Development and validation of the Singing Voice Function Self-Efficacy Scale (Singing-VoSES)

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ABSTRACT

This investigation aims at developing and validating a scale measuring perceived self-efficacy in singing with respect to voice function, the *Singing Voice Function Self-Efficacy Scale* (*Singing-VoSES*). A panel of voice experts validated an 18-item scale, which was subsequently administered online, targeting specifically professional and semi-professional female singers. This inclusive criteria was met by a total of 439 participants. Results of both exploratory and confirmatory factorial analysis suggested that Singing-VoSES is a valid scale, with items grouped into 3 self-efficacy dimensions: *Higher Range and Transitions*, *Middle Range* and *Lower Range*. *Middle Range* and

Lower Range were both significantly higher than *Higher Range and Transitions*. Singing high notes and notes within transitional vocal ranges both require a refined neuromotor control of the voice and thus may be particularly challenging. Comparisons between pre and postmenopausal singers were made as menopause has been associated with low self-efficacy and changes in voice function. Significantly higher self-efficacies for *Higher Range and Transitions* and *Middle Range* were found in pre as compared to postmenopausal singers, corroborating previous reports of self-perceptions of a less functional voice in association with menopause.

Keywords: Self-efficacy; Voice function; Professional singers; Females; Menopause

I. INTRODUCTION

A. Contextualizing self-efficacy in singing

Self-efficacy has been defined as 'the beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments' (Bandura, 1997, p. 11). According to Bandura's social cognitive theory, which is centered on how people's thoughts, believes, feelings and self-reflections influence their actions and behaviors, those with low self-efficacy fail to believe in their abilities (Bandura, 1986). As a consequence, when facing adversities, effort and persistence will be reduced and lower-level solutions will be adopted (Bandura, 2006; Jafary et al., 2011). Self-efficacy has an impact on goal settings, aspirations, life choices and outcome expectations (Bandura, 2006). It is a strong predictor of academic motivation (Lane & Lane, 2001; Schunk, 1991), motor-learning (Wulf & Lewthwaite, 2016) and successful performance (Bandura, 1986; McPherson & McCormick, 2006; Schunk, 1991).

Given the importance of self-beliefs to personal behavior, self-efficacy has been studied in a wide variety of areas, including health care and education (Honicke & Broadbent, 2016). However, to what concerns voice, studies focusing on self-efficacy are still scarce. Previous studies have shown that patient's compliance has more influence on results of voice therapy than type of exercise; patient's compliance depends on self-believes about technical ability to produce the desired expected outcome (Verdolini-Marston et al., 1995). Thus, self-efficacy is determinant to results of voice care interventions. Nevertheless, only one scale measuring voice-related self-efficacy was found in a systematic review containing 32 other voice-related patient-reported outcome measures (Francis et al., 2017). This questionnaire, the *Voice Self-Efficacy Questionnaire* (VSEQ), was developed and validated to assess the impacts of the use of specific terminology during voice therapy (Gillespie & Abbott, 2011). With respect to voice pedagogy, a non-validated scale, the *Singing Self-Efficacy Scale for Emerging Adolescent Males* (SSE) was designed to assess self-efficacy during vocal development of male adolescent choristers. The results found that years of voice training impact more on singing self-efficacy than changes in voice quality caused by puberty (Fisher, 2014). The SSE was also used to measure singing self-efficacy in female adolescent choristers before and after practicing a specific exercise regime. Older adolescent singers presented higher SSE scores than younger ones (Owen, 2017). This result corroborates previous studies indicating that self-efficacy is influenced by age. For example, in older adults, self-efficacy becomes lower when a given activity is perceived as belonging to a "younger domain" (Artistico et al., 2003; Bausch & Michel, 2014).

Current pedagogical practices in music education recommend the development of self-appraisal and self-evaluation skills in students to assist their transition into the professional world (Lennon & Reed, 2012). This seems particularly important to singers, as they have been recognized poor judges of their own abilities. For example, a singer judges other singer's intonation more accurately than self-intonation. However, the tendency for overestimating intonation accuracy tends to decrease with increasing singing proficiency (Larrouy-Maestri et al., 2021). Guiding singers in measuring the results of their training and performance outcomes is crucial for the development of self-efficacy, and, with it, metacognition (Hallam, 2001), a distinctive feature between students and professional musicians (Hallam, 2001).

B. Self-efficacy in professional singers: the effects of age and sex

Singing requires high-level brain activity and superior skills of neuromotor coordination. In order to produce a single vocalization, a vast network of brain regions controlling a large number of muscles are engaged (Zarate, 2013). One may imagine how complex will be to produce several vocalizations while changing pitch, timbre and loudness (Kleber & Zarate, 2019). As higher demanding neuromotor tasks require higher self-efficacy (Abbas & North, 2018), those who master their vocal instrument for musical and expressive purposes, i.e., professional singers, are expected to require high self-efficacy. However, through lifespan, both voice and brain function change (Linville, 2001); one may argue that these changes also may affect self-efficacy. For example, the results of previous studies concerning physical activity suggested that, over time, adults present a reduction in self-efficacy (McAuley & Jacobson, 1991). To what extent this could also be applied to self-efficacy in singing is still unknown, especially for female professional singers. This question seems relevant, as female singers are particularly susceptible to voice changes due to female-specific vocal and reproductive endocrinological characteristics, the latter concerning current sex steroid hormonal concentrations and respective impacts on mechanisms that regulate sexual development, function, and reproduction (Hunter et al., 2011; Lã et al., 2012).

As compared to males, females have shorter vocal folds and thus a higher number of vocal fold collisions (Hunter et al., 2011). Also, they can have less efficient glottal closure (Dejonckere, 2001) and present fewer collagen fibers (Hammond et al., 2000) and less hyaluronic acid in intermediate layers of vocal folds mucosa (Butler et al., 2001). These unique features expose female singers to a higher risk of developing occupational voice disorders as compared to male singers (Dejonckere, 2001; Hunter et al., 2011). In addition, the complexity of female's reproductive endocrine system has been associated with greater variations in voice quality and in neurophysiological activity during lifespan (Abitbol, 2006). Besides the menstrual cycle, the use of hormonal contraception, pregnancy and variations on sex steroid hormones (i.e., estrogens, progesterone and testosterone), have been described to impact on voice, especially at menopause (Abitbol et al., 1999; Lã & Ardura, 2022). During this stage of life, singers generally report timbral differences and reduced pitch range, loudness, flexibility, and agility (DeMaio, 2013; Elliott, 2017; Price, 2010; Fiuza et al., 2021). These symptoms seem to impact on their attitudes towards vocal performance (Bos et al., 2020), perhaps a consequence of reduced singing self-efficacy.

Besides aging, sex has also been reported to affect self-efficacy. For example, it has been found that, after training, aging females present higher increase in perceived self-efficacy and success as compared to aging males. Such result was claimed to be related to the fact that, previous to training, female's self-efficacy baseline is lower than males, a possible consequence of social stereotypes that lead females to underestimate their capabilities (Bausch & Michel, 2014). Females also present lower self-efficacy with respect to career-related choices and occupational goals, a trend confirmed by their underrepresentation in the fields of mathematics, engineering, chemistry and physics (Zeldin et al., 2008).

The scarce number of studies addressing singing self-efficacy justifies further research, especially concerning professional singers and the female voice. A functional vocal instrument is crucial to musical and expressive performances (Radionoff, 2008). Given the importance of voice source quality to vocal timbre (Herbst, 2017; Sundberg, 1987), a starting point to measure singing self-efficacy could be to focus on perceptual correlates of physiological parameters determining voice function. These include: (i) vocal loudness, which is mainly affected by subglottal pressure (Titze, 2021); (ii) vocal range, a consequence of varied tension and extension of the vocal folds (Titze, 1994); and (iii) phonation types, associated with different degrees of vocal fold adduction and glottal configurations (Patel et al., 2020). The present investigation aims at developing and validating a scale measuring self-efficacy in singing with respect to voice function, the *Singing Voice Function Self-Efficacy Scale* (*Singing-VoSES*), targeting female professional and semi-professional singers. In addition, this scale's sensitivity to voice-related menopausal changes was also assessed by comparing its scores between pre and postmenopausal singers.

II. METHOD

A. Development of the Singing Voice Function Self-Efficacy Scale (Singing-VoSES)

Items of Singing-VoSES were drawn based on literature concerning: (i) physiology of the singing voice; (ii) singer's vocal health; (iii) stages of singing voice development; and (iv) singing achievement in music examinations (Cohen et al., 2007; Fisher, 2014; Phyland et al., 2013). A preliminary list containing 18 items was created, assessing the ability to sing at different combinations of pitch, loudness and breathing conditions. Pitch and loudness were key parameters when creating these items because their physiological correlates (i.e., fundamental frequency and subglottal pressure, respectively), are both crucial to voice function and to perceptual assessments of voice quality in singing (Ternström et al., 2016). Besides vocal adduction, the tension and extension of the vocal folds (which result in changes in pitch), and subglottal pressure (which is related to breath management and leads to different perceived vocal intensities), are both crucial to the quality of the voice source, and thus, to perceived timbre (Herbst et al., 2015, 2019; Sundberg, 1987). In addition, the control of both pitch and loudness have been described as prerequisites to master singing and thus necessary when evaluating the ability to perform specific singing tasks (DeLeo LeBorgne & Weinrich, 2002; Sulter et al., 1995). Singing proficiency is highly related to the ability of controlling these parameters independently. For example, in a *messa di voce*, singers are required to change loudness without changing pitch nor timbre. In addition, pitch range is determinant to vocal registers (Titze, 1994). As consensus on terminology and on definitions of registers has not yet been reached (Henrich, 2006; Herbst et al., 2019; Miller & Schutte, 2005), the use of terms such as “chest voice”, “head voice”, “falsetto”, “mix voice”, “*passaggio*”, were avoided. Instead, the term *transitional regions of the voice* was used. This also allowed data gathering with singers of different musical genres.

The content validity of the scale was evaluated by a panel of voice experts: laryngologists, speech and language pathologists and teachers of singing. They were all recruited through first and second authors personal and professional contacts in countries including Australia, Brazil, Germany, Sweden, UK and USA. From the 21 contacted experts, a total of 9 volunteered to participate. Evaluators were requested to rate item’s clarity and adequacy with respect to the questionnaire’s construct, i.e., self-perceived ability to perform specific singing tasks. A 4-point Likert scale was used instead of a scale with an odd number because the latter tends to provide neutral answers (Choi & Pak, 2005). For each item, *Content Validity Index* was calculated by the proportion of experts’ responses rated with 3 and 4 in adequacy. They were also asked to indicate the appropriateness of item’s inclusion with a “yes/no” question, for later calculation of *Item Acceptance Ratio*. Finally, suggestions on each item’s drafting were encouraged.

B. Participants and procedures

Ethical approval was obtained from the Ethical Committee of the National Distance Learning University (UNED) in Madrid, Spain. Participants were recruited using a combination of different methods which included: (1) contacting personal and professional acquaintances of the first two authors through WhatsApp groups, via e-mail and messaging on Facebook; (2) e-mailing about 100 professional contacts from a pre-existing list created to advertise international continuing education courses on voice pedagogy developed by the two first authors; (3) through a link added to an existing survey page of the National Association of Teachers of Singing in USA (NATS); (4) advertising the study on several voice pedagogy groups created on Facebook; (5) publicizing the study on the first two authors personal and professional Instagram and Twitter accounts; and (6) adding a link to the online questionnaire in the project's designated website. Inclusive criteria were: (i) to be a female professional or semi-professional soloist singer of any musical genre, using a classification of professional and semi-professional soloist singers proposed elsewhere (Bunch & Chapman, 2000); (ii) to be an English speaker, with English as the first or second language to guarantee full understanding of all questions; (iii) to be more than 18 years. Participants who were professionally diagnosed with hearing impairments, had restrictions to understand or give an informed consent and were amateur or choir singers, were not included.

Data collection was carried out from the beginning of November 2020 until June 2021. All respondents provided a written informed consent for inclusion and collection/use of data. Singing-VoSES was filled in online, using the following instruction: 'Select the option that best reflects the degree of your agreement to the following statements (1, totally disagree; 6, totally agree)'. A Likert-type scale was used following the recommendations described elsewhere on how to measure self-efficacy (Bandura, 2012). Moreover, items were created following early recommendations on designing self-efficacy scales, using the wording 'I can …' for all items (Bandura, 2006: 313). In addition to the Singing-VoSES, there were questions addressing: (i) socio-demographic information, such as age, educational level and English proficiency;

(ii) information on health status, including endocrinological state (i.e., menstrual cycle characteristics in terms of frequency, regularity, presence and absence, and also presence or absence of disorders of the endocrine system that may have an indirect impact on voice quality, namely endometriosis, polycystic ovarian syndrome and hypo/ hyperthyroidism (Anderson et al., 2006), use of hormonal therapy, reflux medication and history of medically diagnosed vocal problems; (iii) professional experience; (iv) type of professional occupation; and (v) information on voice use and vocal habits.

C. Analysis of validity and reliability

Internal validity was analyzed by means of a two-step factorial validation analysis. First, to identify latent variables, an exploratory factorial analysis was carried out. Second, a confirmatory factorial analysis was used to corroborate the initial structure. This was achieved by means of a structural equation model. This procedure tested model fitting to data by using the following fit indices: (i) χ^2/df; (ii) the *Comparative Fit Index* (CFI); (iii) *Tucker–Lewis Index* (TLI); (iv) the *Root Mean Square Error Approximation* (RMSEA); and (v) the *Standardized Root Mean Square Residual* (RSMR). The suggested cut-off values were: (i) $1 < c^2/df < 3$; (ii) CFI > 0.90; (iii) TLI > 0.90; (iv) RMSEA < 0.06; and (v) RSMR < 0.08 (Hair et al., 2010; Hu & Bentler, 1999). Once latent variables were defined, a reliability analysis was carried out by means of Cronbach’s alpha.

D. Singing-VoSES sensitivity to voice-related menopausal changes

To assess the sensitivity of Singing-VoSES to voice-related menopausal changes, scores were compared between pre and postmenopausal singers. For this comparison, only singers aged between 40 and 65 years were included, providing a total of 155 responses. As recommended elsewhere, to help minimizing biases of age-related symptoms when the goal is the sole study of menopausal-related effects, three groups of women should be included in comparative studies: postmenopausal, premenopausal middle-aged, and premenopausal younger women (WHO, 1996). In the present study, only middle-aged premenopausal and postmenopausal singers were included. This choice was based on results of previous studies which demonstrated a significant drop in mean speaking fundamental frequency in women in their 40s when compared with women in their 20s (Guimarães & Abberton, 2005; Ma & Love, 2010). Thus, when assessing voice-related perceived changes, it is recommended to control effects of age on voice characteristics such as as fundamental frequency (Lã & Ardura, 2022). In addition, the distribution of singers in pre and postmenopausal groups followed the criteria recommended by the *Stages of Reproductive Ageing Workshop* (STRAW): to use menstrual cycle variability as the principal criteria when distinguishing reproductive (pre-menopause), transiting into menopause (peri-menopause) and post-menopause stages (Harlow et al., 2012; Soules et al., 2001). Thus, the postmenopausal group included singers that were currently experiencing: (i) at least twelve consecutive months of amenorrhea; and (ii) were not using hormonal replacement therapy (HRT). The premenopausal group included singers that: (i) were experiencing regular menstrual cycles; (ii) if menstrual cycles were irregular, had episodes of amenorrhea shorter than 1 to 2 consecutive months; (iii) were not using any type of hormonal medication; and (iv) were not pregnant. For both groups, singers were excluded if they have had vocal and/ or endocrinological problems medically diagnosed for at least 12 consecutive months prior to answering to Singing-VoSES.

A Mann-Whitney test was carried out comparing Singing-VoSES scores between pre and postmenopausal singers. Effect sizes were estimated using the Rosenthal's formula, applying the following reference values: $r = .5$ (large effect); $r = .3$ (medium effect); and *r* = .1 (small effect). Differences between Singing-VoSES dimensions were compared by means of a Friedman test, followed by Wilcoxon signed-ranked tests for *Post hoc* pair-wise comparisons. All computations were performed using SPSS and AMOS (Arbuckle, 2010).

III. RESULTS

A. Sample characteristics

From a total of 684 responses, two were excluded: one response was not valid (the reported current age was 3 years, and the age of menopause was 11 years) and the other was an empty questionnaire due to non-consent to proceed with data analysis. From 682 respondents, only 439 (64.4%) met the inclusive criteria of being a professional or semi-professional soloist singer: 131 responses were from non-singers, 111 where from choir singers, and one from an amateur singer. Table 1 summarizes respondents' characteristics concerning socio-demographic information, vocal and general health status, and professional experience.

Table 1. Sample characteristics (n = 439); *SD* = standard deviation.

	Total (n %)
Age	
Mean ± *SD*	43.73 ± 11.9
Educational level	
PhD	51 (11.6)
Master	211 (48.1)
Post-secondary degree	142 (32.3)
No post-secondary degree	35 (8.0)
Menstrual cycles	

Yes	287 (65.4)
No	151 (34.4)
Pregnant	1 (0.2)
Oral contraception	
Yes	84 (19.1)
No	355 (80.9)
Hormonal replacement therapy	
Yes	33 (7.5)
No	406 (92.5)
Diagnosed endocrine problems	
Yes	96 (21.9)
No	343 (78.1)
Smoking habits	
One cigarette once a while	14 (3.2)
Less than 5 a day	2 (0.5)
More than 5 a day	2 (0.5)
No	421 (95.9)
Diagnosed voice problems	
Yes, a long time ago (more than 2 years)	119 (27.1)
Yes, in the recent past (between 1 and 2 years)	19 (4.3)
Yes, currently (less than 1 year)	15 (3.4)
No, never	286 (65.1)
Years of professional experience	
Mean ± *SD*	18.9 ± 11.6
Voice education	
Yes, I currently do	233 (53.1)
Not now, but I have done it in the past	206 (46.9)

B. Expert evaluation

The results of the expert validation revealed a mean item adequacy and a mean item clarity of 3.87 and 3.85 (out of 4), respectively. The *Content Validity Index* revealed a score of .98 (out of 1) and the *Item Acceptance Ratio* reached a mean value of 95.06 %. The scale was presented with one single dimension and experts did not suggest the need for further distribution or items grouping. Language revision was made following evaluators' suggestions for all items. For example, 'high/ low/ mid voice' were changed to 'higher/ lower/ middle range', 'soft/ loud' were changed to 'softly/ loudly'. Three items were rewritten: (1)'I can sing with no breaks when I glide from low to high' changed to 'I can sing through transitional regions of my voice with ease'; (2) 'I can move from my mid voice to low voice with no problems' was rewritten as 'I can easily glide from higher to lower range'; (3) 'I can move from my low voice to high voice with no problems' was modified to 'I can easily glide from lower to higher range'.

C. Exploratory factorial analysis

For the exploratory factorial analysis, 229 women were randomly selected from the total sample of 439 singers. The sample adequacy for this analysis was tested by means of the Kaiser-Mayer-Olkin statistic (KMO = .932). The correlation between items was large enough to apply factorial analysis, as shown by Barlett's sphericity test ($\chi^2(153) = 3964.0$; $p < .001$).

The 18 items retained from the results of the expert validation were introduced in the exploratory analysis using a *Principal Axis Factor*. This yielded a total of 3 factors and 18 items (see Table 2). To assist in the interpretation of the factors, a varimax rotation was used. The final factorial solution accounted for 70% of the total variance, with three latent variables and their corresponding explained variance being: *Higher Range and Transitions* (58.39 %); *Middle Range* (3.60 %); and *Lower Range* (8.01 %).

Table 2. Singing-VoSES items and corresponding factor loadings.

Factor loading	**Item**
Higher Range and Transitions	
.846	I can sing comfortably in my higher range.
.843	I can sustain a long phrase or note in tune in my higher range.
.696	I can sing loudly in my higher range.
.693	I can sing in tune in my higher range.
.686	I can easily glide from lower to higher range.
.682	I can easily glide from higher to lower range.
.668	I can sing softly in my higher range.
.573	I can sing through the transitional regions of my voice with ease.
Middle Range	
.806	I can sing comfortably in my middle range.
.666	I can sing loudly in my middle range.
.657	I can sustain a long phrase or note in tune in my middle range.
.608	I can sing softly in my middle range.
.550	I can sing in tune in my middle range.
Lower Range	
.817	I can sustain a long phrase or note in tune in my lower range.
.765	I can sing comfortably in my lower range.
.733	I can sing in tune in my lower range.
.694	I can sing loudly in my lower range.
.589	I can sing softly in my lower range.

D. Confirmatory factorial analysis

The confirmatory factorial analysis was carried out in the randomly selected second part of the sample (n = 210). The three-factor structure found in the exploratory factorial analysis presented a reasonable adjustment to the collected data. The fit indices obtained were: (i) χ^2/df = 3.8; CFI = .824; (ii) TLI = .803; (iii) RMSEA = .075; (iv) RSMR = .09.

E. Reliability

Cronbach's alpha for the three dimensions were: (i) *Higher Range and Transitions*: α = .938; (ii) *Middle Range*: α = .938; and (iii) *Lower Range*: α = .919.

F. Singing-VoSES sensitivity to voice-related menopausal changes

To assess Singing-VoSES sensitivity to voice-related menopausal changes, scores were compared between pre and postmenopausal singers. These groups were created based on participants reported information on menstrual cycles, namely presence, absence, frequency, and regularity, and restricting their age range between 40 and 65 years. A total of 155 singers (30.31 % of the 439 singers included) were selected: 86 premenopausal and 69 postmenopausal. Table 3 summarizes singer's characteristics, divided into pre and postmenopausal groups.

Table 3. Singers' characteristics, experience level and vocal habits, presented for premenopausal (n = 86), postmenopausal (n = 69) and total sample (n = 155) of singers; *SD* = standard deviation.

	Premenopausal n (%)	**Postmenopausal n (%)**	**Total n (%)**
Age			
Mean (SD)	46 (±4.0)	57 (±5.0)	51 (±7.0)
Educational Level			

PhD	19 (22.1)	5 (7.2)	24 (15.5)
Master	38 (44.2)	38 (55.1)	76 (49.0)
Post- Secondary Degree	24 (27.9)	25 (36.2)	49 (31.6)
No post- secondary degree	5 (5.8)	1 (1.4)	6 (3.9)
Smoking habits			
One cigarette once a while	3 (3.5)	1 (1.4)	4 (2.6)
Less than 5 a day	0 (0.0)	1 (1.4)	1 (0.6)
More than 5 a day	2 (2.3)	0 (0.0)	2 (1.3)
No	81 (94.2)	67 (97.1)	148 (95.5)
Diagnosed with a voice problem			
Yes, a long time ago (more than 2 years)	22 (25.6)	14 (20.3)	36 (23.2)
Yes, in the recent past (between 1 and 2 years)	6 (7.0)	4 (5.8)	10 (6.5)
Yes, currently (less than 1 year)	0 (0.0)	0 (0.0)	0 (0.0)
No, never	58 (67.4)	51 (73.9)	109 (70.3)
Years of professional experience			
Mean (SD)	21 (±8.0)	29 (±10.0)	24 (±10.0)
Voice education			
Yes, I currently do	42 (48.8)	29 (42.0)	71 (45.8)
Not now, but I have done it in the past	44 (51.2)	40 (58.0)	84 (54.2)
I practice / have practiced vocal exercises with a teacher of singing			
Every day	7 (8.1)	5 (7.2)	12 (7.7)
More than twice a week	5 (5.8)	4 (5.8)	9 (5.8)
Twice a week	4 (4.7)	6 (8.7)	10 (6.5)
Once a week	28 (32.6)	16 (23.2)	44 (28.4)
A few times a month	25 (29.1)	14 (20.3)	39 (25.2)
Never	17 (19.8)	24 (34.8)	41 (26.5)
I practice / have practiced vocal exercises with a therapist			
Every day	1 (1.2)	0 (0)	1 (0.6)
More than twice a week	0 (0)	0 (0)	0 (0)
Twice a week	0 (0)	0 (0)	0 (0)
Once a week	4 (4.7)	2 (2.9)	6 (3.9)
A few times a month	8 (9.3)	8 (11.6)	16 (10.3)
Never	73 (84.9)	59 (85.5)	132 (85.2)
I practice / have practiced vocal exercises with a vocal coach			
Every day	1 (1.2)	2 (2.9)	3 (1.9)
More than twice a week	1 (1.2)	6 (8.7)	7 (4.5)
Twice a week	3 (3.5)	1 (1.4)	4 (2.6)
Once a week	18 (20.9)	7 (10.1)	25 (16.1)
A few times a month	26 (30.2)	11 (15.9)	37 (23.9)
Never	37 (43)	42 (60.9)	79 (51)
I practice / have practiced vocal exercises alone at home			
Every day	37 (43)	26 (37.7)	63 (40.6)
More than twice a week	26 (30.2)	18 (26.1)	44 (28.4)

Twice a week	10 (11.6)	10 (14.5)	20 (12.9)
Once a week	7 (8.1)	6 (8.7)	13 (8.4)
A few times a month	5 (5.8)	6 (8.7)	11 (7.1)
Never	1 (1.2)	3 (4.3)	4 (2.6)
Vocal warm-up habits (before work)			
Never/rarely	22 (25.6)	7 (10.1)	29 (18.7)
Sometimes	14 (16.3)	21 (30.4)	35 (22.6)
Often/very often	26 (30.2)	23 (33.3)	49 (31.6)
Always	24 (27.9)	18 (26.1)	42 (27.1)
Vocal cool-down habits (after work)			
Never/rarely	46 (53.5)	38 (55.1)	84 (54.2)
Sometimes	12 (14.0)	11 (15.9)	23 (14.8)
Often/very often	20 (23.3)	16 (23.2)	36 (23.2)
Always	8 (9.3)	4 (5.8)	12 (7.7)

Table 4 displays the means and standard deviations of each dimension for the total sample of singers included in this analysis, divided into pre and postmenopausal groups. Results of the Mann-Whitney test and corresponding Rosenthal effect-sizes are also included. For the total sample, the scores of the three dimensions of singing self-efficacy are high but significantly different (χ^2 = 49.09. p < .001). *Post hoc* analyses showed that *Middle Range* and *Lower Range* singing self-efficacies displayed similar levels (5.06 and 5.10, respectively), being both significantly higher than the *High Range and Transitions* dimension (4.74) (Z = - .612; p < .001; r = - .051. and Z = - .647; p < .001; r = - .054, respectively). Comparisons between pre and postmenopausal singers rendered significant differences for both *Higher Range and Transitions* and *Middle Range* dimensions, with premenopausal singers presenting higher self-efficacy scores.

Table 4. Mean (*M*) and standard deviation (*SD*) for the three dimensions of Singing-VoSES. Results are presented for the total sample (n = 155) and for pre (n = 86) and postmenopausal (n = 69) singers. The results of the Mann-Whitney test and

corresponding Rosenthal effect-sizes (*r*) are also displayed in the last two columns, respectively.

Dimensions	**Total sample**		**Premenopausal**		**Postmenopausal**		**Statistical results**	
	M	*SD*	*M*	*SD*	*M*	*SD*	*p*	*r*
Higher Range and Transitions	4.7	1.3	4.9	1.2	4.5	1.3	.04*	- .13
Middle Range	5	1.1	5.2	1.1	4.8	1.3	.03*	- .18
Lower Range	5.1	1.2	5.2	1.1	4.9	1.3	.43	- .09

Significance * $p < .05$.

G. Correlation analyses

Table 5 presents Spearman correlation coefficients for both pre and postmenopausal singers. Significant correlations were found for all pairs of dimensions. For premenopausal singers, the Spearman correlation coefficient ranged from .678 (*Higher Range and Transitions*/ *Lower Range*), to .764 (*Higher Range and Transitions*/ *Middle Range*). The corresponding coefficients for postmenopausal singers were similar, ranging from .660 (*Higher Range and Transitions*/ *Lower Range*) to .806 (*Higher Range and Transitions*/ *Middle Range*).

Table 5. Spearman correlation coefficients between Singing-VoSES dimensions: the upper and lower parts of the matrix concern pre (in bold) and postmenopausal (in italic) scores, respectively.

Dimensions	Higher Range & Transitions	Middle Range	Lower Range
Higher Range & Transitions	1	**.764****	**.678****
Middle Range	*.806***	1	**.694****
Lower Range	*.660***	*.763***	1

Significance ** $p < .01$

IV. DISCUSSION

The aim of this study was to create and validate a scale that measures singing voice function self-efficacy in professional and semi-professional singers (Singing-VoSES). High self-confidence in own's abilities is required when musicians aim at achieving optimal performances (Bandura, 1986; McPherson & McCormick, 2006; Schunk, 1991). In addition, perceptions of singing voice function self-efficacy seem important to pursue; without a functional voice, a singer's musicality and artistry may be compromised (Radianoff, 2008). Taking into account the uniqueness of the female vocal instrument earlier discussed, Singing-VoSES targeted female professional and semi-professional singers. Their level of proficiency was high, 18.93 years (*SD* = 11.6), eight years more than the previously reported landmark of 10 years-experience to achieve a professional level in music (Manturzewska, 1990).

Voice physiology is relevant to voice function and to perceived voice characteristics. Addressing different combinations of physiological parameters affecting voice quality simultaneously is required (Selamtzis & Ternström, 2017). Thus, Singing-VoSES items were designed to combine vocal loudness, pitch and breath control. The high mean item clarity, content validity and item acceptance ratio obtained from the expert evaluation suggested that items were designed appropriately. The results revealed no losses of the initial 18 items; three dimensions were identified, grouping items with excellent reliability into 3 factors, all related to vocal range ($\alpha > .9$). Also, *Middle Range* and *Lower Range* self-efficacies were both significantly higher than *Higher Range and Transitions*. Given the professional experience of respondents, this result seems rather surprising. However, mastering voice control over a wide range of frequencies is a constant endeavor in a singer's life. Moreover, singing in the higher and transitional regions of the voice both require similarly complex physiological adjustments to control voice function (i.e., subglottal pressure, vocal adduction and tension and extension of the vocal folds). Thus, it was not surprising that items concerning singing in a higher range and within the transitional regions of the voice were grouped into a single self-efficacy dimension, henceforth named *Higher Range and Transitions*. Varying pitch requires fine control of intrinsic muscles of the larynx, which result in varied combinations of vocal fold mass, tension and extension (Titze, 1994). The higher the pitch, the more tense and the thinner the vocal folds. This consequently requires adjustments of both subglottal pressure and vocal adduction in order to maintain or, purposely disrupt, timbre and loudness (Sundberg, 1987; Titze, 1994). Thus, one may agree that singing at a higher range requires great skills in controlling the physiological parameters that determine voice quality (Jeanneteau et al., 2020; Neumann et al., 2005; Sulter et al., 1995; Unteregger et al., 2020), being perceived by singers as a greater challenge. Moreover, to be able to sing comfortably at pitches situated at transitional regions of the voice requires a fine neuromotor control of breath energy, voice source and articulatory adjustments (Echternach et al., 2017, 2021; Neumann et al., 2005). Within these regions, unexpected perturbations of vocal folds vibrations may occur, resulting in loss of vocal control with sudden pitch jumps, unwanted voice distortions and problems with intonation (Titze, 2008).

Singing-VoSES development and validation was made during COVID-19 pandemic. Thus, one may argue that self-efficacy scores could be different if singers would not be experiencing a significant reduction (or even total lack) of performing opportunities. In fact, during the pandemic, lower levels of self-efficacy were found in association with higher levels of psychological distress (Karademas and Thomadakis, 2021; Losada-Baltar et al., 2020). Although for the present study, scores of singing function self-efficacy were high (between 4.7 and 5.1, out of 6), it may be relevant to apply this scale also in a non-pandemic scenario. Another valuable future application of this scale could be the study of the relationship between self-efficacy and hours of practicing. Previous studies have shown that self-efficacy is a strong predictor of motivation (Lane & Lane, 2001; Schunk, 1991; Wulf & Lewthwaite, 2016); more motivated musicians spend more hours practicing (McCormick & McPherson, 2003; McPherson & McCormick, 2006). Nevertheless, information on self-efficacy sensitivity to musical instrument playing is still scarce, especially when it concerns to singers and musical genres.

The development of self-efficacy is related to mastery experiences, vicarious experiences, social or verbal persuasions and physiological indexes (Bandura, 1986, 1997, 2006, 2012). The latter relates to the awareness of current physical and emotional status (Bandura, 1986, 1997; Hendricks, 2016; Zeldin et al., 2008). For a musician, an optimal physiological arousal is required to achieve excellency in performance (Lehmann et al., 2007). When physiological arousal surpasses the individual optimum (an inverted U-shape according to *Yerkes & Dodson Law* of physiological arousal and performance quality), performance quality may be compromised. Thus, people tend to avoid intimidating situations, or, in order words, situations in which coping strategies may be exceeded (Lane et al., 2001). In the particular case of a singer, one may argue that an intimidating situation would be to perform under non-optimal voice function conditions, such as those occurring during menopause (Bos et al., 2020; Elliott, 2017; Price, 2010). Our results seem to support this assumption; *Higher Range and Transitions* and *Middle Range* dimensions were higher in pre as compared to postmenopausal singers. It is therefore possible that, after menopause, previous vocal resources applied to convey musical expressiveness may no longer be available. If coping strategies have not yet been developed, the degree of situational stress will raise. Performing under such higher physiological (and cognitive) anxiety may result in an appalling performance experience (Hardy & Parfitt, 1991, Wilson & Roland, 2002), leading to lower levels of self-efficacy. Assisting singers in developing coping strategies to maintain high self-efficacy during menopause should therefore be encouraged. The creation of supportive networks and continuing educational programs targeting female singers during menopausal transition could constitute an important starting point. Verbal persuasions providing positive feedback on performance accomplishments constitute a power tool to the development of self-efficacy for those who already have achieved high levels of self-efficacy (Pitts, 2000).

One may argue that differences in self-efficacy between pre and postmenopausal singers could be related to ageing and not necessarily to menopause; aging is a confounding factor when studying menopause-related conditions (WHO, 1996). However, the present investigation has followed the recommendations provided elsewhere on restricting age range and applying menstrual cycle variability as the principal criteria when defining pre and postmenopausal groups (Harlow et al., 2012; Soules et al., 2001; Lã & Ardura, 2022). To further clarify on impacts of menopause on self-efficacy, future investigations may compare Singing-VoSES between female and male singers, matched for age and level of proficiency.

VI. CONCLUSION

Singing-VoSES is a reliable and validated scale to measure self-efficacy with respect to singing voice function. Higher range and transitional regions of the voice require higher self-efficacy as compared to middle and lower ranges. Comparisons of Singing-VoSES scores between pre and postmenopausal singers suggested that premenopausal singers seem to have higher self-efficacy as compared to postmenopausal singers with respect to both *Higher Range and Transitions* and *Middle Range* self-efficacy dimensions. Thus, the scale seems to be sensitive to voice-related menopausal changes. Further investigations on the impacts of menopause on perceived self-efficacy are thus worthwhile to be pursued. Low self-efficacy negatively impacts on career choices, and may lead to devastating consequences, such as premature retirement. Applying Singing-VoSES at different points of a singer's career, comparing effects of sex and age, seems another possible direction for future research. In addition, Singing-VoSES can be of value when assessing outcomes of (re)habilitation of singers' voices and longitudinal effects of different pedagogical approaches to voice education.

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DECLARATION OF INTERESTS

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TABLE CAPTIONS

Table 1. Sample characteristics (n = 439); *SD* = standard deviation.

Table 2. Singing-VoSES items and corresponding factor loadings.

Table 3. Singers' characteristics, experience level and vocal habits, presented for premenopausal (n = 86), postmenopausal (n = 69) and total sample (n = 155) of singers; *SD* = standard deviation.

Table 4. Mean (*M*) and standard deviation (*SD*) for the three dimensions of Singing-VoSES. Results are presented for the total sample (n = 155) and for pre (n = 86) and postmenopausal (n = 69) singers. The results of the Mann-Whitney test and corresponding Rosenthal effect-sizes (*r*) are also displayed in the last two columns, respectively.

Table 5. Spearman correlation coefficients between Singing-VoSES dimensions: the upper and lower parts of the matrix concern pre (in bold) and postmenopausal (in italic) scores, respectively.