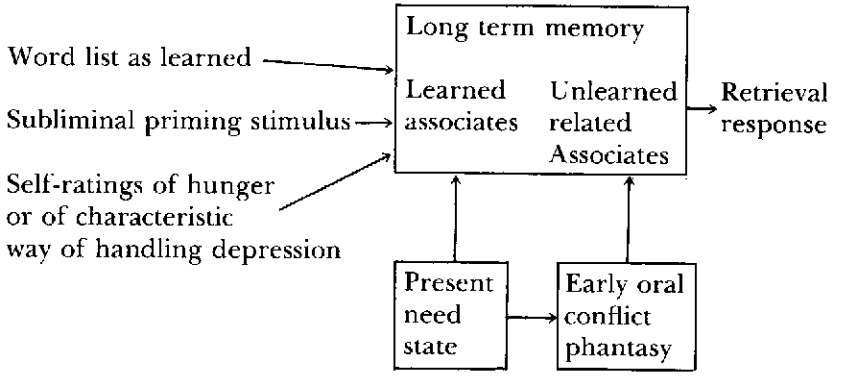
In studies of the latter phenomena (Corteen and Wood, 1972; Corteen and Dunn, 1974), subjects had to shadow (repeat back) prose

on one ear while individual words, including city names that had previously been associated with electric shock, were presented to the other ear. Though totally unaware of the words on the "unattended" ear, those which had been associated with shock, produced significant electrodermal responses from the subject's hand. Since the monitoring of and response to the words on the "unattended" ear did not interfere with the shadowing task, we must suppose that the brain is capable of simultaneously processing two independent streams of information, one above, the other below, consciousness.

Subliminal Perception and Memory

Yet another point of contact between paranormal and subliminal phenomena is in connection with memory. In both cases, it seems that ultimate responses are mediated by the brain's capacity to store information. Somehow, both extrasensory transmissions *and* subliminal stimuli gain access to unconscious memory. But here again, emotion and motivation play a significant role. Researches by Spence and his colleagues (Spence and Ehrenburg, 1964; Spence and Gordon, 1967) illustrate this issue. In one study, subjects who had been food-deprived were required to learn and recall lists of words containing associates to the word "cheese." In a subsequent recall task, only those subjects who were (1) hungry, (2) had rated themselves for feelings of hunger and (3) had been presented with the subliminal word "cheese" retrieved significantly more "cheese associates" than those who had either not been hungry, or had not rated themselves for hunger, or had not received the subliminal stimulus "cheese."

In a second experiment (Spence and Gordon, 1967), involving a similar paradigm, only subjects who (1) had felt rejected by their peers, (2) were characteristically prone to indulge in oral behavior to reduce feelings of depression and (3) were presented with the subliminal word "milk," showed significantly greater recall for associates to "milk" in a memory task than did subjects who lacked any one of the preconditions for this improvement in retrieval from long term memory. A further significant and interesting result from this investigation was that the rejected, oral, "subliminal," group actually recalled associates to "milk" which had *not* figured in the memory task. Since these intrusions were of such early milk associates as "suck," "nipple," etc., Spence and Gordon concluded that the present state of need (to remove feelings of anxiety and depression) plus the subliminal stimulus "milk" served to activate a much older oral fantasy related to an early feeding situation. The concatenation of factors responsible for the data from these experiments are depicted in the following flow diagram:



Physiological Bases of Perception without Awareness

A problem common to both sensory and extrasensory perception is the nature of those physiological processes which mediate between the external "stimulus" and the response whereby the organism indicates that he has been affected by this stimulus. In the case of telepathic communication, we simply do not know at what stage of cerebral processing the "stimulus" gains access to and hooks into the cerebral mechanisms of the recipient. A look at data from studies of subliminal perception might at least suggest some hypotheses regarding possible points of entry for the so-called extrasensory stimulus.

By way of a start, let's put together the data from three lines of research. First, there are studies by Libet et al. (1967) which involved using subdural electrodes, placed directly upon the somatosensory cortex, to record the cerebral effects of a tactile stimulus applied to the hand area of fully conscious patients who had been undergoing stereotaxic therapy for intractable pain. The principal finding from this paradigm was that a subliminal tactile stimulus applied to the hand evoked the early components of the compound evoked potential at the site of the cortical projection of the area stimulated. With increase in the peripheral stimulation two things happened, pari passu with the subject reporting consciousness of the stimulus the later components of the evoked potential appeared in the EEG record. This is probably the single most direct demonstration of the fact that consciousness of a previously subliminal stimulus depends upon coincident contribution from the ascending reticular activating system.

Other findings, pointing to the same conclusion, include Fuster's (1958) demonstration that a monkey's tachistoscopic recognition thresholds for a food-related stimulus may be modulated by concurrent stimulation of the mesencephalic reticular system. Finally, there are

those studies of perceptual defence, mentioned earlier, which suggested that consciousness of a visual stimulus depends upon a preconscious semantic analysis and emotional classification at a cortical level leading to cortico-reticular interaction, which, in turn, increases or decreases cortical arousal via the fibers of the ascending reticular system.

Our second set of data having possible relevance to both subliminal and extrasensory phenomena comes from studies of neurologically caused "blind sight" (Weiskrantz and Warrington, 1974; Poppel, Held and Frost, 1973). The main conclusion from these studies is that, though cortically blind through structural damage to the CNS, these organic patients may, nevertheless, respond to visual stimuli presented in those areas of the visual field from which they receive no conscious impression. In the light of related findings by Ikeda and Wright (1974) it has been suggested that this "blind sight" is mediated by a secondary visual system involving the retina, the superior colliculus, the pulvinar and the association cortex. Whether this system, which appears to operate without giving rise to conscious experience and evidently provides for the orienting response, is implicated in other sorts of subliminal or extrasensory perception remains an interesting possibility.

Yet a third group of experiments which we need to consider are those involving unconscious registration of external stimuli in pattern-masking paradigms (Marcel and Paterson, 1976), in binocular rivalry (Walker, 1975), during fading of a stabilized image (Riggs and Whittle, 1967) and in the evoking of "K" complexes (in the EEG) by emotionally important auditory stimuli presented during sleep (Oswald, Taylor and Treisman, 1960). In all four of these paradigms not only does the brain continue to be affected by stimuli of which the mind remains unaware but, in at least two of them (pattern masking and stimulation during sleep), carries out a complex semantic analysis of the stimulus inflow. Given that the end result of subliminal perception is almost indistinguishable from extrasensory perception, namely, a purely statistical effect upon the probability matrix underlying the possible repertoire of behavioral and autonomic responses, it seems reasonable to ask at which processing stage extrasensory effects begin to occur—at the peripheral receptor, the midbrain, thalamic relays, cortex, or reticular system? If the results of extrasensory perception are likened to those of subliminal perception, then they must involve preconscious semantic analysis, emotional coding and access to long-term memory. Hence, we must assume that extrasensory effects lock into the nervous system at some stage prior to those responsible for these functions, yet capable of modulating the arousal systems of the brain. Sensory relays in the midbrain, thalamus, association cortex, or limbic system

would all be possible candidates for this hypothetical mediating function. But let us look at some other factors which may be relevant to this problem, namely, those subject and situational variables which appear to be critical for subliminal perception. As to the former, the two most important appear to be arousal level and hemisphericity. Whereas numerous researches (see Dixon, 1971) have found that subliminal influences are maximal when the subject is in a relaxed state (presumably low arousal), a recent study by Sackiem (1977) has indicated that this relationship between arousal and subliminal influences is also greatest in people showing *right* hemisphericity. Subliminal effects are generally weaker in people showing left hemisphericity and in that case depend upon attentive readiness.

As to situational variables, the most striking finding to date from many researches (see Dixon, 1971) is that subliminal effects appear negatively correlated with stimulus energy. The further below threshold, the weaker or briefer the stimulus, the stronger its effect which, as we noted earlier, may be qualitatively quite different from that of a supraliminal stimulus.

Subliminal Perception, Psychosomatic Disorder and PK

There are grounds for believing (see Dixon, 1978) that the processes underlying subliminal perception phenomena in normals are closely kin to those responsible for psychosomatic conversion symptoms in those patients who quite involuntarily and unconsciously transform psychic conflict into a somatic outlet.

The following similarities between subliminal and psychosomatic phenomena are particularly relevant to this viewpoint:

(1) In both subliminal and psychosomatic phenomena the individual may remain totally unaware of cause/effect relationships, of the contingencies between stimulus and response.

(2) In both "syndromes" the stimulus makes contact with and activates complexes of emotionally charged ideas in unconscious long-term memory.

(3) In perceptual defence, as in psychosomatic disorder, the subject is prevented from experiencing negative affect. In both cases he, in a sense, trades negative affect for a somatic outlet.

(4) Both subliminal and psychosomatic disorders may involve the unconscious conversion of psychic material into a symbolic representation.

(5) In some psychosomatic disorders (e.g. asthma), a potentially threatening emotional stimulus may initiate a stress response involving the autonomic nervous system. The same holds true for subception

phenomena and in the subliminal effects demonstrated for dichotic listening (Corteen and Wood, 1972).

(6) The very close relationship between the two classes of phenomena is confirmed by the fact that subliminal stimulation has been successfully used to investigate and to ameliorate psychosomatic symptomatology (see Beech, 1959; C. Fisher, 1954; S. Fisher, 1968; Silverman, 1976; Tyrer, 1978), suggesting that identical processes may be involved in the two cases.

What possible relevance has all this to paranormal phenomena? Simply this. The psychosomatic process which seems to involve the same sort of mechanisms as underlie subliminal perception is a very special case of something that goes on in certain parapsychological demonstrations, namely, an influence of mind, of knowledge and feelings about knowledge upon matter.

Maybe a joint examination of the three sets of phenomena—the subliminal, the psychosomatic and the paranormal, may have a spin off for our comprehension of all three!

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DISCUSSION

BELOFF: In your talk, you cited the work on subliminal perception as raising doubts about any dualism. Now, it wasn't too clear, though, from the context, whether it was the dichotomy of conscious versus unconscious, or whether it was the dichotomy of mind versus brain, because one shouldn't automatically equate mind and consciousness. I mean, there are conceptions of mind which make it very much more comprehensive than just the aspect of consciousness that is often taken as the distinctive attribute of mind. It seems to me that if it weren't for the existence of such phenomena as ESP and PK, one would be very tempted to think of unconscious processing like subliminal perception, as the automatic physical workings of the brain and distinguish that from mentalistic processes which involve consciousness. But given that there are psi phenomena, one is faced with the very difficult problem as to what entity or source it is that produces these phenomena, and here it doesn't look very much as if brain processes, from what we know about them from brain physiology, etc., should give rise to such phenomena that they should be responsible for it, and, therefore, one looks elsewhere and one says that mind might be a source of psi phenomena as it is a source of consciousness and other things.

DIXON: I'm sorry if I misled you into thinking I'm taking an anti-dualism view. What I was trying to point out was that, if you change a purely physical relationship, the signal to noise ratio, discernible effects move from one realm into another—from cerebral to mental

and conscious, and that the dichotomy that I was interested in was between purely cerebral processing (which can be explained in physiological terms) and conscious experience, which cannot. If I had only looked at subliminal perception studies and had heard of ESP, but had never studied it, I feel I could encompass parapsychological phenomena in terms of the dichotomy I'm talking about between conscious experience and unconscious processing. They share a final common path. The subject in an ESP experiment, whether he's guessing cards or describing what's going on in the mind of someone who is having a dream, is ultimately using the same physiological mechanisms as those involved in subliminal perception. Somehow, somewhere along the line psi transmission, or whatever it may be, is locking into the nervous system to produce effects comparable to those of subliminal perception. The interesting problem is, where does this occur? Is it at a sensory or motor level of processing? Preconscious or in consciousness?

BELOFF: I don't quite follow from your reply what you conceive of as responsible for this information transmission that takes place.

DIXON: The information transmission, do you mean, in telepathy?

BELOFF: Either in a PK transaction or ESP—I don't mind which, but what is it that interacts with the external world, when it doesn't seem to be the brain?

DIXON: Frankly, I don't know. You say it doesn't seem to be the brain, but I don't know any evidence to show it isn't the brain. We have an experiment now, being run by a student of mine. Neither she nor her subjects seem to be able to distinguish between effects occurring with the stimulus present or with the stimulus absent. Subliminal perception trials and ESP trials produce the same effects. As I point out in my paper, there are so many similarities between subliminal and psi effects—the laterality factor, the fact that state of relaxation appears to be a very important variable and that mild emotion and some volition appear to be common to both.

BELOFF: I entirely accept these analogies. I simply want you to admit that mind might be involved in subliminal perception as well.

PRIBRAM: The way you talk about things is reminiscent of Brentano. For him, unconscious processes were physiological and the province of brain physiologists. But consciousness is a psychological process that is separate from these physiological processes. However, Brentano has a cryptic footnote that says, "that's all true, unless Leibnitz is correct in his monadology." What I'm saying is that Leibnitz was correct in his

monadology—that we have a *cortical* process which is responsible for consciousness, and this is the same position that Freud took in the "Project" where he said, "The part of the brain responsible for consciousness is cortex." All the rest of the brain, of course, deals with unconscious processes. And the Weiskrantz/Worthington experiments that you quoted bear this out. If one takes away the cortex, one no longer has self-reflective consciousness, but stimulus processing goes on reasonably well nonetheless.

DIXON: It seems to me that consciousness depends upon a relationship between the cortex and the arousal system. I find it very difficult to think that the consciousness system was physiologically or anatomically separate from the information transmission system.

BUDZYNSKI: The listening task which you mentioned reminded me of a paradigm that we're using now, which is to present very fast paced random numbers into the right ear (the speed is about two numbers per second) and have the individuals recite these numbers aloud, at the same time presenting other information in the left ear. This information is presented in such a form that it can be absorbed by the right hemisphere. In terms of what aphasics can absorb, the language is slow, redundant, concrete, lots of voice intonation. One of the things that we did with this type of paradigm is to present ten weight loss suggestions to people. Additionally there was a kind of a "hooker" which said "the back of your neck will itch." All this was presented below the conscious auditory threshold. It's loud enough to hear if you were to direct your attention to that other ear, but if you stick with the task of reciting the random numbers you're not aware consciously of that other material going in. Now, what we did when we presented this to a group of people was to count the number of scratches that people manifested and there were sixteen total scratches out of a group of twenty, twelve scratchers (some were repeaters). Afterwards I asked them how many heard a suggestion that had nothing to do with weight loss. Two people out of the twenty had, but neither one of those had scratched. Those who did scratch had not heard the suggestion and were not consciously aware of it, and yet carried out the simple task, as though they were hypnotized and had an amnesia for the suggestion. These kinds of studies are still continuing. We are now trying to affect other kinds of things, such as attitudes and belief systems, with this sort of paradigm. I was struck by the fact that it seems to me that a renewed interest in subliminal processes is very relevant at this stage.

DIXON: Well, it's nice to hear that. What's particularly intriguing about your paradigm is that the scratching response is not one people would particularly want to make.

TART: You said that you didn't see how subliminal perception could be reconciled by the dualistic view. I don't think it's reconcilable with classic dualistic views, which assume that the M/L system is involved in every conscious psychological process, but I think one of the chief points I didn't make in enough detail in my presentation was the enormous self-determination, the automatization of the B system. You don't need the M/L system involved for many psychological processes. It really is as your diagram showed, a parallel process in many instances; it's not necessarily involved. So I think they're quite reconcilable.

DIXON: They may well be, but having been reared in the tradition that one should always try and explain everything in terms of brain mechanisms, it's very difficult to accept these other views, but I'm moving in that direction particularly as we do get people who show psi results from time to time under subliminal conditions.

HONORTON: You refer to the study by Oswald, Taylor and Treisman on evoking "K" complexes. I believe there is a serious methodological flaw in that study. Several years ago, I attempted to do a parapsychological version of that experiment and ran into an article by LaVerne Johnson and Arnie Lubin in *Psychophysiology*, which clearly shows that "K" complexes cannot be considered independent. The statistical analysis that Oswald and his associates used assumed that each "K" complex was an independent event, so I think the question as to the significance of that work is somewhat in doubt.

DIXON: Yes, that's why I mentioned the Berger experiment, because there they have the third variable—the fact that the person actually reported a significant image and subsequently matched the stimulus with the accounts of the dream.

HONORTON: I think your description of the subliminal psi experiment was probably insufficient to get into the conscious recognition system of those who were not in St. Louis and heard the paper. Since you're talking about points of contact between subliminal perception and psi, I wonder if you might want to describe that study in a little more detail, for the benefit of those who were not at the St. Louis conference.

DIXON: I've been a subject in this study and I'd hoped I'd be able to bring some definitive data, but unfortunately the experimenter hasn't collected enough yet. What she does is to compare subliminal with extrasensory transmission. The subject sits in a dark room. The trial I was on also involved a ganzfeld condition, ping-pong balls over the eyes and while listening to white noise. During the trial, either a subliminal message or an ESP transmission from an experimenter in another part of the building is added to the white noise. Then a check-

list is brought to the subject who has to check off what he thought were the stimuli. Neither the experimenter nor the subject knows which group the subject is in—whether he's in a subliminal group, or extrasensory group, or a control group, and obviously neither the experimenter nor the subject knows whether the particular stimulus is being presented at any one time. Half the subjects are run under the ganzfeld condition and half are run under the other condition. At the time I left London, she had significant effects under both subliminal and extrasensory conditions, but no difference between the two at all.

SMALL: I'd like to know if you can clarify this question of the threshold, because it seems to me that this is not something that is absolute, but something that is variable, adjustable according to the subject. It seems to me the only way to determine this would be statistically; that is, the threshold is that point at which the subject seems to identify a certain percentage of the stimuli correctly. If you have a point where the subject is identifying zero percent of those stimuli correctly, then how can we speak of perception in any sense? And yet if he is identifying in fact some percentage incorrectly, then how do we determine what percentage should determine what is subliminal and what is not? It seems there is bound to be some sense perception there, so how would you discriminate that? If there are parallels which seem to be emerging between paranormal processes and subliminal processes, then we should see some of the things that have been found in psi experiments, such as psi missing and decline effects, for example, emerging in subliminal experiments as well. The experiment that Dr. Budzynski was talking about seems relevant to this, but again, it seemed to be not quite really subliminal perception that we're talking about. If you can get the subject to show that he has been making use of that action in some way, that it is influencing his behavior, then you have clear evidence that he has incorporated it, otherwise it seems more like a statistical effect.

DIXON: Most studies of subliminal perception have not in fact taken the psychophysical threshold as their datum. Subliminal stimuli are usually presented two to five decibels below the lowest level at which the subject ever reported being conscious of the test stimulus. The more sophisticated studies using signal detection theory, look for changes in d' as opposed to changes in beta e.g. in perceptual defense experiments it has been shown that subliminal stimuli produce significant changes in d' rather than in β. The other criterion for the stimulus being subliminal is not in terms of measuring the threshold at all, but in terms of the fact that the person's response when he is unconscious of the stimulus is quite different (though causally related to the stimulus) from that given when the stimulus is supraliminal.