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Decision Making Regarding Conscious and Nonconscious Perception in Detection and Discrimination Tasks

A study was done of decision making in simple psychophysical tasks of detection and discrimination. The experiments showed that it is possible to discriminate stimuli in a nondiscrimination zone and for different threshold values to exist for identical stimuli simultaneously. Any signal under the appropriate conditions can exceed the threshold and be consciously perceived or, conversely, recede into the subthreshold zone of nondiscrimination. The threshold of conscious perception of a signal plays a highly important role in the regulation of signal detection and discrimination processes.

Notwithstanding the fact that research on threshold phenomena has been going on for more than a century already, scholars have yet to arrive at a consensus regarding thresholds. This article is an attempt to propose a possible solution to the problem.

The prevailing view today is that the magnitude of the stimulus that generates sensations in an observer characterizes not the capabilities of the sensory system but rather the level to which the system is attuned at that moment. Nevertheless, the general notion persists that the threshold of perception is

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Translated by Steven Shabad.

directly related to conscious awareness. Classical psychophysics and current psychophysical theories describe solely the realm of conscious experience.

Gustav Fechner (1860), who originated threshold theory, used the concept of a threshold to designate the critical value of a stimulus above which its effect generates a sensation in a human being and below which this sensation does not occur. This view was shaken in later research by a number of empirical facts, such as the false-alarm phenomenon.

For example, in H. Richard Blackwell's high-threshold theory (1953) a threshold is regarded as a fixed critical point: if a stimulus does not reach the threshold, it cannot generate a sensation under any circumstances, but in certain situations the test subject may switch to guessing stimuli. The psychophysical model based on signal detection theory uses the concept of a criterion (Tanner and Swets, 1954). According to this model, a signal is always observed against background noise, and the magnitude of the noise constantly fluctuates. To determine whether what the observer senses at the moment is merely noise or a signal is present against its background, a person independently establishes a criterion, below which a decision is made that a signal is absent. Robert Duncan Luce's two-state theory (1963) retains the concept of a threshold as a critical point below which a signal cannot be detected, but adds the assumption that even in the absence of a stimulus there is a probability that a sensory effect will occur. In a certain sense, Luce's model combines Blackwell's high-threshold theory with signal-detection theory. There is also a theory of a low threshold that lies in the noise domain (Swets, 1961), which hypothesizes the existence of a threshold that lies in the domain of small values of a stimulus and is therefore covered by noise.

Among current psychophysical theories, we should mention the wave theory of difference and similarity (Link, 1992), which is a new model of detection and discrimination. According to Stephen W. Link, the electrical processes that occur in nerve tissue under the influence of sensory signals have a wavelike character. What is meant here are primarily neurophysiological characteristics rather than subjective sensory effects. Signal detection is based on a comparison of an external signal with an internal referent (standard), which is also wavelike in nature. A sensory impression of detection occurs if the amplitude difference between the compared waves exceeds the threshold. This theory assumes a discrete type of operation of the sensory system and proposes a variant of a logarithmic relationship between the amount of the sensation and the stimulus magnitude. To sensory ability and decision making, Link adds a third component in signal detection—response resistance. This is information accumulated before a response occurs. The result of discrimination is determined by one reflexive factor—sensory ability—and two voluntary ones—the decision-making criterion and response resistance. In essence, the position of the author of wave theory regarding the role of stimulus intensity is similar to previous concepts. Overriding importance is ascribed to the observer's sensory ability and to physical factors. A great deal of attention is focused on explaining neurophysiological processes in the sensory system; it remains unclear, however, what role extrasensory factors play and how a sensation occurs from a stimulus.

Thus, the task of signal detection or discrimination in psychophysical theories is regarded as a simple sensory task. The threshold (or criterion) may change, depending on the tasks that the observer is performing, but it is assumed that a person cannot perceive and precisely identify subthreshold (subliminal) information. This proposition is contradicted by numerous facts that have been determined in research on subliminal information processing. We will address only some of them.

Some of the first experimental studies in this area were conducted by McCleary and Lazarus (1949). They presented nonsensical five-letter combinations to test subjects. During the presentation of some of the combinations the test subjects were made to experience electric shock. After prolonged practice the combinations were presented to the test subjects at a rate that far outstripped the possibility of recognition. Nevertheless, when the combinations were presented in the practice series with electric shocks, there was an increase in galvanic skin response (GSR).

A study by Kunst-Wilson and Zajonc (1980) showed that preferences in choosing between two alternatives are influenced by nonconsciously perceived information. Similar results were obtained in a study by Mandler, Nakamura, and Van Zandt (1987).

Marcel's effect (1983) is well known in science: a word presented for only ten milliseconds influences subsequent processing of verbal information.

Pessiglione et al. (2007) demonstrated in their study that an image presented for fifty and even seventeen milliseconds was nonconsciously perceived by participants even though people said in both cases that they had not seen anything.

Besides experimental data, we should also mention theoretical propositions put forth by contemporary scholars. For example, Kihlstrom, Barnhardt, and Tataryn (1992) and Kunzendorf and McGlinchey-Berroth (1998) contend that subthreshold stimuli were above the threshold that separates conscious stimulation from the nonconscious type, but below the threshold for consciously produced perception. In their view, there are situations in which a person perceives a stimulus but is not aware of its presentation.

Merikle, Smilek, and Eastwood (2001) write that there are two different thresholds of conscious perception—an objective one and a subjective one. Accordingly, three different states can be identified: no stimulus is recorded up to the first threshold; a person has no subjective sensation between the first and second thresholds, but implicit processing can occur; and conscious perception occurs above the second threshold.

Overgaard et al. (2006) go even further in their article, asserting that there are different types (possibly thresholds) of conscious perception.

Dixon (1971) enumerates several situations of nonconscious perception:

1. A test subject reacts to a stimulus whose strength and duration are below his threshold of perception, which has been determined beforehand.
2. A test subject senses a stimulus effect but has no concept of the nature of the effect.
3. A reaction may be recorded to a stimulus that a test subject knows nothing about.
4. A test subject has some concept of the stimulus, but any reaction to it is denied.
5. A test subject knows about his reaction to it, but does not understand (or denies) the connection between them.

There are a number of other phenomena, in our view, that are closely related to the problem of nonconscious perception. They are illusions and ambiguous images. An experiment by Gaida (1972) describes a change in sensitivity under illusory conditions. Test subjects were asked to compare two identical segments bounded by lines. One of the segments was filled with dots while the other was blank. From the standpoint of traditional psychophysics, it would seem that an illusion should not influence sensory processes. Nevertheless, it was proved experimentally that accuracy in comparing the two segments depends on whether the segment is filled with dots or not. The “filled-segments illusion” influences the differential threshold and significantly increases the probability of an error.

In an illusion of size, for example, in the Ebbinghaus-Titchener illusion (1902) or the Muller-Lyer illusion (1889), two items of the same size (lines, concentric circles) are present, and we consciously perceive them as being of different sizes. The false conscious perception does lend itself to correction even after measuring instruments are used. The true size of the lines in the Muller-Lyer illusion remains nonconsciously perceived. But what is even more surprising is that a video recording of the finger measurement of the figure’s central segments in the Muller-Lyer illusion showed that the distance between the fingers is the same, that is, it corresponds to the correct length of the lines rather than the illusory length. The test subject simultaneously consciously perceives the lines to be of different lengths and nonconsciously gives a correct sensorimotor response that the segments are equal.

In ambiguous images the reversal is based on the fact that at each moment in time only one possible variant is consciously perceived. The nonconsciously perceived variant also influences subsequent responses by test subjects. In Fillipova's experiments (2006) the unnoticed meanings of ambiguous images exert a negative priming effect: the amount of time to perform a task contextually related to a nonconsciously perceived meaning is greater than the time to perform a neutral task or a task related to a consciously perceived variant of the ambiguous image. Perceptual illusions and ambiguous images can be assigned to one of Dixon's groups of situations of nonconscious perception (a reaction may be recorded to a stimulus that a test subject knows nothing about).

Ambiguous images superbly demonstrate how a subliminal stimulus can become consciously perceived. But what if all subliminal stimuli are consciously perceived under certain conditions? In this case, it turns out that in measuring the threshold of detection we are dealing with the threshold of conscious perception of a stimulus, which depends not so much on the observer's sensory ability and the stimulus magnitude as on the processes occurring in consciousness.

Thus, the first hypothesis of our study can be formulated:

1. *In a task of detecting a stimulus placed in the conditions of an ambiguous (or illusory) image, the detection threshold may change in accordance with the mode of perception of the ambiguous (or illusory) figure.*

Since nonconscious perception of a signal proves to be unrelated to the reception of the signal by the sensory system, one can assume that a correct perception of the differences between the signals is possible even when a person is not aware of these differences. Some experimental data attest to the possibility of discrimination in the nondiscrimination zone. In the case of discriminating auditory stimuli, Bardin and Indlin (1993) showed that a person is able to work with stimuli in the nondiscrimination zone as distinct stimuli by isolating additional sonic characteristics. And Pakhomov (1985) in his research found that a test subject's responses in conditions of indiscriminability depended on the previous response to precisely the same stimulus. But this requires identifying the presentations, which in itself is an almost more difficult task than signal detection.

Hence the second hypothesis of our study:

> 2. *The discrimination of stimuli in the nondiscrimination zone will be successfully accomplished even though they are not realized.*

The task of stimulus detection

To test the hypothesis that there is a threshold of conscious perception of a stimulus, various types of experimental procedures were developed (the stimulus in each of them was placed in a situation of ambiguous or illusory images).

Experiment 1: Determining the influence of the mode of perception of ambiguous images on the threshold of stimulus detection

The purpose of the experiment was to determine the threshold of detection of a dot on the "front" and "back" face of a Necker cube.

Method

The first experiment used the ambiguous image of a "Necker cube." A white dot was located on one of the faces of the Necker cube (a black image on a white background). In practically every case the face that changed position was easier to perceive as the "front" one. At the start of the experiment a choice was made of the cube position that the test subject found easier to perceive. The subject's task was to find the dot.

A method of minimal changes and a method of constants were used to determine the thresholds. In the method of minimal changes the test subject was presented ten slides during which the dot shrank in size and ten slides during which the dot grew. The subject would say "yes" if he saw the dot during a presentation and "no" if he did not see it. In the method of constants ten slides were presented with dots on the face. The size of the dots was close to threshold values. The slides were presented in random order. The distance to the computer screen was four meters.

A few days later the second part of the experiment was conducted. During this time the test subject had been practicing to consistently perceive the Necker cube in another position (to see the "back" face instead of the "front" one, or vice versa). The instructions and conditions did not change. Twenty people took part in the experiment.

Results

The results showed a difference in the values of the stimulus detection threshold for sixteen out of the twenty test subjects (when using the method of minimal changes) and for seventeen out of the twenty (when using the method of constants). When the location was “front” face the value of the threshold was significantly lower than when that face was perceived as the “back” one (Wilcoxon Rank-Sum test, $p < 0.01$).

Experiment 2: Identifying the influence of the Delboeuf illusion and the Ebbinghaus-Titchener illusion on the stimulus detection threshold

The purpose of the experiment was to determine the influence of the illusory change in the size of internal dots in a modified Delboeuf illusion and Ebbinghaus-Titchener illusion on the value of the threshold of their detection.

Method

The second experiment used a modified Delboeuf illusion and Ebbinghaus-Titchener illusion. First the method of minimal changes was used to measure the threshold of detection of internal dots in the modified Delboeuf illusion. The study participants were presented a sequence of slides with a gradual decrease (increase) in the size of the internal dots. The test subject was asked to say “yes” if he saw a dot during a presentation and “no” if he did not see one. If he did not see a dot only in one of the circles, he was to indicate in which one. The large figure was located to the right or left of the small one.

In the second part the method of constants was used to determine the threshold of detection of internal dots in the modified Delboeuf illusion and Ebbinghaus-Titchener illusion. Each version of the location of the figures was presented five times.

Eighty-five people took part in the experiment, and about 60,000 measurements were taken.

Results

When the threshold was determined by the method of minimal changes, for eight out of ten subjects the value of the stimulus detection threshold in the large circle was significantly higher than in the small circle (Wilcoxon Rank-Sum test, $p < 0.01$).

Experiment 3: Identifying the influence of the Ponzo illusion on the stimulus detection threshold

Method

The Ponzo illusion was used. The essence of this illusion is that the location of objects on the plane along a straight line with a predefined perspective influences the perception of the size of these objects. Objects of equal size located farther away in accordance with the perspective seem larger than those located closer.

In accordance with the illusory situation it is assumed that the threshold of detection of identical stimuli located on the same plane with a perspective depicted will be different (the threshold of detection of the objects located "farther away" will be lower than the threshold of detection of the "closer" stimuli). A modified Ponzo illusion—an image of a soldier—was chosen as a basis. The buttons on his coat were the stimulus material. The square-shaped buttons had a gap in them on one of the four sides—left, right, top or bottom. The side the gap was on was changed in random order. The test subject had to state sequentially, beginning with the first soldier, on which side each of three soldiers had the gap in his button.

In all, ten cards were presented. Fourteen people participated in the experiment, and 1,680 measurements were taken.

Results

For eleven of the fourteen test subjects, a difference was found in the values of the detection threshold of the gap in the button: when the button was on a soldier situated in the foreground the threshold value was higher than when the button was on a soldier situated in the background (Wilcoxon Rank-Sum test, $p < 0.01$).

Experiment 4: The change in differential thresholds during perception of the horizontal-vertical illusion

Kochnova (2007) [reference omitted in original] conducted a study under our direction in the General Psychology Department of St. Petersburg State University on differential thresholds during the perception of illusory objects in the case of the horizontal-vertical illusion.

The hypothesis was that the level of the differential threshold in the comparison of the two lines will depend on the illusory concept of the length of the lines rather than the true difference in their lengths.

Method

The method of constants was used. The illusory perception of the vertical line as the longer one was expected to hamper detection of the difference in lengths of the two vertical lines compared with the horizontal ones. The difference between the two horizontal lines, meanwhile, will be gauged more accurately.

The test subject was shown an image of the horizontal-vertical illusion and asked to compare the horizontal line with the vertical one and, if they were not equal, to say which one was longer. Images of the illusions were shown on sequentially presented cards (a black image on white background). There were twenty-four cards. The difference in the length of the lines varied from 0 to 12 mm. The cards were presented in random order. Ten people participated in the experiment, and 480 measurements were taken.

Results

As a result it was determined that nine out of the ten test subjects saw a 6 mm difference for the horizontal lines (which under the illusion seem longer). For the vertical lines (which under the illusion seem shorter) nine out of the ten test subjects saw a difference of only 10 mm (dependent t-test, $p < 0.01$). This is confirmed by the fact that the proportion of errors for the vertical lines was 47.5 percent, while for the horizontal lines it was 19 percent.

Experiment 5: The change in differential thresholds during perception of the size-weight or Charpentier's illusion

Method

Charpentier's illusion occurs when two spheres of different sizes and equal weight are presented. If such spheres are presented simultaneously to both hands or in sequence to one hand and the subject is asked to estimate their weight, he usually makes a mistake—the large sphere seems lighter than the small one.

According to the concepts of traditional psychophysics, the differential thresholds for spheres of equal weight should be identical. The more an object weighs, the more weight must be added to it (or subtracted from it) for the test subject to feel the difference between the original and altered weight. The illusion is assumed to change the value of the differential threshold: when the small sphere (which seems heavy) is used, the differential threshold will be higher than when the larger sphere is used.

First the test subject, with eyes closed, was presented two spheres (one large, one small), one at a time, in his right hand. He was asked to compare the weight of the spheres. If one sphere weighed less, the test subject was to tell the experimenter up to what point the sphere's weight had to be increased for the spheres to be equal. The spheres could be compared as many times as necessary.

Then the test subject, with eyes closed, was presented the large sphere in his right hand. The sphere was gradually filled with water until the test subject said that the sphere's weight had changed. In the next trial the small sphere was presented, with a similar task. The spheres alternated throughout the experiment. Altogether thirty probes were conducted with each test subjects. Eleven people took part in the experiment, and 440 measurements were taken.

Results

The results showed that for ten of the eleven test subjects the differential threshold was significantly higher for the small sphere than for the large one (Wilcoxon Rank-Sum test, $p < 0.01$).

The task of stimulus discrimination

To test the hypothesis of nonconscious discrimination in the nondiscrimination zone, psychophysical experiments were conducted in which stimuli of both visual and auditory modalities were used.

Experiment 6: Comparison of pairs of horizontal segments

Method

Test subjects were presented visual stimuli (horizontal segments) for discrimination. First the subject's individual nondiscrimination zone was determined (with the aid of a modified method of average error). Then the test subject was presented two segments, one of which was always constant, while the other alongside it varied both within the nondiscrimination zone and outside it (the method of constants). The test subject had to determine whether the left-hand stimulus was shorter than the right-hand one, equal to it or longer. Forty-three people took part in the experiment, and 4,730 trials were conducted.

Table 1

Empirical Frequencies of Pairs Consisting of Two Consecutive Responses to an Identical Presentation

Sequence	To correct	To incorrect	To response "equal"
From correct	105	78	226
From incorrect	92	58	129
From response "equal"	197	116	547

Note: Only for presentations in which segments differed within the nondiscrimination zone; instances in which equal segments were presented are not considered.

Results

We analyzed the preferences when the answer changed upon presentation of the same pair of stimuli that differed within the nondiscrimination zone (we should note that such presentations were not consecutive). Then the empirical frequencies of certain pairs of responses were compared (see Table 1)—for example, how frequently an erroneous response was subsequently changed, compared with its repetition, and so forth.

Significant differences in these frequencies were obtained, which suggests the manifestation of an aftereffect. The aftereffect means that a person's repeated response to the same presentation depends on his previous response. But it is impossible to repeat errors or correct responses without knowing where they were made. At the same time, the test subjects judged all of the presentations to be identical or extremely similar. Moreover, the test subject's proclivity for repeating correct rather than incorrect responses suggests that information about the correctness/incorrectness of each response was known to the test subject but closed to conscious perception. Such results are evidence of nonconscious discrimination.

For example, if the subjects have the correct response ("longer" or "shorter") when segments that differed within the nondiscrimination zone were presented, then they repeated it with significantly greater frequency they changed it to an erroneous "shorter" or "longer" (f-test, $p < 0.01$). This occurred in 105 cases and 78 cases, respectively, although the theoretical probabilities of both decisions were roughly equal (since we can assume that in the nondiscrimination zone a person prefers to give the response of "equal," while he gives other responses with random probability).

The majority of responses in the nondiscrimination zone were also the response “equal” (56.5 percent), but if test subjects gave another response, then significantly more often it was a correct response (26 percent) than an incorrect one (17.5 percent) (f-test, $p \leq 0.001$).

Experiment 7: Choosing one of three/five segments that is equal to a reference segment

Method

Test subjects were presented visual stimuli (horizontal segments) for discrimination. First, as in Experiment 6, the test subject’s individual nondiscrimination zone was determined (with a modified method of average error). Then a reference segment was presented, along with three/five segments for comparison (in parts one/two, respectively). In part two the same reference and segments were presented, and two new segments were added for comparison. All of the segments to be compared differed from the reference segment within the nondiscrimination zone. The test subject’s task was to decide which of the segments presented for comparison was equal to the reference segment. Fifty-nine people took part in the experiment, and 3,540 trials were conducted.

Results

In processing the data of the seventh experiment, we did a somewhat different analysis, involving a change in the test subject’s task: the empirical and theoretical frequency distributions of a certain pair of responses were compared. Unlike the fifth experiment, it was possible here to accurately calculate the theoretical probability of a repeat response given the condition of nondiscrimination.

In the task of choosing among alternatives that subjectively seem equal, a person randomly chooses one of the options, which is confirmed by our data. For a choice among three options, the mean probability of a correct response is 30 percent; for a choice among five, it is 20 percent. Accordingly, if the segments are not distinguishable to the eye, then the repeat responses in part two must also be random.

Since the test subject had three possible responses in part one and five in part two, and only one response was correct, then the theoretical probability of an initial correct response was 1/3, while the theoretical probability of a repeated correct response (in part two) is 1/3 * 1/5 = 1/15. Accordingly, the theoretical probability of changing a correct response to an erroneous one

Table 2

Empirical and Theoretical Frequencies of Pairs Consisting of Two Responses to an Identical Presentation

Possible pairs consisting of two consecutive responses to an identical presentation	Empirical frequency of pair	Theoretical frequency of pair	Theoretical probability of pair
Two repeated correct responses in a row	103	102	1/15
First response correct, second wrong (among "old" options)	235	204	2/15
First response correct, second wrong (among "new" options)	212	204	2/15
First response wrong, second correct	180	204	2/15
First response wrong, second response wrong (among "old" options)	212	204	2/15
First response wrong, second response wrong (among "new" options)	368	408	4/15
Two repeated wrong responses in a row	220	204	2/15
Totals	1,530	1,530	1

Note: First response was given in part one of the experiment; the second response in part two.

among the "new" options (i.e., when one of the two new added segments was chosen as the correct one in part two) is 1/3 * 2/5 = 2/15. The theoretical probabilities for other combinations of responses were calculated in a similar manner (see Table 2).

Significant differences were obtained between the empirical frequencies of a certain pair of responses and the expected theoretical frequencies (chi-square test, $p < 0.05$), which suggests that the test subject's actions are not random. This is possible only if discrimination among the segments takes place.

Repeated incorrect responses were given more often than the theoretical (220 instances as opposed to 204, respectively). The empirical frequency of a sequence in which the first response was erroneous and the second one was a different erroneous one (among the "old" options) was higher than the theoretical (212 instances as opposed to 204). At the same time, the empirical frequency of a first erroneous response followed by a different erroneous response, but chosen from the "new" options, was lower than the theoretical (368 instances as opposed 408). Therefore, if the test subjects made mistakes, they preferred to choose among the "old" rather than the "new" options.

Experiment 8: Comparison of pairs of sonic signals

Method

Test subjects were presented pairs of sounds of identical frequency (1,000 Hz), but of different volumes. One of the signals in the pair (the reference signal) was always of constant volume (70 dB). The volume of the other signal varied within the following ranges: 0; 0.25; ±0.5; ±0.75; ±1; ±1.5; ±2; ±3; ±4; ±5 dB with respect to the volume of the reference signal. In all, there were twenty versions of the variable signal. Each version was presented ten times. Altogether there were 200 presentations during the experiment (not counting practice presentations). Each signal lasted 0.1 second. The interval between the two signals in a pair was 1 second. The test subject was given the task of determining which of the signals in the pair was louder (the first sonic signal was quieter than the second, louder, or equal to it). After each response, the test subject had to rate his confidence in the correctness of his response on a two-point scale (confident/not confident). Two seconds elapsed between the confidence rating and the beginning of the following pair of signals. The position of the reference signal in the pair (presented as the first or second sonic signal) and the difference in volume between the reference and the signal to be compared with it were changed in a random manner. Twenty people took part in the experiment, and 4,000 trials were conducted.

Results

The results showed that all of the participants in the study clearly perceived a difference in volume of 5 dB. In analyzing the percentage of correct and incorrect responses and the reaction time, we can identify a range of ±1.5 dB as the nondiscrimination zone for all test subjects. Beyond this range, virtually all the participants in the study showed a sharp increase in the percentage of correct responses and a decrease in reaction time. For some participants the changes occur at a difference of more than 1.5 dB. At the same time, within the range of ±1.5 dB, all the participants in the study were not consciously aware of the differences between the sounds.

We performed an analysis that was already done on the data in the sixth experiment (with a similar design). The empirical frequencies of certain pairs of responses were compared with one another (see Table 3).

Table 3

Empirical Frequencies of Pairs Consisting of Two Consecutive Responses to an Identical Presentation

Sequence	To correct	To incorrect	To response “equal”
From correct	264	74	272
From incorrect	57	31	85
From response “equal”	272	75	580

Note: Only for presentations in which segments differed within the nondiscrimination zone; instances in which equal segments were presented are not considered.

Significant differences in these frequencies were found. Within the nondiscrimination zone test subjects most often repeat the response “equal”—in 580 instances—but if they changed it, then they switched significantly more often to a correct response—in 272 instances—rather than to an incorrect one—85 instances (f-test, $p < 0.001$). Furthermore, as in the sixth experiment, the theoretical probabilities of both decisions were roughly equal, since we can assume that in the nondiscrimination zone a person prefers to give the response of “equal,” while he gives other responses with random probability.

But if the test subjects gave a correct response (“louder” or “quieter”), then they repeated it significantly more often—in 264 instances—than they changed it to an erroneous response—74 instances (f-test, $p < 0.001$).

Discussion of results

The results of the first five experiments (the stimulus detection task) show that the decisive factor in stimulus detection was not so much the operation of the sensory system and the physical characteristics of the signal as the conditions of presentation, specifically conditions that are objectively identical in their physical parameters. At the same time, the ambiguity of images affords an opportunity to decide how to perceive a stimulus that is included in an illusory situation. It was precisely the illusory change in the stimulus that made it possible to establish a difference in the detection thresholds of identical signals. This also applies to the study of differential thresholds in the case of Charpentier’s illusion: if accuracy in detecting weight differences between the spheres depended only on the operation of the sensory system and the physical characteristics of the stimulus, we could not have established a difference in the estimation of weights for the large and small spheres. This suggests that the accuracy of the responses was influenced specifically by the illusion rather than the actual intensity of the stimulus.

We believe that the issue in this case is the threshold of conscious perception rather than the threshold of detection.

An analysis of the next three experiments leads to the conclusion that the study participants successfully discriminated among visual and auditory stimuli even in the zone of subjective nondiscrimination. The significant differences in the empirical frequencies of certain pairs of responses and the difference between them and the expected theoretical frequencies signifies that a person somehow memorizes his decision when a stimulus pair is presented and gives the next response to the same presentation on the basis of the previous one (i.e., an aftereffect takes place). Such behavior is possible only under the following conditions: first, memorizing each presentation (its difference from other presentations); second, memorizing segments (e.g., the difference between the "new" options and the "old" ones in the second experiment); third, discriminating among the segments presented (since the position of the segments each time was changed in a random manner). Yet the test subjects sense all of the stimulus pairs that differ within the nondiscrimination zone to be absolutely identical. Therefore, the sensitivity thresholds measured in the psychophysical experiments characterize psychic rather than physiological limitations.

One possible explanation of the identified phenomena can be offered in terms of Allakhverdov's theory—psychologic (Allakhverdov, 1993, 2000).

According to this theory, all of the patterns in the operation of the psyche and consciousness are produced in the cognitive process. Psychologic adds idealization: no physiological limitations are imposed on the brain, but all of the limitations imposed on a person's conscious capabilities are predetermined by the logic of cognitive activity. It is assumed that the brain (in its ideal version), possessing unlimited capabilities, automatically analyzes all incoming signals from the environment. There are limits to the ability to detect and discriminate, depending on physiological and genetic mechanisms, but they play no role in the subjective decision making regarding detection or discrimination. Thus, all signals are received, but not all are consciously perceived. There is a mechanism of consciousness that makes decisions about which incoming signal will be consciously perceived and which will not. This decision is based on previously developed patterns and hypotheses generated by the mechanism of consciousness. A decision to consciously perceive a stimulus is fundamentally different from a decision that a signal exists against background noise. While the issue in psychophysical theories is the decision about whether a signal has come in or not, it is possible to decide to nonconsciously perceive a signal even when the signal has already been received and identified. Commenting on this, Allakhverdov writes:

> No matter what state a person is in, he cannot perceive something that exceeds his physiological capabilities of perception! Why then is a person not aware if he perceives? Could it really be because of noise? But then the noise must not be where it is expected to be: it is not the physiological processes of the sensory system but consciousness that "makes noise." (Allakhverdov, 2000, p. 417)

In consciousness, says Allakhverdov, any stimulus is perceived only as a representative of a certain class of stimuli. Therefore the conscious detection of a signal is possible only after a specific decision is made to assign this signal to some class of stimuli. All of the stimuli within a given class are equated to one another, and therefore signals are not differentiated within a class. The criterion for assignment to a certain class is established by the person himself, based on the task. However, in order to assign stimuli to a certain class, one must know how to differentiate among the stimuli themselves. Only when two different stimuli are differentiated between each other can they be volitionally equated to one another and assigned to one class. Otherwise there will be no volitional act. In order to independently set the boundaries of the zone of signal indiscriminability, one must be able to discriminate among stimuli within this domain. But as soon as a criterion for assignment to a class is established, the observer automatically ceases to see (i.e., consciously perceive) existing differences.

Allakhverdov clarifies his idea by proposing an interferential model for comparing the signal and the reference. For the mechanism of comparison, a complete match between the stimulus and the reference is identical to a situation in which there is no stimulus. At this moment the consciousness cannot verify the information that the stimulus and the reference match; the very fact of the match cannot be consciously perceived. A small change in the reference, however, generates an interferential picture, which enables consciousness to determine that the signal is hardly different from this altered reference but not identical to it. A kind of parallel to the uncertainty principle arises: the penalty for accuracy is that it is impossible for the mechanism of consciousness to verify the accuracy of the reflection and, as a result, the evaluation of this accuracy is subjectively uncertain. Conversely, the subject receives information that the reflection is more or less accurate only when the signal and the reference are differentiated (Allakhverdov, 1993, pp. 195–212).

Our studies, based on Allakhverdov's approach, showed that even in simple psychophysical tasks subthreshold perception takes place, and there may be different values of thresholds for identical stimuli simultaneously. These results allow the very concept of threshold to be viewed differently. Of course, there is a threshold for the sensory system to receive a signal, whose value is related to the body's physiological capabilities, but they do not play any role in psychophysical experiments. A deaf person, for example, does not hear sounds, but he is also unable to judge that he does not hear them, since he does not know what sounds are. Whatever cannot be discriminated by the sensory system clearly has no subjective meaning for a person. How can a person train his sensory sensitivity if he has no sensory capabilities for improving discrimination among signals? The value of a threshold depends on the hypotheses adopted by the mechanism of consciousness and the subsequent assignment of a signal to a class of consciously or nonconsciously perceived stimuli. Thus, under appropriate conditions any signal can exceed the threshold and become consciously perceived or, conversely, recede into the zone of conscious nondiscrimination. The threshold of conscious perception of a signal plays a highly important role in regulating the processes of signal detection and discrimination.

References

Allakhverdov, V.M. 1993. *Opyt teoreticheskoi psikhologii (v zhanre nauchnoi revoliutsii).* St. Petersburg.

———. 2000. *Soznanie kak paradoks (Eksperimental′naia psikhologika. T. 1*). St. Petersburg.

Bardin, K.V., and Iu.A. Indlin. 1993. *Nachala sub″ektnoi psikhofiziki.* Moscow.

Blackwell, H.R. 1952. "Studies of Psychophysical Methods for Measuring Visual Thresholds." *Journal of the Optical Society of America,* vol. 42, no. 9, pp. 606–16.

Dixon, F. 1971. *Subliminal Perception: The Nature and Controversy*. New York: McGraw-Hill.

Filippova, M.G. 2006. "Rol′ neosoznavaemykh znachenii v protsesse vospriaitiia mnogoznachnykh izobrazhenii." Avtoref. kand. diss. St. Petersburg.

Gaida, V.K. 1972. "Zritel′noe prostranstvennoe razlichenie i problema kodirovaniia vizual′noi informatsii pred"iavliaemoi cheloveku." Avtoref. kand. diss. Leningrad.

Kihlstrom, J.F.; T.M. Barnhardt; and D.J. Tataryn. 1992. "Implicit Perception." In *Perception Without Awareness,* ed. R.F. Bornstein and T.S. Pittman, pp. 17–54. New York: Guilford Press.

Kunst-Wilson, W.R., and R.B. Zajonc. 1980. "Affective Discrimination of Stimuli That Cannot Be Recognized." *Science,* vol. 207, no. 4430, pp. 557–58.

Kunzendorf, R.G., and R. McGlinchey-Berroth. 1998. "The Return of 'the Subliminal.'" In *Imagination, Cognition, and Personality,* vol. 17, pp. 31–43.

Link, S.W. 1992. *The Wave Theory of Difference and Similarity*. Hillsdale, NJ: Erlbaum.

Mandler, G.; Y. Nakamura; and B.J. Van Zandt. 1987. "Nonspecific Effects of Exposure on Stimuli That Cannot Be Recognized." *Journal of Experimental Psychology: Learning, Memory, and Cognition,* vol. 13, no. 4, pp. 646–48.

Marcel, A.J. 1983. "Conscious and Unconscious Perception: An Approach to the Relations Between Phenomenal Experience and Perceptual Processes." *Cognitive Psychology,* vol. 15, no. 2, pp. 238–300.

McCleary, R., and R. Lazarus. 1949. "Automatic Discrimination Without Awareness." *Journal of Personality,* vol. 18, pp. 171–79.

Merikle, P.M.; D. Smilek; and J.D. Eastwood. 2001. "Perception Without Awareness: Perspectives From Cognitive Psychology." *Cognition,* vol. 79, pp. 115–34.

Overgaard, M.M.; J. Rote; K. Mouridsen; and T. Zoëga Ramsøy. 2006. "Is Conscious Perception Gradual or Dichotomous? A Comparison of Report Methodologies During a Visual Task." *Consciousness and Cognition,* vol. 15, no. 4, pp. 700–708.

Pakhomov, A.P. 1985. "Mikrodinamika effektivnosti vypolneniia zadach obnaruzheniia." In *Psikhicheskie kharakteristiki deiatel′nosti cheloveka-operatora,* pp. 66–71. Saratov.

Pessiglione, M.; L. Schmidt; B. Draganski; et al. 2007. "How the Brain Translates Money into Force: A Neuroimaging Study of Subliminal Motivation." *Science,* vol. 316. pp. 904–6.

Swets, J.A. 1961. "Is There a Sensory Threshold?" *Science,* New Series, vol. 134, no. 3473 (July 21), pp. 168–77.

Tanner, W., and J. Swets. 1954. "A Decision-Making Theory of Visual Detection." *Psychological Review,* vol. 61, pp. 401–9.