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Probability Assessment of the Value of Psychophysiological Stimuli

During a psychophysiological test, the relative extent of psychophysiological reactions is recorded by means of a polygraph. Using testing methodology, a polygraphologist assesses these values and makes a decision: is the test subject associated with the crime; and if so, in what way? Every polygraphologist assesses which stimulus was able to produce psychophysiological reactions.

Up until now, psychologists and psychophysiologists have intuitively considered the value of a stimulus to be its meaningfulness to an individual, its ability to

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attract his attention, its relevance to him, etc. Y. Kholodny (2006) believes that the value of a stimulus is the relationship of an information stimulus and a study subject in the specific situation of the content of the question to be decided. Particularly at present in applied psychophysiology (polygraph testing), this kind of interpretation of the value of a stimulus may be debatable.

Up until now, sometimes attempts have been made to assess the value of stimuli according to the extent of the psychophysiological reaction. Since the psychophysiological reaction being measured is by nature a complex phenomenon, not noted for its specificity or stability, any attempt to perform such a measurement becomes unreliable. This is first of all demonstrated by the fact that a stimulus of certain significance will every so often periodically cause the study subject to experience psychophysiological reactions of varying size and type. The extent of a psychophysiological reaction depends on many external and internal factors, which it is not possible to fully assess in the context of a specific psychophysiological test (V. Varlamov, G. Varlamov, 2000).

It is complicated to interpret the cause of psychophysiological reactions because of their nature and because of the consistency of psychophysiological reactions. Whereas in classic psychophysiological testing simple stimuli are usually used, in polygraph testing the stimulus is not a question in the usual sense (a word, a photo, an object, a diagram, a chart, a map, etc.) (Nakayama, 2002; Saldziunas, 2008), but rather the whole complex context resulting from the questions, answers and the general testing situation, which is conditioned by a broad range of external and internal factors that are linked one way or another with polygraph testing and influence the subject being tested.

Let us say that in a simple situation a study subject is affected by sound stimulus (S), for example, a question requiring a simple yes/no answer. Within a very short time the person experiences a psychophysiological reaction (R), which is recorded in some form by the polygraph. It is obvious that the psychophysiological reaction recorded (R) will be the function of several dimensions:

$$R = f(S, E, P, M) \tag{1}$$

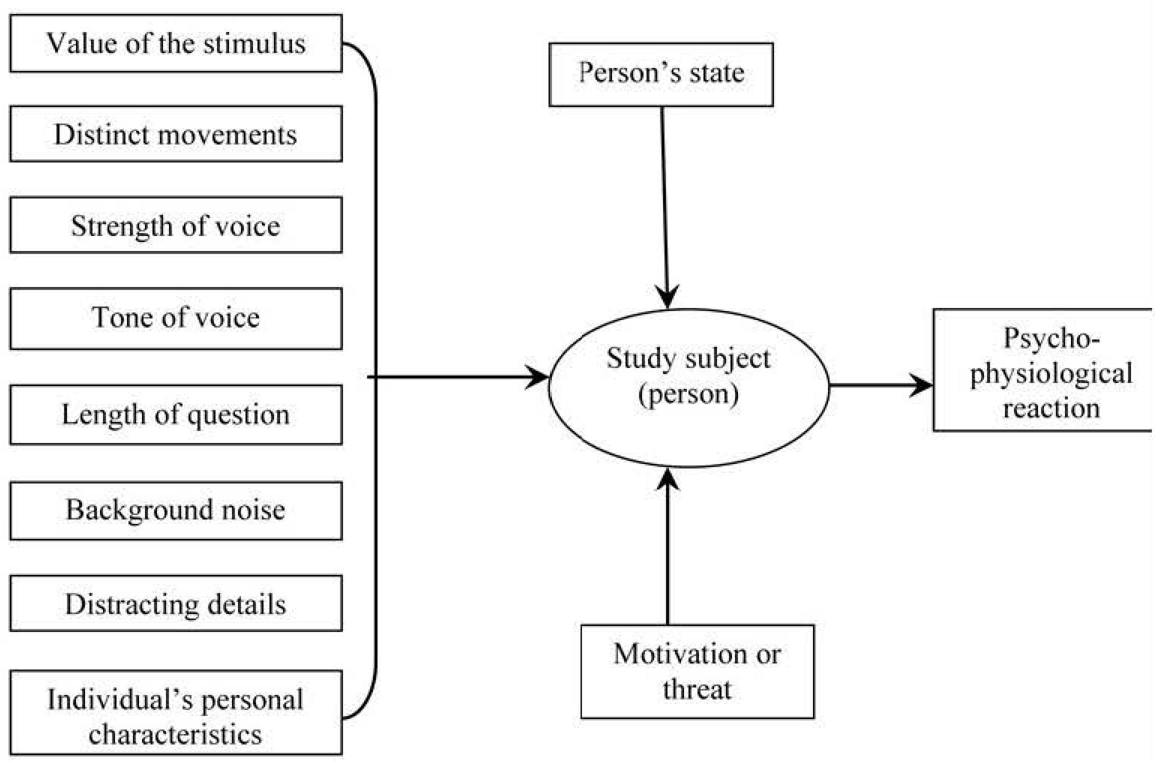
Where S = the nature of the stimulus,
E = environmental factors,
P = the individual's personal characteristics,
M = movements of the study subject.

Each one of these dimensions depends on other factors. For example, the nature of the stimulus (S) depends on the loudness (L) of the specialist administering the question, his tone of voice (W) and its duration (T). In addition, the nature of the stimulus (S) includes the subjective interest (I) that each person perceives in the stimulus. The subjective interest (I) of the stimulus depends in turn on the content of the question and the study subject's subjective view of it, including whether or not the study subject has answered this question before the testing takes place. Environmental factors (E) depend on background noise (N), details that distract attention (D) and so forth. It is very difficult to evaluate what an individual's personal characteristics depend on. It should be noted that P depends on the time, i.e. P(t). With regard to the factors identified above, the psychophysiological reaction may be expressed thus:

$$R = f(I,M,L,W,T,N,D,P(t)...) \quad (2)$$

This can be seen in the diagram in Figure 1.

Figure 1. Diagram of psychophysiological reactions measured by a polygraph.



The principal task of psychophysiological testing is to determine, during the measuring of reactions, to what extent the interest (I) of the stimulus to the patient influences the psychophysiological reaction (R). All polygraphologists know that it is not possible to totally exclude the effect of all other factors on the psychophysiological reaction. When organising polygraph testing it is possible to achieve minimal influence from the loudness of voice, tone of voice, length of question, background noise and distracting details. In a real work situation it is never possible to guarantee that any of the factors named above will not accidentally have an influence. It follows that, in repeated testing where the study subject is exposed to the same stimulus, we will not get a psychophysiological reaction (R) of the same size. It needs to be noted that all these accidental effects are of an arbitrary nature, and the psychophysiological reactions they cause are not systematic. Therefore, during the polygraph testing the polygraphologist has to decide: is the psychophysiological reaction recorded of an accidental nature or was it caused by the primary stimulus (I)? In classical methodology (Matte, 1997) it is recommended that the genuine psychophysiological reactions and the non-genuine ones (artefacts) be assessed by their extent time-wise in the polygram and by other non-systematic features.

Without doubt, doing this is a complex task that can only be achieved by an experienced polygraphologist. Using a polygraph of increased sensitivity will not help to resolve this issue. Two principles are offered for the solution of this problem:

- measurement of the psychophysiological reactions using ranking
- in order to determine convincingly whether the psychophysiological reactions are caused by the stimulus, the stimulus needs to be applied to the subject repeatedly.

A ranked evaluation simplifies the evaluation of the reactions before the next statistical or other processing of the data. This type of evaluation of physiological reactions is economic, reliable, responsive and sufficiently stable against arbitrary fluctuations. It is quite straightforward when used in real work situations.

On the basis of that which is explained above, measurement of the psychophysiological reaction (R) alone does not suffice as an assessment of the value of a stimulus. Keeping in mind that the nature of the incidental factors is arbitrary, the following principle may be formulated: the value of a psychophysiological stimulus is proportional to the non-arbitrariness of the recorded psychophysiological reaction. That is to say, a stimulus is meaningful to a subject if the reaction caused by it is not accidental. This principle allows a quantitative evaluation to be made on the basis of probable values. It is on the basis of this principle that the ChanceCalc® algorithm used in the Diana-01 polygraph was created.

Characteristics of the ChanceCalc® Algorithm:

- may be applied when working with practically all the tests known to be used today
- its high sensitivity minimises the possibility of the Othello or Brokau trap (Ekman, 1992) occurring
- enables the possibility of measuring psychophysiological reactions in an automated way and performing an expert evaluation
- enables the possibility of presenting the polygraph test results quantitatively with the likelihood of statistical error identified
- enables a maximally convincing result to be obtained. This will be explained further.

Figure 2. Conclusion Formulation Algorithm

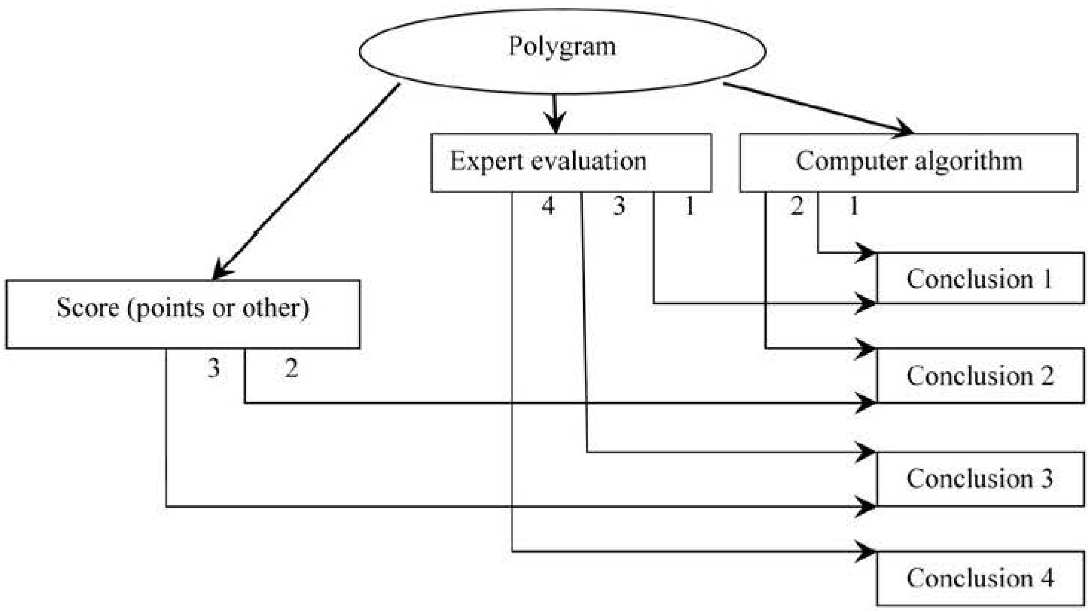


Figure 2 illustrates the algorithm for how conclusions are reached on the basis of a given polygram. This algorithm does not account for computer acoustic response signal analysis, including latent time scientific content analysis (SCAN) (Sapir, 1987), assessment of the study subject's non-verbal behaviour, etc. (Soshnikov, 2008). First of all the polygraphologist evaluates the curves of the measured psychophysiological reactions expertly or using a global approach (Kircher and Raskin, 2002) and a computer program. If the results of both evaluations coincide, the polygraphologist may write up his conclusion (Conclusion 1). If the results do not coincide, a numerical evaluation is performed. When the computer and numerical evaluations coincide, a conclusion is formulated (Conclusion 2). When the expert evaluation and the numerical evaluation coincide, Conclusion 3 is formulated. Conclusion 4 is used when no objective and convincing result could be obtained. This means that this is not a suitable case for polygraph testing, or a mistake has been made in the course of the analysis. Some possible errors are:

- not entirely accurate primary information about the event
- the questions and answers for the polygraph test were not formulated correctly
- the conditions were not appropriate for a polygraph test (various distractions)
- the study subject did not feel well or was not motivated, etc.

If Conclusion 4 is arrived at, the psychophysiological testing is either abandoned as unsuccessful or the methodological errors are fixed and the test is repeated after new questions are formulated.

From what has been stated above, we can conclude that a more reliable conclusion is obtained when the expert evaluation and the computer evaluation of the psychophysiological reaction curves are based on different principles; for example: the expert evaluation is based on the ranking principle and the computer evaluation on the probability principle.

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