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Tolerance of the VocaLog Vocal Monitor by Healthy Persons and Individuals With Parkinson Disease

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Summary: Objective. To assess subject tolerance of extended use of the VocaLog™ vocal monitor (VM), a device marketed to log calibrated decibel sound pressure level.

Study Design. Prospective between-subjects design including two age- and sex-matched groups: individuals with Parkinson disease (IWPD) and healthy persons.

Methods. After an initial session to calibrate the device and demonstrate its use, participants wore the VM during waking hours for five consecutive days. At a second visit to return the VM, participants completed a survey and a short interview regarding their experience with and perceptions of the device.

Results. Those with PD and control subjects reported relatively few issues with use of the VM. There were no group differences regarding convenience, others' reactions, technical issues, or future participation in similar studies. Participants with PD indicated similar frequency of discomfort issues but higher severity ratings for discomfort during VM use compared with healthy participants.

Conclusions. The VocaLog™ offers a method to monitor vocal loudness during everyday activities for several consecutive days. The device was well tolerated by participants from both groups. IWPD reported greater discomfort than controls, possibly reflecting altered sensory perceptions associated with PD. The current data offer some reassurance that this VM can be tolerated by both healthy persons and those with PD for clinical and research purposes.

Key Words: Voice monitor–Parkinson disease–Instrumentation.

INTRODUCTION

Speech-language pathologists working in the area of voice disorders use a variety of aerodynamic, acoustic, perceptual, and other measurements of vocal function.[1,2] Instrumental measures may be useful for describing the voice, making diagnoses, and tracking voice changes as a function of time, disease state, or interventions.[3] Currently, instrumental measures are typically collected in a clinical environment because of factors such as environmental control, lack of portability, cost, and risk of instrumentation damage.

Effective diagnosis and management of voice disorders depends on accurate information about vocal behaviors on a day-to-day basis. Furthermore, initial treatment in the clinic can establish healthier voice patterns in cases of overuse or underuse, but this is only functional if targets are carried over to home and work situations. In instances such as these, it would be ideal to sample patients' voices in their own daily environments. Portable devices for sampling voicing outside of the clinic have become available recently and vary by the type of data recorded, the length of recording capacity, the physical parameters of the device, and pricing.[4] Per the manufacturer's website, the Ambulatory Phonation Monitor (KayPENTAX, Montvale, NJ) includes an accelerometer that adheres to the skin of the neck and a sizable recording box that can record approximately 18 hours of data regarding estimated sound pressure level (SPL) and fundamental frequency (F_0). The VoxLog (Sonovox AB, Umea, Sweden) uses an accelerometer, an environmental microphone, and a pocket-sized monitor, with a maximum recording duration of 7 days for SPL and F_0 data according to the manufacturer's website. The VocaLog™ (Griffin Labs, Temecula, CA) is a smaller vocal monitor (VM) designed to track vocal activity including decibel (dB) and phonation time for up to 3 weeks via a contact microphone and is commercially available at roughly one-fifth the cost of other portable VMs. The high portability and low cost of the VocaLog™ make it an appealing clinical option. However, tolerance for wearing the device has not yet been evaluated.

Dysphonia is a prevalent symptom among individuals with Parkinson Disease (IWPD), and increased loudness is a primary target across most current treatment strategies.[5] A portable means of monitoring vocal loudness across settings would be especially helpful in this population because impairments in motor learning[6,7] may negatively impact carryover effects of voice treatment. However, the neuropathologies underlying PD have also been show to affect sensorimotor integration, resulting in abnormal perception that may affect IWPD's tolerance for wearing the monitoring device during daily activities. Schalling et al collected subjective feedback from six IWPD who wore the previously described VoxLog. They reported positive responses to questions about ease of use, wearing the device again, and handling of the VoxLog, but some negative feedback was also provided. This included three of six IWPD indicating that the device was "unwieldily large," one indicating it was difficult to wear, another reporting a tight fit on the neck, and some relaying that people in the community commented about the presence of the device.[8] Although positive overall, these responses do suggest that wearing some type of

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monitor may be perceived negatively by IWPD. Similarly mixed reviews were reported by Hunter, in a study of teachers (n = 14) who wore an early version of a voice dosimeter developed by The National Center for Voice and Speech for 2-week intervals. The dosimeter included an accelerometer at the base of the neck and a data logging device (larger than the VM used in the present study). The teachers reported an overall positive experience. However, negative feedback was provided on survey items regarding skin irritation on the neck, carrying the dosimeter throughout the day, inconvenience, and visibility of the device by communication partners (one of whom expressed concern about recording of conversation).[8] We are unaware of studies that compared user experiences with a VM across subject populations.

The purpose of this study was to obtain user feedback regarding convenience, comfort, and distraction during use of the VocaLog and to compare responses from IWPD and healthy controls. Feedback from those wearing a VocaLog™ has not been reported. Each monitor on the market has its own physical (size, weight, and so forth) and user features that could create unique user experiences. We hypothesized that IWPD would find the VM less convenient, less comfortable, and more distracting than their healthy peers.

METHODS

Participants

Twenty adults with idiopathic PD and 20 age- and sex-matched adults without PD participated. The IWPD were 11 males and nine females between the ages of 47–89 years (mean: 64.5 years) with the PD diagnosis confirmed by their treating neurologist. None of the IWPD had hearing impairments, previous surgery or neurological conditions (other than PD) that might affect speech, or previous neurosurgical intervention for PD management. Individuals in the non-PD group had normal hearing and speech and no history of surgery or disease that might affect speech or sensory perception. They were age matched to IWPD within ±2 years (mean: 64.7 years). All participants provided written informed consent for study participation after verbal and written review of the purpose, duration, and nature of the study. The study was approved by the Human Subjects Committee at the University of Kansas Medical Center.

Instrumentation

Each VocaLog™ unit consists of a pager-sized monitor, a contact microphone held in place by an adjustable band partially surrounding the neck, a monitor-to-microphone cord, and the VocaLog™ software. A manufacturer-provided docking station and USB cable were used during calibration but were not part of the daily wear and maintenance performed by participants. Based on manufacturer reports, there are some differences in the analysis window and estimating procedures for loudness by the VocaLog™ compared with other devices. Details regarding the device's methodology and accuracy for discriminating between phonatory activity and other sounds, indexing parameters associated with vocal loudness, and estimating speaking time were not clearly defined in the manufacturer's description of the device. Results of a previous investigation, which indicated the device was accurate in logging silence and dB values that were strongly correlated with a trusted external sound level meter, have been reported elsewhere.[10] The device is also capable of real-time tactile feedback although this feature was not used in this study. The investigator-authors had no involvement in the development, manufacture, or sale of the device.

Procedures

Each participant attended two study sessions in the laboratory and wore the VM for several intervening days as part of another study protocol. During the first session, the contact microphone was custom fit for comfortable wear, participants were provided with instructions and practice for donning/doffing the device, and the VM was calibrated. Participants left the session with the VM in place and wore it during waking hours for 5 consecutive days while performing their normal daily activities. They returned to the laboratory and completed a post-study questionnaire (Appendix A), as well as additional voice recordings for other protocols. Using 10-cm visual analog scales (VAS), wherein 0 represented no problems for a parameter and 100 indicated maximum difficulty, each subject rated: comfort, distraction to the speaker, distraction to the listening partner, convenience, and embarrassment factors. They also answered several other queries regarding whether they would advise others to use such a device, technical issues across the 5 days of wear, and factors pertaining to participation in the study (motivation to contribute to research, time involved, and so forth).

Calipers were used to measure from the left end of the VAS line to the subject's mark for each of the 5 main ratings. These data were compared across groups using *t* tests. Comments from the related interviews were categorized, tallied, and compared across groups via chi-square tests.

RESULTS

Mean ratings clustered in the lowest 30% of the VAS for both groups across all ratings. IWPD reported higher scores (ie, lower tolerance) than non-PD participants in all areas except embarrassment, but differences were statistically significant only for overall comfort (Table 1). The IWPD's mean rating (32.9 mm) was statistically significantly higher than the controls (21.1 mm) and indicated a greater sense of discomfort by the PD group.

Responses to the open-ended interview questions revealed further details about the experiences of IWPD and controls who used the VM. There was a trend toward greater frequency of complaints within the PD group for categories of convenience, discomfort, and technical issues, but group differences did not reach statistical significance for any category or subcategory (Table 2).

A majority of participants from each group reported some inconveniences associated with use of the VM (75% of IWPD and 65% of controls). Positioning of the device and cord during everyday activities (and associated wardrobe issues such as

TABLE 1.
Visual Analog Scale (VAS) Ratings out of 100 mm From Individuals With Parkinson Disease (PD) and Healthy Controls who Wore the VocaLog™ Monitor for Several Days

	VAS Rating (mm)				
	PD	Control	*T*	df	*P*
Convenience					
Mean	30.7	21.5	1.576	38	0.123
SD	19.6	17.4			
Comfort					
Mean	32.9	21.1	2.153	38	**0.038**
SD	17.9	16.5			
Distraction to user					
Mean	24.8	16.9	1.152	38	0.256
SD	21.3	21.7			
Distraction to others					
Mean	17.9	15.6	0.329	38	0.744
SD	21.4	21.9			
Embarrassment					
Mean	6.9	7.9	−0.338	38	0.737
SD	7.3	11.8			

Abbreviation: SD, standard deviation.
The bolded p-value indicates that the group differences achieved statistical significance at less than or equal to .05.

choosing pants with pockets to hold the VM) were the most prevalent convenience-related criticisms.

Group differences in comfort were not present but sizable percentages of each group reported discomfort (50% of IWPD and 35% of controls). Participants who reported discomfort described specific feelings of itchiness, sweatiness, and tightness associated with the neck microphone, and general awareness of the VM's presence. The discomfort was generally not severe enough to interfere with study participation. One IWPD experienced neck irritation to a degree that caused him to discontinue wearing the VM after the first day of data logging.

The PD and control groups did not differ in the proportion who noticed reactions to the VM from communication partners or others during daily activities. Although there were not group differences, the majority of users in each group (60% of IWPD and 65% of controls) reported some reaction from others. Sixty percent of participants indicated that others had obviously noticed and/or inquired about the device. Two control participants noted that communication partners expressed concern about conversations being recorded. Study participants across groups reported that an average of 3.6 people inquired about the VM device over the 5 days of wear with a range of 0 to more than 20 inquiries reported.

The groups did not differ in terms of self-reported technical issues related to wearing the device. The majority of participants indicated no technical issues (75% of IWPD and 90% of controls). There did not appear to be any particular technical issue that occurred with higher frequency than others.

Finally, most participants from both groups indicated that they would volunteer to wear the VM device for another study in the future (100% of IWPD and 85% of controls) and would encourage others to do so (95% of both groups). Of those who offered specific reasons for these responses, a desire to contribute to research, ease of use, and minimal discomfort were cited as incentives, whereas the time and expense of traveling to the study site were deterrents.

DISCUSSION

The VM is intended for home use by individuals with voice issues or with suspected voice issues. Individuals who wore the device across several consecutive days reported some perceptions that need to be considered by those interested in using the VMs. Additionally, detailed information about the user experience might enable providers to preemptively address any potential challenges to the utilization of the VM for a given user.

Although no group differences were observed, sizable percentages of both the PD and control groups reported issues with the convenience of wearing the device. Most of these concerns pertained to positioning the device, microphone, and cord, and to planning wardrobe choices to accommodate the device. Simple adaptations such as the use of a nonslip substance like Dycem on the microphone might prevent it from shifting during wear without making the device tighter on the neck. The addition of a belt clip to the logging device would likewise ease its placement. A few participants from both groups reported that wearing the VM disrupted their daily routine. Although virtually all users indicated they would wear the device again and would even encourage others to wear one, clinicians might need to talk to potential users about ways to minimize inconvenience and to possibly convey a strong rationale for why wearing the device is important. Overall, the current findings are in general agreement with Schalling et al who also evaluated feedback from IWPD after wearing a monitor that was similar, but not identical, to the VM. That is, users reported a positive response in general, but also some negative feedback regarding its wear and noticeability by communication partners.

Participants in the PD group reported similar frequency and types of complaints about discomfort as those from the control group, but the intensity of IWPD's discomfort as rated on the VAS was higher than the controls. This may be a reflection of nonmotor symptoms of PD, which include both sensory and neuropsychiatric components. Mounting evidence indicates that IWPD exhibit altered sensation and sensory integration of auditory, visual, and pain cues.[6,11–14] Both peripheral and central sources of distorted sensation in PD have been described.[15] The basal ganglia appear to have a key role in sensory gating, in that they can inhibit cortical responses to sensory information.[11,16,17] The insula also has been implicated as contributing to nonmotor symptoms of PD.[18] PD-related changes in certain brainstem nuclei and neurotransmitters appear to alter the excitability of neurons associated with pain modulation.[19] Histological studies identified abnormalities in the pharyngeal nerves of IWPD.[20] Because of these disruptions in afferent neurophysiology, IWPD may actually sense pain differently than their

TABLE 2.
Comparison of the Proportion of Parkinson Disease (PD) and Control Group Subjects Reporting Specific Types of Inconvenience, Discomfort, Reactions by Others, and Technical Issues Related to Wearing the VocaLog™ Monitor

	PD (N)	Control (N)	χ^2	*P*
Inconvenience				
None	5	7	0.476	0.490
Device placement and cord issues	11	7	1.616	0.204
Wardrobe issues	2	4	0.784	0.376
Social activity concern	2	3	0.229	0.633
Disrupted daily routine	3	3	0.000	1.000
Discomfort				
None	10	13	0.921	0.337
Related to cord	3	0	3.243	0.072
Related to microphone position	4	4	0.000	1.000
Related to sensation on neck	5	3	0.625	0.429
Reactions by others				
None	8	7	0.107	0.744
Inquired about device/study	7	6	0.114	0.735
Noticed but did not ask	5	6	0.125	0.724
Assumed other purpose for VM	4	4	0.000	1.000
Fear of being recorded	0	2	2.105	0.147
Technical issues				
None	15	18	1.558	0.212
Beeping/vibrating	2	0	2.105	0.147
Accidentally pushing button	0	1	1.026	0.311
Not knowing VM was on/off	0	1	1.026	0.311
Positioning of device	2	0	2.105	0.147
Cord catching/unplugging	1	0	1.026	0.311
Future participation				
Volunteer for similar study again	20	17	3.243	0.072
Encourage others to volunteer	19	19	0.000	1.000
No reasons provided	9	12	9.023	0.342
Motivation: research contribution	7	4	1.129	0.288
Motivation: easy to use	2	3	0.229	0.633
Motivation: minimal discomfort	3	0	3.243	0.072
Disincentive: transportation cost	2	0	2.105	0.147

Notes: There were no statistically significant group differences for any variable.

non-PD peers. Additionally, neuropsychiatric issues such as anxiety, depression, and sleep disorders have been widely described in PD[21] and are associated with lower quality of life scores and higher pain levels across a number of chronic diseases such as fibromyalgia,[22] multiple sclerosis,[23] and PD.[24,25] The higher discomfort ratings reported by IWPD are consistent with other reports of nonmotor symptoms of PD and must be considered when using the VM in IWPD.

The results of the present study suggest that the use of a voice monitoring device may affect the speaker's communication behaviors as well as those of their interaction partners. First, the very presence of the device used by Schalling et al[8] served as a reminder to speak louder and more often according to participant reports. Furthermore, Hunter reported that 7 of 14 teachers felt the dosimeter affected their voice (unspecified as to how) and 5 never reached a point that they were unaware of the monitor when wearing it even after 2 weeks of continuous use.[9] The current findings along with those from Schalling et al and Hunter suggest that simply wearing a VM may alter when and how the wearer communicates. Second, the majority of people wearing the VM in the present investigation as well as all 14 teachers from Hunter's study reported that others commented on or noticed the device.[9] Although the impact of the device on the communication behavior of those with whom the wearer is interacting was not measured in any of the referenced studies, the potential implications must be considered in evaluating any data logged by the device. Eliminating the wearer's awareness of the monitor may be impossible, but the effects on conversation partners may be minimized if the user takes steps to fully conceal the device under clothing. Alternatively, participants and their communication partners should be reassured that the VM is only capable of logging vibrations of the neck tissue and therefore cannot record articulatory movements or ambient sounds from other speakers or the environment. Finally, advances in smartphone technology may offer more socially acceptable and cost-effective means of monitoring voice use over time.[26]

Few technical issues were reported by wearers from either group. This could be a reflection of the relatively simple design of the device, the brief training provided at the initial session, or the technological savvy of the participants. The VM, as configured for this study, did not require participants to push its single button or unplug the microphone for any reason. Additionally, the contact microphone was held in place by a flexible semicircular band that was fit to each participant's neck during the first visit; no adhesive was necessary.

In summary, participants generally found the VM to be innocuous, to the extent that they would use the device again and recommend it to others. There were few group differences in tolerance ratings in contrast to the expected outcome. The minimal inconvenience and discomfort associated with VM use appeared to be outweighed by the perceived advantages such as contributing to the advancement of research even without personal benefit. These results extend the findings of previous studies using larger devices, wherein healthy participants and those with PD reported occasional physical and social discomfort associated with VM use. The specific and detailed feedback from participants in this study offers opportunities to make the VM more acceptable to future wearers. The results of this study suggest that the VocaLog could be tolerated by a variety of populations in future studies with minimal modifications.

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APPENDIX A

POST-STUDY QUESTIONNAIRE

Please answer the following questions as honestly and with as much detail as possible. For the items that ask you to rate a particular aspect of the vocal monitor, please place a slash or "tic" mark on the line to indicate your rating.

Convenience

1. Please rate how convenient the Vocal Monitor was to use:

Extremely convenient extremely inconvenient

2. Please explain any specific problems you had with the Vocal Monitor that made its use inconvenient:

_____
_____
_____
_____

3. Did you have any difficulty remembering to wear the Vocal Monitor in the morning? If so how frequently did this occur?

_____
_____

Comfort:

4. Please rate how comfortable you found the Vocal Monitor:

Extremely comfortable extremely uncomfortable

5. Please explain any specific problems you had with the Vocal Monitor related to how comfortable it was to use:

_____
_____
_____
_____
_____

Distraction:

6. Please rate the level of distraction/disruption wearing the Vocal Monitor created in your daily life:

Little to no distraction high level of distraction

7. Did wearing the Vocal Monitor keep you from engaging in any of your normal daily activities? Please explain:

_____
_____
_____
_____
_____

8. Please rate the level of distraction the Vocal Monitor created for people that you talked to during your daily activities:

Little to no distraction high level of distraction

9. Did other people ask you about the Vocal Monitor? If so, approximately how many?

_____

10. Please describe some of the reactions other people had to your Vocal Monitor:

_____
_____
_____
_____
_____
_____
_____

11. Please rate the level of embarrassment you felt while wearing the Vocal Monitor:

little to no embarrassment Extremely embarrassed

12. Did you find the Vocal Monitor easy to hide under clothing? Please describe any measures you took to conceal the Vocal Monitor and if it was successful:

Technical Issues:

13. Did you experience any technical problems with the Vocal Monitor (beeping, or vibrating etc)? Please explain:

14. What advice would you give to other people that may participate in a study using a Vocal Monitor?

15. Would you encourage other people to participate in a study using a Vocal Monitor? Would you participate in another study using a Vocal Monitor? Why or why not?