Survey of Biofeedback Interfaces for Pelvic Floor Muscle Training

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Abstract

Designing a positive user experience for bodily disruptions like incontinence is a major challenge in e-health technologies. We plan on exploring how older women can work with biofeedback from their pelvic floor to retain or regain urinary continence. As a first step, we took stock of existing interaction modes. We present the results of a survey of existing interfaces of biofeedback systems for pelvic floor muscle training for home use. The results show that biofeedback is usually presented via small handheld devices, which might not be ideal for the audience. We conclude that future developments should consider how to use ambient, tangible, or embodied interaction possibilities to empower older people to take charge of their condition.

1 Biofeedback to Treat Incontinence in Older Women

An extensive body of research addresses e-health technologies, e.g. personalizing fitness by feeding back data on bodily functions. Yet for women's health, the advances in technology, IT, and HCI often are not reflected in how interventions and treatment are designed (Almeida et al., 2016). Incontinence is a bodily disruption highly prevalent in older people. Urinary incontinence is defined as the involuntary loss of urine mainly caused by urge, stress or mixed urinary incontinence (Herderschee et al. 2011); prevalence is higher in women than in men. For older people, urinary incontinence leads to manifold medical, social, and economic problems and restrictions. Additionally, it poses a substantial cost factor and is the primary reason that old people are admitted in residential care (Coyne et al., 2014). With this broad and substantial impact on people's lives, designing for older women's pelvic health is an area where advances in HCI could contribute significantly (Almeida et al., 2016).

Behavioral approaches to incontinence focus on the healthy functioning of the pelvic floor musculature that sets the tone for the whole process of urine storage and micturation. The effectiveness of pelvic floor muscle training to reduce urinary incontinence has been confirmed (Dumoulin et al., 2014); it can bring about anatomic changes and improve both

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subjective and objective measures of incontinence and prolapse. Pelvic floor muscle training leads to significant improvement for older women suffering from incontinence. An exercise training program combined with biofeedback has thus been recommended as first-line treatment (Herderschee et al., 2011).

There are a variety of devices that are used for biofeedback in clinical practice to assist with pelvic floor muscle training, and biofeedback is used to complement pelvic floor muscle training in many practices. Biofeedback for pelvic floor muscles in women is usually done via a smart object – an intravaginal probe – using either pressure measurement or surface electromyography (Bø, 2012). Biofeedback for pelvic floor muscles is typically administered in a clinical practice. Yet to be effective, training of pelvic floor muscles must be continued at home to achieve improvement (Lamin, Parrillo, Newman, & Smith, 2016). There are some devices developed for individual training at home, either as an extension of a clinical apparatus or as a stand-alone solution for home training. They use an intravaginal probe and a device that instructs the training and feeds back the pelvic floor muscle activity. For the training period, these probes are inserted in the vagina; the training sessions are conducted by the women herself at home or whichever location she chooses.

Our long-term aim is to develop interaction possibilities that empower older women by giving them a way of interaction with the biofeedback from their pelvic floor in a way that offers them a positive user experience. To get an overview of the systems available to them, we surveyed existing interfaces of biofeedback systems for pelvic floor muscle training for home use. Our approach and the results are presented in the following section, in the last part of the paper we briefly discuss their implications.

2 Survey of Interfaces of Biofeedback Systems

Methods and Materials – An internet and literature search was conducted to find all commercially available interfaces for biofeedback devices for pelvic floor muscle training in a home setting for women. IEEE Xplore and ACM Digital Library, Medline, Embase, Cochrane Library were searched using keywords "biofeedback" combined with "pelvic floor muscle training" and "women" and "home". If these did not yield any results, the keyword "biofeedback" was used combined with "urinary incontinence". Databases were searched from their inception to February 2016, limits were set to include English only articles. In addition the reference lists of all papers found relevant were handsearched and relevant sources were reviewed to determine whether any interfaces for home training were used, if so, they were also included in this review. Since the purpose was to simply identify all commercially available interfaces used for pelvic floor muscle training at home, relevant articles were defined as those that provided manufacturer or supplier information for interfaces used in the paper. Therefore, there were no particular evaluative scores that the elimination of an article was based on. When brand or manufacturer were provided, the manufacturer website was searched to find further information. When vaginal sensors were used for biofeedback of pelvic muscles in a clinical setting, the internet was searched to see if any examples of this intravaginal sensor with an interface for home use could be found.

Also, it was checked whether the companies identified as the producers of devices for pelvic floor muscle training offered any other interfaces for intravaginal probes. Because available interfaces might not have been used for research reported in peer-reviewed papers, the Internet was also searched using the Google search engine, using "biofeedback" combined with "pelvic floor" and "home [unit]". The search focused on interfaces working with digital signals, mechanical interfaces were not taken into account.

Results – Thirty-one commercially available interfaces for home training of pelvic floor muscles with intravaginal probes were identified. They included 24 interfaces for intravaginal probes working with electromyographic (EMG) signals (Aware[17], biotic+[21], Bravo series (BioBravo, MyoBravo, SineBravo)[13], CONTImove S[3], FemiScan Home Trainer[11], FemiScan Inco Trainer[11], IncoMOVE[5], InTone[2], Levator Elite LE9011[16], Levator Mini LT2051A[16], Maxi Plus 2 LE3100[16], Maxi Plus LE1000[16], MyoTrac Infiniti[20], MyoTrace[15], NeuroTrac MyoPlus Pro[22], NeuroTrac MyoPlus2/4 (Pro) [22], NeuroTrac Simplex[22], Pathway MR Series[18], Pelvita+[6], Peritone[14], ProCept Home[8], ProFit lady[8], PTA (Programmable Training Assistant)[6], U-Control[20]) and 7 interfaces for intravaginal probes working with sensor measuring pressure applied to the probe (Elvie[4], KegelSmart[9], kGoal[12], Leva[19], Pericoach[1], Peritron[10], X300 Pelvic Muscle Trainer[7])[1]. There was one device (KegelSmart) that does not have an external interface, instead it simply interacted through vibration (during training) and LED signals (before training) of the intravaginal probes. Another device (FemiScan Home Trainer) has a headset as an interaction device. The other 29 interaction devices were handhelds: The five remaining intravaginal probes using pressure measurement wirelessly connected to smartphones and allowed an interaction via an app. The 24 interfaces for EMG measurement were handheld devices connected via cable and were specifically designed for presenting the EMG measurement (except for the headset). They used visual and sometimes audio signals for interaction, one device (ProFit lady) also had vibration as a kinaesthetic signal.

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3 Discussion: Going Beyond Handheld Devices

In our survey of interaction possibilities with intravaginal probes for home training of pelvic floor muscles we found that in most cases the interaction is made possible through handheld devices. The biofeedback is usually presented via a user-interface on a small device, often a meter presenting numbers on a low-contrast display. The connection to the external interface is usually via cable. Newer pressure based devices graphically present the data on a smart phone, connected via Bluetooth. For older people, this interaction device might be unfamiliar or feel inappropriate, and the screen size and presentation is not optimal for conditions that often come with old age such as loss of sight or challenges with motor-skills. Based on the idea that physical, tangible and reconfigurable “physicalizations” (Jansen et al., 2015) that match people’s own perspective, needs, and interests encourage them to understand and work with the data they produce, we see a chance to improve user experience when feeding back pelvic floor muscle activity to older people. Physical forms, lights, shapes or wearables could enhance sense-making for the users by providing hybrid expressive representation (Hornecker & Buur, 2006) through physical ambient alerts or cues that signal meaningful changes or events as a change in the physical environment. There is pioneer work in HCI to use augmented systems to support intimate bodily knowledge (Almeida, Comber, Wood, Saraf, & Balaam, 2016), but the specific needs and wishes of older women are yet to be considered in designing for a positive user experience with regard to biofeedback from the pelvic floor. Future studies of HCI to support continence in older women should go beyond small handheld devices and explore how we can use ambient, tangible and embodied interaction to empower older women to take charge of their health.

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