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A Comparison of Voice Amplifiers and Personal Communication Systems for Hypophonia: An Exploration of Communicative Participation

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ABSTRACT

Purpose: The primary purpose of this study was to evaluate how individuals with hypophonia (HP; also referred to as HP participants) and their primary communication partners (PCPs; also referred to as PCP participants) rate communicative participation before and after experience with a speech amplification device. A secondary purpose was to evaluate pre- and post-device effects on self-rated communicative participation for each of the three speech amplification devices trialed outside of the laboratory.
Method: Seventeen individuals with HP and their PCPs participated in a crossover design study that compared three different amplification devices: a wired belt-pack amplifier, a wireless stationary amplifier, and a personal frequency modulation (FM) system. Both the individuals with HP and their PCPs self-rated communicative participation at baseline and after trialing each device following 1-week device trial periods at home. Patient-reported outcome measures included the Communicative Effectiveness Survey (CES) and the Voice Activity and Participation Profile (VAPP). Following study completion, participants indicated whether they would like to select a specific device to continue using.
Results: Overall, HP participants rated communicative participation following device use higher than that in the pre-device condition, with the FM system resulting in the overall highest VAPP ratings and second highest CES ratings. Furthermore, HP and PCP participants rated these measures similarly. Finally, HP participants who selected a device to continue using self-reported lower total communicative effectiveness scores and greater voice activity limitations and participation restrictions at baseline in comparison to the nonselectors.
Conclusions: This study contributes to an increased understanding of how communicative participation is experienced within this clinical population resulting from speech amplification. It is suggested that the inclusion of participation-based outcome measurement is essential to ensure a multidimensional and comprehensive approach to device prescription for individuals with HP.

Hypophonia (HP) is one of the primary dysarthric speech features of hypokinetic dysarthria associated with Parkinson's disease (PD; Adams & Dykstra, 2009; Logemann et al., 1978) and multiple system atrophy (MSA; Testa et al., 2001). Speech intensity levels for individuals with HP (also referred to as HP participants) are, on average, 2–5 dB SPL lower than those for healthy, age-matched control participants (Adams et al., 2006; Fox & Ramig, 1997). A robust body of literature demonstrates

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that individuals with HP can have difficulty regulating speech intensity in conversational tasks (Adams et al., 2006; Fox & Ramig, 1997; Ho, Bradshaw, et al., 1999; Ho, Iansek, & Bradshaw, 1999; Kempler & Van Lancker, 2002).

Treatment approaches for hypokinetic dysarthria are classified as behavioral treatment approaches, such as the Lee Silverman Voice Treatment (Ramig et al., 2004); in-ear devices that capitalize on the Lombard effect to increase vocal intensity, such as SpeechVive (Rodriguez et al., 2022; Stathopoulos et al., 2014); and biofeedback approaches, such as sound-level meters, oscilloscopes, and Visi-Pitch (PENTAX Medical, 2019). Common to these approaches is the goal of improving various aspects of speech and voice impairments associated with hypokinetic dysarthria, including HP. Despite this goal, an issue with biofeedback and behavioral speech therapy is the maintenance and transfer of gains made beyond the clinical setting, known as the "transfer of treatment" issue (Adams & Dykstra, 2009; Gaballah et al., 2019; Rubow & Swift, 1985). Furthermore, many individuals with PD and MSA face additional challenges, such as memory impairment and cognitive dysfunction (Costa et al., 2008; Pfeiffer et al., 2014; Testa et al., 1993). These factors may also contribute to difficulties with the maintenance of new skills or behavioral changes learned in treatment (Oxtoby, 1982). The "transfer of treatment" issue is arguably one of the most important concerns in the treatment of hypokinetic dysarthria.

A potential solution to the "transfer of treatment" issue is the use of assistive speech amplification devices. Speech amplification devices are a type of portable augmentative and alternative communication device that serves to amplify an individual's natural voice. Speech amplification devices may contribute to significant improvements to speech intelligibility and speech intensity by increasing the audibility of speech and by facilitating self-correction through self-monitoring (Greene et al., 1972). An advantage of amplification devices is they require little instruction or training, and users are not required to develop new patterns of behavior (Adams & Dykstra, 2009). Furthermore, these devices can provide immediate benefit to an individual's communication, and this benefit will remain in effect for as long as the individual continues to utilize the assistive device (Adams & Dykstra, 2009).

Speech amplification devices can be divided broadly into two categories: voice amplifiers and personal frequency modulation (FM) systems (Adams & Dykstra, 2009). Voice amplifiers can be further divided into two main classes of devices: wired portable and wireless stationary. Portable wired voice amplifiers typically have a speaker system that is worn on the body around the waist, clipped to a pocket, or worn on a lanyard. Attached to this portable amplifier is a headset or lavalier microphone that is worn by the user (Knowles et al., 2020). Stationary voice amplifiers include a microphone that is attached to a small unit that transmits the speech signal wirelessly to an audio speaker located up to several meters away from the talker (Knowles et al., 2020; see also Duffy, 2013). The third category of speech amplification is a wireless FM communication system. FM systems represent a novel approach for the treatment of HP because of their typical application for individuals with hearing loss (Harkins & Tucker, 2007; Laplante-Lévesque et al., 2010). When an FM system is modified for an HP application, the individual with HP wears the headset microphone, and their speech is transmitted wirelessly to a pocket-size very high frequency (VHF) receiver and amplified through headphones worn by their communication partner. With the exception of studies by Andreetta et al. (2016) and Knowles et al. (2020), there appear to be no other studies that have reported using FM communication systems for the treatment of HP.

Knowles et al. (2020) compared the performance of three amplification devices for HP across the parameters of speech-to-noise ratio (SNR) and sentence intelligibility. The results of this study revealed that speech amplification produced beneficial outcomes, as evidenced by greater SNR levels and sentence intelligibility, in comparison to no device use in both quiet and background noise conditions. Interestingly, for the acoustic and perceptual measures of SNR and sentence intelligibility, the FM system was associated with higher SNR levels and higher sentence intelligibility scores, respectively, compared with those of the wireless stationary amplifier (Nady WA-120BT; similar to the BoomVox) or the portable wired belt-pack speech amplifier (ChatterVox).

Although the acoustic and perceptual outcome measures are essential in the evaluation of speech amplification devices, it is also essential to include patient-reported outcomes measuring the construct of communicative participation to provide a multidimensional lens of rehabilitation (Threats, 2007). The construct of communicative participation has its roots within the conceptual framework of the World Health Organization's (WHO's) International Classification of Functioning, Disability and Health (ICF; WHO, 2001). According to the ICF, "participation" is a construct that refers to the nature and the extent of an individual's involvement in life situations (WHO, 2001). Restrictions in participation represent the difficulties individuals can experience in life situations due to the circumstances of their health condition (WHO, 2001). Eadie et al. (2006) defined *communicative participation* as "...taking part in life situations where knowledge, information, ideas or feelings are exchanged. This may take the form of speaking, listening, reading, writing or nonverbal means of communication" (p. 309). Included within

the construct of participation is *communicative effectiveness*, defined as one's ability to communicate messages successfully in home and community settings to fulfill life roles (Hustad, 1999). Communicative participation has been explored and examined in hypokinetic dysarthria across several studies (Baylor et al., 2011; Dykstra et al., 2015; McAuliffe et al., 2017), all of which have demonstrated interferences to communicative participation in this population. Unfortunately, what remains understudied and poorly understood is how communicative participation is rated following interventions targeted at increasing speech intensity or improving speech intelligibility. What also remains unknown is if communicative participation affects one's decision to adopt the use of a speech amplification device in their daily lives.

Communicative participation has also been studied from the perspective of proxy ratings made by the primary communication partners (PCPs; also referred to as PCP participants) of individuals with hypokinetic dysarthria (Donovan et al., 2008; Dykstra et al., 2015). Since communication is inherently dyadic in nature, obtaining the perspectives of PCPs is important because it can determine if differences in perception exist and can be of value clinically in the provision of strategies to overcome communication breakdown between partners (Dykstra et al., 2015). Unfortunately, the potential differences or similarities in how individuals with HP and their PCPs rate communicative participation following speech amplification device use remain unexplored.

Purpose

This study extends the research of Knowles et al. (2020), who evaluated user performance of three amplification devices (i.e., ChatterVox, Nady WA-120BT, and Nady 351-VR) across acoustic (SNR) and perceptual (speech intelligibility) parameters in both quiet and background noise conditions (Knowles et al., 2020). The primary purpose of this study was to evaluate how individuals with HP and their PCPs rate communicative participation before and after experience with a speech amplification device. A secondary purpose was to evaluate pre- and post-device effects on self-rated communicative participation for each of the three speech amplification devices trialed outside of the laboratory.

Three main objectives were examined in this study:

1. to evaluate self-rated communicative participation at baseline and after device use,
2. to determine if ratings of communicative participation differ for individuals with HP versus their PCPs, and
3. to explore potential differences in communicative participation at baseline between participants who selected a device versus those who did not.

Method

This study is part of a larger data set collected by Knowles et al. (2020), who sought to identify device preference and the performance of three amplification devices hypothesized to improve speech intensity and speech intelligibility for individuals with HP. A clinical crossover design was employed to compare three types of amplification devices that could be used by individuals with communication disorders: a wired belt-pack voice amplifier (Device A), a wireless personal amplifier (Device B), and a wireless personal FM communication system (Device C). The Western University Human Research Ethics Board approved this study (HSREB: 106169), and it was registered as a clinical trial (ClinicalTrials.gov Identifier: NCT02407067).

Participants

Two groups participated in this study: individuals with HP (HP group) and their PCPs (PCP group). The HP group included 17 individuals with HP (four women, 13 men; age range: 54–78 years). Of these individuals, 15 had a primary diagnosis of idiopathic PD confirmed by their primary neurologist (author M.J.). One individual had a primary diagnosis of MSA-predominant cerebellar ataxia, and one had a diagnosis of possible Parkinsonism. All individuals were judged to have HP by an experienced movement disorder neurologist (author M.J.). Inclusion criteria for the HP participants included that they (a) had received a neurological diagnosis at least 6 months prior to testing, (b) exhibited mild-to-moderate HP (as rated by an experienced speech-language pathologist [SLP; author S.G.A.]), (c) were between the ages of 50 and 85 years, (d) had no history of other neurological or voice disorders, and (e) were otherwise in good general health. All HP participants were stabilized on anti-Parkinson's medication, except for one participant (HP13) who had recently adjusted his medication schedule. Seven participants had received deep brain stimulation surgery of the subthalamic nucleus as an adjunctive intervention to treat the symptoms of PD. Eight participants had previously received speech therapy to address speech concerns related to PD. Hearing screenings were done at a 40 dB HL threshold at 500, 1000, 2000, and 4000 Hz in both ears, and failing the screening was not an exclusion criterion. Seven HP participants passed the hearing screening, and 10 participants failed at one or more frequencies. Cognitive status was not an exclusion criterion, although the Montreal Cognitive Assessment (Nasreddine et al., 2005) was used to screen for

cognitive impairment. Participant demographics for the HP group are presented in Table 1.

The second group of participants was composed of individuals serving as PCPs to their respective partner with HP. The PCP group included 17 individuals (13 women, four men; age range: 54–79 years). Prior to primary-study enrollment conducted by Knowles et al. (2020), each potential HP participant was instructed to select someone with whom they spoke regularly to accompany them to all study visits. In 16 cases, this was a spouse, and in one case, it was an adult child (PCP13). To not place restrictions on the selection of the communication partner most appropriate for the HP participants, the only inclusion criterion for the PCP group was that they were between 18 and 85 years of age. Hearing status was not an exclusion criterion, but hearing screenings for the PCP group were completed. Screenings were done at a 40 dB HL threshold at 500, 1000, 2000, and 4000 Hz in both ears, and failing the screening was not an exclusion criterion. Eleven PCP participants passed the hearing screening, whereas four PCP participants (PCP04, PCP07, PCP17, and PCP21) did not pass the 40 dB HL hearing screening and did not wear hearing aids. Two PCP participants wore hearing aids (PCP06 and PCP14). The role of the PCP participants was to provide device ratings alongside their partner throughout the trial periods, including outcome measures related to communicative participation.

Devices

On the basis of recommendations by Andreetta et al. (2016) and of the Knowles et al. (2020) protocol, four device conditions were included: a pre-device condition and three device conditions referred to as Devices A, B, and C. These three devices were chosen to capture an array of device styles and device capabilities and to appeal differently to each participant dyad based on factors such as lifestyle, communication needs, and speech symptoms (Knowles et al., 2020).

Device A is a portable wired belt-pack speech amplifier (ChatterVox; 5 W). The talker wears a lightweight headset microphone connected to an external speaker worn as a belt pack.

Device B (Nady WA-120BT; 20 W) is a wireless personal amplifier, similar to the BoomVox in form and function, consisting of a lightweight, wireless headset microphone (Nady HM-20U) that transmits wirelessly over a VHF channel to a stationary speaker that projects speech several meters away from the talker. The external speaker is 21 × 26 × 13 cm and weighs 2.4 kg.

Device C (Nady 351-VR) is a personal FM communication system, similar to the Phonic Ear Easy Listener. A lightweight headset microphone (Nady HM-20U) worn by the talker transmits the speech wirelessly to a pocket-size VHF receiver, which is then amplified through headphones worn by the listener. In the primary study by Knowles et al. (2020), the HP participants wore the headset microphone, and the PCP participants wore the headphones.

Patient-Reported Outcome Measures

The HP participants completed two patient-reported outcome measures, namely, the Communicative Effectiveness Survey (CES; Donovan et al., 2007) and the Voice Activity and Participation Profile (VAPP; Ma & Yiu, 2001), from their own perspective. PCP participants completed the same set of patient-reported outcome measures from the perspective of how they perceived the communicative participation of their partner with HP. HP participants completed the Levels of Speech Usage (LSU; Baylor et al., 2008) scale only during the baseline visit as a means of providing additional context related to their level of habitual speech usage.

The CES (Donovan et al., 2007) is an eight-item patient-reported outcome measure of communicative effectiveness across eight different communicative contexts. Using a 4-point Likert scale ranging from 1 (*not at all effective*) to 4 (*very effective*), the individuals rate how effectively they communicate in each communicative context and situation. Lower CES scores are associated with poorer ratings of communicative effectiveness, and higher CES scores are associated with better ratings of communicative effectiveness. The CES was selected to measure communicative participation because it has been used in several studies exploring communicative effectiveness for individuals with hypokinetic dysarthria (Donovan et al., 2007, 2008; Dykstra et al., 2015), contains items that are applicable and relevant for speech amplification device use, and is a valid and reliable measure of communicative participation (Donovan et al., 2007, 2008).

The VAPP (Ma & Yiu, 2001) is a 28-item patient-reported outcome measure that evaluates the activity limitations and participation restrictions of individuals with voice disorders. Each item is scored on a 100-mm visual analog scale, with the anchors *never* and *always* (Ma & Yiu, 2001). The VAPP consists of five sections: self-perceived severity of voice problem, effect on job, effect on daily communication, effect on social communication, and effect on emotion. Each section of the questionnaire constitutes a section score. The sum of the five section scores gives rise to the total score, which is a maximum of 280. Items in each of Sections 2 (Job), 3 (Daily Communication), and 4 (Social Communication) can be further computed to give rise to two additional scores for each

Table 1. Participant demographics for the hypophonia (HP) group.

Participant	Sex	Age	LED	Diagnosis	Years since diagnosis	DBS	UPDRS	UPDRS Speech	MoCA	LSU	HP hearing screening	PCP hearing screening
HP01	M	75	750	PD	9	No	40	3	16	I	Fail	Pass
HP02	M	54	0	PD	7	Yes	31	3	22	U	Fail	Pass
HP03	M	75	750	PD	8	No	29	2	23	U	Fail	Pass
HP04	F	78	800	PD	14	No	35	2	20	I	Fail	Fail
HP06	M	67	550	PD	21	Yes	29	3	22	U	Fail	Hearing aids
HP07	F	72	0	PD	16	No	30	1	26	R	Pass	Fail
HP08	M	65	1200	PD	15	No	20	1	21	U	Pass	Pass
HP11	M	72		PD	11	Yes			20	I	Pass	Pass
HP12	M	59	400	PD	10	Yes	37	2	24	I	Pass	Pass
HP13	M	71	400	PD	0.5	No	31	1	22	I	Fail	Pass
HP14	F	67	600	PD	31	Yes	43	2	19	I	Fail	Hearing aids
HP16	M	70	100	PD	17	Yes	18	2	23	I	Fail	Pass
HP17	M	71	0	MSA-C	5	No	23	2	27	I	Fail	Fail
HP18	M	72	820	PD	2	No	45	3	25	U	Fail	Pass
HP19	M	59	1350	MSA-P	8	No	52	3	26	I	Pass	Pass
HP21	M	60	610	PD	12	No	17	2	29	I	Pass	Fail
HP22	F	68	750	PD	15	Yes	36	1	25	I	Pass	Pass

Note. **Bolded** participants indicate device selectors. LED = levodopa equivalence dosage; DBS = deep brain stimulation; UPDRS = Unified Parkinson's Disease Rating Scale; UPDRS Speech = speech item score from the UPDRS; MoCA = Montreal Cognitive Assessment; LSU = Levels of Speech Usage scale; PCP = primary communication partner; M = male; PD = Parkinson's disease; I = intermittent; U = undemanding; F = female; R = routine; MSA-C = multiple system atrophy—cerebellar type; MSA-P = multiple system atrophy—Parkinsonian type.

section: (a) The Activity Limitation Score (ALS) is derived from the first question of each category and ascertains the extent of activity limitation. These questions include the following: "Is your job affected by your voice problem?" "Do people ask you to repeat what you have just said because of your voice problem?" and "Does your voice problem affect you in social activities?" (b) The Participation Restriction Score (PRS) is derived from the second question of each category, which ascertains the extent of participation restriction. These questions include the following: "In the last six months, have you thought of changing your job because of your voice problem?" "In the last six months, have you ever avoided talking to people because of your voice problem?" and "In the last six months, have you ever avoided social activities because of your voice problem?" (Ma & Yiu, 2001). Higher VAPP scores are associated with greater activity limitations and participation restrictions (i.e., higher scores are worse), and lower VAPP scores are associated with less activity limitations and participation restrictions. The VAPP was selected as the second measure of communicative participation because it is a valid and reliable instrument to measure voice-related activity limitations and participation restrictions (Ma & Yiu, 2001).

The LSU (Baylor et al., 2008) is a self-report categorical scale used for describing and coding the speech usage of individuals and across a range of communication disorders. Speech usage is rated in terms of the amount, frequency, type, and importance of speaking situations that people may encounter (Baylor et al., 2008). HP participants selected their everyday degree of speech usage from five different categories: undemanding, intermittent, routine, extensive, and extraordinary (Baylor et al., 2008).

Protocol

HP and PCP participants completed the study over four visits, described in greater detail below. Briefly, the baseline visit consisted of a single visit to the laboratory (Visit 1). During the baseline visit, participants completed the patient-reported outcome measures described above and briefly trialed each of the three devices. During Visits 2–4, participant dyads were given each device for 1 week at a time to try at home. Following these longer home trial periods, either participant dyads would return to the laboratory or the researcher (author T.K.) would visit them in their homes at which time the participant dyad completed the two participation-based patient-reported outcome measures (CES and VAPP).

Visit 1: Baseline

During the baseline visit, the HP and PCP participants completed two patient-reported outcome measures (CES and VAPP). HP participants also completed the LSU only during the baseline visit. Following the completion of the patient-reported outcome measures, hearing and cognitive screenings were completed. The details of the primary study that included the additional outcome measures of SNR and speech intelligibility are described in a previous report (see Knowles et al., 2020).

Visits 2–4: At-Home Device Trials

At the end of the baseline visit, one of the three devices was randomly selected to be trialed first. A randomization plan was developed for the selection of the second and third devices (see Table 2). HP participants were informed that they would be given the opportunity to try each of the three devices at home, over three separate trial periods, lasting approximately 1 week each. HP participants were instructed on the basic elements of use for the device they would trial. In order to ensure that participants could experience several communicative contexts and situations and become familiar with each device, participants were instructed to use the device at least twice during the week, for at least 2 hr, in more than one setting, and with more than one person, if possible. Participants were instructed to indicate if they did not adhere to these instructions. No participants self-reported any issues adhering to the device use instructions.

Following the completion of each 1-week device trial period, the participant dyads met with the researcher (author T.K.; a single visit following each 1-week device

Table 2. Device order and randomization.

Participant	Device Trial 1	Device Trial 2	Device Trial 3
HP01	C	A	B
HP02	B	C	A
HP03	A	C	B
HP04	C	A	B
HP06	B	C	A
HP07	C	A	B
HP08	A	B	C
HP11	C	B	A
HP12	C	A	B
HP13	C	B	A
HP14	C	A	B
HP16	C	B	A
HP17	A	C	B
HP18	A	B	C
HP19	B	A	C
HP21	A	C	B
HP22	B	A	C

Note. HP = hypophonia; A = ChatterVox; B = Nady WA-120BT; C = Nady 351-VR.

trial period) at which time the participants completed the battery of patient-reported outcome measures related to communicative participation (i.e., CES and VAPP). Both the HP and PCP participants completed their own set of patient-reported outcome measures as described in the baseline visit. Consistent with the baseline visit, each HP participant was instructed to complete the patient-reported outcome measures from their own perspective, whereas PCP participants were instructed to complete the patient-reported outcome measures in terms of how they perceived their partner.

Statistical Analyses

The statistical analyses of each study objective are described below.

Self-Rated Communicative Participation Reported by HP Participants: Pre- Versus Post-Device

CES. A repeated-measures (RM) analysis of variance (ANOVA; Total CES) and one RM multivariate analysis of variance (MANOVA) with eight dependent variables determined if there were changes in communicative effectiveness at baseline (pre-device) versus post-device use. There was one within-group independent variable: device with four levels (pre-device, post–Device A, post–Device B, and post–Device C). Communicative effectiveness item mean scores comprised the eight dependent variables. Post hoc evaluations compared pre- and post-device effects for each of the three speech amplification devices trialed. The following specific pre- and post-device condition comparisons were evaluated: (a) pre-device versus post–Device A, (b) pre-device versus post–Device B, and (c) pre-device versus post–Device C.

VAPP. Three RM ANOVAs (Total VAPP, ALS VAPP, and PRS VAPP) and an RM MANOVA with four dependent variables determined if there were changes in VAPP scores across pre- versus post-device use. There was one within-group independent variable: device with four levels (pre-device, post–Device A, post–Device B, and post–Device C). The subscale categories (Cs) on the VAPP served as the four dependent variables (C1: "self-perceived severity of voice problem," C3: "effect on daily communication," C4: "effect on social communication," and C5: "effect on emotion"). Although there are a total of five subscale categories on the VAPP, C2: "effect on job" was omitted because most HP participants were retired from employment. Post hoc evaluations compared pre- and post-device effects for each of the three speech amplification devices trialed. The following specific pre- and post-device condition comparisons were evaluated: (a) pre-device versus post–Device A, (b) pre-device versus post–Device B, and (c) pre-device versus post–Device C.

HP Versus PCP Self-Rated Communicative Participation Evaluated in the Four Device Conditions

Please note that for this objective, the variable of interest is group (i.e., HP vs. PCP), and as a result, univariate statistics and post hoc comparisons are not reported for the device comparisons.

CES. A two-factor RM ANOVA (Total CES) and a two-factor RM MANOVA evaluated differences in CES scores between HP and PCP participants across device conditions. There was one between-groups independent variable: group with two levels (HP participants and PCP participants). There was one within-group independent variable: device with four levels (pre-device, post–Device A, post–Device B, and post–Device C). Communicative effectiveness item mean scores comprised the eight dependent variables.

VAPP. Three two-factor RM ANOVAs (Total VAPP, ALS VAPP, and PRS VAPP) and a single two-factor RM MANOVA evaluated differences in VAPP scores between HP and PCP participants in each of the device conditions. There was one between-groups independent variable: group with two levels (HP participants and PCP participants). There was one within-group independent variable: device with four levels (pre-device, post–Device A, post–Device B, and post–Device C). VAPP subscale category scores comprised the four dependent variables.

Selector Versus Nonselector Self-Rated Communicative Participation at Baseline (Pre-Device)

Please note that for this objective, the variable of interest is group (i.e., selectors vs. nonselectors), and as a result, univariate statistics and post hocs are not reported for the device comparisons.

CES. A two-factor RM ANOVA (Total CES) and a two-factor RM MANOVA compared differences in self-rated communicative participation at baseline between HP participants who selected a device to continue using (selectors) and HP participants who chose not to continue using a device (nonselectors) following study completion. There was one between-groups independent variable: group with two levels (selectors and nonselectors). There was one within-group independent variable: device with four levels (pre-device, post–Device A, post–Device B, and post–Device C). Communicative effectiveness individual item mean scores comprised the eight dependent variables.

VAPP. Three two-factor RM ANOVAs (Total VAPP, ALS VAPP, and PRS VAPP) and a two-factor RM MANOVA compared differences in self-rated VAPP scores at baseline between selector and nonselector groups. There was one between-groups independent variable:

group with two levels (selectors and nonselectors). There was one within-group independent variable: device with four levels (pre-device, post–Device A, post–Device B, and post–Device C). VAPP subscale scores comprised the four dependent variables (C1: "self-perceived severity of voice problem," C3: "effect on daily communication," C4: "effect on social communication," and C5: "effect on emotion").

For all analyses, the interpretation of effect sizes was based on Cohen (1988), where $\eta_p^2 = .01$ indicates a small effect, $\eta_p^2 = .06$ indicates a medium effect, and $\eta_p^2 = .14$ indicates a large effect. Although the overall α criterion was .05, alpha corrections were made based on the recommendations of Hummel and Sligo (1971). More specifically, for MANOVAs with no significant multivariate effects, the alpha was adjusted for subsequent univariate analyses by dividing the overall α of .05 by the number of dependent variables (Hummel & Sligo, 1971).

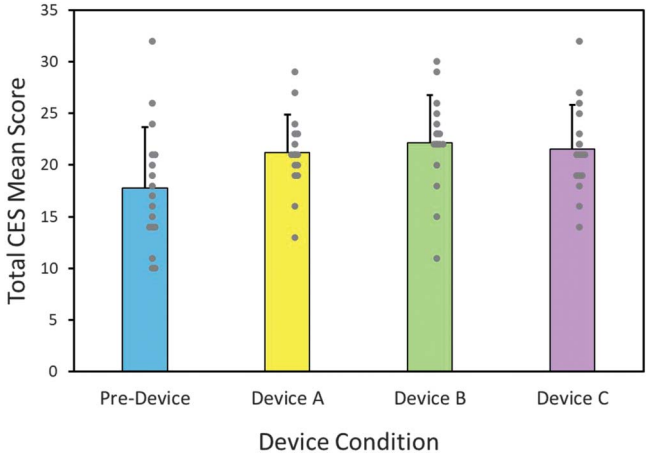
Results

Self-Rated Communicative Participation Reported by HP Participants: Pre- Versus Post-Device

CES. The RM ANOVA based on the Total CES score was significant for device, $F(3, 48) = 3.66$, $p = .019$, $\eta_p^2 = .186$. This result was statistically significant and demonstrated a large effect size. Based on the significance of the RM ANOVA, post hoc comparisons allowed us to examine in more detail pre–post comparisons for each device trialed. The Total CES score for the pre-device condition ($M = 17.76$, $SD = 5.90$) was not significantly different from that of Device A ($M = 21.18$, $SD = 3.67$; $p = .072$), but the score for the pre-device condition was significantly lower than those for the post–Device B ($M = 22.18$, $SD = 4.57$; $p = .017$) and post–Device C ($M = 21.53$, $SD = 4.28$; $p = .029$) conditions. Figure 1 graphically presents Total CES mean scores based on the device condition.

Results of the RM MANOVA revealed a significant multivariate main effect of device based on the eight CES questions (Qs), $F(24, 93) = 2.16$, $p = .004$, $\eta_p^2 = .348$. This result was statistically significant and demonstrated a large effect size. At the univariate level, CES Q5: "Being part of a conversation in a noisy environment," $F(3, 39) = 5.88$, $p = .002$, $\eta_p^2 = .312$; CES Q7: "Having a conversation while traveling in a car," $F(3, 39) = 2.95$, $p = .044$, $\eta_p^2 = .185$; and CES Q8: "Having a conversation with someone at a distance," $F(3, 39) = 11.14$, $p < .001$, $\eta_p^2 = .462$, were significant, and all demonstrated a large effect size. Post hoc comparisons were completed for the CES questions with significant univariate main effects (CES Q5, Q7, and Q8) to determine the differences based on specific devices. Post hoc comparisons of the pre- versus post-device conditions related to CES Q5: "Being part of a conversation in a noisy environment" indicated that the mean score for the pre-device condition ($M = 1.93$, $SD = 0.91$) was significantly lower than those for the post–Device B ($M = 2.93$, $SD = 0.61$; $p = .005$) and post–Device C ($M = 2.79$, $SD = 0.57$; $p = .017$) conditions. The post hoc comparison of the pre-device condition was not significant for the post–Device A condition ($M = 2.42$, $SD = 0.82$; $p = .110$). Post hoc comparisons of the pre- versus post-device conditions for CES Q7: "Having a conversation while traveling in a

Figure 1. Total Communicative Effectiveness Survey (CES) mean scores based on the device condition. Standard deviations are expressed through error bars. Device A = wired belt-pack amplifier; Device B = wireless personal amplifier; Device C = personal frequency modulation system.



car" indicated that the mean score for the pre-device condition (M = 2.21, SD = 0.97) was significantly lower than those for the post–Device A (M = 2.86, SD = 0.66; p = .033) and post–Device C (M = 3.00, SD = 0.78; p = .028) conditions. The post hoc comparison of the pre-device condition versus the post–Device B condition (M = 2.79, SD = 0.80) was not significant (p = .104). Post hoc comparisons of the pre- versus post-device conditions based on CES Q8: "Having a conversation with someone at a distance" indicated that the mean score for the pre-device condition (M = 2.07, SD = 0.91) was significantly lower than those for the post–Device B (M = 3.36, SD = 0.84; p = .001) and post–Device C (M = 3.29, SD = 0.46; p < .001) conditions. The post hoc comparison involving the pre-device condition versus the post–Device A condition (M = 2.71, SD = 0.82) did not reach significance (p = .057).

VAPP. The RM ANOVAs based on the Total VAPP, $F(3, 45) = 17.56$, $p < .001$, $\eta_p^2 = .539$; VAPP ALS, $F(3, 45) = 20.66$, $p < .001$, $\eta_p^2 = .579$; and VAPP PRS, $F(3, 45) = 14.91$, $p < .001$, $\eta_p^2 = .499$, mean scores were all significant for device. These results demonstrated large effect sizes. Based on the significance of the RM ANOVA, post hoc comparisons allowed us to examine in more detail pre–post comparisons for each device trialed. The Total VAPP score for the pre-device condition (M = 145.80, SD = 50.49) was significantly higher than those for the post–Device A (M = 81.43, SD = 41.57; p < .001), post–Device B (M = 86.04, SD = 51.75; p = .001), and post–Device C (M = 77.89, SD = 28.32; p < .001) conditions. Figure 2 graphically presents Total VAPP mean scores based on the device condition.

Post hoc comparisons indicated that the VAPP ALS score for the pre-device condition (M = 14.01, SD = 5.16) was significantly higher than those for the post–Device A (M = 6.23, SD = 3.87; p < .001), post–Device B (M = 6.91, SD = 5.01; p < .001), and post–Device C (M = 6.42, SD = 2.93; p < .001) conditions. Figure 3 graphically presents VAPP ALS mean scores based on the device condition.

Post hoc comparisons indicated that the VAPP PRS score for the pre-device condition (M = 12.23, SD = 5.56) was significantly higher than those for the post–Device A (M = 5.34, SD = 4.15; p < .001), post–Device B (M = 7.22, SD = 5.93; p = .003), and post–Device C (M = 5.40, SD = 3.09; p < .001) conditions. Figure 4 graphically presents VAPP PRS mean scores based on the device condition.

Results of the RM MANOVA revealed a significant multivariate main effect of device based on the four VAPP subscale category questions, $F(12, 111) = 3.865$, $p < .001$, $\eta_p^2 = .264$. At the univariate level, all VAPP subscale categories were significant: C1: "self-perceived severity of voice problem," $F(3, 45) = 8.42$, $p < .001$, $\eta_p^2 = .360$; C3: "effect on daily communication," $F(3, 45) = 18.78$, $p < .001$, $\eta_p^2 = .556$; C4: "effect on social communication," $F(3, 45) = 27.53$, $p < .001$, $\eta_p^2 = .334$; and C5: "effect on emotion," $F(3, 45) = 8.24$, $p < .001$, $\eta_p^2 = .355$. Post hoc comparisons were completed for the VAPP subscale categories with significant univariate main effects (VAPP C1, C3, C4, and C5) to determine the differences based on specific devices. Post hoc comparisons indicated that the VAPP C1: "self-perceived severity of voice problem" mean score for the pre-device condition (M = 6.16, SD = 2.41) was significantly higher than those for the post–Device A (M = 3.20, SD = 1.99; p = .001), post–Device B

Figure 2. Total Voice Activity and Participation Profile (VAPP) mean scores based on the device condition. Standard deviations are expressed through error bars. Device A = wired belt-pack amplifier; Device B = wireless personal amplifier; Device C = personal frequency modulation system.

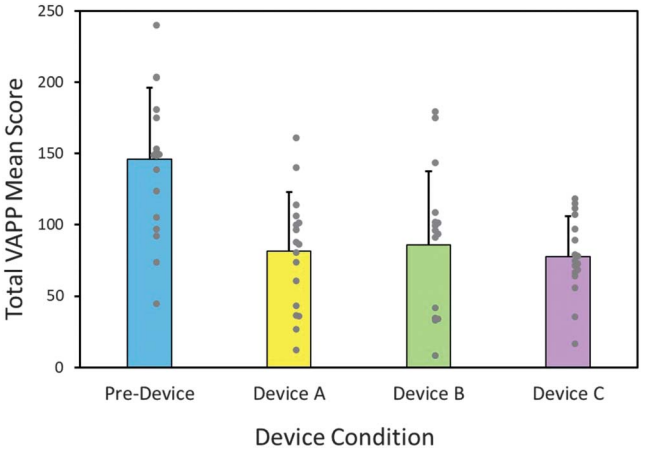


Figure 3. Voice Activity and Participation Profile (VAPP) Activity Limitation Score (ALS) mean scores based on the device condition. Standard deviations are expressed through error bars. Device A = wired belt-pack amplifier; Device B = wireless personal amplifier; Device C = personal frequency modulation system.

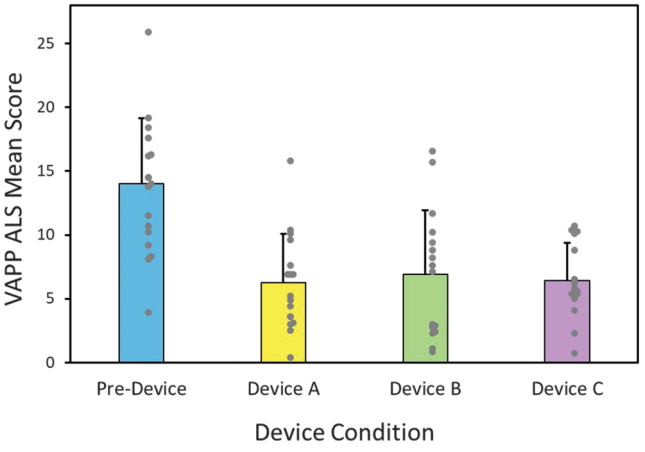
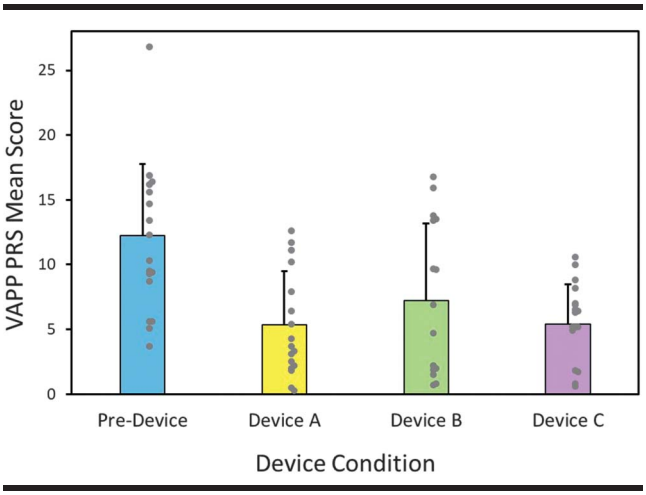


Figure 4. Voice Activity and Participation Profile (VAPP) Participation Restriction Score (PRS) mean scores based on the device condition. Standard deviations are expressed through error bars. Device A = wired belt-pack amplifier; Device B = wireless personal amplifier; Device C = personal frequency modulation system.



(M = 3.82, SD = 2.57; p = .002), and post–Device C (M = 3.60, SD = 2.08; p < .001) conditions. Post hoc comparisons indicated that the VAPP C3: "effect on daily communication" mean score for the pre-device condition (M = 74.33, SD = 22.19) was significantly higher than those for the post–Device A (M = 38.79, SD = 20.33; p < .001), post–Device B (M = 40.43, SD = 26.59; p < .001), and post–Device C (M = 39.01, SD = 16.64; p < .001) conditions. Post hoc comparisons revealed that the VAPP C4: "effect on social communication" mean score for the pre-device condition (M = 20.76, SD = 9.62) was significantly higher than those for the post–Device A (M = 12.59, SD = 8.62; p = .005), post–Device B (M = 12.81, SD = 9.48; p = .006), and post–Device C (M = 11.82, SD = 6.70; p = .001) conditions. Finally, post hoc comparisons revealed that the VAPP C5: "effect on emotion" mean score for the pre-device condition (M = 42.06, SD = 16.95) was significantly higher than those for the post–Device A (M = 26.83, SD = 17.71; p = .001), post–Device B (M = 28.96, SD = 18.43; p = .018), and post–Device C (M = 23.45, SD = 11.94; p < .001) conditions.

HP Versus PCP Self-Rated Communicative Participation Evaluated in the Four Device Conditions

CES. The two-factor RM ANOVA based on the Total CES score revealed a statistically significant difference for device, $F(3, 96) = 11.74$, $p < .001$, $\eta_p^2 = .268$, but not for group, $F(1, 32) = 0.371$, $p = .577$, $\eta_p^2 = .011$. The Device × Group interaction was not significant, $F(3, 96) = 0.553$, $p = .661$, $\eta_p^2 = .016$. These results demonstrate a large effect size for device and small effect sizes for group and the Device × Group interaction. This nonsignificant interaction indicates that each group gave a similar pattern of CES ratings across the different device types and conditions.

Results of the two-factor RM MANOVA revealed a significant multivariate effect for device, $F(24, 223) = 5.512$, $p < .001$, $\eta_p^2 = .346$, but not for group, $F(8, 21) = 0.910$, $p = .527$, $\eta_p^2 = .257$. The univariate statistics with a corrected α of .00625 revealed no significant differences in individual CES question ratings between the HP and PCP participants. The Device × Group interaction was not significant, $F(24, 223) = 1.290$, $p = .172$, $\eta_p^2 = .118$.

VAPP. The first two-factor RM ANOVA based on the Total VAPP score revealed a statistically significant difference for device, $F(3, 93) = 28.22$, $p < .001$, $\eta_p^2 = .477$, but not for group, $F(1, 31) = 0.776$, $p = .385$, $\eta_p^2 = .024$. The Device × Group interaction was not significant, $F(3, 93) = 0.517$, $p = .671$, $\eta_p^2 = .016$. These results demonstrate a large effect size for device, a medium effect size for group, and a small effect size for the Device × Group interaction. The second two-factor ANOVA based on the VAPP ALS revealed a statistically significant difference for device, $F(3, 93) = 32.81$, $p < .001$, $\eta_p^2 = .514$, but not for group, $F(1, 31) = 1.641$, $p = .210$, $\eta_p^2 = .050$. The Device × Group interaction was not significant, $F(3, 93) = 0.963$, $p = .414$, $\eta_p^2 = .030$. These results demonstrate a large effect size for device and medium effect sizes for group and the Device × Group interaction. Finally, the third two-factor ANOVA based on the VAPP PRS revealed a statistically significant difference for device, $F(3, 93) = 21.69$, $p < .001$, $\eta_p^2 = .412$, but not for group, $F(1, 31) = 0.609$, $p = .441$, $\eta_p^2 = .019$. The Device × Group interaction was not significant, $F(1, 31) = 1.764$, $p = .159$, $\eta_p^2 = .054$. These results demonstrate a large effect size for device and medium effect sizes for group and the Device × Group interaction.

Results of the two-factor RM MANOVA revealed a significant multivariate effect for device, $F(12, 230) = 7.29$, $p < .001$, $\eta_p^2 = .247$, but not for group, $F(4, 27) = 0.215$, $p = .928$, $\eta_p^2 = .031$. The univariate statistics with a corrected α of .0125 revealed no significant differences in the four VAPP subscale ratings between the HP and PCP groups. The Device × Group interaction was not significant, $F(12, 19) = 1.038$, $p = .456$, $\eta_p^2 = .396$.

Selector Versus Nonselector Self-Rated Communicative Participation at Baseline (Pre-Device)

CES. The two-factor RM ANOVA based on the Total CES score was significant for both device, $F(3, 48) = 3.66$, $p = .019$, $\eta_p^2 = .186$, and group, $F(1, 15) =$

7.370, $p = .016$, $\eta_p^2 = .329$, indicating that the selector group ($M = 19.62$, $SD = 2.42$) had significantly lower Total CES scores than the nonselector group ($M = 23.15$, $SD = 2.40$) across device conditions. The Device × Selectors interaction was not significant, $F(3, 45) = 1.460$, $p = .238$, $\eta_p^2 = .089$. These results demonstrate large effect sizes for device and group and a medium effect size for the Device × Group interaction.

The two-factor RM MANOVA for CES Q1–Q8 revealed a significant multivariate effect for device, $F(24, 84) = 1.647$, $p = .05$, $\eta_p^2 = .309$, but not for group, $F(8, 5) = 3.218$, $p = .107$, $\eta_p^2 = .837$. The Device × Selectors interaction, $F(24, 84) = 1.254$, $p = .215$, $\eta_p^2 = .256$, was not significant. These results demonstrate large effect sizes for device, group, and the Device × Group interaction.

Significant univariate main effects were found for CES Q3: "Conversing with a familiar person over the telephone," $F(1, 12) = 35.764$, $p < .001$, $\eta_p^2 = .749$, and CES Q4: "Conversing with a stranger over the telephone," $F(1, 12) = 29.187$, $p < .001$, $\eta_p^2 = .709$. Post hoc comparisons were completed for the CES questions with significant univariate main effects (CES Q3 and Q4). The post hoc analyses focused on the comparison across groups (selectors vs. nonselectors). The post hoc comparison for CES Q3: "Conversing with a familiar person over the telephone" indicated that the selector group ($M = 2.37$, $SD = 0.21$) had a significantly lower score than the nonselector group ($M = 3.06$, $SD = 0.20$; $p < .001$). The post hoc comparison for CES Q4: "Conversing with a stranger over the telephone" indicated that the selector group ($M = 2.02$, $SD = 0.31$) had a significantly lower score than the nonselector group ($M = 2.93$, $SD = 0.31$; $p < .001$).

VAPP. The first two-factor RM ANOVA based on the Total VAPP score was significant for both device, $F(3, 42) = 10.81$, $p < .001$, $\eta_p^2 = .436$, and group, $F(1, 14) = 8.467$, $p = .011$, $\eta_p^2 = .377$. This result indicates that the selector group ($M = 109.84$, $SD = 28.61$) had significantly higher Total VAPP scores than the nonselector group ($M = 61.65$, $SD = 31.55$) across device conditions. These results demonstrate large effect sizes for device and group. The Device × Selectors interaction was not significant, $F(3, 42) = 0.813$, $p = .494$, $\eta_p^2 = .055$, suggesting that the pattern of differences among the four device conditions was similar across the selector and nonselector groups based on Total VAPP scores. This result demonstrates a medium effect size for the Device × Group interaction. Figure 5 presents the Total VAPP mean scores for selector and nonselector groups.

The second two-factor RM ANOVA based on the VAPP ALS score was significant for device, $F(3, 42) = 12.11$, $p < .001$, $\eta_p^2 = .464$, and group, $F(1, 14) = 6.691$, $p = .022$, $\eta_p^2 = .323$, and demonstrated large effect sizes for device and group. This result indicates that the selector group ($M = 9.43$, $SD = 2.77$) had significantly higher VAPP ALS scores than the nonselector group ($M = 5.27$, $SD = 3.06$) across device conditions. The Device × Selectors interaction was not significant, $F(3, 42) = 0.998$, $p = .403$, $\eta_p^2 = .067$, and demonstrates a medium effect size. Overall, this result suggests that the pattern of differences among the four device conditions was similar across the selector and nonselector groups based on VAPP ALS scores. Figure 6 presents the VAPP ALS mean scores for the selector and nonselector groups.

The third two-factor RM ANOVA based on the VAPP PRS score was significant for device, $F(3, 42) = 8.783$, $p < .001$, $\eta_p^2 = .386$, but not for group, $F(1, 14) = 2.88$, $p = .116$, $\eta_p^2 = .167$. These results demonstrate a

Figure 5. Total Voice Activity and Participation Profile (VAPP) mean scores for the selector and nonselector groups in each device condition. Standard deviations are expressed through error bars. Device A = wired belt-pack amplifier; Device B = wireless personal amplifier; Device C = personal frequency modulation system.

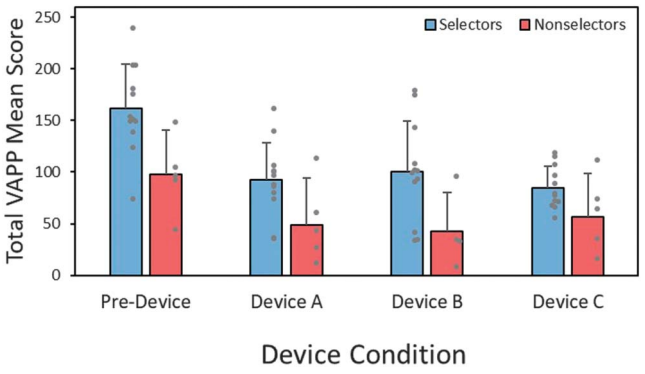
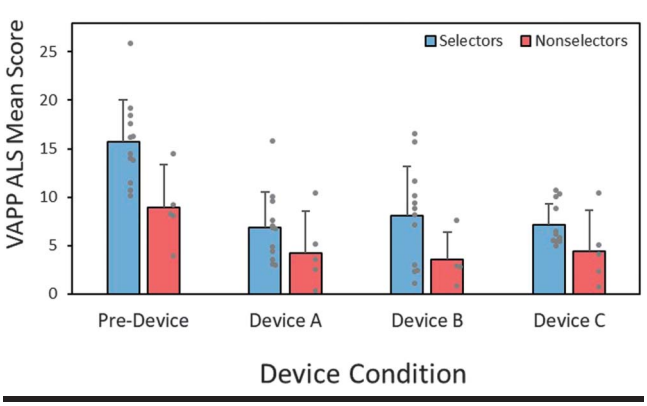


Figure 6. Voice Activity and Participation Profile (VAPP) Activity Limitation Score (ALS) mean scores for the selector and nonselector groups in each device condition. Standard deviations are expressed through error bars. Device A = wired belt-pack amplifier; Device B = wireless personal amplifier; Device C = personal frequency modulation system.



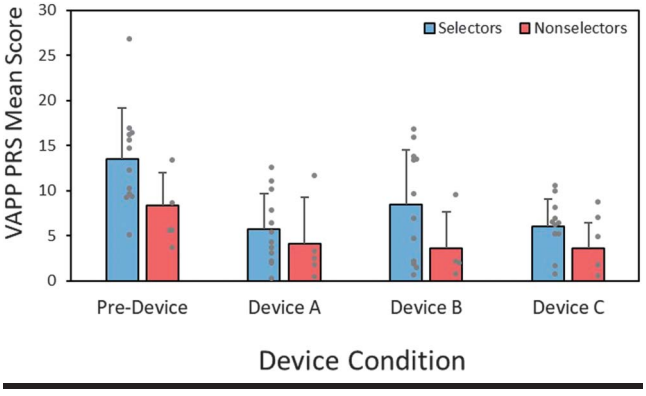
large effect size for device and a medium effect size for group. The Device × Selectors interaction also revealed nonsignificant results, $F(3, 42) = 0.804$, $p = .499$, $\eta_p^2 = .054$, and a small effect size for this interaction. Figure 7 presents the VAPP PRS mean scores for the selector and nonselector groups for each device condition.

The two-factor RM MANOVA based on the four VAPP subscale categories revealed a significant multivariate effect for device, $F(12, 103) = 2.464$, $p = .007$, $\eta_p^2 = .199$, but not for group, $F(4, 11) = 2.92$, $p = .072$, $\eta_p^2 = .515$. These results demonstrate large effect sizes for device and group. The Device × Selectors interaction also revealed nonsignificant results, $F(12, 103) = 0.656$, $p = .789$, $\eta_p^2 = .063$, and a medium effect size. A significant univariate main effect was found only for subscale C1: "self-perceived severity of voice problem," $F(1, 14) = 9.290$, $p = .009$, $\eta_p^2 = .399$. The post hoc comparison for VAPP subscale C1: "self-perceived severity of voice problem" indicated that the selector group ($M = 4.77$, $SD = 1.28$) had a significantly higher score than the nonselector group ($M = 2.46$, $SD = 1.43$; $p = .009$).

Discussion

This study builds on the empirical literature related to the effect of speech amplification for individuals with HP. Our results, in concert with those in Knowles et al. (2020), suggest that speech amplification improves acoustic, perceptual, and participation-based aspects of communication, regardless of the type of amplification device trialed. This finding is encouraging because the prescription of a speech amplification device can provide immediate improvement to communicative functioning and solves the "transfer of treatment" issue, which is of concern for individuals with hypokinetic dysarthria (Adams & Dykstra, 2009; Gaballah et al., 2019; Rubow & Swift, 1985).

Figure 7. Voice Activity and Participation Profile (VAPP) Participation Restriction Score (PRS) mean scores for the selector and nonselector groups in each device condition. Standard deviations are expressed through error bars. Device A = wired belt-pack amplifier; Device B = wireless personal amplifier; Device C = personal frequency modulation system.



A secondary examination revealed pre- and post-device effects on self-reported communicative effectiveness and voice activity and participation for each of the three speech amplification devices trialed. Device B (wireless personal amplifier) and Device C (personal FM system) emerged as the two devices producing the highest ratings of communicative effectiveness in comparison to baseline. More specifically, HP participants self-rated more effective communication when trialing the FM system (Device C) for communicative contexts related to communicating while traveling in a vehicle and while communicating with someone at a distance. These findings align with those of Dykstra et al. (2015), who reported that speaking in noisy environments (including vehicles) and with increased interlocutor distance represented acoustically challenging environments for individuals with HP. Knowles et al. (2020) also reported that the FM system (Device C) produced the greatest SNR levels and speech intelligibility in background noise in comparison to Device A (wired belt-pack amplifier) and Device B (wireless personal amplifier). The use of an FM system may be especially beneficial in these specific communicative contexts because of the increased SNR benefits (15–20 dB; Hawkins, 1984) afforded by this amplification approach.

Overall ratings of communicative effectiveness and voice activity and participation did not reveal significant differences between HP and PCP participants across the three device conditions. These findings demonstrate that PCPs appraise communicative participation similarly to their partners with HP. This finding is consistent with those in other studies demonstrating similarities in participation and quality-of-life ratings made between individuals with hypokinetic dysarthria and their PCPs (Dykstra et al., 2015; McRae et al., 2002; Parveen & Goberman, 2017). Our results are also consistent with the findings of Ball et al. (2004) and McAuliffe et al. (2010), who found no significant differences in ratings of communicative effectiveness in patient–proxy dyads representing individuals with amyotrophic lateral sclerosis and traumatic brain injury, respectively. Examining communicative participation from the perspectives of both the individual with HP and their PCP is important and can be of clinical value for several reasons. The first reason relates to understanding perceptions within a communicative dyad, especially when perceptions do not agree. This information can allow an SLP to facilitate a discussion with the dyad regarding the reasons for the discrepancies and provide educational strategies to improve speaker–listener communicative interactions (Dykstra et al., 2015). The second reason is that ratings made by both the individual with

the communication disorder and their PCP are beneficial because this information may provide the clinician with an opportunity to establish treatment goals that are mutually agreed upon by both parties (Donovan et al., 2008). Finally, the third reason relates to the reliability of PCPs to serve as proxies. Although it is always preferable to have the individual with the communication disorder provide self-ratings or self-report, there may be situations or contexts in which the communication partner needs to provide ratings on their partner's behalf, such as in times of illness. The results of our study provide support for the reliability of proxy ratings related to the construct of communicative participation for individuals with HP following speech amplification.

Ratings of communicative effectiveness and voice activity and participation differed significantly between the selector and nonselector groups. The selector group self-reported less effective communication and greater voice activity limitations and participation restrictions than the nonselector group. In general, the selector group appears to differentiate from the nonselector group in terms of lower participation-based scores at baseline and overall lower SNR and speech intelligibility (see Knowles et al., 2020). Furthermore, the demographic information collected related to years since diagnosis, Unified Parkinson's Disease Rating Scale (UPDRS) speech scale scores, and the LSU all revealed differences between groups. More specifically, for the selector group, years since diagnosis ranged from 8 to 21 years. Comparing this time range to that for the nonselector group, years since diagnosis was less, ranging between 0.5 and 16 years. In addition, for the selector group, UPDRS speech item scores were primarily in the range of 2–3, representing mild-to-moderate speech impairment, respectively. In comparison, the nonselector group had UPDRS speech item scores ranging from 1 to 2, representing minimal-to-mild speech impairment, respectively. Finally, an inspection of the demographic information related to the self-rated level of speech usage (Baylor et al., 2008) revealed that most participants in the selector group reported low levels of speech usage, either as undemanding or as intermittent. In comparison, most participants in the nonselector group reported intermittent daily speech usage, with one participant reporting routine daily speech usage. This additional contextual information provided by the LSU highlights that, at baseline, the selector group self-reported very restricted daily speech usage. This finding supports those in previous research demonstrating that lower levels of speech usage are associated with poorer communicative participation outcomes (McAuliffe et al., 2017). Taken together, a possible interpretation of these group differences may be related partially to overall dysarthria severity. It is possible that the selector group was composed of individuals with a more severe communication disorder, related either to HP severity or to the presence of other dysarthric symptoms associated with hypokinetic dysarthria. As a result, the selector group may have experienced less effective communication and increased voice-related activity limitations and participation restrictions in their daily lives, but following speech amplification, the selector group may have experienced a greater perceived benefit to communicative participation in comparison to not using speech amplification. Conversely, the nonselector group may not have experienced the same magnitude of perceived benefit to communicative participation following speech amplification because of a less severe communication disorder.

Limitations

Several limitations in this study warrant discussion. The first limitation relates to the modest sample size of 17 participant dyads and the heterogeneity of our HP participants. Both of these factors limit the generalizability of findings. Although study participants were recruited based on the presence of HP as their primary dysarthric feature, there were factors not controlled for such as HP severity and the presence of other dysarthric symptoms. It is possible that other variables such as fatigue, mobility issues, and self-perceived speech severity may have also influenced ratings of participation during device trials (Baylor et al., 2011; Dykstra et al., 2015; McAuliffe et al., 2017). The next limitation relates to the amount of time our study participants trialed each of the three amplification devices. Although the inclusion of longer term device trial periods is a relative strength of this study, the 1-week device trial period may not have provided adequate time to gauge the effect of an amplification device on communicative participation. It is possible that participants did not have the opportunity to experience each of the specific communicative contexts included on the participation-based outcome measures. For example, on the CES, one item asks participants to rate communicative effectiveness while communicating when upset or angry, whereas another item asks participants to rate communicative effectiveness while speaking with a stranger on the phone. It is possible that some of these communicative contexts were not fully experienced during the given week a participant was trialing a specific amplification device. Relatedly, all participants were instructed to use each amplification device over different occasions for at least 2 hr (Knowles et al., 2020). Despite this instruction, several participants reported not adhering to this request, especially when they did not feel the device was beneficial or useful to their life circumstances (Knowles et al., 2020). This sentiment related to the perceived usefulness or enjoyability of using the device may have resulted in even

less opportunities to experience, and subsequently rate, communicative participation across the three device trials. Unfortunately, data related to the amount of time used with each device were not obtained from our participants. This study limitation restricts the generalizability of findings and the interpretation of results. The final limitation relates to the personal communicative style of the HP participant as well as the communicative characteristics of the participant dyad. For example, participant dyads with limited social networks and who communicate primarily with each other may have been more inclined to rate communicative participation higher after using the personal FM system (Device C). Conversely, participant dyads with broader social networks and who engage in more social activities and with several communicative partners may have rated Device C as less favorable because of its design to be used with a single communication partner. Relatedly, participants with broader social networks, involving multiple communication partners, may prefer devices that have an external loudspeaker feature that amplifies the speech signal to a broader audience, such as Device A or Device B. Exploring how speech usage and communicative style influence device preference, device acceptance, and communicative participation warrants future study.

Future Directions

Future studies may wish to explore how communicative participation is experienced across different amplification devices using phenomenology. This qualitative methodology could explore the lived experiences of individuals with HP and determine the barriers to and facilitators of communicative participation following speech amplification. Future studies may also wish to explore the development of a screening tool based on salient participation-based outcome measures or specific items on these measures (e.g., Total CES score, VAPP C1: "self-perceived severity of voice problem," VAPP ALS). The development of a screening tool may help predict individuals who are most likely to adopt the use of speech amplification in their daily lives versus those who do not adopt speech amplification. As discussed previously as a study limitation, a future study should obtain detailed information related to the specific communicative situations experienced during each device trial period and the amount of time spent trialing each device. This additional information could also help determine if differences exist between device selectors and nonselectors based on these factors. Finally, a future study may seek to explore systematically how speech usage, communicative style, communicative frequency, and self-perceived speech severity influence communicative participation, device preference, and device acceptance.

Summary

This study extended the research of Knowles et al. (2020) by evaluating how HP and PCP participants rated communicative participation both before and after experience with three different speech amplification devices outside of the laboratory. Although preliminary, this study has contributed to an increased understanding of how communicative participation is rated following speech amplification. We suggest that the inclusion of participation-based outcome measurement, in addition to acoustic and perceptual outcome measurement, is essential to ensure a multidimensional and comprehensive approach to device prescription in this clinical population.

Data Availability Statement

The data sets generated and/or analyzed during this study are available from the corresponding author on reasonable request.

Acknowledgments

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