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Preliminary communication

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Self-induced scrotal hyperthermia in man followed by decrease in sperm output. A preliminary report*

Selbstinduzierte Skrotum-Hyperthermie beim Menschen mit nachfolgendem Abfall der Spermatozoendichte im Ejakulat. Vorläufiger Bericht.

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We have taught Subjects *(Ss)* to induce an increase of their scrotal temperature through biofeedback training; concomitantly we monitored their sperm output over a period of 180 days.

Biofeedback techniques have recently been introduced to facilitate autonomic training in humans (SCHWARTZ; SHAPIRO et al.). These techniques present information to the trainees, via auditory and visual displays, concerning the automatic changes produced by each training trial. Thus, *Ss* attend to and manipulate the display rather than relying on the perception of subtle internal feedback signals. The work of GREEN et al. has demonstrated that *Ss* can consciously and deliberately induce a temperature increase in their hands when in a relaxed state.

MILLER and DICARA using brain stimulation as reinforcement, observed conditioning of heart rate changes in curarized rats and by the same technique effected salivation in dogs. MILLER and BANUAZIZI reported rats could contract or relax their large intestines when reinforced with brain stimulation. Other conditionable autonomic responses include heart rate, respiratory rate, and conditioned eosinopenia, in animals and human *Ss* (ENGEL et al. — 1966, ENGEL et al. — 1967, LAW et al. — 1959).

In the human, as in most mammals, the testes are located in the scrotum outside the abdominal cavity (LUNN; MOORE — 1954 a). Extensive measurements showing a scrotal-rectal temperature difference have been reported, the scrotal temperature being consistently lower (AGGER). Testicular temperature parallels closely scrotal temperature (WAITES). The scrotum is equipped to regulate its temperature "by virtue of its constitution" and can thus function "as a thermoregulator for the testis" (MOORE — 1954 b). After application of various heating procedures to the scrotum of animals, degenerative changes of the testicular tissue have been observed (CHOWDHURY et al., COLLINS et al.).

In the human, increase of scrotal temperature by external heat treatment leads to a reduction of sperm density in semen (MACLEOD et al., ROBINSON et al.). The lowest sperm density of the ejaculate is usually evident five weeks after the heat application. This response is generally explained by interference of the heat with the process of spermatogenesis (MACLEOD et al., ROBINSON et al.). Systemic fever also can decrease the sperm output in the ejaculate as we have shown previously (FRENCH et al.).

We studied 5 healthy volunteering *Ss* ranging in age from 18 to 35 in whom a physical examination revealed no genital abnormality. Semen was collected manually in glass

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beakers and was examined immediately after liquefaction, usually 30 minutes after collection. We instructed the *Ss* to observe a continence of at least 24 hours and not more than 48 hours for the entire duration of the study (FREUND). In addition, each *S* was cautioned to abstain from any heat-inducing activities (i. e. sauna baths, prolonged hot baths, etc.) and to notify the experimenters of any febrile condition.

In an investigation of the normal sperm output of the *Ss*, we conducted a series of five semen analyses for each of the *Ss* (FREUND, SWYER). Semen samples were examined once every two weeks for eight weeks prior to the heat treatment. Sperm density (the number of spermatozoa per ml), as well as the total number of spermatozoa per ejaculate (density times volume) fell within the normal range (Figure 1, Table 1) (ELIASSON; FREUND).

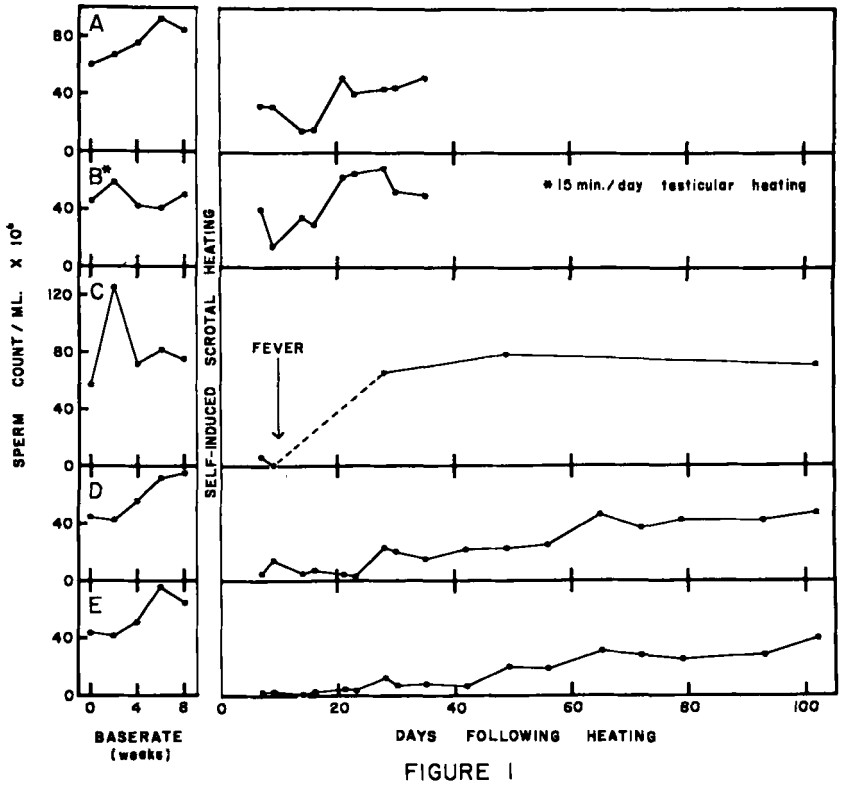

FIGURE 1

Figure 1: Sperm density (sperm count × 10^6/ml) in five subjects before and after five daily sessions of self-induced scrotal heating (30 min./day, *B: 15 min./day).

While establishing this baseline for the sperm output of the *Ss*, we started their relaxation training. They were trained by autogenic-biofeedback methods in order to raise their hand temperature at will. This training employed the basic JACOBSON relaxation techniques and instructions. Biofeedback information was provided by a portable thermistor bridge designed by the authors; this equipment visually displayed temperature changes over a 10° C range to an accuracy of ± 0.2° C. An audible threshhold signal could be pre-set to activate at any selected temperature level. All *Ss* had twelve hand temperature training sessions, of 30 minutes each, extending over a four week period. For the entire

Table 1: Volume (ml), sperm density — SD — (X 10^6/ml), and total number of spermatozoa per ejaculate — TNS — (X10^6/specimen) before and after five daily sessions of self-induced scrotal heating (30 min./day).

subject	parameters	baseline (weeks)					days following the first day of scrotal heating													
		0	2	4	6	8	7	9	14	16	21	23	28	30	35	42	49	65	100	107
A	Volume	2.0	1.8	2.0	2.2	2.4	2.1	2.2	2.0	2.2	2.0	2.3	2.1	1.8		1.6				
	— SD —	60	67	75	92	85	32	32	15	16	51	40	45	45		53				
	— TNS —	120	120	150	202	204	67	70	30	35	102	92	93	81		84				
B*	Volume	2.5	2.7	2.6	2.5	2.8	2.5	2.0	3.0	2.0	2.6	2.5	2.6	2.2		8.5				
	— SD —	45	58	42	41	50	40	15	35	30	63	65	69	52		50				
	— TNS —	112	156	99	102	140	100	30	105	60	163	162	179	114		125				
C	Volume	2.0	3.0	3.0	3.0	3.1	3.0	2.0					2.8				2.5			2.7
	— SD —	57	125	71	81	75	6	0					65				78			70
	— TNS —	115	375	213	243	232	18	0					182				195			189
D	Volume	2.6	2.0	2.0	2.2	2.8	2.0	2.0	2.8	2.4	2.0	1.8	2.1	2.3	2.1	1.8	2.5	3.0	2.8	
	— SD —	45	42	54	71	74	5	14	5	7	4	3.5	23	20	15	21	22	46	47	
	— TNS —	117	84	108	156	207	10	28	14	16	8	6.3	48	46	31	37	55	138	131	
E	Volume	1.0	1.3	1.0	1.0	1.2	1.0	1.5	1.2	1.0	1.2	1.4	1.0	.8	1.3	1.2	1.1	1.1		1.1
	— SD —	45	43	51	75	64	2	2	0	2	5	4	12	7	8	6	20	31		40
	— TNS —	45	55	51	75	76	2	3	0	2	6	5	12	5	10	7	22	34		44

* Maintained heating for only 15 minutes per day.

duration of the last two training sessions they were able to induce at least a 3° C increase in ventral hand skin temperature. All sessions (including the following sessions of scrotal heating) were held in the evening at the same time for each *S* (SAKAI), while ambient temperature was constant at 25° C.

After sperm baseline and hand temperature training procedures were completed, we began the second phase of autogenic-biofeedback training. The thermistor was attached to the medial ventral surface of the scrotum, while the *S* was in a supine position. As a control, we first measured the scrotal temperature during 30 minutes without giving the *Ss* any instructions (day 0). We then instructed four of the five *Ss* to raise their scrotal temperature to at least body temperature and to maintain that increase for 30 minutes on each of five successive days (days 1—5). The remaining *S* (Figure 1, B) was given the same instructions, but was told to maintain the increase for only 15 minutes in an attempt to observe a difference in sperm count due to duration of hyperthermia.

Table 2: Scrotal temperatures before (day 0) and during five consecutive sessions (days 1—5) of self-induced heating. Temperatures were kept constant for 30 min. except in B.

subject	scrotal temperatures (° C)					
	day 0	day 1	day 2	day 3	day 4	day 5
A	34.6	33.0	33.0	37.5	35.5	36.5
B*	34.0	37.5	36.5	37.0	37.0	37.5
C	33.5	34.5	35.5	36.0	36.5	36.0
D	34.0	37.5	37.0	38.0	37.0	37.0
E	34.0	37.5	37.5	38.0	38.5	38.5

* Maintained heating for only 15 minutes per day.

Table 2 compiles the scrotal temperature prior to, as well as during, the biofeedback training. These temperatures stayed constant at the values listed for the entire duration of the sessions (30 minutes; or in B, 15 minutes). Thus, in the training sessions the *Ss* were either able to raise their scrotal temperature immediately or not at all.

As can be seen, three of the five *Ss* were able to raise their scrotal temperature effectively at the onset of the first session. The two remaining *Ss* effected such temperature change at the beginning of the second and third training sessions. It should be noted that there was no change in oral temperature throughout the sessions.

Semen analyses were begun on day 7 following the first day of scrotal heating, and continued over a period of 102 days. The results of these analyses are presented in Figure 1 and Table 1. While previous research had noted a decline in sperm density no earlier than three weeks after the onset of external scrotal heating (MACLEOD et al., ROBINSON et al.), inspection of our data shows there was a marked decrease already evident in sperm counts taken seven days following the first day of selfinduced scrotal heating in three of the five *Ss* (C, D, and E). In the two remaining *Ss* there appeared a less accentuated and slower decline (A after 14 days and B after 9 days). One of these *Ss*, as previously noted (A), had not succeeded in heating his scrotum until the beginning of the third training session, while the other *S* (B) heated for only 15 minutes on each of the five days.

The lowest sperm levels were seen 9 (*Ss* B, C)—21 (*S* D) days after the first session of self-induced scrotal heating. In contrast, earlier work had shown an interval of at least five weeks between the onset of external scrotal heating and minimal sperm output in the ejaculate (MACLEOD et al., ROBINSON et al.).

A return to baseline levels took place after 65 and 102 days in the *Ss* who reached the highest temperatures (D and E). Unfortunately one *S* (C) developed a brief episode of systemic hyperpyrexia and had to be omitted following the sample collected on day 9. He was again included on day 28 since his sperm count had returned to a level consistent with his previous baseline.

The average time required for the transport of sperm through the male genital tract, from release in the tubules to appearance in the semen, has been determined to be twelve days with the minimal time being two days (ROWLEY et al.). The suppression of sperm output seven days following the onset of self-induced scrotal heating thus required an interference with sperm transport and cannot be explained by damage to the germinal epithelium. However, the long lasting decrease of sperm density *Ss* D and E indicates an additional interference of self-induced scrotal heating with spermatogenesis.

The data in this study clearly support the premise that (1) scrotal heating can be brought under voluntary control through the use of biofeedback training and (2) sperm counts are subsequently lowered to sub-fertile levels with brief periods of sterility occuring in two cases studied thus far. Further studies of this phenomenon are currently in progress in our laboratories.

Summary

Five human subjects were trained to induce hand and later scrotal heating in an attempt to reduce directly their number of viable spermatozoa. All subjects were trained for a one month period to induce increases in hand temperature followed by a five day period of self-induced scrotal heating. One week following the first day of scrotal heating a reduction in sperm counts in all cases was observed when compared to a previous 60 days base line level. The results indicate that the temperature of the human scrotum can be brought under voluntary control. The response in sperm output suggests an interference with sperm transport as well as spermatogenesis.

Zusammenfassung

Bei fünf Personen wurden Untersuchungen darüber angestellt, inwieweit es möglich ist, die Spermatozoendichte in Ejakulat durch eine selbstinduzierte Hyperthermie des Skrotums zu senken. Methodisch wurde so vorgegangen, daß mittels autogener Bio-Feed-Back-Methoden, mit denen man nach JACOBSON z. B. die Handtemperatur erhöhen kann, die Skrotaltemperatur erhöht wurde. Zunächst wurde über einen einmonatigen Rhythmus die Erhöhung der Handtemperatur trainiert, anschließend wurde über 5 Tage die Skrotaltemperaturerhöhung trainiert. Bereits eine Woche nach dem ersten Tag der Erhöhung der Skrotaltemperatur konnte ein Rückgang der Spermatozoendichte im Ejakulat festgestellt werden. Es wird die Schlußfolgerung gezogen, daß die Skrotaltemperatur willentlich unter Kontrolle gebracht werden kann. Die Reaktion der Spermatozoendichte deutet auf einen Eingriff am Spermatozoentransport ebenso wie an der Spermiogenese hin. Die sexuelle Carenz hatte jeweils zwischen 24 und maximal 48 Std. betragen, die Ejakulate wurden durch Masturbation gewonnen. Außerdem waren die Versuchspersonen gehalten, sich keiner sonstigen Hitzeanwendung (Bad, Sauna etc.) auszusetzen.

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