Original Research Article

PRANAYAMA HEALTH SCALE: CONCEPTUALIZATION, DEVELOPMENT, VALIDATION AND RELIABILITY FOR ADOLESCENTS' WELL BEING

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Abstract: Pranayama techniques are enshrined in the ancient Indian yoga text books. The concept on pranayama health scale (PHS) is developed based on these scriptures. The present study is an attempt to develop a psychometric scale entitled Pranayama Health Scale (PHS) to measure individuals' physical and mental health and pranic wellbeing. A sample size of 1,253 adolescents was recruited on a convenient sampling basis to evaluate the psychometric properties of PHS. Content validity and face validity were done as a part of theoretical analysis. Construct validity was assessed through Exploratory Factor Analysis and Confirmatory Factor Analysis using SPSS and AMOS *version* 25. Reliability of the scale was tested using Cronbach's alpha and Spearman-Brown coefficient. The final scale consisted of 12 items, which produced a latent variable with Spearman-Brown coefficient of 0.97 and Cronbach's alpha of 0.96. PHS scores are positively correlated (p<0.001) with Yoga Self-Efficacy Scale (YSES). Goodness of Fit indices comprising Absolute, Incremental and Parsimonious fits were also calculates from the scale scores are within the accepted range confirming the validity of the model. The pranayama scale could be beneficial for the general health and well being of adolescent groups.

Key words: Pranayama; Health; Psychometric properties; Instrumental study.

Introduction: More than 5,000 years ago, yoga journey begun in India as an ancient science of holistic health and care system[1] and proposed numerous practical healing techniques such as Pranayama (pran = vital energy, ayam = flow) or breath control for pranic well being. The concept of pranayama was developed based on four major Indian text books of yoga viz; *Patanjali Yog-Darshana*[2], *Gheranda Samhita*[3], *Hatha yoga pradipika*[4], *Shiv Samhita* [5]. The core concept of pranayama was explained in Patanjali Yog-Darshana[6], the pranayama conept is explained in the form of three verses; *"tasmin sati shvasa prashvsayoh gati vichchhedah pranayamah"* (control of inhalation- exhalation breathing cycle is pranayama). *"Bahya abhyantara stambha vrittih desha kala sankhyabhih paridrishtah dirgha sukshmah"* (inhalation – exhalation and retention with time as a control factor). *"Bahya abhyantara vishaya akshepi chaturthah"* (holding the breath cycle steadily). Gheranda samhita[3, 7] declares pranayama concept in the form of

aphorism; "*Sahitaha suryabhedan ujjayi sitlisch tatha, bhastrika, bhramari, murchha ,kewali cha asht kumbhakah"*(combination of eight different breath holding techniques – sahit, suryabhedan, ujjayi, sitali, shitkari, bhastrika, bhramari, kewali). Hatpradipika[4] explains the pranayama concept as; *"Atha kumbhakabhedah suryabhedanamujjayi sitkari sitali tatha Bhastrika bhramari murchcha plavinityashtakumbhakah"* (suryabhedan, ujjayi, sitakari, sitali, bhastrika, bhramari,murchaa, and plavini). Though, the aphorism is same as the Gheranda[5], only its two techniques – sitali and plavani are different. In Shiva Samhita: alternate left and right nostril breathing by holding breath.

All the above scriptures[8] give more or less the same concept but with different operational techniques. In a nutshell, the concept of pranayama is all about breath- control, regulation[40], deep breathing, holding the breath leading to better health for both mind and body[8]. Its various benefits are; a) cleaning of nadis (vessels) resulting into vital energy[9] b) breathing helps in concentration[10] c) feeling body-mind lightness[11] d) pranayama cures many ailments[12] e) free from dualities of life[9].

The conceptualization process of pranayama was not carried out by many of the current researchers[13]. Rather, many of them focussed on therapeutic aspects of pranayama without giving much of importance to the conceptualization of the pranayama. In our current study, we focussed both on concept and therapeutic aspects. Generally, pranayama improves pulmonary functions in healthy individuals[14]. Additional general health benefits of pranayama were found in chest expansion, breath holding time[15], systolic blood pressure reduction[16].

Therapeutic outcomes of pranayama in patients with chronic heart failure[17], reduces the levels of pro-inflammatory cytokines[18], improved peak expiratory flow rate, chest expansion[15]. Further, pranayama techniques provide nerve stimulation[19], increased comfort, relaxation, pleasantness, vigor, alertness, reduced symptoms of arousal, anxiety, depression, anger, and confusion[20], decrease in perceived level of stress in professional and personal lives[21]. Effectiveness of yoga in the management of depression and glycemic control in type 2 diabetes mellitus patients[22]. Improved physical health among healthy university students[23], decrease in parasympathetic and/or increase sympathetic control of the heart[24, 39]. Pranayama enhanced attention skills[25], provides peace, happiness, optimistic attitude, self esteem and proper coordination between mind & body[25], and improves performance in the digit vigilance test[41]. It helps in stress, anxiety[26], and weight reduction, improved muscle strength, endurance[27], reduction of craving, withdrawal symptoms of cigarette smoking[28], and overall health improvement[29]. Hence, we first developed the concept so that yoga therapy techniques could be applied to all ailments. The conceptual frame is developed based on ancient Indian yoga texts along with its therapy applications for better health and well being.

Conceptual Frame: Pranic wellbeing conceptual frame may be developed based on the ancient Indian yoga text books[2, 3, 4, 5] as shown in Fig.1. The Eastern philosophies unlike the western psychologies[30] have developed a flavour to study the atma, brahma, wisdom, jivanmukta etc. Yoga philosophy on the other hand delineated this process and developed a scientific method of maintaining the physical and mental wellbeing perfectly through Pranayama[31]. The four ancient yoga text books; Yoga darshana[2], Gheranda samhita[3], Hatha pradipika[4] and Shiv samhita[5] explain pranayama regulation of breathing in different types (as shown in the Fig. 1) but conveying the same meaning of breath regulation. The benefits of pranic well being are also shown in the frame and these are; vital energy & concentration, Cure many ailments, feeling of body-mind lightness, free from duality of life. The vital energy is provided by breath regulation. Neurological sciences show the relation between the brain neurons and vital energy[32, 33, 34]. This subtle energy is the main key for the autonomous functioning of central nervous system[42] in the brain. This subtle energy may cleanse the duality of thoughts. The non communicable diseases like tension, depression, negative emotions, and stress

etc. may be cured through the regular and systematic practices of pranayama therapy techniques[43, 44]. The advanced technique is intended for people with extensive control over

their muscles and nervous system, who have already mastered the middle group of yoga practices.
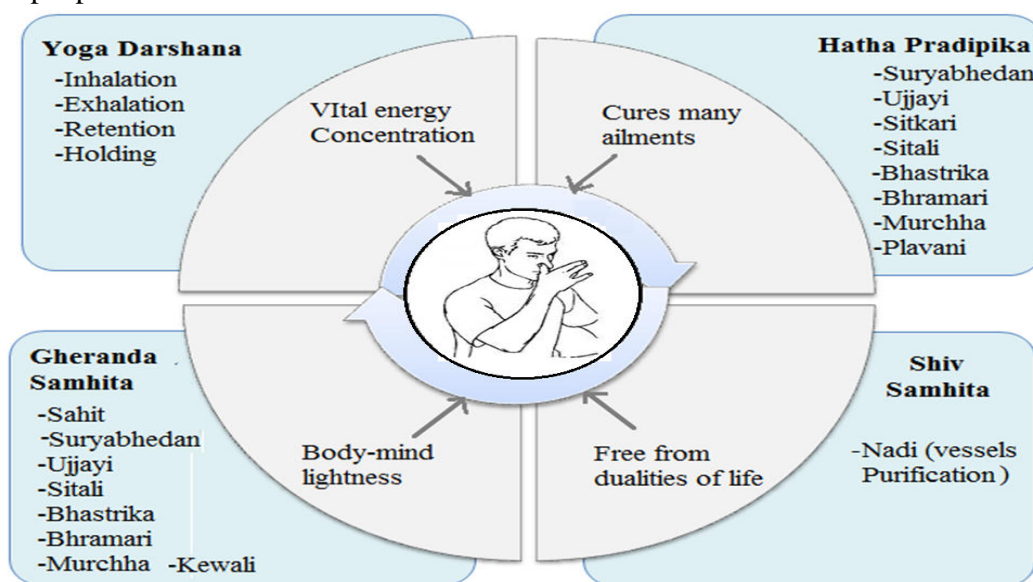
Fig.1 Pranic-wellbeing frame of reference

Methods
Participants: DeVellis RF[45] recommends a ratio of 1:15 or 1:20 as an ideal sample size. Learning from the literature, a sample size of greater than 300 or 400 was decided to ensure the sample adequacy. The present study on scale validation was conducted with sample of 1,253 adolescents individuals who were selected based on convenient sampling basis. The study was conducted in Bhopal city of Madhya Pradesh state, India. An age group of the individuals was considered as the criterion for inclusion and adolescents aged between 10-18 years were included in the study. The individuals who consented to provide data were considered in the sample size selection. The data were collected from 5 April to 4 May 2018.

Procedures of scale development: Scale development is a systematic process that is carried out different stages. Following recommendations of DeVellis RF[45] and Pasquali L[46] scale development for the present study was accomplished in two stages viz; item generation, Statistical measures.

Item generation: We developed the initial item pool for pranayama on the lines of methodology given by Montero I & Leon OG[51]. We considered benefits of pranayama as the constructs for scale development. The present research employed combination of deductive and inductive methods of initial item pool generation as recommended by Kapuscinski AN & Masters KS[52]. As a result, 20 items were developed under the selected content domains using Likert scale[53].

Statistical measures
To estimate the content validity of the initial item pool, the expert panel comprised a group of experts from psychiatry, psychology, yoga science departments. As suggested by Waltz CF[54], the experts' panel determined the content validity index (CVI). Visual appearance of the tool such as consistency of the style, formatting, readability and feasibility as prescribed by Devon HA[55] were tested by applying the initial level scale with 40 individuals. The respondents were asked to judge the user-friendliness of the tool. Feedback from the respondents was incorporated to improve the tool. The psychometric analysis involves a number

of techniques to test construct validity and reliability of the scale. DeVellis RF[45] strongly recommends the combined use of Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) to achieve consistent results of the psychometric indices.

Results

General characteristics of the sample: A sample size of 1253 adolescents in the age group ranging 11 to 18 years were selected for the study to test the psychometric properties of the pranayama health scale (PHS). The group covers both male 626 (49.96%) and female 627 (50.06%) populations. Among the total participants, 99.01% practiced pranayama during the yoga classes lasting 40 minutes each class for a period of one month. The demographic details of the subjects are given in Table 1.

Table 1: General characteristics of the participants

Characteristics	Total (N = 1253)		Population			
			Male (N = 626)		**Female** (N = 627)	
	N	%	N	%	N	%
10-12 years	311	24.82	156	50.16	155	49.84
13-14 years	315	25.14	159	50.48	156	49.52
15-16 Years	319	25.46	155	48.58	164	51.41
17-18 Years	308	24.58	156	50.64	152	49.35

Item generation: As a result based on the conceptual frame work of pranayama (Fig. 1), 20 items were generated as the initial pool of items under the selected major content domain viz; pranayama. From the initial pool of 20 items, 6 items on the PHS were deemed to be invalid based on experts rating and 14 items were retained with content validity index[57] value of 0.84. After modifying the scale based on rating by the experts, the scale was individually administered to 40 students who regularly practiced pranayama. Further two items were reduced resulting into 12 items based on respondents' feedback.

Exploratory factor analysis (EFA):

The scale evolved after the above analysis, 12 items were administered to 1,253 participants to ensure an appropriate sample size. Kaiser-Meyer-Olkin (KMO) measure is used to assess the sample adequacy and to prove the correlation matrix an identity matrix Bartlett's Test of Sphericity is conducted. The KMO sample adequacy was 0.96 which indicated marvellous level and the Bartlett's Test of Sphericity for adequacy of scale was highly significant at p<0.001. Principal Component Analysis method of factor extraction was used and one factor was extracted explaining 71.36 % of the total variance. Results of the Scree plot technique indicated extraction of one factor with 12 variables. Values of communalities ranged between 0.586 and 0.73. Factor loading measures ranged from 0.77 to 0.86. To undertake the most appropriate interpretation, the loading values were carefully examined using Hair JF[64] guideline for practical significance. Since all the factor load values of 12 variables were greater than 0.40, all of them were retained in the scale for next level confirmatory factor analysis.

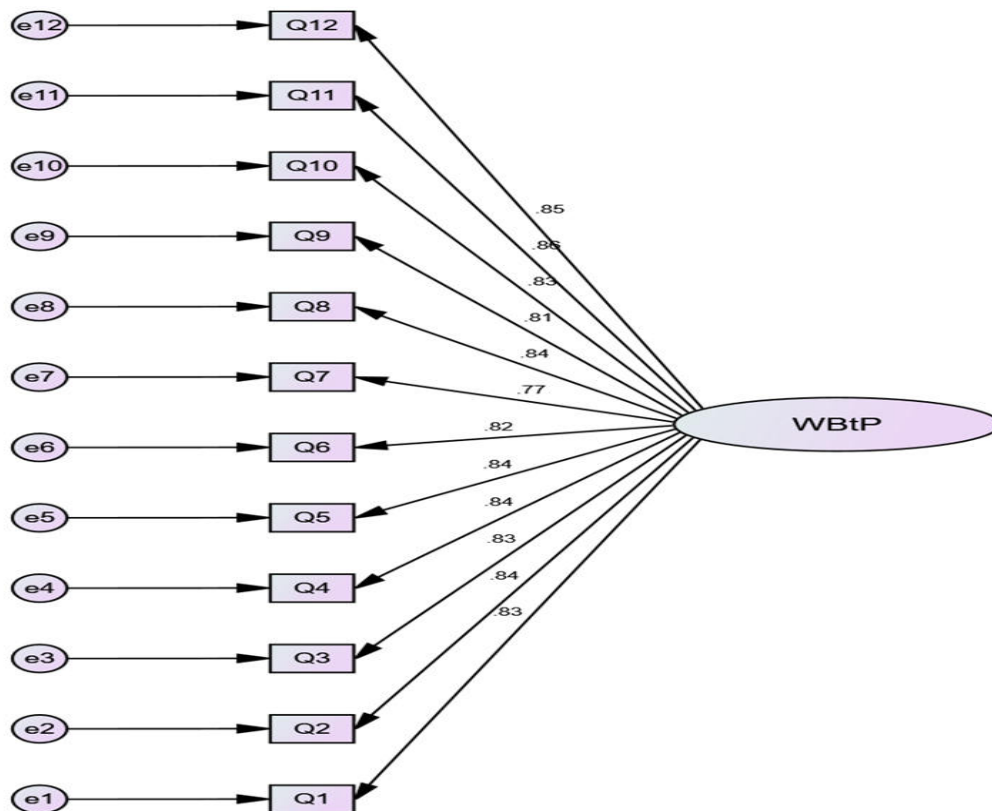**Confirmatory factor analysis (CFA):**

To strengthen our findings, a CFA structural equation modelling is used to test the developed factor structure through EFA with one latent factor and 12 observed variables. The model obtained from confirmatory analysis is presented in Table 2 and in Figure 2.

Convergent validity: We performed three additional factor extractions to confirm the model structure, presented in Table 3. This table shows item quality (Chi-square), composite reliability (CR), and average variance extraction (AVE) were quantified to test convergent validity. Statistical significance of all the items in the model indicates presence of convergent validity. All factors had values of 0.50 or higher, demonstrating that the observed variable sufficiently reflected its construct's latent variable[61]. Factors with a CR of 0.96 were considered good[62], and the value of AVE was 0.68 for the scale under consideration[63].

Table 2: Factor loadings of 12 items Pranayama Health Scale (PHS) with Regression coefficients

Domain/Item	factor loadings
Q1: My breath is in my control.	0.83
Q2: I can hold my breath.	0.84
Q3: My right nostril is more active than left.	0.83
Q4: My left nostril is more active than right.	0.84
Q5: One can balance both left and right nostrils.	0.84
Q6: I find it difficult in balancing left and right nostrils.	0.82
Q7: Practice of breathing leads to stability of body and mind.	0.77
Q8: One can feel lightness of the body with breath control.	0.84
Q9: I am free from health hazards through breathing practices.	0.81
Q10: I can focus my mind better through breathing practices.	0.83
Q11: Regular breathing practices leads to wellbeing.	0.86
Q12: One can attain personality development through pranayama.	0.85
Regression coefficient	**0.83**
Composite Reliability (CR; ≥0.6)	**0.96**
Average Variance Extraction (AVE; ≥0.5)	**0.68**

Fig. 2: WBtP model produced by confirmatory factor analysis

Construct validity: In confirmatory factor analysis[56] many indices of model fitness are used to test construct validity. Hair JF[64] recommends to use at least one index from model fit categories namely absolute fit, incremental fit and Parsimonious fit. Results obtained in the present study on model fitness indices are presented in Table 3. All three different fit indices minimum level was achieved[63]. The statistical fitness indices improved immensely the one factor structure.

Table 3: Model fitness indices for PHS

Sl. no.	Name of category	Name of index	Accepted level	Study result
1.	Incremental fit	Comparative Fit Index (CFI)	>0.90	0.979
		Tucker-Lewis Index (TLI)	>0.90	0.974
		Normed Fit Index (NFI)	>0.90	0.97
		Adjusted Goodness of Fit (AGFI)	>0.90	0.951
2.	Parsimonious fit	Chi Square/Degrees of Freedom (Chi-square/df)	<3.0; or <0.5	4.66*
3.	Absolute fit	Discrepancy Chi Square (Chi-square)	P>0.05	0.0001
		Root Mean Square of Error Approximation (RMSEA)	<0.08	0.05
		Goodness of Fit Index (GFI)	>0.90	0.966

Note: * indicates Wheatson, B., et al., (1977) ratio of normed chi square to df is < 5 which is a reasonable value. The ratio obtained in the present study was 4.66 and hence it could be inferred that the value is reasonable to judge that the model has parsimonious fitness.

Concurrent validity: A Yoga Self Efficacy Scale (YSES) developed by Birdee GS[49] with 3 constructs and 12 items was selected to test concurrent validity of the present scale. YSES has been developed to measure self-efficacy among the practitioners of Yoga in American context. The tool has been evolved based on the theory of self-efficacy. YSES has robust internal consistency with Cronbach's alpha value of 0.93 and good construct validity measures. When the scale was administered in our study, it had Cronbach's alpha value of 0.87. The scores of the scale developed in the present study were correlated with YSES. Since the data were not normally distributed, non-parametric tool of association measurement namely Spearman's correlation coefficient was applied. Both the scores were positively correlated (ρ=0.87) and it was significant (p<0.001). Presence of criterion validity was proved due to positive and significant correlation coefficient between the newly developed scale and an established scale.

Reliability: Internal consistency of the 12-item was assessed by calculating Crohbach's alpha measure, Spearman Brown coefficient and composite reliability measure. The Crobbach's alpha value was 0.96 while studies suggest that above 0.7 suggest high levels of internal reliability[55]. Spearman-Brown coefficient of split half reliability was 0.97. Composite reliability measure was 0.96.

Inter-item correlations matrix data are shown in table 4. The ideal range of average inter-item correlation is from 0.56 to 0.73 and these items are close and almost repetitive. All questions had values of .50 or higher, thus demonstrating that the observed variable questionnaire give consistent and appropriate results[65].

Test-retest reliability: Test-retest reliability was assessed over a month's time in 300 participants. The Intra-class correlation coefficient (ICC), Cronbach's alpha and one-sample statistics was used to calculate the test-retest reliability. ICC for single measures 0.68 and for average measures were 0.96 considered an adequate reliability scores[66]. The Overall scale reliability for the items was better, with Cronbach's alpha 0.96. These results confirm the 12 items pranayama health scale has good stability. Test-retest analysis data mean value as 3.43±0.90 with significant t-value at p<0.001 were same over a month's time showed the consistency of the data.

Table 4: Inter-item correlations matrix

	Q12	Q11	Q10	Q9	Q8	Q7	Q6	Q5	Q4	Q3	Q2	Q1
Q12	1											
Q11	**0.73**	1										
Q10	0.692	**0.713**	1									
Q9	0.673	0.689	**0.666**	1								
Q8	0.71	0.729	0.676	**0.651**	1							
Q7	0.623	0.651	0.673	0.602	**0.625**	1						
Q6	0.811	0.697	0.662	0.657	0.656	**0.559**	1					
Q5	0.725	0.765	0.69	0.681	0.68	0.66	**0.686**	1				
Q4	0.716	0.721	0.773	0.696	0.697	0.626	0.675	**0.659**	1			
Q3	0.679	0.699	0.677	0.785	0.665	0.618	0.711	0.696	**0.695**	1		
Q2	0.694	0.69	0.689	0.658	0.814	0.655	0.692	0.713	0.686	**0.679**	1	
Q1	0.69	0.7	0.679	0.654	0.709	0.738	0.649	0.688	0.699	0.657	**0.704**	1

Discussion: Systematic steps as prescribed in the literature of psychometric research were adopted to develop this instrument. The pranayama concept developed based on ancient Indian yoga philosophical texts[47] as an extensive literature review (deductive method) and consulted with relevant people about the subject (inductive method)[67,50, 58]. The initial item pool, which had 20 items got reduced to 12 items with one construct at the end of the study. It has been validated and found to be reliable by using the psychometric analysis. The stated objective that pranayama is related to health and wellbeing has been proved with final regression coefficient value (Table 2). It was calculated using EFA and CFA statistical analytical techniques[59, 60] to assess the influence of dhyana on health and well being. In terms of scale's validity, reliability and factor structure of pranayama scale. The results of this study suggest that the pranayama scale is providing an appropriate instrument for measuring the wellness among adolescents and support the factor structure, reliability, and validity of the measures. We identified one factor of the pranayama scale as Wellbeing through Pranayama (WBtP) exhibited good internal reliability and constituted a model with a good fit (GoF) with the data. The research community, over the years, has developed a number of GoF Indices to test the construct validity. The GoF Indices are categorized into three groups' namely absolute fit indices, incremental fit indices and parsimonious fit indices. Absolute fit indices are a quantity of degree of fitness of the model to the empirical data. They offer the most fundamental measure of the fitness[64]. Goodness of Fit Index (GFI) is another absolute fit index. According to Tanaka JS & Huba GJ[68] GFI is equivalent to R^2 in regression analysis. In the lines of R^2 measure, for GFI also Adjusted index is calculated (AGFI). Root Mean Square Error of Approximation (RMSEA) is a population based index and is less sensitive to sample size. Tucker Lewis Index (TLI) has values range between 0 and 1. Models with values close to 1 show better fit. Likewise, Normed Fit Index (NFI) values range from 0 to 1 and values above 0.90 indicate better fit[67]. According to Hair JF[64] a parsimonious model is significant to prove that the postulated model fits the data in comparison with a complex model. According to Wheaton B[69] the ratio of Normed Chi square/df is reasonable. The ratio obtained in the present study was 4.66 and hence it could be inferred that the value is reasonable to judge that the model has parsimonious fitness. The results of this study suggest that the pranayama scale is providing an appropriate instrument for measuring the wellness among adolescents and support the factor structure, reliability, and validity of the measures. The 12-item pranayama scale is a short scale that

can be administered both for general population and for school setting[48]. The age appropriateness is compared with the adolescent psychiatry of the quality of life[70]. The psychometric quality of the pranayama scale is generally comparable to the pattern matrix, goodness of fit and factor loadings of the CFA analysis carried out by Huang CH[71]. Sun J[72] has brought out unique associations between wellbeing and personality aspects. The score of the new scale positively and significantly correlated with the standardized scale namely Yoga Self-Efficacy Scale[49] to prove existence of concurrent validity.

Conclusion: In this paper, we developed the concept of pranic wellbeing as an outcome of pranayama health scale (PHS). The health benefits in preventing the modern life ailments such as stress, anxiety, tension depression were based on four ancient yoga scriptures. And these benefits were also derived from EFA loadings which show the standard regression coefficients varying above 0.80 indicating very good correlation between different factors leading to pranic wellbeing confirmed by structural equation CFA model. The analysis was done using the latest version *SPSS* and *AMOS* 25.

Conflict of interest: Authors and co-author, declare that they have no conflict of interest.
Author Contribution: The main author is the administrative head and the remaining co-author contributed to the data analysis and its statistical interpretation.
Compliance with Ethical Standards
Disclosure of potential conflict of interest: Authors and co-author declare that they have no conflict of interest to this work.

Research involving human participants and/or animals: This article does not contain any studies with animals.
Informed consent: Informed consent was obtained from all individual participants included in the study.

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