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Increasing Mental Performance with Oxygen Multistep Therapy

Computer-assisted measurements of information-processing capacity, intelligence, short-term memory, and other parameters of cerebral performance¹

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With 6 illustrations

Technical vocabulary: oxygen multistep therapy, hyperoxia, computer test, information psychology, intelligence test, memory test, cerebral performance insufficiency

Abstract

This paper reports on the process of measuring basic parameters of mental performance in 59 subjects before and after oxygen multistep therapy (O₂-MT). The computer-assisted measurement results were compared with the results of 14 control patients. Before, that is without O₂-MT, a marked, age-dependent decline in sensory memory capacity (general fluid intelligence) can be observed. O₂-MT – complemented by Brain Jogging – leads to a significant *0.4-0.7 sec. increase in present duration and a 1.4-1.9 bit/sec. increase in information assimilation ability*, thus resulting in an increase of sensory memory capacity by 19-23% in two test groups. Short-term memory itself did not improve in comparison to the control patients, however. Moreover, *the times for accomplishing tasks involving perception, interference and reaction improved significantly by 12-18%*. In the screening test for cerebral insufficiency (CI), which is based on these factors, suspicion of CI could be ruled out for 18 of 59 patients.

¹ On behalf of the research project “Oxygen Multistep Therapy” of the Health Ministry of the GDR.

1. Introduction

Inspired by publications by B. FISHER and S. LEHRL dealing with the use of computers to test cerebral performance (5, 6) and "Brain Jogging" (3) as well as a follow-up on several earlier research projects (2), the objective of this research series was:

- to carry out precise *measurements of the various parameters of mental performance before and after oxygen multistep therapy (O₂-MT /1/)* and
- to optimize O₂-MT by implementing Brain Jogging (3), with a view to increase cerebral perfusion.

2. Methodology

Testing and Brain Jogging was implemented using *DiaMed test system MZ 731*, consisting of a Sharp MZ 731 computer (64 KB RAM) with an external cassette recorder, printer, and monochrome monitor (Fig. 1).

The following programs were available for *performance testing*: the accelerated test for general intelligence and memory = KAI + G (6) and the screening test for cerebral insufficiency = C.I. Test (5). The first test, *KAI + G* measures:

- the *flow of information to sensory memory* (in bits/sec., abbr. C_K), corresponding to the central information processing velocity (information assimilation)
- the so-called *present duration* (in sec., abbr. T_R), in other words the time that information is retained in full consciousness (sensory memory)
- the *sensory memory capacity* (in bits, abbr. K_K) as a product of C_K and T_R (capacity of all information that the test person has at his conscious disposal)
- general intelligence independent of experience (in points, abbr. IQ), which is also called *fluid or current intelligence* and closely correlates with the sensory memory capacity (K_K)



Fig. 1. Computer measuring station for measuring different parameters of mental performance. Software on cassettes. Test subject dialogue – monitor – space bar of the Sharp computer

- the *flow of information* to the preconscious *short-term memory* (in bits/sec., abbr. C_{vw}), the velocity in which new information is learned
- the *memory quotient* (in points, abbr. MQ), which is calculated from C_{vw} . The KAI + G test takes about 12 min.

Der *C. I. test* measures:

- the *perception velocity* with a “symbol/number test” (recognizing 41 symbols among 126 signs) – indicated in sec.
- *psychic interference and reaction time* (sum of 16 instances of the different stimulus in irregular alternation with an indifferent stimulus; in sec.)
- the *premorbid intelligence level*, the so-called *crystallized intelligence* that is independent of the experience (in points, abbr. IQ, as multiple-choice vocabulary intelligence test A, abbr. MVT-A)
- once age has been asked and crystallized intelligence measured, the measured values from the first two subtests are corrected and compared to the reference values. Depending on whether the reference values exceed the first two measurement values or not, the final results of this test appear as 0 (no suspicion), 1 (suspicion of...) or 2 *C. I. points* (strong suspicion of cerebral insufficiency). The *C. I. test* takes about 10 min.

The results of both tests are displayed on the monitor at the end of each particular test and printed out by the printer. The printer protocol of both tests before and after O_2 -MT is shown in Fig. 2 as a typical example.

Unlike with testing, the computer program “*Brain Jogging*” allows the subject to select the type, length, and difficulty of the exercise in order to avoid demands that are too high or too low. Here the subject can choose from among 3 different exercises: information assimilation, retaining information in conscious memory for a few seconds (present duration), or learning and recalling information in short-term memory. *Brain Jogging*, scheduled for a time directly adjacent to that of an O_2 -MT session, was implemented for about 10 min. The acceptance level of the subjects with regard to these novel computer-assisted exercises was high. In the dialog screen, the subject only needed to press a green button, which greatly simplified the procedure.

before				after			
KAI + G U 41.1				KAI + G U 42.1			
TR	CK	KK	CUW	TR	CK	KK	CUW
5.5	11.62	63	2.7	6.5	13.88	89	3.7
		IQ	MQ			IQ	MQ
		90	95			105	108
CEREBR. INS. UI.0				CEREBR. INS. UI.0			
Age: 56 IQ: 107				Age: 56 IQ: 110			
			Act. Ref. o. I				Act. Ref. o. I
Counting symbols				Counting symbols			
		Time measured:	25.00			Time measured:	21.50
		Time corrected:	25.00 22.46			Time corrected:	21.50 22.22
			1				0
Interference test				Interference test			
		Time “PRESS N.”:	9.20			Time “PRESS N.”:	7.10
		Time corrected:	18.40 17.60			Time corrected:	14.20 17.30
			1				0
Strong suspicion of cerebr. ins.				No suspicion of cerebr. ins.			

Fig. 2. Sample computer printout of results for a 56-year-old male subject before and after O_2 -MT (KAI + G test and screening test for cerebral insufficiency)

Translator comment: It's not completely clear what “UI” and “o. I.” (the same as in the German text) stand for in the tables. It's possible that “UI” is short for “User Interface,” while “o. I.” is short for “ohne Insuffizienz,” which in English would be “w/o I.” or “without insufficiency.” This is only a guess.

Test subjects

In the research series, 59 subjects (34 men, 25 women) averaging 56.9 years in age were included. All of them were people who had been treated using O₂-MT within a certain span of time and for whom testing was possible (no severe cerebral insufficiency, adequate vision). Along with CNS diseases (cerebral performance insufficiency, depression, migraines, chronic headache, post-concussion syndrome, “vegetative dystonia”), there were cases of sensory organ diseases (eye, ear, equilibrium), cardio-vascular diseases (hypertonic, coronary heart disease, hypotonia, compensated cardiac insufficiency) and metabolic diseases (diabetes mellitus, metabolic syndrome) in the mixed group of patients.

Process

The tests were generally carried out by the same test facilitator at the same time of day (usually in the late morning, rarely early morning). Influence by chance disturbance factors was already minimized by the computer program itself; for instance, it only evaluated the best result of 4 information assimilation tests.

In order to reduce the influence of effects specific to the exercise, the subjects took an unevaluated training test the day before. That way they were able to get to know the test process and contents, which greatly reduced test anxiety and inhibitions concerning the computer system at the time of the actual initial value tests.

Subject compliance was good. They gladly took part in the O₂-MT that was carried out free of charge and during the performance tests generally took a personal interest in achieving their best results both before and after the O₂-MT. The attempt by more intelligent subjects to achieve better results than actually possible (by guessing or simplifying the task) was observed both during initial measurements as well as during final measurements. Likewise, hypernervous reactions (e.g. prematurely or incorrectly pressing the button, which was penalized by the computer with poorer results) were possible during the entire time of the test.

The fact that testing demanded the subjects’ full attention was evident from spontaneous verbal utterances as well as facial expression and gestures. The two tests were always carried out in the same order, with the KAI + G test first and then the CI test, so that during the CI test, as the second test, it was already possible for there to be fatigue-induced effects.

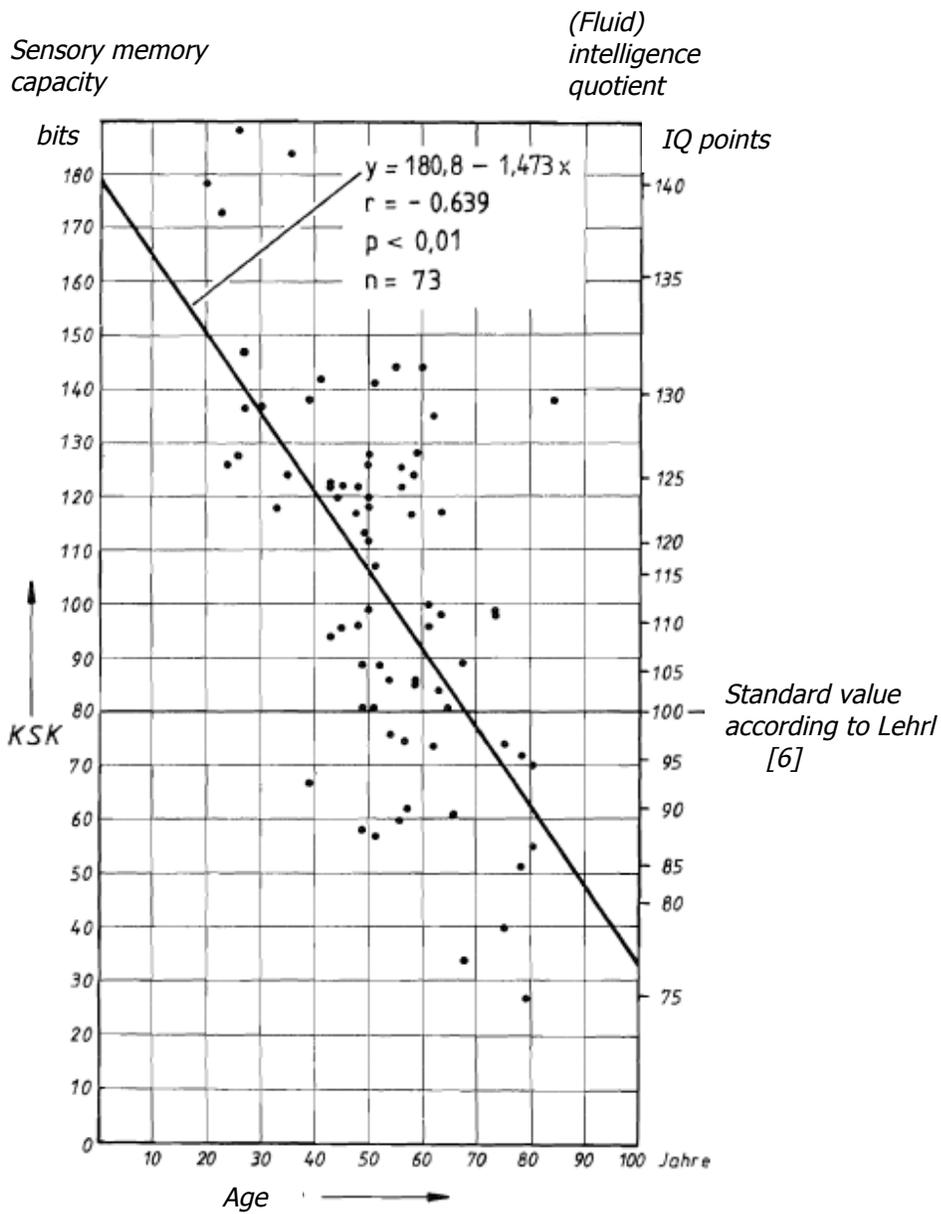
The variation of O₂-MT usually carried out was the 36-hour process, GK 4-I (n = 45), more rarely the variation with two to four 15-min. rapid processes, GK 2-I (n = 14).

Final measurements were taken one to three days after the final O₂-MT session (possibly with a weekend in between).

We carried out research in *two series*:

1. At first, we only had one version of the KAI + G available to us. Initial and final testing sessions were done using the same test. The results were compared to those of a control group (n = 14), 10 male, 4 female), 35-74 years old, average age 53 yrs.), who did not receive any O₂-MT between testing – separated by a similar interval of time.
2. After half of the research period had elapsed, we received 5 parallel forms of the KAI + G test, which made it possible to use a different version of the KAI + G test in each instance for training, initial, and final testing. The same version of the CI test was given every time.

The parameters are normally distributed in the population. For statistical calculations, Student’s t-test for independent random samples was used.



<p><i>Jnst. M. v. Ardenne</i></p>	<p><i>Age dependency of sensory memory capacity ($\hat{=}$ general fluid intelligence) for 73 subjects not treated with O₂-MT. Measurement after single practice the day before.</i></p>	<p><i>No. 379 O₂ multistep research</i></p>
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Fig. 3

Table 1. Results of testing mental performance using computers before and after oxygen multistep therapy

Parameters	Meas. unit	Control group n = 14 (m: 10, f: 4) 52.9 ± 9.8 years				
		before	after	abs.	deviation rel. %	signif.
1. KAI + G test for general intelligence and memory						
Present duration	sec.	6.64	6.61	-0.03	-0.5	n. s.
Flow of information to sensory memory	bits • s ⁻¹	13.13	13.42	+0.29	+2.2	n. s.
Sensory memory capacity	bits	88.4	90.0	+1.6	+1.8	n. s.
IQ of fluid intelligence	points	105.2	106.1	+0.9		n. s.
Flow of information to short-term memory	bit • s ⁻¹	3.26	4.01	+0.75	+23.0	0.01
MQ – memory quotient	%	102.5	111.6	+9.1		0.01
2. CI test for cerebral performance insufficiency						
CI suspicion, overall	points per subj.	0.79	1.07	+0.28	+35.4	n. s.
IQ of crystallized intelligence “perception velocity” (time required)	points	113.6	118.9	+5.3		n. s.
Interference and reaction times	sec.	22.96	24.58	+1.62	+7.0	n. s.
Deviation of fluid crystallized intelligence	sec.	19.47	20.49	+1.02	+5.2	n. s.
	points	-8.4	-12.8	-4.4		

3. Results

Figure 3 shows *sensory memory capacity dependent on age* (all measurements before or without O₂-MT). A marked age-related drop in the maximum amount of information available to the consciousness can be observed with a tendency towards below-normal values starting around the 65th year.

Table represents the *results of the KAI + G test* in the control group and both test groups. While the control subjects – with the exception of the short-term memory test – do not show any changes, the following *in part highly significant improvements* are measurable in the test groups treated with O₂-MT:

- The *present duration* goes up by +0.4 or 0.7 sec., respectively.
- The *ability to assimilate information* increases by +1.9 or 1.4 bits/sec., respectively.
- The resultant *sensory memory ability* calculated as a global quantity of the conscious information content increases by +19.2 or 20.2 bits, respectively, in other words 19-23%. The latter corresponds to a rise in IQ of +11 or 12 absolute points, respectively.

The slight increases in short-term memory measured in the control groups are not significant and correspond to the effects of repeating the testing, for there was also a genuine increase in the memory quotient for the control group.

Table 2 provides an overview of the main results of the CI screening test. In 18 of 59 patients, there was no suspicion of cerebral performance insufficiency at all after O₂-MT

Test group I n = 30 (m: 20, f: 10) 56.0 ± 12.1 years					Test group II n = 29 (m: 14, f: 15) 57.8 ± 12.0 years				
before	after	abs.	deviation rel. %	signif.	before	after	abs.	deviation rel. %	signif.
7.12	7.50	+ 0.38	+ 5.4	0.02	6.53	7.28	+ 0.74	+11.3	0.01
14.16	16.04	+ 1.88	+13.3	0.001	13.42	14.81	+ 1.39	+10.3	0.001
102.0	121.1	+19.2	+18.8	0.001	89.4	109.6	+20.2	+22.6	0.001
112.7	123.8	+11.1		0.001	105.8	118.0	+12.2		0.001
4.07	4.25	+0.18	+4.5	n. s.	3.46	3.77	+0.31	+9.0	n. s.
112.4	114.5	+2.1		n. s.	105.0	108.8	+3.8		n. s.
0.97	0.40	-0.57	-58.8	0.01	0.97	0.52	-0.45	-46.4	0.05
115.9	116.1	+0.2		n. s.	115.0	119.0	+4.0		0.01
23.01	19.43	-3.59	-15.6	0.001	24.44	20.73	-3.71	-15.2	0.01
16.12	14.23	-1.89	-11.7	0.01	18.60	15.96	-2.64	-14.2	0.05
-3.2	+7.7	+10.9			-9.2	-1.0	+8.2		

(compared to before). The greatest improvements occurred in patients who initially had had to be placed in the group reserved for those with strong suspicion.

The individual results of the CI test are represented in Table 1. In the test groups, the time for solving the perception task goes down by -3.6 and 3.7 sec., respectively, and the time needed for the interference task and the sum of the reaction times by -1.9 and 2.6 sec., respectively, both of which are significant ($p < 0.05-0.001$).

This means that there is an increase in *performance* of 13.3 to 18.5%. That results in a drop in the average CI suspicion points per patient from 0.97 to 0.4 or 0.52, respectively.

In contrast, the control group showed no improvement; in fact, there was actually a slight tendency to get worse in both tasks.

The IQ of *crystallized intelligence* increases slightly in all three groups, from 115 to 119 points ($p < 0.01$)

Table 2. CI test overview for 59 subjects before and after oxygen multistep therapy

	before	after	deviation
No suspicion	19	37	+18
Suspected CI	23	17	- 6
Strongly suspected CI	17	5	-12
	59	59	

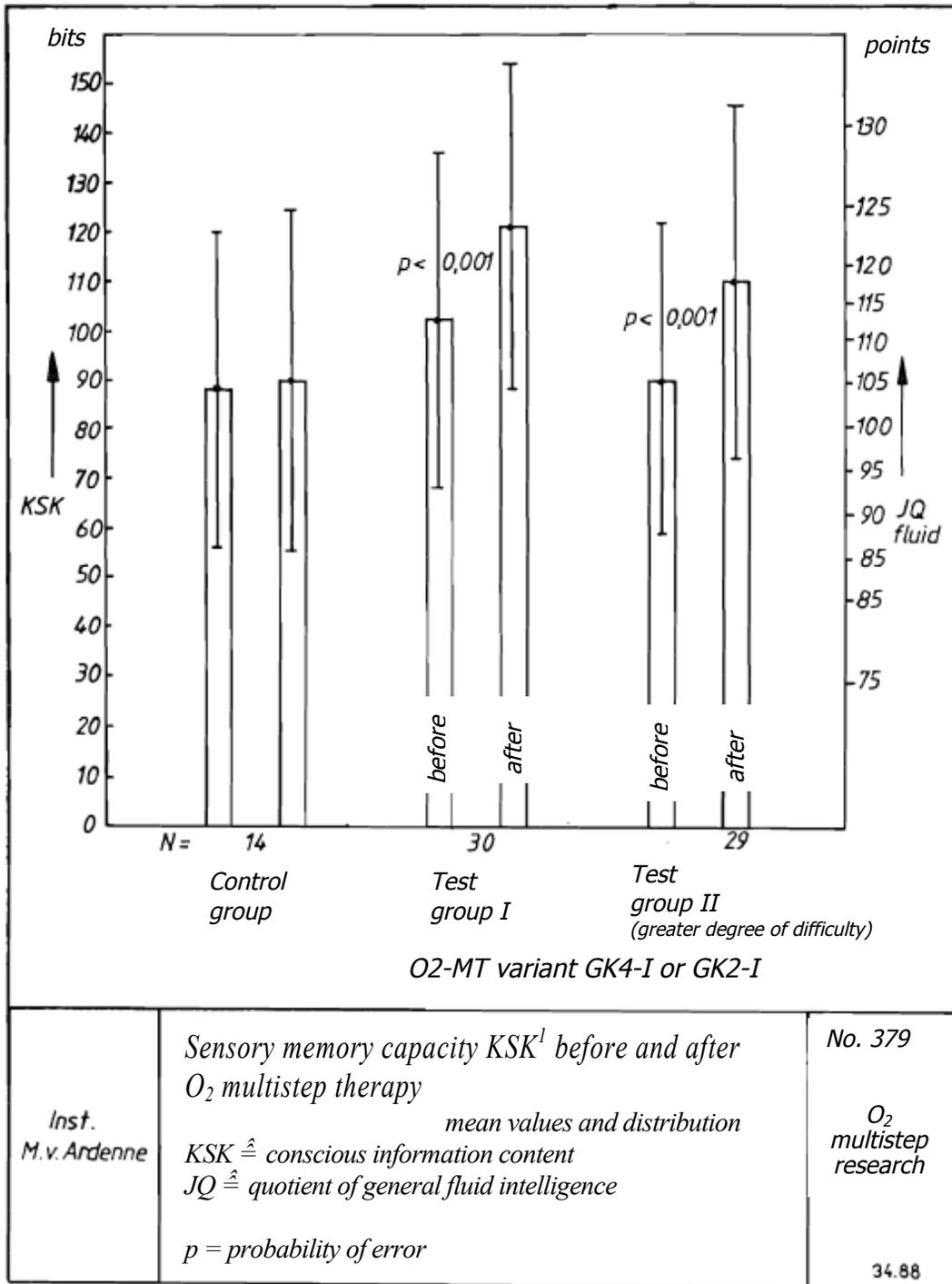
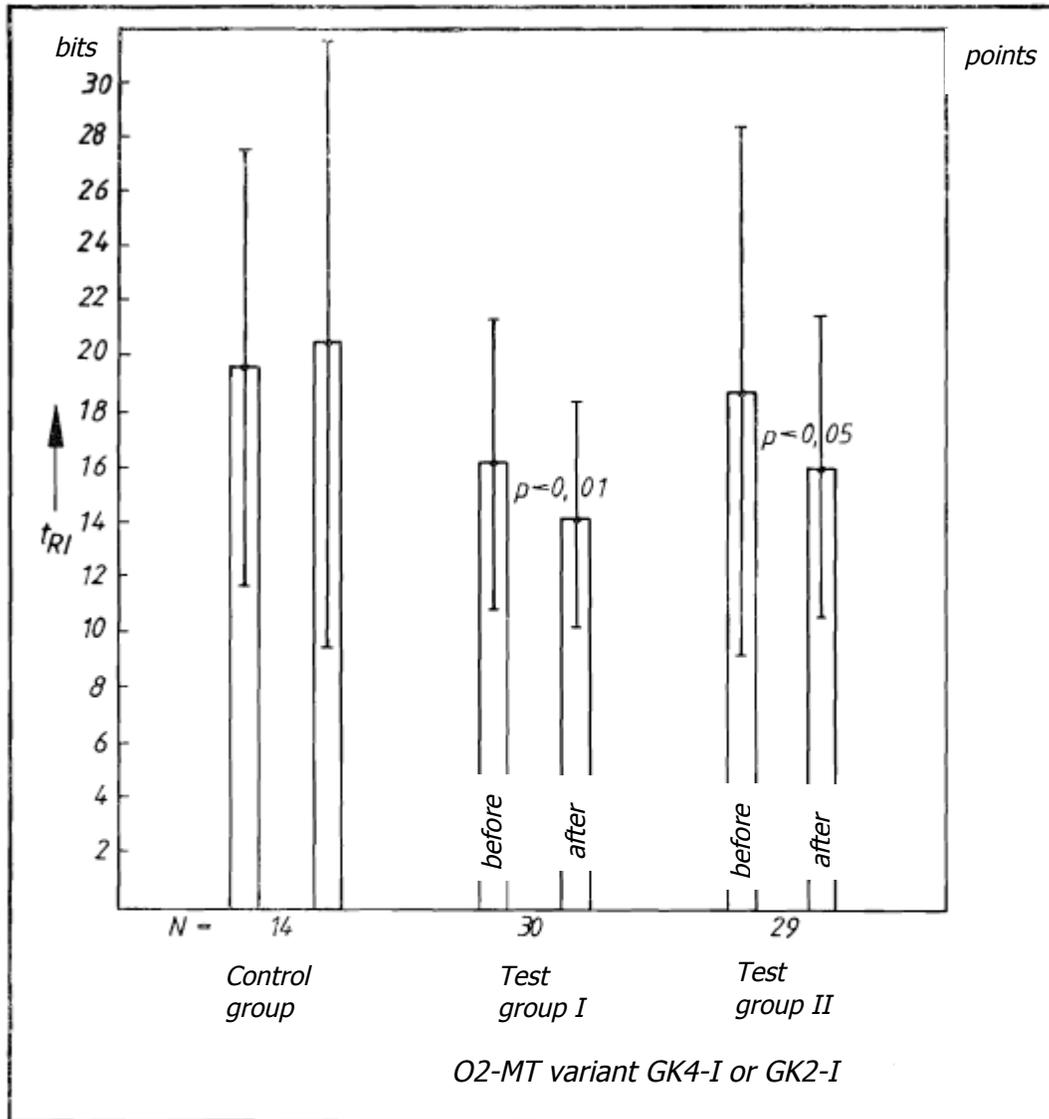


Fig. 4

\bar{i} This parameter combines the measured length of present duration T_R and the measured increase in the flow of information to sensory memory C_K . Measuring system according to S. Lehl – B. Fischer [9]



<p><i>Inst.</i> M.v.Ardenne</p>	<p><i>Time t_{RI} for solving reaction and interference tasks before and after O₂ multistep therapy.</i></p> <p style="text-align: center;"><i>mean values and distribution</i></p> <p><i>p = probability of error [9] [10]</i></p>	<p>No. 379</p> <p style="text-align: center;"><i>O₂ multistep research</i></p> <p style="text-align: right;">35.88</p>
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Fig. 5

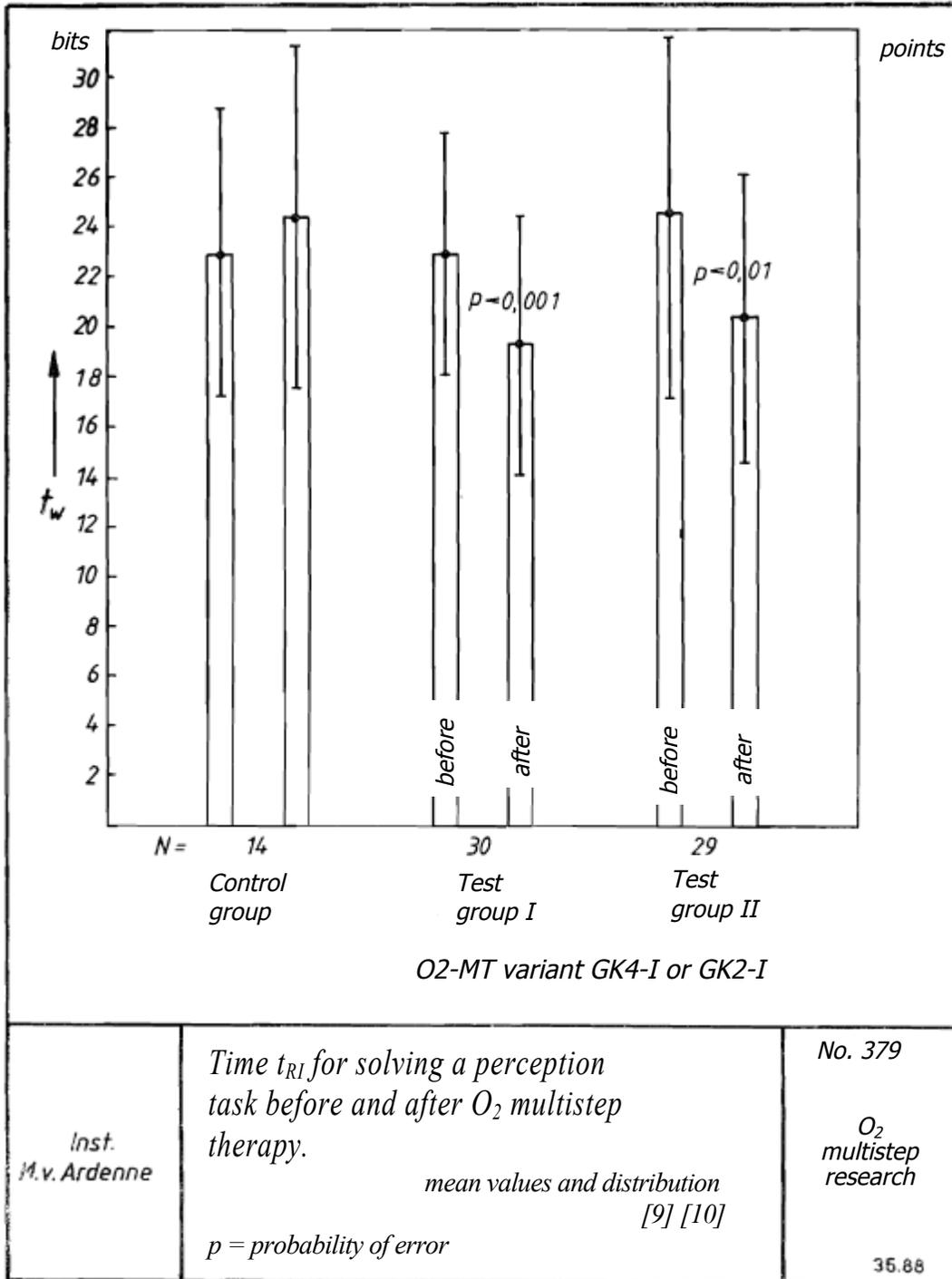


Fig. 6

in test group II. In conjunction with our study there are also findings involving the *abatement of depression symptoms after O₂-MT treatments* (1).

Figures 4, 5, and 6 provide a graphic representation of the results of the measurements of sensory memory capacity, interference and reaction time, and perception velocity corresponding to the values in Table 1 both before and after oxygen multistep therapy.

4. Discussion

The process of conducting mental performance tests is disputed in the literature; however, their use is generally approved for medical diagnostics (8). The KAI + G test developed by Lehrl et al. (6) is suited to measuring basic parameters of information psychology (10). It was later computerized, together with the CI test (5). The advantages of computer-assisted testing (CAT), such as incorruptibility, precision, diversity, a high standardization level, rapid and nearly error-free results calculation are highlighted in (9). Our initial values for sensory memory capacity lie somewhat above the standard values (80 bits) reported by (6, 10), presumably due to adaptation by the subjects as a consequence of the training test.

The interindividual deviation of our groups was 31-35 bits and is comparable to the value of 30 bits indicated in (7). While (7) did not notice a reduction in sensory memory capacity until ages greater than 65, it is already true for middle-age according to the measurements presented here (Fig. 3).

Our test group II was nearly 2 years older and constituted a higher percentage of women. Their initial values were poorer than those of Group I. Even though Group II was tested on a more difficult task (parallel forms of the KAI + G test), their increase in mental performance due to O₂-MT (with Brain Jogging) was greater (+20.2 bits = 23%) than that of group I (+19.2 bits = 19%).

In the CI test as well, which was the same for groups I and II, there was a greater therapy effect in Group II (the times for solving the individual tasks were more greatly reduced). This does not affect the CI points as much, since amount the time values of this group exceeded the reference values was greater.

The surprising improvement of even the crystallized intelligence in Group II could only be explained by an improved ability to access the vocabulary that had been learned and tested earlier. There was even improved mental performance in patients who – for whatever reason – had not been able to participate in Brain Jogging.

Contrariwise, (4) even achieved increases – to a comparable extent – with Brain Jogging alone, although with considerably greater times and with patients of an internal clinic who had a more advanced capacity to learn. A quarter of our patients only took part in Brain Jogging 0-3 times.

The improvements to mental performance measured correspond well to the *reduction of the reaction time with O₂-MT* (2) found earlier, the *increase in nerve conduction velocity by 10%* measured only recently (Dr. Vogel, Dr. Holzhüter, Hamburg, 5 test subjects), as well as the *positive O₂-MT effects on endogenous depressions* found previously in individual cases, where, according to patient claims, O₂-MT produced the same effects as did 3 weeks of infusion therapy combined with antidepressives.

The tendency of control subjects to get worse in the CT test needs to be discussed. These subjects made an exerted effort in the final KAI + G test and partially improved their performance (e.g. short-term memory). However, they evidently could not fall back on a genuine increase in performance capacity, which thereby produced greater fatigue and led to poorer results in the subsequent CI test.

The “Foundation for Promoting O₂ Physiology Research according to von Ardenne, registered association” would like to heartily thank the author for provision of the computer work station.

5. References

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Editorial note:

The auditor of the periodical had instructions (1-3), of which Prof. Dr. h. c. mult. M. VON ARDENNE was made aware. Several changes were thereby made to the manuscript. However, the publisher nevertheless desired to have the publication and was in agreement with this note by the editor.