Доклади на Българската академия на науките
Comptes rendus de l'Académie bulgare des Sciences

Tome 56, No 11, 2003

MEDECINE
Physiologie

LIGHT-PRESSURE SENSITIVITY OF THE HAND DURING MIDDLE ADULTHOOD. AGE DIFFERENCES AND FEMALE ADVANTAGE

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(*Submitted by Corresponding Member M. Papasova on July 10, 2003*)

Abstract

The Semmes-Weinstein Aesthesiometer (SWA) is a widely used instrument for assessment of light-pressure sensitivity.

This study examines light-pressure sensitivity of dorsal and palmar sides of the third finger's nail bed of both hands with SWA during middle adulthood (age range 30–50 years) as a function of age, sex, handedness and location. For the first time pressure sensitivity thresholds were assessed in a locally representative sample of healthy middle aged adults (N=181).

Repeated measures ANOVA revealed significant main effects of gender and age [gender: F= 44.97, $p < .0001$, age F= 7.79, $p < .01$]. In addition the average of the observed threshold was around filament 3.22, S.D.= 0.43, i.e. about 2/3 of the observed thresholds were above the normal values commonly recommended by monofilament manufactures.

In sum: Age- and gender-specific revision of the existing norms and use of locally appropriate normal thresholds are recommended in order to enhance the clinical relevance of SWA.

Key words: light-pressure sensitivity, Semmes-Weinstein Aesthesiometer, age differences, gender differences, hand

Introduction. Light-pressure sensitivity or touch sensitivity is one of the oldest and most common stimulations in the repertoire of neurological sensory examination. The earliest scientific work on the subject dates back to 1894, when von Frey determined thresholds for pressure sensitivity by applying probes with varying force to different skin areas. Currently, the most widely used measuring instrument for testing pressure sensitivity is the Semmes-Weinstein Aesthesiometer (SWA). It is a simple, easy to calibrate, consistent, reliable and portable device, reminiscent of the hairs originally used by von Frey [1-3]. SWA allows the application of relatively well-controlled

The present study was conducted in the context of the project MIND (Memory and Intelligence in Development, PI: P. B. Baltes, P. Frensch, U. Lindenberger) at the Max Planck Institute for Human Development and Education, Berlin.

and reproducible force stimuli [4-6] and is well suited for the measurement of touch thresholds in clinical and experimental settings.

Several investigations have dealt with the effects of age and gender on hand pressure sensitivity as measure by SWA. Unfortunately, these studies did not yield a consistent picture of age and gender differences for at least two reasons:

- Relatively small sample sizes tested, i.e. from 2 to 64 subjects [3,7-8] combined with restricted age ranges, or

- Uneven age and gender distributions at a very wide age range, i.e. N= 136, age range = 16 – 67 years [9], N= 130, age range = 7 – 76 years [10].

Or, the planning of the testing pre-programmed low statistical power of the existing differences. In addition, introducing even small variations in testing instruments and procedures may also have contributed to the inconsistency among findings. Only DESROSIER et al. [11] tested a large randomly selected sample (N= 360) but the subjects were old and very old adults (age range = 60 – 94 years).

Using the SWA, the purpose of the present study is to examine the presence of age, gender, hand, location effects in a representative and comparatively large (N= 181) sample of middle-aged adults. SWA was chosen for (a) its world-wide use in clinical practice and (b) for the scarcity of appropriate normative data for this test. To enhance the generalizability of our results, a large survey research institute was asked to recruit an approximately equal number of men and women in two age brackets (i.e. 30–39, 40–50 years) using random selection. Thus, the present study reports for the first time data on SWA, based on a random, locally representative sample of middle-aged adults.

Subjects and methods. As a part of an extensive study on sensory and intellectual functioning in middle adulthood, we examined hand touch thresholds in 218 healthy volunteers, aged 30–50 years. Participants' medical history was assessed with an interview. From the original group of 218 subjects several were excluded from the analyses, because of epilepsy, severe head injuries or for missing medical history information. Non-right handers (left-handers and ambidextrous) were also excluded. The remaining 181 adults were right-handed, did not suffer from diseases known to affect tactile performance or nervous system and did not have calluses on the fingers.

Two locations on each hand third finger were tested, i.e. four locations/touch thresholds per person. The examination started on the volar surface where the filaments were applied to the fingertips proceeding to the dorsum of the fingers near the nail root. Thus, areas with hair growth and callus were avoided. Stimulation always started with the dominant hand and closely followed the directions given in the commercial set of the SWM. Specifically, the monofilaments were applied slowly with sufficient pressure to create a 45° bend in the filament, were held in that position for about 1.5 seconds, and were then removed. Participants were asked to indicate when they feel the stimulus by saying "yes" or "no". Responses with a delay more than three second were repeated.

Touch threshold determination followed standard psychophysical procedures. Subjects' visual control on the procedure was prevented. Testing started in ascending manner with the lowest monofilament from the set, i.e. monofilament 1.65. Pressure was gradually increased until the participant gave positive responses on three successive trials. After that testing in descending order started with the second monofilament above the ascending end and proceeded in single steps until three successive zero scores were reported. It took about seven to ten minutes to examine both hands. The pressure threshold for each hand was calculated as the mean of the first ascending and the last descending touch response.

In less than 15% of the cases a skidding of the filament top, probably caused by the participant's very smooth or sweating skin, was noted. In these instances, the corresponding monofilament was administered again.

Results. The distribution of the observed thresholds is summarized in Fig. 1. Touch thresholds are expressed in log 10 of the applied force in 0.1 mg units (Fig. 1).

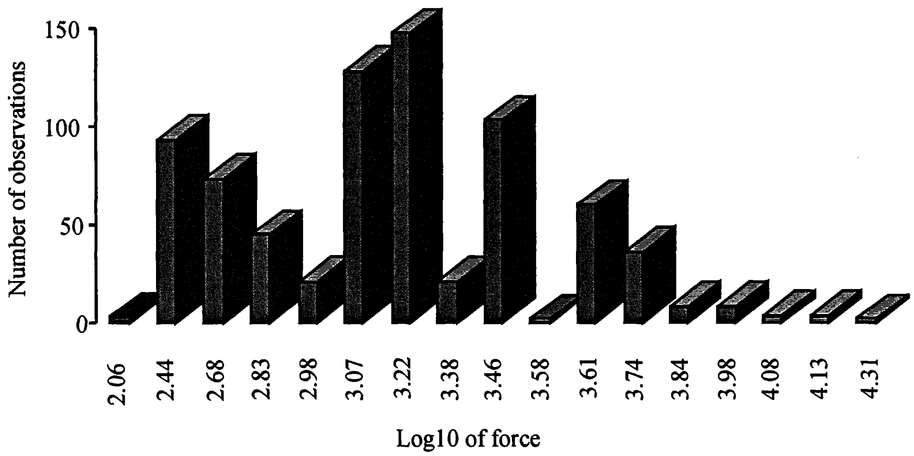

Fig. 1. Distribution of the observed thresholds

The average of the distribution is 3.16, S.D. = 0.43, minimal value = 2.04, maximal value = 4.31. 75% of the detected thresholds are higher than the generally accepted cutoff (monofilament 2.83). The thresholds' distribution is almost bell shaped and positively skewed (skewed to the right), which is not unexpected because for the most biological parameters the upper limit of normality is not fixed. This is the case with touch thresholds, too.

Data were analysed by hand (dominant versus non-dominant) × location (dorsal versus palmar) × age group (2) × gender (2) repeated measures analysis of variance using the MANOVA procedure of SPSSX. Table 1 reports means and standard deviations for all cells of the design.

Table 1

Light-pressure sensitivity as a function of age, gender, location and hand. Distribution of the observed thresholds

	Right hand				Left hand			
	Palmar		Dorsal		Palmar		Dorsal	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
30–39 years								
Men	3.20	0.42	3.14	0.40	3.25	0.43	3.13	0.35
Women	2.86	0.36	2.96	0.39	2.83	0.39	2.98	0.37
40–50 years								
Men	3.30	0.32	3.34	0.37	3.27	0.39	3.24	0.28
Women	3.06	0.38	2.99	0.38	3.01	0.39	3.03	0.35

Significant effects of age and gender were observed, age: $F_{(1,180)} = 7.79$ $p < 0.01$ and gender $F_{(1,180)} = 44.97$ $p < 0.0001$). Women were more "sensitive", i.e. they had lower touch thresholds than men (Fig. 2).

The analysis of the data did not reveal associations between touch thresholds and tested hand (left vs. right) as well as between touch threshold and tested finger location (volar vs. dorsal), i.e. the main effects of hand and location were insignificant. The latter is not unexpected as in 43.27% of the trials the touch thresholds of both

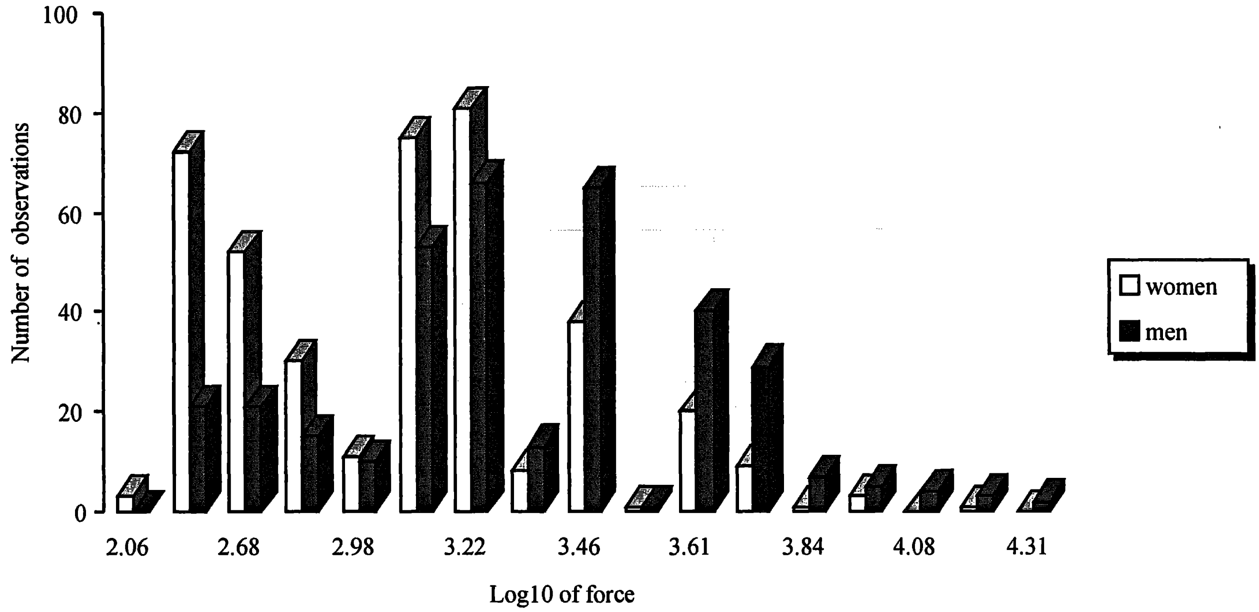

Fig. 2. Sex difference in touch thresholds (N= 181, men = 86, women = 95)

hands were identical. A gap equal to one monofilament between hands sensitivity was detected in 48.9% of the cases. In 6.73% of the trials the participants had difference in touch thresholds of both hands equal to two monofilaments and only in 1.18% the difference was three or four filaments.

Additional analyses: We also examined pressure sensitivity in 18 non-right-handed participants. With no exception, the values observed for these individuals fell well within the ranges observed for right-handers of the same gender and age group. In addition, we explored whether pressure sensitivity was related to years of education, and found no evidence for such association.

Discussion. The main goal of this study was to assess light-pressure sensitivity of the hand in a locally representative, moderately large sample of middle-aged adults, stratified by age and gender. Our results replicate the female advantage in pressure sensitivity observed in earlier studies [8,12]. More important, we found that pressure sensitivity was significantly reduced in 40–50 as compared to 30–39-year-old. So far, age-associated changes in light-pressure sensitivity were observed mainly after the age of 60 [11]. The present study extended these findings to younger ages, and documents the existence of age differences in light-pressure sensitivity for the middle adulthood. Given the restricted age range of the present study, the presence of statistically significant age differences, albeit small in magnitude, is remarkable.

The thresholds measured in the present investigation are higher that the norms provided by the "Directions for using Semmes-Weinstein Aesthesiometer" [13]. 75% of the detected thresholds are higher than the generally accepted cutoff – monofilament 2.83, which is supposed to be the upper limit of normal cutaneous sensation according to monofilament manufacturers. Applying this criterion only 25% of our healthy participants experienced touch thresholds that corresponded to the norms. The others fell into the first two levels of sensory changes "Diminished light touch" between monofilaments 3.22 and 3.61 and "Diminished protective sensation" between monofilaments 3.84 – 4.31. Even the maximum of the distribution fells into the level of "Diminished light touch". Thus, our data confirm the results of previous studies and extend the observations into middle adulthood. To illustrate the discrepancy between experimental data and existing norm, Fig. 3 provides a summary of the frequency distributions reported in five studies with SWA [7,8,11]. Only studies with enough data for meta-analysis are included in the figure. Papers [14-17] lacking significant or detailed data for age, gender or sex distribution of the subject group(s) were rejected, nevertheless that their results are in conjunction with our study. It is unlikely that the discrepancy between the norms and the results of all empirical studies, including ours, is due to cohort and/or cultural differences, because the studies deviating from the norms cover a wide range of different cultures and generations. Instead, the most straightforward explanation is that the SWA norms were based on a small number of young subjects and do not reflect pressure sensitivity in the general population.

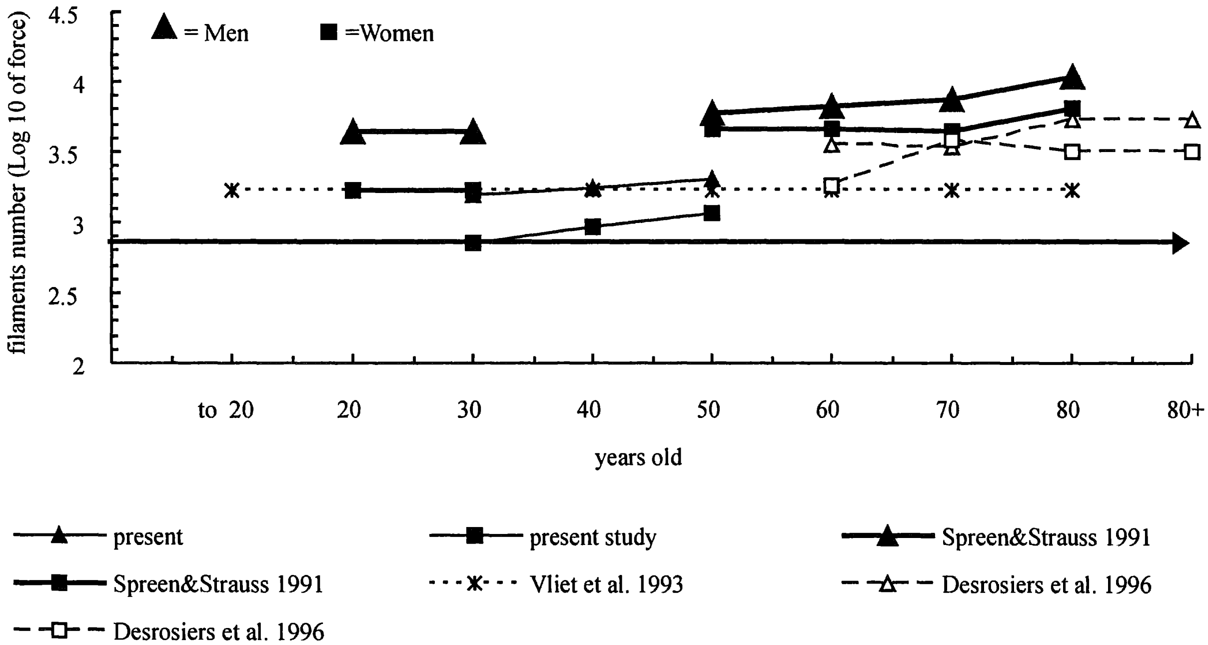

Fig. 3. Light-pressure sensitivity thresholds of the hand observed in five different studies. The solid line represents the normative cutoff

What is more, the generalizability of our results is enhanced by the fact that a large survey research institute was asked to recruit an approximately equal number of men and women aged 30 to 50 years using random selection. Thus, the present study reports for the first time data based on a random, locally representative sample of middle-aged adults.

Conclusion. New norms need to be established to enhance the clinical relevance of SWM, including a specification of normal tactile functional sensory thresholds. As SWM is widely used in clinical practice [16-19] the determination of such norms would have beneficial financial consequences by restricting further clinical and paraclinical examinations to those who really need them.

Note. The SWM used in the study are product of Stoelting Company, Oakwood Center, 620 Wheat Lane, Wood Dale, Illinois 60191, USA.

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