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## Information Throughput Characteristics – a New Method for Evaluation of Visual Efficiency

Charakteristiken des Informationsdurchsatzes –  
eine neue Methode der Einschätzung des Sehwirkungsgrades

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A method based on information theory for computer-aided assessment of visual capacity has been elaborated. In this method, the rate of recognition of visual targets is considered along with the accuracy of perception. Measurements are performed in a wide range of optical stimulus intensities (the Landolt ring size ranging from 0.125 to 1.57, in 10 logarithmic steps). For each step the information throughput (IT) is calculated and the results are displayed as a function of stimulus intensity. Thus, the IT characteristics of the visual system, with regard to motor response, are obtained. Within the reported range, they reveal low-pass properties of the system. Preliminary experiments show that these curves are useful in the evaluation of visual performance, especially in ergophthalmology. A recently developed IBM PC-based system for automatic measurements of the IT characteristics is described. Some aspects of application of the method are also discussed.

*Schlüsselwörter:* Sehwirkungsgrad, Informationsdurchsatz, Sehschärfe, Reaktionszeit, Ergophthalmologie

Eine auf der Informationstheorie basierende Methode zur rechnergestützten Einschätzung der Sehleistung wurde ausgearbeitet. In dieser Methode wird sowohl die Erkennungsgeschwindigkeit von Sehtestzeichen als auch die Genauigkeit der Perzeption berücksichtigt. Die Messungen werden in einem breiten Stärkebereich des optischen Reizes durchgeführt (in den Abmessungen des Landolt-Rings von 0,125 bis 1,57 in 10 logarithmischen Stufen). Für jede Stufe wird der Informationsdurchsatz (ID) berechnet, und die Ergebnisse werden als eine Funktion der Reizstärke angezeigt. Auf diese Weise werden die ID-Charakteristiken des Sehsystems mit Berücksichtigung der motorischen Reaktion gewonnen. Im besprochenen Bereich weisen sie auf ein Tiefpaßverhalten des Systems hin. Die ersten Experimente zeigen, daß diese Kurven bei der Einschätzung der Sehleistung, besonders in der Ergophthalmologie, nützlich sind. Ein neues, auf einem IBM-PC implementiertes System zur automatischen Messung von ID-Charakteristiken wird beschrieben. Einige Anwendungsaspekte dieser Methode werden ebenfalls diskutiert.

### 1 Introduction

In the evaluation of visual performance of individuals, especially in ergophthalmology, subjective tests are used in which visual tasks are as close as possible to those occurring in real occupational or home environment. For many visual activities the rate of recognition of objects is of the same importance as the accuracy of this process. The first aspect is mainly the goal of psychological investigations (measurements of reaction times), while the latter is of interest for ophthalmologists (research in the field of visual thresholds).

Both approaches can be combined thanks to information theory, offering some quantitative criteria referring to the rate and correctness of information transmission processes. Investigations of »visual capacity« (»effective visual acuity«), introduced by Weston, and the later works of other authors [1], were based on

the analogy with communication channel. Shannon's theory has been used for the assessment of visual functions in some tests in which information throughput, or information flow rate, was determined. However, the instrumental basis of those tests was rather primitive and only one optical stimulus intensity was used (mainly – suprathreshold, eventually near the threshold).

Present-day technical means enable overcoming the hitherto existing limits and development of new methods. For example, numerous computerized methods and apparatus for subjective examinations of the most important functions of the visual system are known [2 - 5].

In his work on implementation of cybernetic methods in the field of automated visual acuity testing [5], the author has proposed an idea of the quantitative description of visual performance by means of »informa-