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Prototype awareness enhancing and monitoring device for trichotillomania

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Abstract

Trichotillomania is an impairing condition that involves repetitive hair pulling. Habit reversal therapy is helpful for many persons with this disorder. Unfortunately, habit reversal therapy is not helpful for everyone and maintenance of gains is often problematic. Successful habit reversal therapy requires the individual to be aware of hair pulling and handling. Unfortunately, most people with trichotillomania report that much of their plucking occurs outside of awareness. Monitoring of trichotillomania behaviors is also problematic. The present project involved a pilot study of a prototype awareness enhancing and monitoring device aimed at increasing the effectiveness of habit reversal therapy. The device included a watch, bracelet, magnetic necklace, and a pager that was hard-wired for remote activation of a vibrating alert when hair pulling behaviors occurred. Following structured diagnostic assessment, three female participants were randomly assigned to be initially observed for varied lengths of time without the device followed by observation with the device in place. The results indicated a marked reduction in trichotillomania behaviors when the device was in place. Semi-structured interviews revealed that the device was very effective in enhancing awareness and monitoring of trichotillomania related behaviors and enthusiastic acceptance of the device was provided by all participants.

Keywords

Trichotillomania; Measurement; Awareness; Habit reversal; Behavior therapy; Device; Multiple baseline

Introduction

The DSM-IV (American Psychiatric Association, 2000) defines trichotillomania (TTM) as recurrent hair pulling resulting in noticeable hair loss. Diagnostic criteria stipulate that hair pulling must be accompanied by an increase in tension before pulling followed by pleasure, gratification, or relief when pulling out the hair. Common hair pulling sites include the

scalp, eyelashes, eyebrows, and pubic regions (Christenson, Mackenzie, & Mitchell, 1991). The prevalence of TTM is in part dependent on the specific criteria used to define the disorder. If full diagnostic criteria are applied, college student samples place the lifetime prevalence rate of TTM at approximately 0.6% but rates climb to 3.4% of female and 1.5% of male students when the diagnostic requirement of increasing tension before pulling followed by pleasure, gratification, or relief is not considered (Christenson, Pyle, & Mitchell, 1991). TTM also has a significant impact on quality of life including interference with work, school, home-management tasks, social life, and close relationships (Woods et al., 2006).

Two subtypes of hair pulling have been observed among persons with TTM - focused and automatic pulling (Christenson & Crow, 1996). Focused pulling involves purposeful hair pulling commonly performed in response to disturbing thoughts or increased anxiety. Persons engaged in focused pulling often report high levels of tension prior to pulling followed by a sense of relief after pulling (Christenson & Crow, 1996). The automatic subtype refers to pulling that occurs outside of the person's awareness. A recent psychometric study of the Milwaukee-Dimensions of Trichotillomania Survey, an instrument designed to measure levels of focused and automatic pulling, revealed two robust, weakly correlated subscales that provide clear support for these two pulling typologies (Flessner et al., 2006). A recent online survey (Trichotillomania Learning Center [TLC] - The Trichotillomania Impact Project [TIP]) found that 56% of TTM sufferers reported high levels of automatic pulling (Flessner, Conelea, Woods, Franklin, Keuthen, & Cashin, 2008).

The most widely tested psychosocial treatment for TTM is behavioral habit reversal training (HRT) (Azrin, Nunn, & Frantz, 1980). HRT treatment components include, but are not limited to: competing reaction (response) training - client practices behaviors that are incompatible with hair pulling such as clenching hands when they pull, feel tempted, or handle hair; awareness training -client learns to be aware of the movements associated with hair pulling; identifying response precursors - client becomes aware of the specific behaviors that immediately precede hair pulling such as handling the face or head; identifying habit prone situations -client learns to identify situations associated with pulling; relaxation - client uses deep breathing and postural adjustment in response to tension; and annoyance review - client lists pulling related problems.

Several studies spanning over 25 years have established a clear scientific foundation for the value of HRT. The effectiveness of HRT has been established via case reports (De Luca & Holborn, 1984; Rosenbaum & Ayllon, 1981; Stoylen, 1996), uncontrolled group trials (Lerner, Franklin, Meadows, Hembree, & Foa, 1998; Rothbaum, 1992) and in randomized trials comparing HRT to psychosocial control treatments (Azrin et al., 1980), anti-depressant medication (van Minnen, Hoogduin, Keijsers, Hellenbrand, & Hendriks, 2003; Ninan, Rothbaum, Marsteller, Knight, & Eccard, 2000), and placebo pills (van Minnen et al., 2003; Ninan et al., 2000). However, although HRT and other related behavioral interventions hold promise in the treatment of TTM, approximately 30–40% of clients in most studies of HRT do not experience clinically significant improvement after acute treatment and maintenance of gains may be especially problematic (Lerner et al., 1998). Considering both medications

and psychological treatment, approximately 60–70% of treatment-seeking clients have been found to be wholly or partially refractory to treatment over time (Cohen, Stein, Simmeon, & Spadaccina, 1995; Lerner et al., 1998) indicating a clear need to improve TTM treatments.

There are several opportunities to improve habit reversal therapy for TTM. One opportunity to improve HRT is to intervene to help clients become more aware of their pulling. Competing response practice is likely one of the most efficacious elements of HRT (Stanley & Mouton, 1996). However, competing response practice requires the individual to be aware of actual and near pulling episodes. Unfortunately, the majority of persons with TTM experience a significant amount of pulling that is outside of awareness (Christenson et al., 1991; van Minnen et al., 2003; du Toit, van Kradenburg, Niehaus, & Stein, 2001). Several authors have stressed the importance of enhancing awareness of TTM behavior. Stanley and Mouton (1996) note that a significant problem in habit reversal training occurs when patients are unable to accept the model of learning that HRT is based upon. This model posits that pulling often occurs in specific habit prone situations, that pulling begins with a series of precursor behaviors (e.g. manipulating hair), and that negative and positive reinforcements maintain the behavior. Acceptance of this model requires awareness of TTM behaviors.

In response to the need to improve awareness, several low-tech strategies, including wearing jewelry, perfume, gloves, have been used to enhance TTM awareness (Boughn & Jaarsma Holdom, 2002; Rapp, Miltenberger, & Long, 1998). Rapp et al. (1998) reported promising results with an electronic awareness enhancement device (modified hearing aid) used with a 36 year old mentally retarded woman with TTM. The device produced a feedback sound when a hearing aid on the wrist and a second on the shirt collar came in close proximity. HRT did not reduce pulling until the awareness enhancing device was in place. With the device, pulling was nearly eliminated yet pulling returned to prior levels when the device was withdrawn.

Beyond awareness enhancement, it is important to note that the loud tone used by Rapp et al. (1998) also likely served as a punisher for pulling. An audio and/or tactile alert upon coming in contact with areas associated with pulling can be experienced as aversive and may contribute to a reduction in TTM behaviors in its own right. Pairing ethically appropriate aversive stimuli (e.g. loud tone) with TTM behaviors presents a second opportunity to enhance HRT.

A third opportunity to improve HRT involves increasing reinforcement of competing responses (i.e. moving hands away from pulling area). When an aversive stimulus is terminated by a behavior, the behavior is likely to be repeated (negative reinforcement). If persons with TTM experience relief from an aversive stimulus by moving one's hand away from a pulling site, this behavior will likely occur more frequently. Moving one's hand away from a pulling site is the first in the chain of motions required to perform a competing response behavior. Gaining relief from aversive alert by performing behaviors that are incompatible with pulling (e.g. moving hands away from pulling site) could prove very helpful as a method to increase adherence to competing response behaviors.

Another potential strategy for improving the assessment and treatment of TTM concerns the monitoring of TTM behaviors. Self-monitoring is an important component of HRT for TTM in that it: helps to bring pulling into awareness (Rothbaum & Ninan, 1994); provides useful information regarding the time, duration, and activity/location associated with pulling; and is a vital source of TTM outcome data for clinical and research purposes. Although accurate monitoring of the frequency/duration of any problem behavior is critical, adherence to common TTM self-monitoring strategies such as collecting hairs and/or completing written logs is often difficult (Miltenberger, Long, Rapp, Lumley, & Elliot, 1998). Apart from the tediousness of these strategies, it is important to note that these self-monitoring methods also require the sufferer to be aware of their pulling behaviors, which, as described above, is problematic (Rothbaum, 1992). Other methods of assessing hair pulling including direct or videotaped observation of hair pulling (Elliot & Fuqua, 2000), photographs (Maguire, Piersel, & Hauser, 1995), and hair counts (Dahlquist & Kalfus, 1984) have also been utilized with mixed results.

TTM is also assessed using psychometric rating scales (e.g. Yale-Brown Obsessive-Compulsive Scale - Trichotillomania [Stanley, Prather, Wagner, Davis, & Swann, 1993], Psychiatric Institute Trichotillomania Scale [Winchel et al., 1992], NIMH Trichotillomania Severity and Impairment Scales [Swedo et al., 1989]). Although these scales have generally good psychometric properties, various reliability problems exist (Stanley, Breckenridge, Snyder, & Novy, 1999) and these instruments do not allow for precise measurement of TTM behaviors. In response to these issues, Stanley and Mouton (1996) note the need for creative approaches to improving self-monitoring and suggest that the ideal measurement strategy should include a reliable method to catalog both the frequency and duration of pulling symptoms.

The present paper reports on a prototype awareness enhancing and monitoring device (AEMD) to assist persons with trichotillo-mania. The prototype device addresses several of the opportunities to improve behavioral therapy outlined above. The prototype AEMD has two primary functions: (1) a vibrating awareness enhancement function which is activated by an investigator when persons with TTM place their hands in a location associated with pulling, and (2) a simulated TTM monitoring function. This laboratory-based trial provides initial data on the feasibility, clinical acceptance, and potential utility of the AEMD concept.

Method

Participants

Three participants with trichotillomania were recruited through the University of Michigan Anxiety Disorders Program (ADP) to participate in this initial feasibility and effectiveness trial. Subject 1 was an 18 year old female high school senior with a 4 year history of pulling eyelashes and eyebrow hairs. She reported a past episode of major depression and was not taking psycho-tropic medication. Subject 2 was a 26 year old woman with an 18 year history of pulling head and pubic hairs. She reported a past history of poly-substance abuse and was taking bupropion and fluoxetine at the time of the study. Subject 3 was a 58 year old female with a 40 year history of hair pulling. She met structured interview criteria for recurrent major depressive disorder at baseline. She was not taking psychotropic medication.

Measures

Diagnostic assessment was made via structured interview (SCID-I/P: First, Spitzer, Gibbon, & Williams, 1995). The SCID does not include questions about TTM. Hence, the SCID was supplemented with the Trichotillomania Diagnostic Interview modified to fit DSM-IV criteria for TTM (Rothbaum & Ninan, 1994). The severity and associated functional impairment related to participants' trichotillomania symptoms were assessed using the NIMH Trichotillomania Severity and Impairment Scales (TSS) (Swedo et al., 1989). This instrument yields a severity score that measures average time spent pulling, time spent pulling on the previous day, resistance to pulling urges, distress associated with pulling, and interference related to TTM. Each item on this portion of the TSS yields a score from 0 to 5 with 5 indicating the highest severity, resulting in a total of 25 possible points. Impairment is measured using a single item that yields a score from 0 (no impairment) to 10 (severe impairment). Data on the psychometric qualities of this clinician-guided measure are limited (Stanley et al., 1999) yet inter-rater reliability ranged from 0.78 to 0.81 in a single study (Swedo et al., 1989). Given sensitivity related to the reporting of hair pulling, a self-report inventory, the Massachusetts General Hospital Hair Pulling Scale (MGHHS: Keuthen, O'Sullivan, & Ricciardi, 1995) was also used to assess TTM symptoms. The MGHHS is seven-item instrument with individual items rated on a 0–4 point (4 = most severe) severity scale. The MGHHS has acceptable test–retest reliability and convergent and divergent validity (O'Sullivan, Keuthen, & Hayday, 1995).

Prototype awareness enhancing and monitoring device

The prototype device included: a watch, bracelet, magnetic neckband, and a pager that was hard-wired for remote activation of a vibrating alert. Participants were informed before the experimental trial began that the device (including the watch, necklace, and bracelet) was designed to alert persons with TTM to actual or near pulling behaviors and to provide precise monitoring of TTM-related behaviors. The prototype mimics a self-contained wireless unit that does not require activation from an observer that is currently under development.

Participants were informed that the prototype device was designed to provide feedback regarding the frequency and duration of TTM-related behaviors. The prototype did not have the capability to actually record TTM behaviors but this function was simulated through an experimenter-generated, computerized graphic presented to the subject at the end of the experiment. This line graph was similar to that pictured in Fig. 1 and depicted the actual frequency of touches, near pulls, or actual pulls over the course of the 4-h experimental trial.

Study design

The study protocol was a multiple baseline across individuals design. Following diagnostic assessment, participants were randomly assigned to be observed without the prototype AEMD device for either 1.5, 2, or 2.5 h in a clinical observation suite at the University of Michigan, Department of Psychiatry. The observation suite includes two rooms: an observation room for the experimenter with a one-way mirror and a button to activate the hard-wired pager alert device; and a subject room appointed with a lounge chair, television, computer, and reading material. Participants were aware that investigators were observing

through the one-way mirror throughout the experiment. After the variable baseline period, participants were observed with the prototype AEMD for the balance of a 4-h experimental period (2.5, 2, and 1.5 h, respectively). Participants were encouraged to engage in activities (e.g. reading, watching TV, using the computer) that were commonly associated with pulling in their natural environment. The multiple baseline across individuals design was utilized in order to control for potential pulling behavior decline due to time spent in the observation room, thus enhancing the internal validity of the pilot trial.

Throughout the 4 h experimental period, two investigators reached consensus regarding the occurrence, duration, and classification of TTM behaviors in real-time. If the subject pulled out a hair, the event was coded as a pull. If the subject handled a selected hair but fell short of pulling, the event was coded as a near pull. If the subject simply touched her head/face without grasping an individual hair, the event was coded as a touch. Each TTM behavior was recorded on a computer spreadsheet which was used to simulate a monitoring function (see above). During the portion of the experiment when the AEMD was in place, the vibrating alert (hardwired pager) was activated by an experimenter when the subject touched her scalp/face for at least 2 s. The device remained activated until the subject moved her hands away from her head.

At the end of the experiment, participants were asked to make estimates about the frequency and duration of their TTM behaviors (actual pulls, near pulls, touches) for comparison to the observer-generated record of these behaviors. After the participants' estimated TTM behavior frequency and duration, they were shown the graph of their actual pulling behaviors and subjective impressions were gathered from the subject about the acceptability and potential utility of the AEMD.

Results

All three participants met full structured diagnostic criteria for TTM. Table 1 reveals participants' scores on the Massachusetts General Hospital Hair Pulling Scale and the NIMH Trichotillomania Symptom Severity and Impairment Scales. Overall, the participants reported moderate trichotillomania symptoms and related impairment.

Graphic presentations of the pilot trial results are presented below (see Fig. 1). The results indicate a marked and lasting reduction in the frequency of near pulling behaviors and incidental touching after the AEMD was put in place for each subject. Actual hair pulling was rare in this trial but all pulling occurred when the device was not in place. Total mean number of TTM behaviors (pull, near pull, touch) per minute was 1.08 (SD = 0.31) without the device followed by a marked reduction to 0.09/min (SD = 0.05) after the AEMD was put in place. Mean combined duration of touches, near pulls, and pulls was 7.27 s/min (SD = 5.26) without the device and 0.12 s/min (SD = 0.02) with the AEMD in place.

Two of the three participants (subject 1 and subject 3) provided estimates of their pulling behavior during the experimental trial. Patient estimates of TTM behaviors markedly differed from rates collected by an investigator through a one-way mirror. Patients retrospectively estimated a total of 25 near pulls and 52 incidental touches, compared to 63

near pulls and 243 incidental touches recorded by the investigator. Putting it another way, only 39% of near pulls and 21% of incidental touches recorded by the investigator were estimated by the patients.

Semi-structured interviews following the experiment revealed that no participants detected that the device was activated externally rather than automatically through internal sensing capabilities. The interviews also revealed enthusiastic acceptance by all participants with each reporting that the device would be useful for themselves and their clinicians. All participants appeared to be willing to purchase an AEMD if one were available at a reasonable price.

Summary

The prototype AEMD tested in this study addresses several opportunities to improve behavioral therapy for TTM. The prototype AEMD's vibrating alert feature was associated with substantial decline in TTM-related behaviors. The decline was likely due to several factors including: TTM behavior awareness enhancement; mild punishment associated with performing TTM behaviors; reactivity to the prototype device; and negative reinforcement of behaviors that were incompatible with pulling (e.g. moving hands away from head terminated the aversive vibrating alert). The AEMD interrupted TTM behaviors quite early in the behavior chain, before extraction occurred, which is important given clinical impressions that urges usually grow after initial hair extraction. The AEMD's simulated monitoring feature yielded substantially more accurate estimates of TTM behaviors compared to retrospective recall from participants. These data clearly support the need for improved monitoring methods. Finally, the AEMD was enthusiastically endorsed by each of the three participants during post-experiment semi-structured interviews. The value of this pilot trial is tempered somewhat by the low rate of actual pulling during the experiment. However, the substantial decline in hair/head touching, which is an important HRT reduction target, provides clear support for the AEMD concept. Additionally, informing participants about the purpose of the device and the predetermined staggering of device introduction reduces the value of the pilot trial to some extent, yet the trial does provide important information about the AEMD's acceptability and potential utility. This promising pilot trial of the hard-wired, investigator activated AEMD has led us to develop a refined wireless AEMD that will automatically alert the wearer to TTM behaviors and will also monitor TTM behaviors.

The AEMD would ideally be incorporated into professionally guided habit reversal therapy. Clearly, the AEMD has great potential to enhance adherence to competing response behaviors and other vital habit reversal strategies. The device brings TTM behaviors into early awareness allowing competing response behaviors to be utilized at the first sign of pulling behavior. The termination of the alert upon moving hands away from pulling sites also likely reduces pulling behavior via negative reinforcement. The AEMD's monitoring functions will also be beneficial throughout the course of habit reversal therapy. The AEMD will be very helpful in establishing baseline and ongoing TTM behavior rates since it records TTM behaviors that occur outside of awareness which is a major advantage over current self-monitoring strategies. Additionally, the AEMD's graphic presentation of TTM

behaviors feature could also provide reinforcing feedback for TTM sufferers as they participate in HRT.

Although the AEMD is likely to be helpful for many patients with TTM, the device has certain limitations. Some TTM sufferers may turn off the device, tolerate the AEMD's alerts, or simply avoid wearing the device. This may be especially true for individuals who engage in substantial amounts of pulling that is planned, purposeful, and fully within their awareness (focused pulling). Conversely, some individuals with extensive focused pulling may find the AEMD's functions to be helpful in reducing both purposeful and automatic pulling given that even persons with severe TTM usually experience a mix of focused and automatic pulling (Woods et al., 2006). Additionally, persons with TTM who primarily pull in areas other than the head (e.g. pubic hair) may have difficulty using the device. Although the present prototype trial was conducted only with persons who pull from the head area, future devices can be developed that will be able to detect pulling in other areas. However, even with these design features, it is likely that the device will not be as helpful for persons who purposefully pull hair and/or for those who try to circumvent its design features. It is important to note that all treatments for TTM require the individual to apply some effort. Pharmacotherapy requires patients to purchase and take the medication, tolerate side effects, and attend medication review sessions. HRT requires individuals to learn HRT procedures and apply them in a concerted effort to reduce pulling. Persons unwilling to extend some effort are unlikely to benefit from the AEMD or any TTM treatment.

If the AEMD's features work as designed and are accepted by patients in daily life, future product development could include a real-time therapist extender function that could help to address adherence problems with HRT outlined above. The AEMD could be programmed to provide real-time reinforcement for improved levels of hair pulling or real-time encouragement when pulling worsens. Therapist extender functions could also include user access to a library of helping screens that describe basic and customized instruction in HRT.

Beyond its potential practical benefits, knowledge that may result from the study of the AEMD concept may also be relevant for the science of learning, brain function, and for the technology involved in its creation. It is likely optimal for the brain to move as many functions as possible to automatic control, thus leaving higher level cortical cognitive processing and attention capabilities available for other needs (Miller & Cohen, 2001). Learning to drive an automobile is an example of this phenomenon whereby early drivers consciously attend to their position within the lane, purposely activate a turn indicator before an intersection, etc. However, once a driver becomes seasoned, most of these behaviors occur outside their awareness. This process clearly facilitates safe driving given that valuable cognitive processing capacity is available for assessing potentially more salient issues such as a possible collision. Once a task is relegated to automatic functioning it is difficult to bring it back into awareness (Miller & Cohen, 2001). Most people with TTM experience just this problem when they try to stop pulling. Early efforts to pay attention to hair pulling behaviors are often difficult to initiate and maintain. It is as if the brain seeks to reestablish pulling as an automatic function requiring little directed attention. The AEMD essentially functions as an emotional/cognitive prosthetic that could help to restore cognitive awareness and control of pulling, possibly even after the device is no longer in use. The

concept of utilizing technology to remedy faulty cognitive and emotional processing is attractive and has far-reaching applications beyond hair pulling and other related impulse control disorders.

The interesting conceptualization of the AEMD as an emotional prosthetic notwithstanding, the limited effectiveness of current treatments for TTM often leaves patients, families, and clinicians in search of additional effective therapies. The AEMD, if found to be useful and effective, has great potential to significantly reduce the symptoms of TTM and its associated functional impairments.

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Fig. 1. Trichotillomania behaviors with and without awareness enhancing and monitoring device: multiple baseline across individuals design.

Table 1

Measures of trichotillomania severity across three participants

Measure	Patient 1	Patient 2	Patient 3
Massachusetts General Hospital Hair Pulling Scale	20	9	18
NIMH Trichotillomania Symptom Severity	11	11	15
NIMH Trichotillomania Impairment Scale	6	9	7