

## Contemporary methods of psychological measurement - Stereopsia

### Introduction

Knowledge within medicine and work psychology properly used influences noticeably the development of many economic enterprises and contributes to economic success.

Professional effectiveness depends on three groups of factors:

- professional preparation of the employee (professional competence);
- psychomotorical and intellectual skills of the employee (psychophysical competence)
- the equipment and organization of the workplace

These three elements form a complicated system of reciprocal interactions:

**knowledge** (general and specific information plus professional experience) – **capabilities** (psychophysical skills, physical and intellectual condition, emotional state etc) – **surroundings** (technical equipment of workplace, physical and psychological conditions)

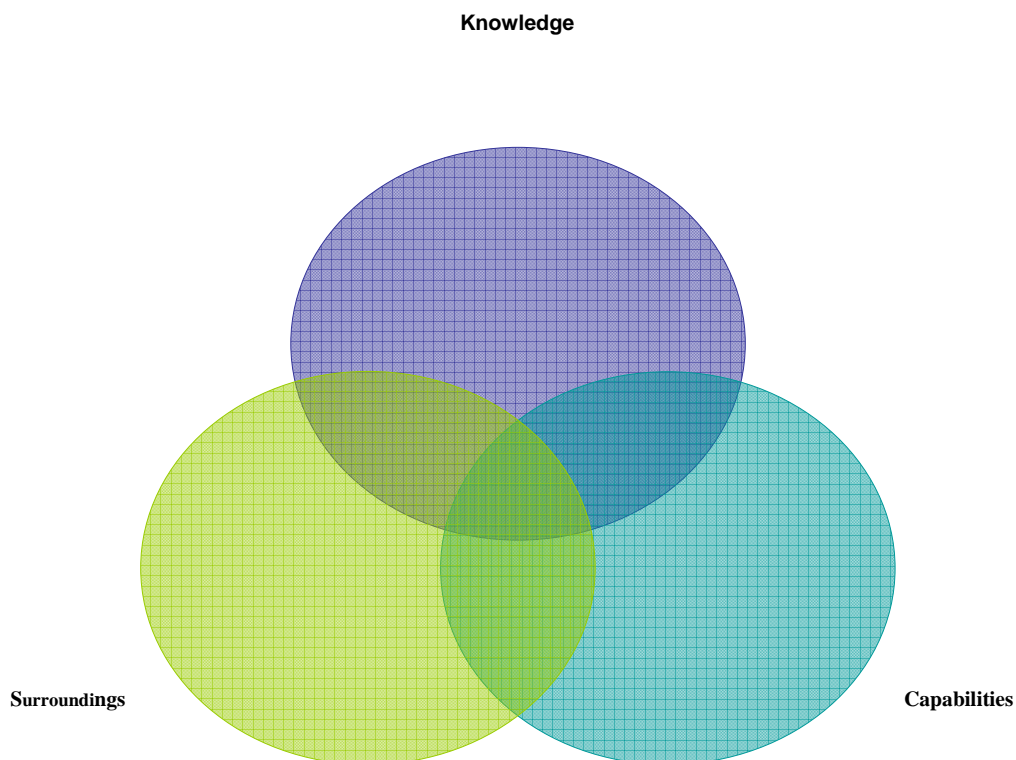


Illustration 1 Conditions of the effects of professional activity.

The presented *triad* shows that prophylactic check-up of people employed on positions that require special psychomotorical skills should have complex and interdisciplinary character, which means that besides the knowledge of medicine and work psychology it is essential to take into account the rules of ergonomics and work safety as well as social psychology which describes interpersonal relations. Only then the selection of people for specific workplaces will not have accidental and sometimes even destructive character. A significant element in this process of selecting proper staff is the diagnosis of psychophysical features that are essential from the point of view of the particular workplace requirements.

Psychological diagnostics used in the Work Psychology Labs is based on methods used in clinical psychology, that is: proper interview, observation and personality questionnaires. On the other hand tools for measuring psychomotorical and perceptive skills can also be used here, These are devices of different kind that enable for example measuring reaction time, measuring the efficiency of sight and mobility coordination or assessing the threshold of sight sensitivity. Their construction is varied from the technological point of view. Part of them are devices based on purely mechanical solutions, others on microprocessor technology. According to my contacts and observations it appears that most equipment in the Work Psychology Labs is outdated, based on solutions that were developed in the 1950s.

Imprecise measuring tools make accurate and reliable diagnosis impossible, which leads to inaccurate decisions about employment (i.e. weak efficiency, numerous mistakes etc) and it may even lead to accidents or disasters which result in the suffering of many people or even death.

This article is the introduction to a series of presentations of contemporary methods of measuring psychomotorical functions that are used in psychological diagnostics, methods which apply the latest achievements of measurement techniques and information study.

## **The mechanism of stereopsia**

Stereopsia is a basic mechanism of depth perception (Grabowska A., Budohoska W., 1995) This mechanism is connected with double eyesight thanks to overlapping the same picture from two different perspectives (ill. 2) <sup>1</sup>.

Spatial vision or stereopsia depends on a few determinants:

- simultaneous movements of both eyeballs;
- coordination of the alignment of both eyes;
- the width of eye configuration;
- the placement of eyes in orbits.

It has to be remembered that stereopsia is a very precise mechanism, but functioning to the depth of a few to a dozen or so metres, until the moment when the axes of sight of both eyes take a practically parallel position (Młodkowski J., 1988).

Depth perception is still possible because the brain learns to suitably interpret stimuli that flow in via the nervous system, basing itself on different kinds of signals. Due to the multiple analysis of sight stimuli a 'map of relations' (or space relations) is created. Such information as the size of objects, their reciprocal proportions, colour saturation as well as reflections and shadows compensate for the lack of full sight from the other eye and help to establish the third dimension.

Difficulty in depth perception or the total elimination of spatial vision can be observed in people with sight disability which has its origin at birth or in early childhood.

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<sup>1</sup> A detailed description of the mechanism of stereopsia can be found in the work by Jan Młodkowski (1998)

Investigating the efficiency of the mechanism of stereopsia seems to have special importance for these aspects of human activity where it is required to differentiate a precise distance between two or more elements situated no further than a dozen or so metres, that is operating mobile vehicles (especially when in the situation of maneuvering within limited area), using precise tools (lathes, millers, manipulators), some sports disciplines etc.

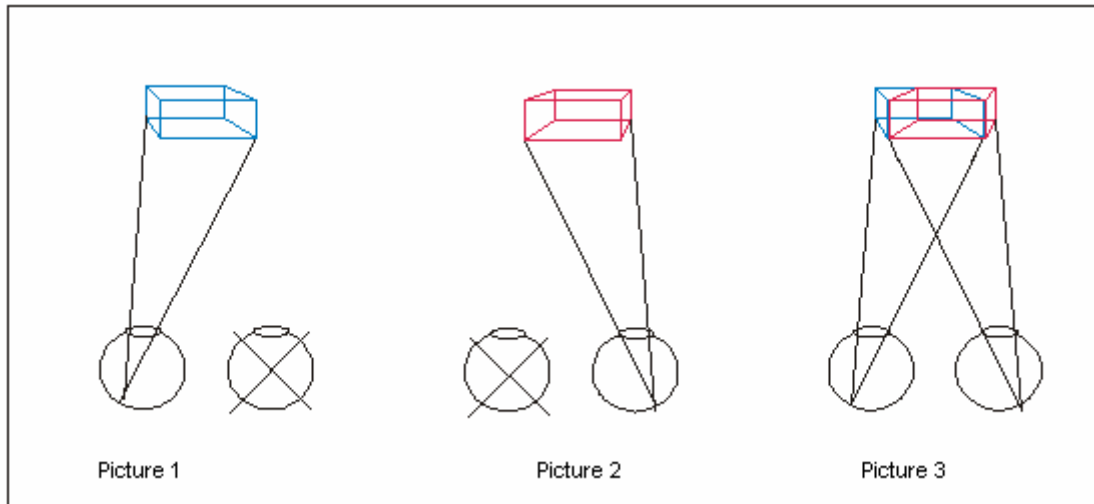


Illustration 2

*The illustration of images documented in the process of perception.*

Picture 1 is an object seen with the left eye while picture 2 with the right eye. Picture 3 shows the object seen with both eyes. To know the presented phenomenon we can do a simple experiment. Put a ruler with a scale vertically to the end of your nose and then place on it a box of matches 10 cm from your face. Closing the left and right eye alternately you can see images shown in illustration 2.

## Review of used measurement tools

Tools for measuring stereopsia used both in Poland and worldwide are divided into two basic groups /ill.3/. The first includes different kinds of graphic charts with a double image which becomes visible with the help of two-colour glasses. The most popular in this group is the Fly Test /Ill.4/ and the Butterfly Test. The Frisby Test is a bit different- its use does not require glasses.

The second group includes mechanical tests with an optical unit or elements placed in real space. The most frequently used in this group are Howard-Dolman and Dufouer mechanical stereometers . In psychological diagnostics the so-called short stereometer /ill.5/ was most often used – one of the first of this kind of tools was the stereometer manufactured in Heinrich Diel factory in Leipzig /cat. nr 1924-1/

Devices for measuring spatial vision operated with the help of a computer appeared in the 1990s, mainly in Psychology Labs.

## Stereopsia measurement

### Graphic charts

### Mechanical stereometres

#### Observation with glasses –Real observation

the Fly Test

the Butterfly Test

other

the Frisby Test

the Lang Test

other

#### Real observation

the Howard-Dolman stereometer

the Dufouer stereometer

the vertical stereometer

other

### Illustration.3

*The classification of tests used in stereopsia measurement*

.....Nowadays devices operated with the use of a microprocessor are used for stereopsia measurement and the results are sent to a computer. It enables their statistical processing and keeping records.

A concise description of chosen methods of stereopsia measurement is given below.



### Illustration 4

The Fly test is a classic set of tests of sifting character, used in checking spatial vision both in Poland and worldwide.

It consists of a few expositions:

- the Fly test
- the Wirth circles test
- the animal test

In the set there are two-colour polarized glasses. Examination with the use of the test allows the assessment of both general and detailed stereopsia. It is used as a standard in ophthalmologist surgeries and by expert doctors in employment medicine checkups.

The 'short' stereometer, popular in the 1960s and 1970s, whose range of measurement is within 30 cm, possessing two side bars moved by hand, has had a lot of variations.

Due to the fact that its value is rather rough, gradually it has been replaced by stereometers with wide measurement range,

It has been preferably used by employment psychologists up to nowadays, mainly for sifting examination.

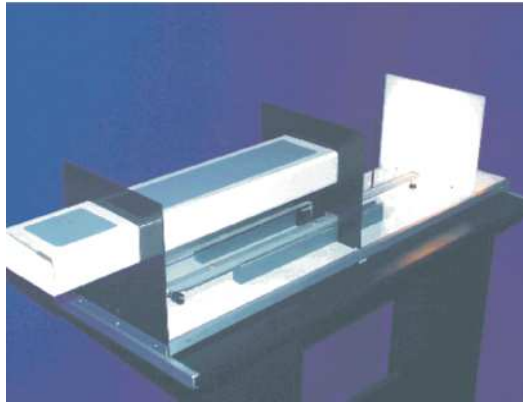


Illustration 4 A short stereometer, based on the Heinrich Diel device.

It is visible from the above shown descriptions how devices presently used for stereopsia measurement differ significantly from one another. Also results achieved by the examined in different labs have different value. To the mentioned differences should be added the fact that interpretation relies on the subjectivity of the person that conducts the examination. Adding to that the lack of irrefutable proof that there is a direct relation between the level of of spatial vision efficiency and efficient performance of certain professional activities there arises a question whether this kind of examination is justified.

At the same time it is known that on many workplaces there is a big range of compensation mechanisms, which compensate for the lacks in spatial vision, even such as one-eye sight, in a sufficient way.

It is thus necessary to prepare examination procedures that will allow the assessment of correlation between particular tests and at the same time define the relationship between a task situation and the effective assessment of space and depth.

### **Tools developed by GPE Psychotronics**

During the diagnostics activity that has been conducted since the mid 1990s two devices for spatial vision examination have been developed. The first of them is an electronic stereometer which in its measurement part is based on parameters given in 'The methodology of the examination of drivers' /Pawlikowska H. Published 1979/. In its essence it is based on the Dolman's construction /1966/.

The second one is its modified version, in which for the arrangement of measuring bars the rule of asymetria has been applied.

### Structure of the device

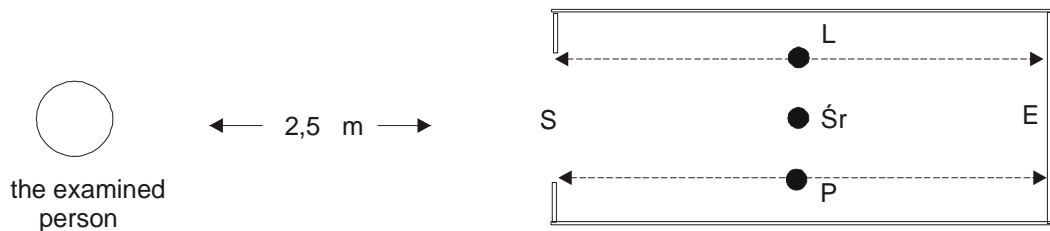
The stereometer consists of a controlling part, display part and a set of buttons for the examined person. The controlling part is a panel consisting of an electronic unit and a microprocessor with an installed program containing examination procedures. It is also equipped with a keyboard that controls the diagnostics process and a liquid crystal screen on which settings and examination results can be displayed.

The examination program allows the automatic measurement of spatial vision in the space that measures 800 x 360 x 180 mm. Its front part is shielded with a front panel with an optical aperture that measures 200 x 30 mm. The back part ends with a screen illuminated in white that measures 360 x 180 mm. The intensity of light at the aperture is 30 Lux. The measurement takes place with the help of three black vertically placed bars with the diameter of 10 mm and the height of 180 mm, which retract or approach the

eyes of the examined person. The distance between the middle parts of the bars in the symmetrical stereometer is 90 mm and in assymetrical one 90 and 40 mm.

### Conditions of conducting the examination

The examination is conducted in a room where daylight is limited. The interior is of 'peaceful' preferably flat colour. The room dimensions are adjusted to the methodological requirements – the distance between the aperture of the display device and the eyes of the examined person should be about 2,5 m – control examination did not show any significant differences in stereopsia measurement both when the examined person was 3 as well as 2 metres from the aperture of the display device.

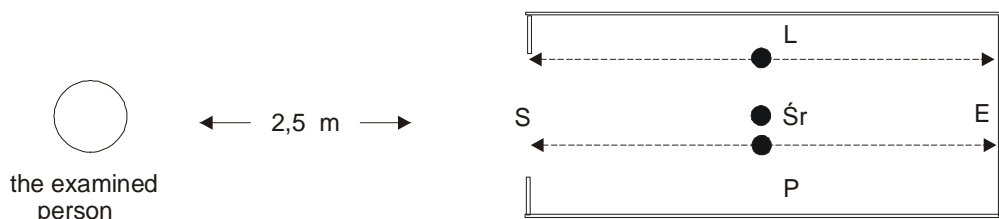


### Illustration 6

*The illustration of stereoscopic measurement in a symmetrical stereometer – view from above*

S – optical aperture  
 Measurement bars L – left P – right Śr - middle  
 Śr. – middle measurement bar  
 E – illuminated screen

With the help of the presented device a lot of research on specifying other factors that influence spatial vision efficiency has been conducted. Some of them /the distance between the examined person and the optical aperture, the intensity of light in the screen, the contents of the given instructions/ were possible to verify. However, during measurement the examined people often try to arrange the peripheral bars so that the space between them and the middle bar is symmetrical.  $L \rightarrow \dot{S}r = P \rightarrow \dot{S}r$ . Measurement completed according to this suggestion is not identical with measurement completed according to the spatial vision efficiency. That is why a construction modification has been made applying assymetry in the arrangement of bars in relation to one another.



### Illustration 7

*The illustration of stereoscopic measurement in an assymetrical stereometer – view from above*

## How to use the device

After switching the device on its name <Stereometr> appears on the screen and then the notice <Setting position>. At this time the position of the peripheral bars aligns the position of the middle bar.

After the calibration finishes the device is ready for work.

## Examination

Examination begins with the presentation of the rules necessary for the functioning of the device. The examined person is asked to try to push the operating buttons that move bars a few times – it helps to recognize the ‘space’ of the measurement area and its range.

After the initial proceedings the examined person is asked to arrange the peripheral bars in the same position as the middle bar.

The button **Auto** allows conducting measurement in the position <closer> and the position <further> in one sequence, while the button **Ręczny (Hand Operated)** allows examination in one of chosen positions.

The position **<bliżej> (<closer>)** on the operating panel with the button **Start** the peripheral bars can be arranged in the position “closer”.

- with the help of hand manipulators the examined person can move the peripheral bars towards the middle bar – so that they align one another – then confirms measurement using the button STOP
- the button **Start** confirms a partial examination

The position **<dalej> (<further>)** on the operating panel the button **Start** arranges the position of the peripheral bars in the position “further”.

- with the help of hand manipulators the examined person moves the peripheral buttons towards the middle button so that they align and confirms measurement with the button STOP
- the button **Start** confirms a partial examination

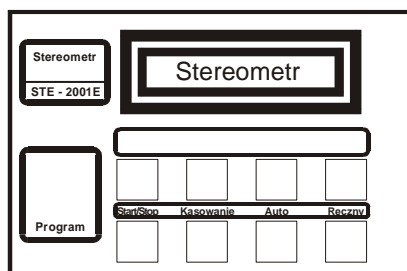


Illustration 8

Operating panel .....Set of buttons for the examined person

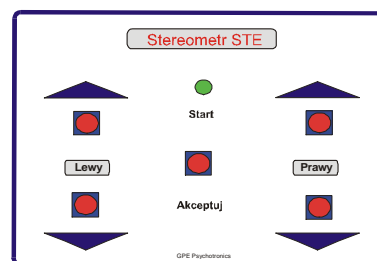


Illustration 9

## The results of an examination

The result of an examination is:

- the distance between each of the peripheral bars from the middle button – given in millimetres
- the sum of distances from conducted measurements
- the arithmetic mean of the sum of measurement distances

It is difficult to include all aspects of the described phenomenon in a short article. In the case of stereopsia it has to be remembered that depth, size and distance perception depends on the perceived dimensions and not the real ones. Thus it seems worth looking for relations between the efficiency of spatial vision and efficient functioning in it.

## **Summary**

Stereopsia is the basic mechanism of depth perception and it is connected with binocular vision thanks to overlapping the same image from two different perspectives. Tools used in stereopsia measurement can be divided into two basic groups. The first of them consists of different kinds of graphical charts with a double image, which becomes visible with the use of two-colour glasses. The second group consists of mechanical tests with an optical unit or elements placed in real space.

The research on stereopsia conducted by GPE Psychotronics has led to the elaboration of two devices that examine spatial vision. The first of them is an electronic stereometer, which in its measuring part is based on parameters given in the 'Methodology of examining drivers'. Its nature is based on the Dolman construction. The second one is its modified version, where the rule of asymmetria has been applied for the arrangement of measuring bars. The aim of the research done by the author is an attempt to verify the accuracy and efficiency as well as practical usability of diagnostics methods in use.

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