ORIGINAL PAPER

Nagoya J. Med. Sci. **66**. 31 ~ 38, 2003

# INFLUENCE OF CHOKING IN JUDO ON VISION IN WELL-TRAINED JUDOKA: AN EXPLORATIVE FIELD STUDY

C. RASCHKA[1], R. RAU[2] and H.J. KOCH[3]

[1]*Institute of Sports Sciences, Johann Wolfgang Goethe University Frankfurt/Main, Germany*
[2]*Public Health Department for the District Wesel, City of Moers, Germany*
[3]*Department of Neurology, General Hospital of the University of Regensburg*

## ABSTRACT

The present study was designed to investigate the effects of a cross-choking-technique commonly used in Judo on visual acuity. In 156 Judokas, experienced in competition, visual acuity was examined before and after choking (Juji-Jime). The average age of the 46 female and 110 male subjects was 22.8 years (standard deviation 10.5 years).

In all examined grades of distance (infinite, 0.55 m and 0.4 m), eye tests showed an improvement of visual acuity after choking on a highly significant scale. In quantitative terms, vision the far sight range was optimized more clearly than in the close ranges. The following mechanisms are discussed as possible causes of the present results: an increase of blinking frequency induced by stress, an optimized tear film covering the cornea, a stenopaeic gap induced by improved blinking, pupillomotor alterations and an improved cerebral processing of visual signals and information.

From an evolutionary-biologic perspective, the benefit of this psychophysiological mechanism might consist in an improvement of visual acuity in moments of danger, approaching from a distance and, thus, better chances of survival.

Key Words: Judo, Choking, Visual Acuity, Eye-test

## INTRODUCTION

A two-stage theory of visual detection has been postulated in psychophysiology (Ullmann and Koch, 1987). In the pre-attentative mode simple features are processed rapidly over the entire visual cortex. The attentative mode, on the contrary, is specialised to particular locations in the visual field, i.e. a focus of attention. This selective attention has gained increasing importance in the recent years as it plays an important role even in the early stages of visual information processing. Attention is related to the physiological state of activation or alertness (vigilance) and therefore subject of external factors such as stimulus, stress, pain or medication (Lindsley, 1987). The practical aspects of selective attention is part of everybody's experience provoked e.g. by intensive stimuli or stress.

Judoka reported about similar experiences after having been choked during competition. After a moment of fainting many judokas described that a state of high alertness evolved with keen-

Corresponding Author: Dr. med. Dr. rer.nat. Dr./Univ. Zürich Horst J. Koch
Neurologische Universitätsklinik im Bezirksklinikum
Universitätsstrasse 84, 93053 Regensburg, Germany
Phone: 0941-941-0 Fax: 0941-941-3205 Email: horst.koch@bkr-regensburg.de

ness of sight and hearing and even a feeling of serenity. On the contrary, observations from previous studies indicate that choking rather leads to a temporary cerebral hypoxia [Lindsley, 1978] accompanied by a transient reduction of central activation and perception [de Marées, 1990].

Is there a physiologic explanation to this contradictory findings? The present study was designed to assess physiological effects of choking on visual acuity as part of the system of perception and, thus, to deliver evidence, which may help to clarify this issue.

## METHODS

Subjects

In 156 Judokas, experienced in competition, agreed to participate on one pre-study day for instructions and one study day. During the study day, optometry was performed before and after choking (Juji-Jime) in each subject. The average age of the 46 female and 110 male volunteers was 22.8 years (standard deviation 10.5 years). All volunteers gave their written informed consent and the study was approved by the faculty of sports sciences.

## OPTOMETRY

*Device and experimental conditions*

In this study we used the "OCULUS Binoptometer II" (Oculus Optikgeräte GmbH, Münchholzhäuser Str. 29, 35582 Wetzlar, Germany), which is designed to assess the acuity of vision, binocular perception and colour vision according to standard international guidelines. This transportable device has a weight of 6.6 kg and measures 436 × 240 × 245 mm in terms of height, width and depth. It contains 20 tests, which are installed on sheets of glass. The binoptometer is being operated by an external unit with LCD-module. The adjustment of distance is programmed for the ranges of 0.4 m, 0.55 m and infinite. Eye cover can be performed on the left and right eye as well as on both sides (binocular). The binoptometer is to be placed on a plane surface, about 1–2 m off the wall. The investigations were carried out in a calm and dim side room of the gym, so that any intensive source of light was avoided. Thus, no reflexions disturbed the volunteers. Irradiation of sunlight, too, was strictly excluded. Tests were carried out shortly before routine evening judo training. All subjects were familiarized with the test device and instructed by a member of the staff on a separate pre-study day.

*Determination of visual acuity, phoria, colour and stereoscopic vision*

"Landolt-rings" were used as signs of norm vision; they were presented to the subject in 8 different positions/configurations: in straight positions (gap on top, on bottom, in left and right position) and in oblique or diagonal positions (gap in 45° angle in respect to straight positions: top right hand, top left hand, bottom right hand, bottom left hand). For each level of visual acuity, 5 signs could be employed, which the volunteer had to identify correctly. The subject was seated in a comfortable position in front of the monitor; his/her eyes had to be placed on the level of marking lines. The monitor was moved into different positions and angles in order to guarantee a comfortable head position in participants wearing glasses. During the examination, different test-fields were presented in a pre-defined sequence. The position of the subjects during the test remained the same. The tests took about 5–7 minutes.

First, a series of small signs was shown to reduce duration of examination. If the volunteer was not able to read these signs, the corresponding test series was repeated with larger signs. Visual acuity was given by the ratio of angles of the emmetropic ($a_o$) and the subject ($a_s$). The test staff noted the last sign (Landolt-ring) of a series, which the volunteer correctly identified. After choking (shime-waza) with the usual "juji-jime-technique" the complete test was repeated within 5–7 minutes after the choking manoeuvre.

In addition to visual acuity generally rather characteristic visual capabilities (phoria, colour and stereoscopic vision) were investigated before and after the choking manoeuvre. Heterophoria, a transient lack of binocular fusion, can occur e.g. as a sequelae of tiredness or alcohol. The characteristic ocular deviation is either directed outward (exophoria) or inward (esophoria). The binoptometer determines the degree of fusion using superimposed bars (Maddox bars) both in on the horizontal and vertical meridian (Oculus Binoptometer II). Colour vision was assessed by Ishihara tables integrated in the Oculus Binoptometer II device. Stereoscopic vision capabilities were determined by means of a stereopsis butterfly test (Stereo Butterfly Test SO1000, Bernell Visual Products, South Bend, USA). With regard to heterophoria, colour and stereoscopic vision only two categories (yes/right or no/false) were documented.

## STATISTICAL METHODS

All data were presented descriptively including Mean/Standard Deviation (SD) and Median/Range. Due to a ceiling effect of visual acuity data line plots were preferred. For the statistical analysis the nonparametric Wilcoxon-test for paired samples was calculated (Siegel and Castellan, 2000). The power is approximately 95% compared with the corresponding t-test. With sample a size of 150, s=0.5 and a discrimination efficiency of 0.1 (acuity) a power of approximately 90 % is achieved. Colour vision, stereoscopic vision and determination of phoria yielded results on a nominal scale (right, false) and were exploratively assessed by means of the McNemar test for related samples (Zar, 1984). Associations between variables were analysed by means of Spearman rank correlation. All calculations were done with commercially available software packages (StatisticaR 6.0, Statsoft, Tulsa, USA and NCSS 2000, J. Hintze, Kaysville, USA).

## CHOKING MANOEUVRE

The choking person approached the volunteer from fronto-lateral, got hold of the upper parts of the "Judo Gi's" (cotton jacket worn in Judo) lapel, and started choking by turning both hands and forearms inwardly, while pulling his arms to his body. By exerting this manoeuvre, a continuous compression of the ventral parts of the neck is being performed, thus affecting the main head-neck-vessels (carotids and jugular veins). As soon as the athlete signalled surrender by tapping with the flat of his hand, choking was stopped. So, in no jukoka fainting occurred. Choking was carried out for an average of 8 s (at least 6 s, maximum 11 s).

## RESULTS

All visual acuity results from the present study can be read in table 1 below. The Wilcoxon test yielded significant ameliorations for all assessed test constellations. The corresponding line plots (Figures 1 to 3) show that this systematic effect was in realiter confined to those subjects who had visual acuities lower than one, i.e. subjects who had sligthly reduced acuity before-hand. However, in some subjects visual acuity transiently increased even more than two units. A supplementary subgroup analysis of women and men showed slightly lower initial visual acuity values in women in order of 0.02 units. On the other hand, the increase of acuity due to choking tended to higher values, the difference between men and women being in order of 0.04 units. Significant negative correlations between age and visual acuity in order of –0.3 to –0.5 were only found at experimental distances of 0.55 and 0.4 meter.

The results of colour vision, phoria and stereopsis assessments are summarized in table 2. Neither standardized stereopsis or colour vision capabilities, nor horizontal or vertical phoria did reveal obvious pathologic findings. As could be expected, no significant changes could be ascertained after the choking manoeuvre, although 3 subjects who failed the colour vision test before choking were able to deal with the colour vision task after the choking manoeuvre.

Table 1: Results of visual acuity measurements of 156 subjects before and after choking (juji-jime) determined for different trial conditions (p-values acc. to Wilcoxon test).

| | **P-value** | **Mean (SD)** | | **Median (Range)** | |
|---|---|---|---|---|---|
| **Test condition** | **P<=X** | **before choking** | **after choking** | **before choking** | **after choking** |
| Right infinite | 0.00001 | 0.73 (0.32) | 0.84 (0.27) | 0.90 (1.0) | 1.0 (1.0) |
| Left infinite | 0.00001 | 0.78 (0.28) | 0.85 (0.24) | 0.98 (1.0) | 1.0 (1.0) |
| Binocular infinite | 0.00001 | 0.86 (0.25) | 0.90 (0.20) | 1.0 (1.0) | 1.0 (0.8) |
| Right 0,55 m | 0.00001 | 0.88 (0.22) | 0.92 (0.19) | 1.0 (1.0) | 1.0 (1.0) |
| Left 0,55 m | 0,00001 | 0.90 (0.19) | 0.94 (0.15) | 1.0 (1.0) | 1.0 (0.8) |
| Binocular 0,55 m | 0.00001 | 0.94 (0.13) | 0.98 (0.08) | 1.0 (0.8) | 1.0 (0.5) |
| Right 0,4 m | 0,00001 | 0.90 (0.21) | 0.93 (0.18) | 1.0 (1.0) | 1.0 (1.0) |
| Left 0,4 m | 0.00001 | 0.91 (0.18) | 0.95 (0.15) | 1.0 (0.9) | 1.0 (0.8) |
| Binocular 0,4 m | 0.00001 | 0.95 (0.13) | 0.95 (0.09) | 1.0 (0.8) | 1.0 (0.6) |

Table 2: Summary of colour vision, stereopsis and phoria tests in 156 subjects before and after a standardized choking manoeuvre (*p-value: 0.134)

| | **Colour Vision*)** | | **Stereopsis** | | **Phoria horizontal** | | **Phoria vertical** | |
|---|---|---|---|---|---|---|---|---|
| | Before choking | After choking | Before choking | After choking | Before choking | After choking | Before choking | After choking |
| **Normality** | 143 | 147 | 153 | 153 | 124 | 123 | 134 | 134 |
| **Anomaly** | 13 | 9 | 3 | 3 | 32 | 33 | 22 | 22 |

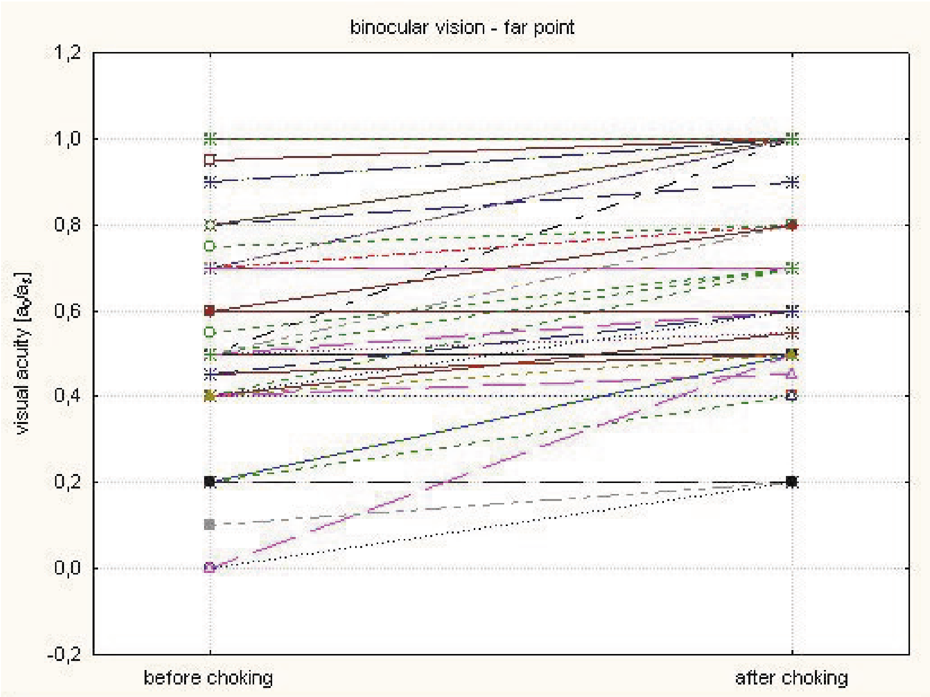


Figure 1: Line plot of binocular visual acuity in 156 subjects before and after choking (distance: far point )

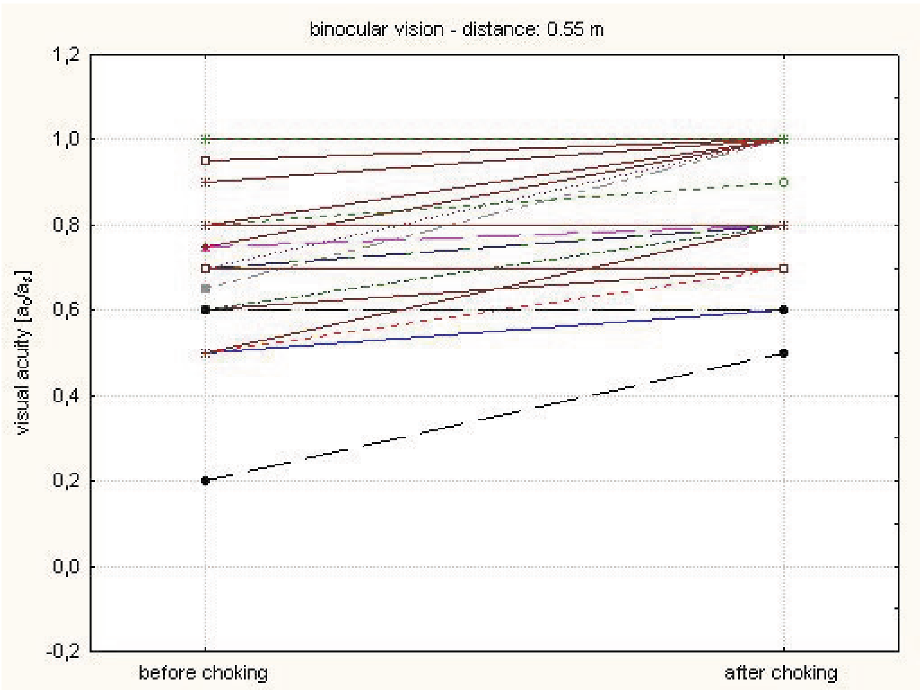


Figure 2: Line plot of binocular visual acuity in 156 subjects before and after choking (distance: 0.55 m)

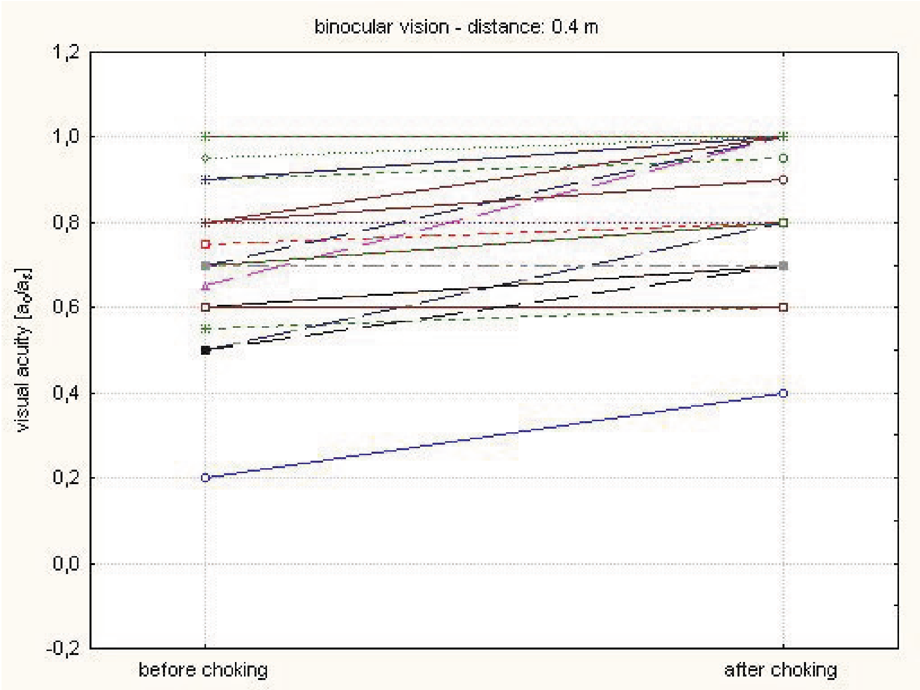


Figure 3: Line plot of binocular visual acuity in 156 subjects before and after choking (distance: 0.4 m)

## DISCUSSION

It is remarkable that under all test conditions a systematic and highly significant improvement of the visual acuity was observed. The effect of choking on visual acuity may be slightly more pronounced in women. Due to a ceiling effect the improvement of visual acuity was only ascertained in those who had slightly reduced vision before the test. However, the results are supported by the fact that in none of the 156 volunteers a deterioration of vision occurred. The transient improvement of vision was recorded in both sexes and at all ages. Visual acuity after choking improved in the left and right eye separately and in binocular vision. As most of the volunteers agreed only to participate in one study day, the course of visual acuity after the study and the influence of repeated choking manoeuvres could not be followed-up but, due to the results of the present investigations, should be assessed in a subsequent controlled trial.

Do these changes of visual perception, induced by stress, have to be put down to an optimized central nervous processing of signals or to an improvement of peripheral sensory perception? There is no specific literature on the topic but experiments which investigated vision during stress may help us to understand the phenomenon. McCrimmon *et al.* (1996) investigated the influence of hypoglycemia on visual function. Many visual tests (contrast sensitivity, inspection time or visual movement detection) were deteriorated after hypoglycemia. However, visual acuity or stereoscopic vision were not altered.

It is well known, that sympathetic activation leads to pupil dilatation and contraction of the ciliary muscle (Schandry, 1998). This may explain the improvement of vision in close ranges, presented here. From a psychophysiological point of view, blinking activity is of importance, when interpreting our findings. According to Schandry (1998), blinking correlates with the reaction to shock, on the one hand; on the other hand, frequency of blinking per time unit serves as an indicator of activation. In general, shock reaction occurs reflectorily to stimuli, which are potentially harmful to the organism (like choking, too, which is potentially life threatening). The blinking reflex is part of this pattern of reaction (Antony, 1985). The biologic function of blinking is to keep the cornea moist. A local pain stimulus above the sternocleidomastoid leads to increased lacrimation.

Both mechanisms – increased blinking frequency and lacrimation – optimize moistening of the cornea, so that minimal inhomogenieties of the corneal surface are smoothed out. Thus, the refractive power might be modified analoguously to vision under water: here, refractive power is reduced and visual acuity for infinite distances is improved [de Marées, 1990]. This plausible explanation is backed up by the fact that in the present study improvement of vision after choking was most pronounced in the far distance range. Another influence on visual perception is certainly being exerted by the pupillary width; its diameter can range from 1.5 mm to 9 mm. Latency of pupil reaction is only 0.2 seconds. Excitation, fear as well as psychic stress due to choking can trigger pupil dilatation by sympathetic innervation as part of the autonomic nervous system. In this mechanism, sympathetic and parasympathetic influences can be distinguished clearly.

Improvement of far vision after choking might also be due to optimized blinking mediated by catecholamines (Burk and Burk, 1996). Blinking causes a stenopaeic gap, which leads to higher acuity in distant vision. This hypothesis again is supported by the fact, that vision after choking improved most clearly in the far distance range. From the evolutionary-biologic point of view, improvement of perception (here: visus or visual acuity) as a stress reaction to a potentially life-threatening danger, which is represented by a choking assault to the neck, embodies an important adaptation of the main organ of perception and orientation in primates. All primates, man included, are "visual animals" (Henke & Rothe, 1998). The outstanding importance of visual perception can be seen in the extent to which the visual sense is represented in the brain: the enormous enlargement and the amount of recently evolved structures (on an evolutionary scale) within the visual cortex in the occipital lobe – as part of the neocortex – demonstrate this fact; the same applies to the multitude of neuronal links between the visual cortex and other cortical areas as well as to phylogenetically older cerebral regions. According to Schmidt (1998), activation of the adrenal body induced by stress may optimize cerebral processing of signals and stimuli.

Choking triggers a typical alert reaction, which Selye (1956) defined as the first of three phases of the general adaptation syndrome. In recent studies (Rau *et al.* 1999; Mangold & Raschka 1999) the typical pattern of sympathetic excitation during the alert reaction could be documented (increased excretion of adrenaline and noradrenaline after choking with "Shime-waza"). Typically enough, Sokolov (1975) called this pattern defensive response. It is mainly due to the mechanism of improved perception in times of jeopardy and corresponds to the concept of selective attention. This improved perception due to alertness helped man to survive, as seen from a phylogenetic standpoint.

In conclusion, the study showed that increased alertness provoked by judo chokeholds improves visual acuity. The course of visual acuity, the effect of repeatedly applied chokeholds on the visual system warrant further investigations.

## REFERENCES

1. Anthony B.J.: In the blink of an eye: implications of reflex modification for information processing. In: *Advances in Psychophysiology.* Ackles P.K., Jennings J.R. & Coles M.G.H. (eds). Vol. 1. pp. 167–218 (1985), JAI Press, Greenwich.
2. Burk A., Burk R. (eds): Augenheilkunde. (1996), Georg Thieme Verlag, Stuttgart, New York.
3. Henke W., Rothe H. (eds): Stammesgeschichte des Menschen. (1998), Springer-Verlag, Heidelberg, Berlin, New York.
4. Lindsley D.B.: Activation, Arousal, Alertness, and Attention. In: *Encyclopedia of Neuroscience*. Adelman G. (ed.). Vol. 1. pp. 3–6 (1987), Birkhäuser Verlag, Boston.
5. Mangold R, Raschka C.: Psychophysiologische Stressreaktionen auf Würgegriffe im Judo. *Deutsche Zeitschrift für Sportmedizin* 50: 145–151 (1999).
6. De Marées H. (ed). Sportphysiologie, 6. Auflage (1990) Tropon, Köln.
7. McCrimmon R.J., Deary I.J., Huntly B.J. *et al.* Visual information processing during controlled hypoglycemia in humans. *Brain*, 119, 1277–1287 (1996).
8. Rau R., Raschka C., Brunner K., Banzer W.: Appréciation des effets physiologiques de l´étranglement au judo par analyses hormonales et électroencéphalographiques. *Sciences & Sports*, 14, 88–93 (1999).
9. Reiner J.: Ein neues Gerät zur Prüfung des binokularen Sehens. *Klin. Mbl. Augenheilkunde*, 170, 147–154 (1977).
10. Schandry R. (ed): Lehrbuch Psychophysiologie. pp. 278–282 (1998), Beltz Psychologie Verlagsunion, Weinheim.
11. Schmidt R.F. (ed): Neuro- und Sinnesphysiologie. pp. 196–198 (1998), Springer-Verlag, Berlin, Heidelberg, New York.
12. Schwarzer R. (ed): Streß, Angst und Handlungsregulation. pp. 11–67 (1993), Verlag W. Kohlhammer, Stuttgart, Berlin, Köln.
13. Selye H. (ed): Stress and disease. pp. 45–121(1956), McGraw-Hill, New York.
14. Siegel S., Castellan N.J.: Nonparametric Statistics. pp. 87–95 (2000) McGraw-Hill, New York.
15. Sokolov E.N.: The Neuronal mechanisms of the orienting reflex. In: *Neuronal mechanisms of the orienting reflex*. Sokolov E.N. & Vinogradova O.S. (eds), pp. 217–235 (1975), Wiley, NewYork.
16. Ullmann S., Koch C.: Selective visual Attention. In: *Encyclopedia of Neuroscience.* Adelman G (ed.). Vol. 1. pp. 86–87 (1987), Birkhäuser Verlag, Boston.
17. Zar J.H.: Biostatistical Analysis. pp. 156–161 (1984), Prentice Hall, Englewood Cliffs.