Gender differences in voluntary micturition control - An fMRI study.

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Introduction

The present study focused on the involvement of brain regions in pelvic floor muscle control in healthy male subjects and follows our previously published study on women [1,2] which demonstrated for the first time reliable BOLD activations in brainstem structure related to micturition. As bladder dysfunction affects both male and female patients, we wanted to use this fMRI experiments to examine cortical und subcortical functions related to voluntary micturition control in males. Furthermore, we compared the activated areas in healthy men and women directly to better prepare the use of fMRI in patients.

Methods

Subjects: Twelve healthy male adults (mean age ± SD: 32.4 ± 7.9 years, age range 19-49 years) without any history of neurological or psychiatric disease participated in the study which was approved by the Ethical Committee of the University of Göttingen. Written informed consent was obtained from all subjects. For comparison of males and females we used the data of our previous published study in 11 females [1,2].

MR Imaging: MR imaging was performed at 3 Tesla (Siemens Trio, Erlangen, Germany) using the standard 8 channel phased-array head coil. Functional imaging was performed using a T2*-sensitive gradient-echo EPI technique with an in-plane resolution of 2 x 2 mm² (TR: 2000 ms, TE: 36 ms, flip angle: 70°, acquisition matrix: 84 x 128). 22 sections of 4 mm thickness angulated in an axial-to-coronal orientation were acquired covering the whole brain and brainstem structures including the pons at high quality,.

Paradigm: All subjects sensed an urgent desire to void due to a filled bladder. During the functional experiments, the subjects were instructed to either (RELAX) release pelvic floor muscles to mimic voiding or (CONTRACT) contract pelvic floor muscles to mimic the interruption of voiding. In an event-related manner the instructions RELAX and CONTRACT were given (2 s each), separated by control conditions (18 s) during which the subjects had to lie relaxed and wait for the next instruction. Each instruction was given 15 times resulting in a total time of 620 s for the fMRI experiment.

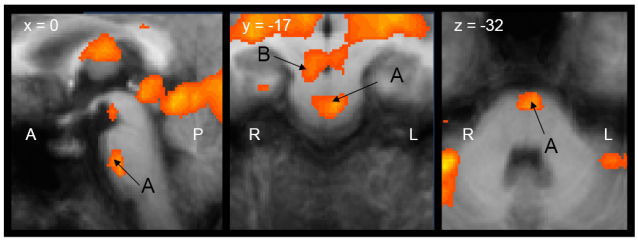

Figure: Subcortical activation patterns revealed by the conjunction analysis of the main effects overlaid onto magnified anatomical sections averaged across male subjects (n = 12). Well located activations are identified in the pons (A) and periaqueductal grey (B). x, y, z – values represent the corresponding Talairach coordinates of the cross-sections. White letters indicate: A: anterior; L: left; P: posterior; R: right..

Contrast/Region	Hemisphere	Talairach coordinates			Peak activation (t-value)
		x	y	x	
Male > female					
Cerebellum	R	20	-70	-30	3.0
	R	15	-45	22	3.1
Precuneus	-	2	-64	33	4.0
Inferior parietal cortex	R	38	-41	43	3.6
	L	-45	-31	40	3.0
Superior frontal cortex	R	26	51	25	3.8
	L	-24	43	37	3.6
Putamen	R	24	12	7	4.1
Fusiform gyrus	R	24	-39	-4	3.7
Posterior cingulate cortex	-	-24	43	37	3.6
Female > male					
Middle temporal cortex	R	44	-49	13	3.9
	L	-45	-45	13	3.6

Table: Differences in activations revealed by the comparison of male and female data (RELAX and CONTRACT)

Results

As previously reported in women, contraction and relaxation of pelvic floor muscles induced strong activations in the brainstem and more rostral areas in our group of healthy men (**Figure**). In general, men showed stronger activations during contraction than women in nearly all identified areas. In contrast, results for the relaxation condition were similar. When directly comparing the conditions RELAX and CONTRACT of male and female volunteers (**Table**), stronger activations were found in females in the middle temporal cortex bilaterally. In male subjects stronger patterns were detected in the right cerebellum, precuneus, inferior parietal cortex, the right putamen, the fusiform gyrus, the posterior cingulate cortex and right superior frontal cortex.

Some of the differences between contraction and relaxation, formerly detected in females, could be found in our group of males as well. The results suggest that in women and men the same cortical and subcortical networks exist for micturition control. Especially, the well located activations in the putative pontine micturition centre and the periaqueductal grey could be identified in both sexes.

Discussion/Conclusion

In this study we evaluated the fMRI response in voluntary control of pelvic floor muscles in men and compared the results with the previously obtained data in women [1,2]. It could be demonstrated, that the same areas in the brainstem as well as suprapontine brain structures are involved in voluntary micturition control in both male and female subjects. However, while the main effects were comparable in men and women, contrasting the conditions RELAX and CONTRACT revealed differences which might reflect gender differences in micturition control. In general, pontine and suprapontine structures involved in voluntary micturition control are similar in both sexes. Nevertheless, gender differences in the activity level of several regions seem to exist in cortical and subcortical representation of the micturition process. However, both conditions (contraction and relaxation) seem to induce different activation intensities in men and women.

References

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