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The relationship between involuntary pelvic floor muscle activity, muscle awareness and experienced threat in women with and without vaginismus

Janneke van der Velde *, Walter Everaerd

Universiteit van Amsterdam, Department of Clinical Psychology, Roetersstraat 15, 1018 WB, Amsterdam, The Netherlands

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Abstract

This study assessed the relationship between involuntary pelvic floor muscle activity, muscle awareness and experienced threat in women with and without vaginismus. Information about this relationship may help understand the mechanism of vaginismus. Twenty-two women with vaginismus and seven control women participated in the study. Women were exposed to four emotion-inducing film excerpts. Vaginal electromyography was recorded. Experienced threat was continuously monitored with the use of a lever. Women responded with increased pelvic floor muscle activity to the threatening and sexually-threatening film excerpt. No changes occurred during the neutral and erotic excerpt. The subjective experienced threat as indicated with the lever showed the same response pattern. However, awareness of changes in muscle activity showed a slightly different pattern. Individual data were inspected. In general, agreement was found between recorded changes in muscle activity and experienced threat. The results of the erotic excerpt showed that awareness of changes in muscle activity is not only determined by information from the pelvic floor muscles, but also by other factors like situational information and the expectations of the women. The data support the idea of a general defense reaction as a mechanism of involuntary pelvic floor muscle activity. © 2001 Elsevier Science Ltd. All rights reserved.

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1. Introduction

Through the years, several theories about vaginismus have been developed. Although the approaches have differed, most emphasized that vaginismus is a functional disorder, and specu-

* Corresponding author. Tel.: +31-20-6970304; fax: +31-20-6971191.
E-mail address: janneke.vandervelde@wxs.nl (J. van der Velde).

lated on the relationship between psychological processes and physiological symptoms. For example, from the psychoanalytic point of view, vaginismus is a symptom of conversion. Unresolved psychosexual conflicts are often seen as cause of the reaction (e.g. Fenichel, 1945; Musaph, 1965). A nice illustration is given by Reich (1972, p. 168) who stated that “Women fear ‘falling into the power of the man’, being injured or exploded within by him. Under these circumstances, the vagina becomes in phantasy of biting organ which is going to render harmless the menacing penis. Every case of vaginismus has this origin. If it appears before the act, its significance is that of refusing penetration to the penis. If it appears during the act, it reveals the unconscious desire to retain the penis or to bite it off.” However, it was not only the psychoanalytic approach that paid attention to the relationship between psychological processes and physiological symptoms. The cognitive-behavioral approach focused on the fact that the vaginistic reaction is conditioned. Vaginismus is a reflexive reaction to the anticipation of pain leading to avoidance of intercourse (Kaplan, 1974; Masters & Johnson, 1970). For that reason treatment should include, among others, desensitization and progressive relaxation training (Shaw, 1994).

In an earlier study (Van der Velde, Laan & Everaerd, 2000), we investigated involuntary pelvic floor muscle activity during exposure to emotional film excerpts. We found an increase in pelvic floor muscle activity during threatening and sexually-threatening film excerpts. There were several remarkable findings. First, the increase of pelvic floor muscle activity was not determined by the sexual content of the film excerpt. During the erotic film excerpt, no increase occurred in pelvic floor muscle activity. Second, both women with and without vaginismus reacted with an increase in pelvic floor muscle activity to the threatening excerpts. Finally, the reaction was not restricted to the pelvic floor region. In the trapezius muscle region the same response pattern occurred as in the pelvic floor muscles. These results were considered to support our hypothesis that vaginistic reactions are part of a general defensive reaction.

However, in this earlier study we did not include continuous measures of subjective experienced emotions. For that reason we decided to replicate the study using other experimenters, other film excerpts and other women to participate as subjects.

The relationship between the physiological changes in pelvic floor muscle activity and the subjective report can be looked upon from different perspectives. First, a defensive mechanism implicates some agreement between physiological changes and experienced emotions, in particular threat. Second, the subjective report may be affected by awareness of (changes in) muscle activity. Agreement between changes in muscle activity and experienced threat in the absence of awareness of these changes, forms possible support for conditioning as a mechanism of vaginismus. For that reason, the aim of this study was, besides replicating the earlier findings, to assess the relationship between pelvic floor muscle activity and subjective report of threat and the awareness of pelvic floor muscle activity.

Continuous measurement of subjective report has been described in the literature (Wincze, Hoon & Hoon, 1977; Wincze, Venditti, Barlow & Mavissakalian, 1980) and has been used in our laboratory during research on sexual arousal in women and men (Janssen & Everaerd, 1993; Laan & Everaerd, 1995). To assess subjective experienced threat during exposure to film excerpts we used a lever, which was attached to the arm of the experimental chair. With this lever, 10 light bulbs could be illuminated. Position of the lever determined the amount of illuminated lights. The lever in the starting position illuminated one light, indicating no threat. The lever in the most forward position illuminated all 10 lights and indicated maximal threat. The lights were placed

underneath the TV monitor so that the women did not need to look away from the screen in order to monitor their subjective report of experienced threat.

2. Methods

2.1. Subjects

Subjects were 22 physician- or self-referred patients with vaginismus and seven control subjects with no sexual or pelvic floor complaints. The mean age was 28.9 (SD=6.8), ranging from 19 to 48 years. All women were nulliparous and pre-menopausal. Nineteen subjects had a steady relationship with a mean length of almost 4 years (ranging from 3 months to 16 years).

The women with vaginismus met the criteria of the Diagnostic and Statistical Manual of Mental disorders (DSM-IV) (American Psychiatric Association, 1994). These criteria for the diagnosis of vaginismus are: (1) a recurrent or persistent involuntary contraction of the perineal muscles surrounding the outer third of the vagina at attempt of penetration with a penis, finger, tampon or speculum; and (2) marked distress or interpersonal difficulty due to the vaginistic reactions.

Almost all women in the vaginismus group ($N=20$) had been diagnosed by a general practitioner or a gynecologist earlier. This diagnosis included a physical examination. Of the control women, all ($N=7$) had had a gynecological exam without abnormal findings. The control subjects had a blank history of sexual and pelvic floor problems. They were able to insert menstrual tampons without difficulty. All women of the control group were experienced with vaginal intercourse. The in- and exclusion criteria were checked in a questionnaire assessing pelvic floor function and sexual function.

2.2. Design

A 2 (Group)×4 (Order)×4 (Stimulus)×10 (Repeated measures) design was employed, with Group and Order as between-subjects factors. All subjects were exposed to four film excerpts (neutral, threat, sexual-threat, and erotic). Four order-groups were created using a 4×4 Latin Square design (Kirk, 1968), such that a film excerpt was preceded or succeeded by each of the other film excerpts only once. Subjects were randomly assigned to one of the four order-groups.

2.3. Setting and apparatus

2.3.1. Stimulus materials

The four film stimuli consisted for 5 min videotapes with sound. The neutral film excerpt was a recording of the weather forecast. The threatening stimulus consisted of a section from the movie 'Jaws'. A scene from the TV movie 'Without her consent' was chosen as the sexually-threatening stimulus. The erotic stimulus was a female-initiated, female-centered erotic videotape as described by Laan, Everaerd, van Bellen and Hanewald (1994).

2.3.2. *Physiological recordings*

Pelvic floor muscle activity was measured using a vaginal surface EMG device (Perry, 1987). This device consists of an acrylic plug with three electrodes lengthwise embedded in its surface. The electrodes were 3 cm in length and placed at 3, 6 and 9 o'clock. The device is 5 cm in length. It was sterilized in a solution of Cidex-activated glutaraldehyde before use (Geer, 1980). Bipolar surface EMG recordings of surrounding muscle groups were made by means of Ag–AgCl pellet electrodes (1 cm² contact area).

All EMG signals were recorded continuously during baselines and film excerpts. EMG signals were recorded using a preamplifier with a frequency range of 1–1000 Hz, and a gain of 1000. The output of this amplifier lead to a variable-gain contour follower with the time constant set at 25 ms, and the gain set at 60 for the pelvic floor and 30 for the surrounding muscle groups, resulting in an overall-gain of 60,000 and 30,000, respectively. The output of the contour follower (commonly referred to as 'integrated EMG') was sampled at a rate of 10 samples per second using a personal computer (IBM compatible 80486/33) and a Keithley system 570 for 12-bit analogue/digital conversion, with an input range of ± 5 volt. All physiological measures were recorded on a WEKAGRAPH OEM 821060 thermo writer (paper speed 100 mm/min). To verify the accuracy of the measurements, the raw EMG of the pelvic floor was sampled at 100 Hz. Off-line integration of this signal showed no significant difference from the output of the contour follower sampled at 10 samples per second. Therefore, the contour follower output was used for analyses.

2.3.3. *Subjective measurements*

2.3.3.1. *Emotional experience* Women were asked to indicate on a 7-point Likert scale (with 'not at all' and 'very strong' as extremes) to what extent they had experienced seven emotions while watching each film excerpt. The emotions (enjoyment, fright, sexual arousal, disgust, relaxation, threat and powerlessness) were presented in random order. One question about the subjective rating of pelvic floor muscle activity was added to this emotion questionnaire. All ratings were collected prior to the first film excerpt and subsequently after each stimulus presentation.

2.3.3.2. *Feelings of threat* Subjective experienced threat was continuously assessed during the film excerpts. Subjects were instructed to move a lever, attached to the chair, to indicate each increase or decrease in threat they might experience while watching a film excerpt.

2.4. *Procedure*

Subjects responded to either an advertisement in a women's magazine or newspaper. They received written information about the procedure and were invited for an interview. During the interview the experiment was explained and questions were answered. Subjects were assured privacy, anonymity and confidentiality. It was stressed that they could withdraw from the experiment at any time. They were asked to fill out questionnaires about sexual and pelvic floor history and function. To minimize coercion, the procedure, including the use of erotic and threatening film excerpts and a vaginal EMG device, was described beforehand. Women who were willing to participate signed a written informed consent form. Subjects were tested individually. Subjects

were not tested during menstruation. At the beginning of the experimental session, the subject was asked to empty her bladder. Surface electrodes were then placed on the abdominal and adductor muscle groups. When the experimenter had left the room, the subject inserted the vaginal device, attached the electrodes to the gluteal muscles and redressed. Depth and placement of the vaginal device were controlled by the shape of the device. The end of the device consisted of a circular plate. Subjects were instructed to insert the probe with the cable at the 12 o'clock position such that the plate would touch their labia. After the subject had signaled to be ready, she was asked to take a supine position. The proper attachment of the electrodes was tested by contractions of the different muscle groups.

After a relaxation period (5 min) and a first baseline measurement (30 s) of all recorded muscle groups, the subject was asked to perform exercises for the pelvic floor muscles and surrounding muscle groups (Van der Velde & Everaerd, 1999). An exit-interview inquired upon subjective experiences and feelings about the experiment.

An appointment for a second experimental session was made. During this session the exercises were repeated. After the exercises, subjects changed places to a comfortable chair in front of a television screen to watch the four film excerpts. The film stimuli consisted of 5-min videotapes. After a 5-min relaxation period and a 30s baseline measurement the first film excerpt was presented. After the excerpt, subjects watched relaxing film excerpts while another baseline measurement was done. Baselines were measured before and after each excerpt. After a 5-min inter stimulus interval the next excerpt was presented. At the end of the experiment subjects were questioned about their emotions during the excerpts, the degree to which they had paid attention to the film excerpts, and whether they had seen the excerpts before.

2.5. Data reduction, scoring and data analysis

All EMG data were entered into a computer program developed at our laboratory that enabled off-line graphical inspection of the raw data. For each baseline recording responses were averaged over the entire 30-s period, resulting in one baseline score (mean baseline in μV) per baseline recording. Muscle activity was calculated as the computer detected change from the preceding baseline.

The data from the continuous measurement of experienced threat measured with use of the lever, were quantified using a Keithley system model 570 for Analogue/Digital conversion (sampling rate 10 Hz). Data were averaged every 30 s, resulting in 10 data points per stimulus presentation.

The BMDP 4 V program (BMDP Statistical Software, 1990 edition) was used for the analysis of variance and covariance. The physiological measures were submitted to a 2 (Group) $\times$ 4 (Order) $\times$ 4 (Stimulus) $\times$ 10 (Repeated measures) design. The Greenhouse–Geisser epsilon procedure was applied to the repeated measures ANOVAs to correct for the violation of the sphericity assumption in repeated measures designs (Vasey & Thayer, 1987).

3. Results

3.1. Manipulation check

The different film excerpts elicited different emotions ($F(3,24)=28.67$, $P<0.0001$). The threatening film excerpt evoked feelings of fright (mean=5.89, SD=1.45) and threat (mean=5.15, SD=1.23). During the erotic excerpt women experienced sexual arousal (mean=4.07, SD=1.52), enjoyment (mean=3.93, SD=1.64) and relaxation (mean=3.70, SD=1.77). Women reported relaxation (mean=4.81, SD=1.82) and enjoyment (mean=3.41, SD=1.74) during the neutral excerpt. The sexually-threatening excerpt induced feelings of disgust (mean=5.48, SD=1.67), threat (mean=5.41, SD=1.39), powerlessness (mean=4.74, SD=1.85) and fright (mean=4.33, SD=1.71). This indicates that the stimulus presentations had their intended effects upon subjective experienced emotions. There was a main effect for sexual arousal ($F(3,78)=78.31$, $P<0.0001$, indicating highest levels of sexual arousal during the erotic excerpt and in lesser extent during the sexually-threatening excerpt. Highest ratings of threat were evoked by the sexually-threatening excerpt and the threatening excerpt ($F(3,78)=84.31$, $P<0.0001$). These findings are graphically presented in Fig. 1.

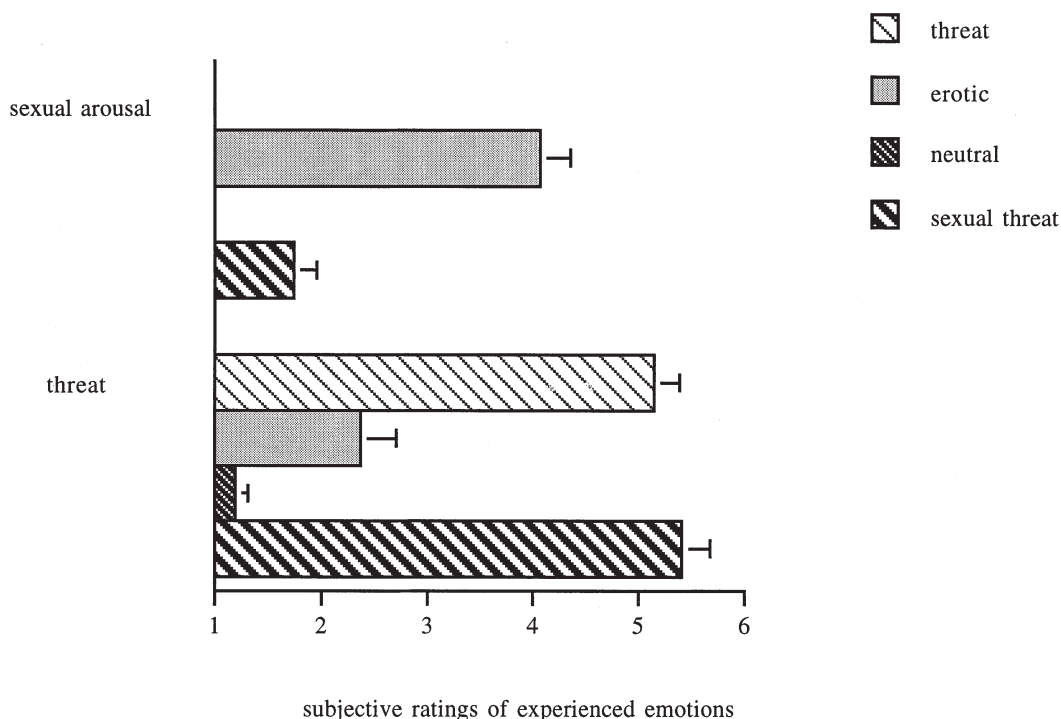


Fig. 1. Subjective ratings of sexual arousal and threat during the four film excerpts.

3.2. Physiological responses to the film excerpts

There were no differences in pelvic floor muscles activity between the women with and without vaginismus. Neither the pelvic floor muscle activity during baselines ($F(1,27)=0.45$, $P=0.51$), nor during film excerpts ($F(1,27)=1.70$, $P=0.20$) differed.

A main effect for stimulus was found ($F(1.98,55.56)=4.63$, $P<0.01$), indicating an increase in pelvic floor muscle activity during the threatening and sexually-threatening film excerpt. These results are presented in Fig. 2.

3.3. Feelings of threat

There was no difference in experienced threat during the films between women with and without vaginismus ($F(1,26)=0.10$, $P=0.76$). The experienced threat differed between the stimuli ($F(3,78)=28.02$, $P<0.0001$). According to the continuous measurements with the lever, most threat was experienced during the threatening excerpt, followed by the sexually-threatening and the erotic excerpt. This is illustrated in Fig. 3. These recordings of the lever were significantly correlated to fright ($r=0.99$, $P<0.01$) and threat (indicated after each excerpt) ($r=0.96$, $P<0.05$).

3.4. Subjective awareness of muscle activity

The subjective report of women about their pelvic floor muscle activity during the film excerpts showed a different pattern per film ($F(3,66)=13.43$, $P<0.0001$). To their experience, the sexually-

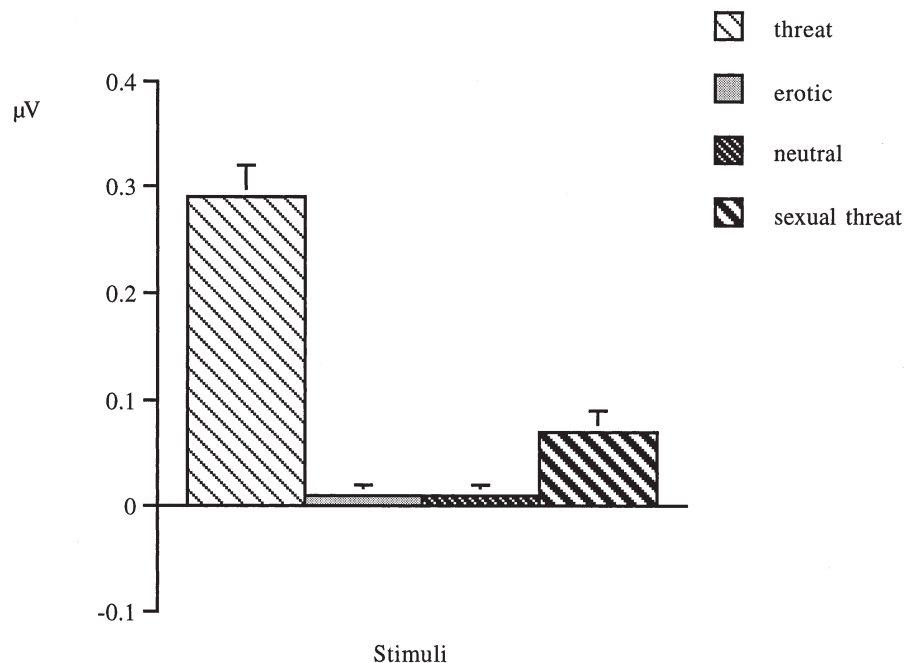


Fig. 2. Changes in pelvic floor muscle activity during the four film excerpts.

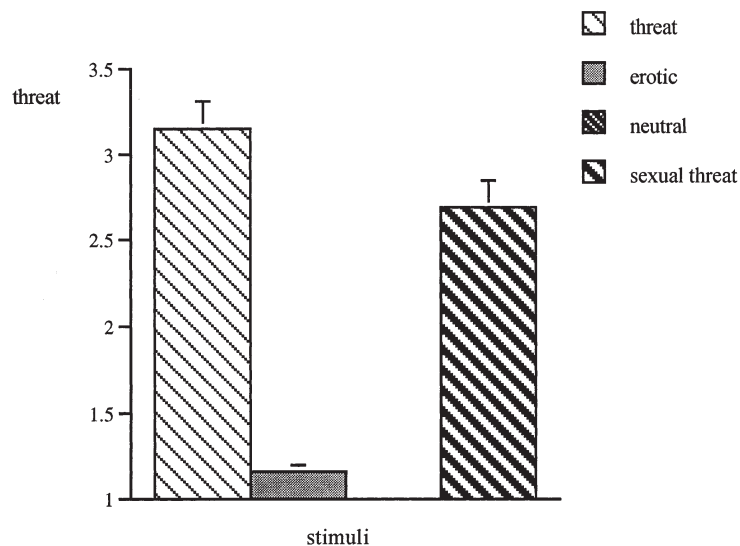


Fig. 3. Threat as indicated with the lever during the four film excerpts.

threatening excerpt evoked most pelvic floor muscle activity, followed by the threatening- and the erotic excerpt (see Fig. 4).

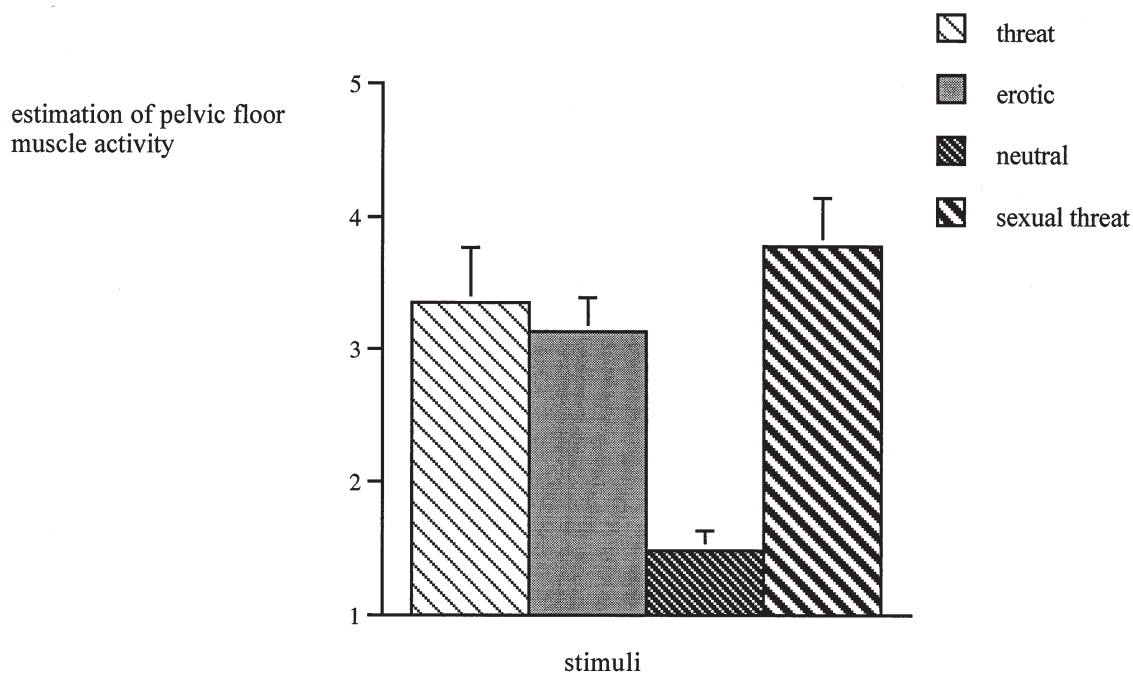


Fig. 4. Estimation of changes in pelvic floor muscle activity during the four film excerpts.

3.5. Relationship between pelvic floor muscle activity and subjective measurements

3.5.1. Subjective experienced threat indicated with the lever

Inspection of the data suggested considerable variance between subjects. We therefore prepared scattergrams per film excerpt of muscle activity and subjective experienced threat as indicated with the lever (see Fig. 5). The scattergrams revealed no variance in subjective experienced threat

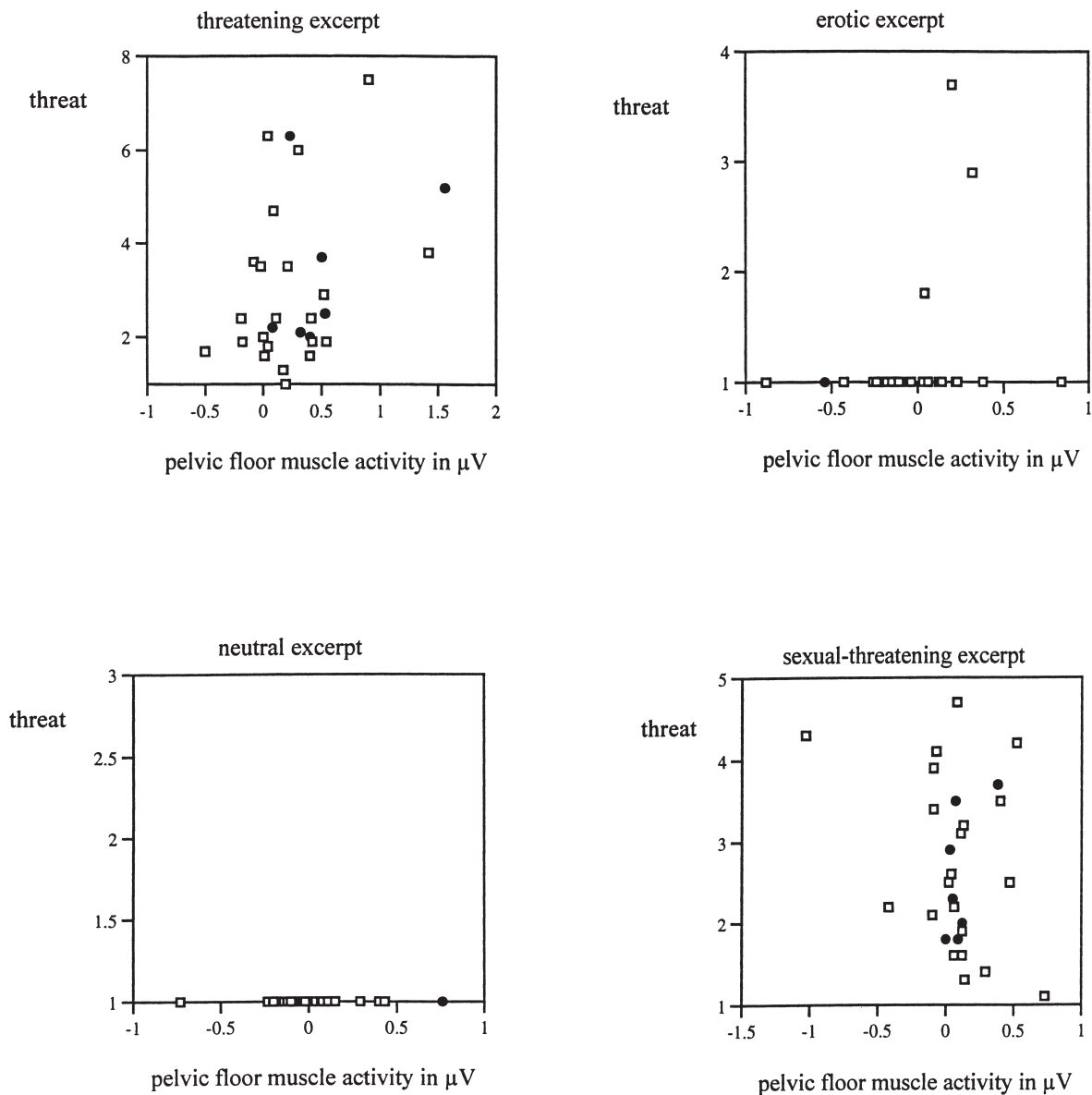


Fig. 5. Scattergram of pelvic floor muscle activity and threat as indicated with the lever during the threatening, erotic, neutral and sexual-threatening excerpt.

during the erotic and the neutral excerpt. For that reason, we only calculated correlation between muscle activity and experienced threat during the threatening and sexually-threatening excerpt. These correlations were, respectively, $r=0.35$ ($P=0.06$) and $r=-0.25$ ($P=0.19$).

For further exploration of the relationship between subjective experienced emotions and physiological reactions in women with vaginismus, we excluded the control women from the following observations. Their results did not differ from the women with vaginismus. Assuming that vaginistic reactions occur as part of a defensive reaction, some agreement between physiological changes and experienced emotions, in particular threat is implicated. To get more information about the relationship between measured changes in pelvic floor muscle activity and feelings of threat as indicated with the lever, we inspected the data per person. A 2×2 table of possible response combinations was calculated (Table 1). During all film excerpts, most women showed agreement in physiological and subjective response. Most variation occurred during the erotic excerpt. However, the response of three of the women who reacted with increased pelvic floor muscle activity during the erotic excerpt without feelings of threat, can be explained by the fact that they reported feelings of disgust during this excerpt.

The findings of the lever were consistent with indication of emotions on the questionnaire after each film excerpt. The correlations between the continuous measurements of threat by the lever during respectively the threatening and sexually-threatening excerpt and the feelings of threat as indicated on the emotion questionnaire were significant ($r=0.52$, $P<0.01$; $r=0.44$, $P<0.05$). Furthermore, there was a negative correlation between threat (indicated with the lever) during the erotic film excerpt and sexual arousal (rated on the emotion questionnaire) ($r=-0.38$, $P<0.05$).

Table 1

Different combinations of response patterns of women with vaginismus ($N=22$); pelvic floor muscle activity and feelings of threat as indicated on the lever during the four film excerpts

Lever threat	Muscle activity EMG			
Threatening excerpt		Yes	No	
	Yes	19	2	21
	No	1	0	1
Erotic excerpt		20	2	$N=22$
		Yes	No	
	Yes	2	2	4
Neutral excerpt	No	6	12	18
		8	14	$N=22$
		Yes	No	
Sexually-threatening excerpt	Yes	0	0	0
	No	4	18	22
		4	18	$N=22$
		Yes	No	
	Yes	14	7	21
	No	0	1	1
		14	8	$N=22$

3.6. Subjective experienced awareness of changes in muscle activity

The correlation between mean pelvic floor muscle activity and the subjective awareness of muscle activity was $r=0.42$. Data of women with vaginismus with regard to pelvic floor muscle activity during the excerpts and the subjective estimation of pelvic floor activity were compared (see Table 2). This awareness of (changes in) muscle activity may affect the subjective report. Most subjective reports were in accordance with the changes in pelvic floor muscle activity. Some disagreement between physiologically recorded and subjective experienced changes in muscle activity was found during the erotic excerpt. During this excerpt, women had the feeling to contract their pelvic floor muscles, while no change from baseline was detected. The differences between physiological and subjective response during the neutral excerpt of the six women who reported increase in pelvic floor muscle activity could be explained by the fact that they rated this activity as minimal activity.

3.7. Additional analyses and observations

Seven women had reported negative sexual experiences. These women differed in their pelvic floor muscle response to the film excerpts from women without these experiences. There was an interaction effect between negative sexual experiences and the stimuli ($F(2,10,56.68)=3.04$, $P=0.05$, $\epsilon=0.70$). Women with negative sexual experiences showed more pelvic floor muscle activity during the sexually-threatening film excerpt and the erotic excerpt. Women without negative sexual experiences showed more pelvic floor muscle activity during the threatening excerpt

Table 2

Different combinations of response patterns of women with vaginismus ($N=22$); pelvic floor muscle activity and estimation of changes in pelvic floor muscle activity

Subjective activity	Muscle activity EMG			
Threatening excerpt		Yes	No	
	Yes	13	1	14
	No	6	1	7
Erotic excerpt		19	2	$N=21$ (1 missing)
	Yes	5	10	15
	No	2	2	4
Neutral excerpt		7	12	$N=19$ (3 missing)
	Yes	1	6	7
	No	3	11	14
Sexually threatening excerpt		4	17	$N=21$ (1 missing)
	Yes	11	6	17
	No	1	2	3
		12	8	$N=20$ (2 missing)

(see Fig. 6). In accordance with these findings is the difference in experienced threat as indicated after each excerpt. Women with negative sexual experiences reported more threat during the erotic and the sexually-threatening excerpt, and a little less during the threatening excerpt, compared to the other women ($F(2.61,65.14)=7.16$, $P<0.001$). Furthermore, these women reported less sexual arousal during the erotic and the sexually-threatening excerpt compared to women without negative sexual experiences ($F(1,25)=4.53$, $P<0.05$).

4. Discussion

Three main conclusions can be drawn from the results of this study. First, women with and without vaginismus show an increase in pelvic floor muscle activity when exposed to threatening film excerpts. As we found in an earlier study (Van der Velde & Everaerd, 1999), it is the threatening content of the situation that evokes this involuntary activity of the pelvic floor.

Second, based on the continuous measurements of threat during exposure to the emotion-inducing film excerpts, there is a relationship between feelings of threat and involuntary pelvic floor muscle activity. The existence of this relationship supports our hypothesis that vaginistic reactions are part of a defensive mechanism. The occurrence of involuntary pelvic floor muscle activity is not restricted to experiences of threat. Other emotions associated with negative affect, like for example the disgust experienced by three women during the erotic excerpt, may elicit the same defensive reaction.

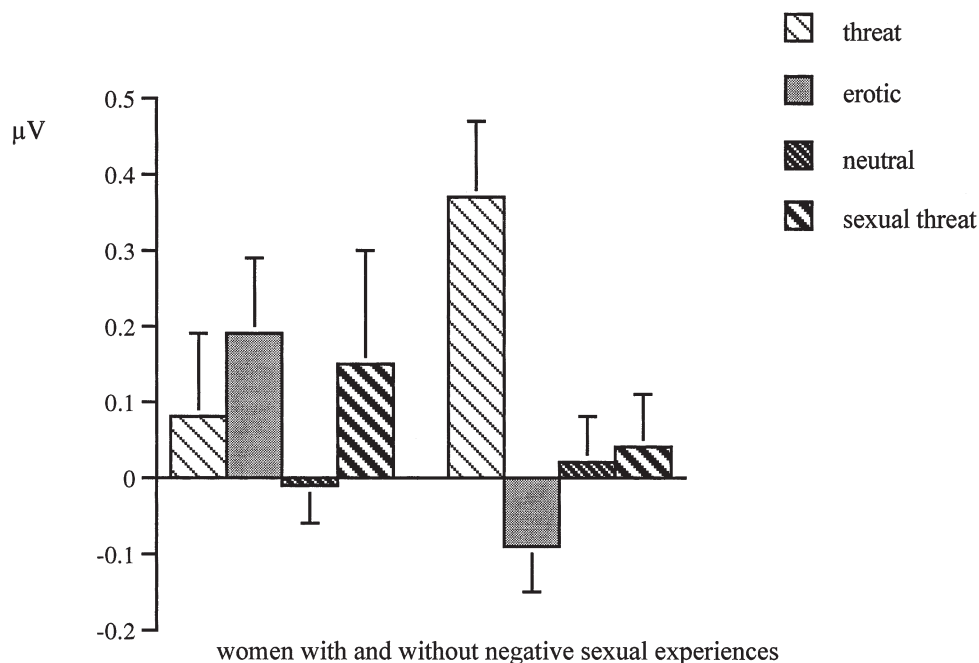


Fig. 6. Changes in pelvic floor muscle activity during the film excerpts of women with and without negative sexual experiences.

Third, there is a considerable amount of variation in awareness of pelvic floor muscle activity between women. Moreover, there does not seem to be a linear relationship between pelvic floor muscle activity and detection of changes in this activity. Pennebaker (1982) stated that perception of physical sensations is not purely based on peripheral receptor information. Situational cues seem to influence the perception. Psychophysiological studies on sexual arousal in women (Laan & Everaerd, 1995) showed variation in awareness of bodily sensations between and within subjects. Besides this awareness, the bodily sensations did not necessarily determine the subjective experienced sexual arousal. Other information, like situational cues of knowledge may be used in report about subjective experiences. This seems an explanation for the subjective report of pelvic floor muscle activity during the erotic film excerpt. During the exit-interview, women sometimes expressed their general belief that contraction of these muscles occurred during sexual arousal. The relationship between particular reactions or sensations and the situation in which they occur, is important for symptom perception. Sensations that occur in a situation which patients have not learned to associate with their symptoms may not be perceived. On demand, women reported non-sexual situations in which they had the same feeling in their pelvic floor. These situations were all stressful, like for example, getting into a traffic-jam, while in a hurry.

Although the report of subjective experienced emotions during the film excerpts indicated substantial levels of threat and arousal, the changes in pelvic floor muscle activity were smaller than expected. For all women, pelvic floor muscle activity during the excerpts was less compared to activity during voluntary contractions of the pelvic floor muscles. This may have influenced the detection of changes in muscle activity during the excerpts.

In conclusion, the results of this study provide evidence for a conditioned general defense reaction underlying vaginistic reactions. This reaction may be established through conditioning. In women with vaginismus, the involuntary contractions of the pelvic floor muscles occur as automatic defensive reactions in situations where conditioning of an emotion–symptom relationship has been established. What remains is the question why some women despite their explicit wish to have intercourse continuously react with vaginistic reactions. The result of the women with negative sexual experiences on the erotic film excerpt indicate that, at least for some women with negative sexual experiences the vaginistic reactions may be explained by the fact that based on earlier experiences erotic situations always have a threatening component. Future studies on the maintaining factors of pelvic floor overactivity and the brain control of vaginistic reactions are needed.

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