Psychometric Properties of the Measure of Love for Nature

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ABSTRACT

Several instruments have been developed to measure the relationship between human beings and nature, one of which is the Love and Care for Nature Scale. Three studies were conducted with the aim of analyzing the functioning of the scale. In the first study (n = 51) the components of the concept were analyzed. It showed a large cluster formed by two others (connectedness and well-being), considered "love for nature", and one two-items cluster referring to "care". Taking into account the "love" items, a second study (n = 1071) was conducted to analyze the psychometric properties of the scale using item response theory and factor analysis, finding that ten of the items present adequate psychometric properties. A third study (n = 151) shows that the ten-item scale has adequate levels of reliability and validity. Consequently, the reduced scale is an adequate measure of love for nature, while an interesting future research line would be to separately study the scale's two components.

1. INTRODUCTION

Since the origins of human beings, there has been a relationship with Nature in different historical and cultural contexts. As Kellert and Wilson (1993) point out, this relationship could be innate, showing even people a biological need to keep in touch with Nature. The complexity of these relationships is reflected when trying to describe them, as individuals themselves find it difficult to express their experiences (Stålhammar and Pedersen, 2017). Thus, in diverse attempts to describe these subjective relationships, researchers have developed different concepts and measures. The aim of all these concepts and their corresponding measures is to describe the relationships between human beings and nature, focusing in some cases on the cognitive dimension and in others on the affective dimension (Amérigo, Aragonés and García, 2012). Nonetheless, despite the differences between these concepts and measures, they are all expressions of the same construct: a subjective nature connectedness (Capaldi, Dopko and Zelenski, 2014; Tam, 2013a). Indeed, Tam (2013a), conducted a study whose aim was to determine whether there is a robust relationship between the different concepts, finding that they actually formed a single latent construct. However, comparison of the correlations of each measure with the different criterion variables traditionally associated with connectedness, mainly variables of personality and well-being, showed that the magnitudes of these correlations were not equal. In other words, it can be considered that all these concepts

share a common part that measures the relationship between nature and human beings from the perspective of self. However, each of these constructs also has nuances that are difficult to pin down.

Among the particularities of each concept, a clear difference is observable between them: some emphasize the link with nature at cognitive level, while others concentrate on the emotional connection, or even a combination of both (Amérigo et al., 2020). Among the first, the most prominent is the concept of connectedness with nature and its corresponding measure, the Connectedness to Nature Scale (CNS) developed by Mayer and Frantz (2004). Frequently used in environmental psychology, it has been the subject of exhaustive analysis at different levels: in terms of concept (Perrin and Benassi, 2009), reliability (Pasca, Aragonés and Coello, 2017) and validity (Pasca, Coello, Aragonés and Frantz, 2018). Other concepts and measures of the cognitive component are "Inclusion of Nature in Self" (Schultz, 2001), "Environmental Identity" (Clayton, 2003), Biospherism (Amérigo, Aragonés, Sevillano and Cortés, 2005), "Connectivity with Nature" (Dutcher, Finley, Luloff and Johnson et al., 2007) and "Commitment to the Environment" (Davis, Green and Reed, 2009). Among the second, the emotional level, the literature is populated by terms such as: "Emotional Affinity toward Nature" (Kals, Schumacher and Montada, 1999), "Love and Care for Nature" (Perkins, 2010) and "Dispositional Empathy with Nature" (Tam, 2013b). Moreover, the approaches based on the emotional connection of people to nature have not been as exhaustively analyzed in psychometric terms as those related to cognition. Among these measures of the affective component, Perkins (2010) proposed the concept of *Love and Care for Nature*, which she defined as a "deep love and caring for nature which includes a clear recognition of nature's intrinsic value as well as a personal sense of responsibility to protect it from harm" (p. 456). The author proposes three dimensions, which she includes in her definition. The first one relates love to feelings of caring. The second dimension refers to love in terms of interconnection with nature. And the third, which refers to the commitment to protect nature. To measure these concepts, the author designed the Love and Care for Nature Scale (LCS).

Another approach to the love for nature, can be the one raised by Kals et al. (1999), who affirm that the term love for nature usually refers to a romantic conception, found in contexts of literary character. They point out that this term is related to others such as

feelings of freedom or security, so they decide to group them together under the label of "emotional affinity toward nature". On the other hand, Lumber, Richardson and Sheffield (2017) define love of nature as “an affective state or sensation that occurs as a result of engaging with nature” (p. 19). In this definition there is a connection between the ideas of love and care analogous to those in the LCS (Perkins, 2010). Another work that advocates for this differentiation between love and care is recently carried out by Dong, Liu, Li, Yang, Liang and Deng (2020), who refer to love based on the triangular theory of love of Stenberg (1986). That is, the authors conceptualize love by distinguishing three dimensions: passion, intimacy and commitment. Passion is understood as the strong and romantic feelings towards nature. Intimacy is based on the closeness and connectedness caused by experiences with nature. And commitment implies the maintenance of these feelings of love.

As can be seen from the above work, it can be expected that, although love is a precedent for care, they could well be differentiated empirically, so that a scale such as the LCS should contemplate both components. A detailed reading of the items seems to reflect both separately in an unbalanced way - more items about love than about care-. This leads us to ask to what extent the concept of love and care for nature, responds to two empirically different dimensions, as well as conducting a psychometric study of the scale.

To this end, we conducted three studies. First, we conducted a study to observe to what extent the components that lend their name to the scale - love and care - are recognized in the items used to define it. Second, another study was carried out to analyze the scale using item response theory models. Finally, we analyzed the convergent and discriminant validity in a third study.

2. STUDY 1

When developing the concept, Perkins (2010) suggests three theoretical dimensions. The first of these refers to a sense of fascination with the natural world, a recognition of its intrinsic value. These feelings, according to the author, are those that trigger the feelings of care and responsibility towards nature, forming the second. The third dimension refers to feelings of interconnectedness and emotional closeness with nature, including a spiritual aspect. However, the author chooses to use two dimensions – love and care – when giving the scale a name, which leads one to wonder exactly which empirical dimensions underpin the instrument

2.1 METHOD

2.1.1 *Participants*

A total of 51 psychology undergraduates, of whom 90.20% were female, participated in this study. Their mean age was 20.37 (SD = 1.04).

2.1.2 *Instrument and procedure*

Each of the 15 items comprising the LCS were printed on different cards of the same size (see Table 1). In a classroom at the Faculty of Psychology, the participants were given the cards and asked to put them into groups, with no prior criteria or number of categories being indicated. No criteria were indicated to avoid introducing bias into the categorizations.

2.2 RESULTS

Using the between-groups linkage method, we conducted a hierarchic cluster analysis. The data matrix was formed from the frequencies in which each item was associated with each of the others.

The results show three different clusters as can be seen in Figure 1. We named the first of these (N1) "connectedness" as it comprised items directly related to individuals' bond with the natural world (e.g. "*I often feel emotionally close to nature*"). The second cluster (N2) included the largest number of items, which all refer to the sense of well-being triggered by contact with nature, a feeling of self-transcendence or spirituality (e.g., "*When I spend time in unspoilt nature I feel that my day- to-day worries seem to dwindle away in the face of the wonder of nature*"). Finally, the third cluster (N3) was made up of just two items, both of which explicitly allude to a drive to protect or care for nature (e.g., "*I often feel a strong sense of care towards the natural environment*").

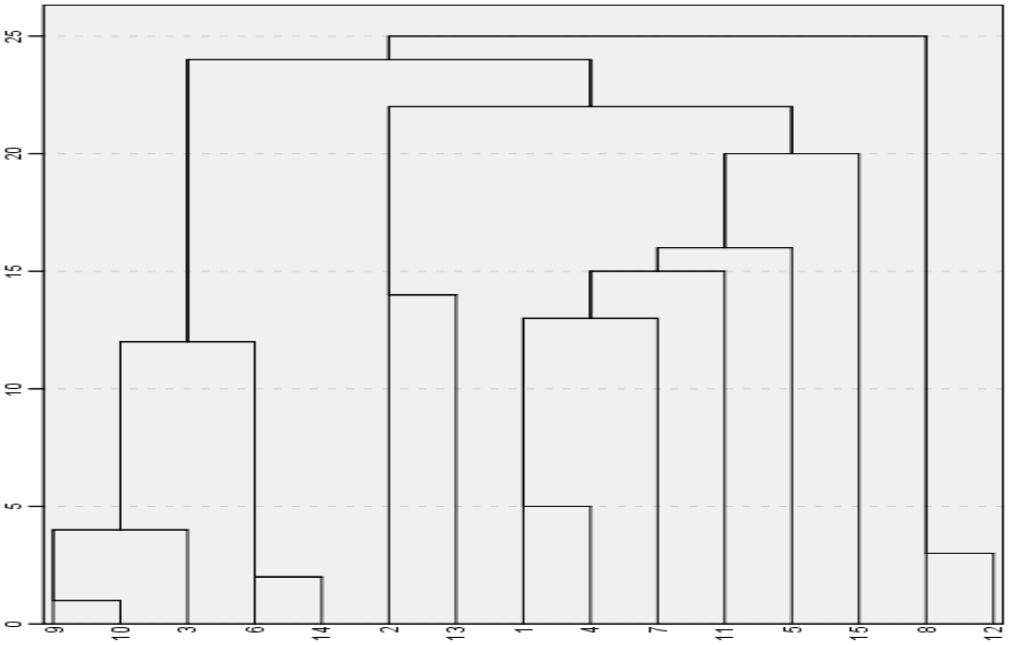

Figure 1: Cluster analysis of the 15 LCN items. The item numbers are at the bottom of the diagram.

2.3 CONCLUSION

The results of this study show that despite the unidimensional nature of the LCS, when individuals are asked to categorize the scale's items, three different dimensions emerge. The first category includes the items that refer to the sense of connectedness with nature, where the traditional bond between human beings and nature is reflected. The majority of items on the scale are included in a cluster that forms the second category alluding to a sense of welfare generated by being in the natural environment, involving an almost spiritual feeling of enjoyment. The third cluster is formed by only two items, which are directly associated with protecting and caring for nature. Thus, it might be said that the Love and Care for Nature Scale is more a scale of "love for nature", with care for nature possibly being considered a separate component.

3. STUDY 2

In light of the findings of the first study, where 13 items were grouped into only one cluster, we decided to conduct a psychometric analysis of these same items referring love. To evaluate the quality of the measure, two techniques were used: the quality of the items was assessed using IRT analysis and the structure of the scale was evaluated by means of factor analysis.

3.1 Method

3.1.1 Participants and Instrument

For the analyses, a sample of 1071 participants was used. The sample comprised different general population sub-samples with an age range of 13 to 77 years. These had been obtained for previous studies (Aragonés, Olivos, Pasca and Talayero, 2015; Vigon, 2016; Pasca et al., 2017; Aragonés and Pasca, 2017; Pasca and Aragonés, 2018; Pasca, 2018; Pérez-López, Pasca and Aragonés, 2018), all conducted between 2015 and 2017. Mean age was 26.42 years (SD = 14.58), and 56.70 % of the participants were female.

The LCS comprises 15 items rated on a 7-point Likert-type scale, where participants express their level of agreement or disagreement with the statements. Nonetheless, following the findings of the previous study, only the 13 items referring to love for nature were considered.

3.1.2 Data analysis

The scale was analyzed using IRT models. These models provide estimators of the parameters characterizing the items that do not depend on the samples of participants to whom the test has been applied. Furthermore, the parameters that characterize a participant do not depend on the sample of items employed (Hambleton & Swaminathan, 1985; Lord, 1980). To analyze items such as those of the LCS using IRT, polytomous models are required to represent the nonlinear relationship between the level of the variable and the probability of responding to a given category (Embretson and Reise, 2000). Samejima (1969) proposed graded response models, because responses cannot always be categorized in terms of correctness or error, which is what IRT has traditionally analyzed. This model is especially suitable for items whose response categories are scored between 1 and the number of categories, so the choice of the highest category implies a higher level in the construct, as is the case with the LCS.

3.1.2.1 Unidimensionality

One of the fundamental assumptions of unidimensional parametric IRT models is that the measured construct is unidimensional—in other words, that the covariance between items can be explained by a single factor. The LCS was originally created to measure the affective component of connectedness only. To assess the factor dimensionality of the scale, a parallel analysis (PA) was conducted using the FACTOR 9.3 program (Lorenzo-Seva & Ferrando, 2006).

3.1.2.2 Calibration of the IRT items

To ascertain the quality of each of the items that make up the LCS, we estimated the discrimination and difficulty parameters, using Samejima's (1969) Graded Response Model (GRM), which estimates individual slopes for each of the LCN items. We evaluated the fit of the model for each item. We carried out IRT analysis with the IRT.PRO program (Cai, du Toit, & Thissen, 2012). Finally, we examined whether there were problems of local dependency. Items exhibiting local dependency will tend to present higher slopes than those shown by other items.

3.1.2.3 Confirmatory Factor Analysis (CFA)

Taking into account the theoretical dimensionality and the dimensionality proposed for the parallel analysis, two CFAs were performed to test the single or double factor structure of the scale, using robust maximum likelihood as the estimator. Error variances were not allowed to co-vary between items. Model fit was assessed using recommendations by Meyers, Gamst, and Guarino (2013) with a non-significant chi-square value ($\chi 2$), a significant root mean square error of approximation (RMSEA $\leq .08$), and a comparative fit index (CFI $\geq .95$), all of which indicated a good fit. Chi-square was considered to be a secondary fit index given its sensitivity to large samples and the frequently resulting underestimation of model fit (Brown, 2006). MPLUS 7.0 (Muthen and Muthen, 2012) was used.

3.2 RESULTS

First, the dimensionality of the scale was analyzed by means of a parallel analysis, using the Unweighted Least Squares (ULS) method. A single factor was obtained in the Exploratory Factor Analysis, explaining 74.19% of the variance, meaning that unidimensionality was assumed.

Next, the overall fit of the 13-item scale was analyzed, obtaining a value of -2LL = 37794.46. At item level, the S - χ^2 statistic was used to assess fit. The results are shown in Table 1, where it can be seen that while most of the items present an acceptable fit, items 14 and 15 do not present a suitable fit to the model ($p < 0.01$). For this reason, these items were eliminated from subsequent analysis.

Table 1: S-X^2 fit statistics of the 15 LCS items.

Item	X^2	*Df*	Probability
1. I feel joy just being in nature.	178.73	171	.3268
2. I feel that closeness to nature is important for my wellbeing.	165.60	154	.2472
3. When I am close to nature, I feel a real sense of oneness with nature.	143.47	154	.7179
4. I feel content and somehow at home when I am in unspoilt nature.	217.29	178	.0238
5. I feel a deep love for nature.	168.45	157	.2516
6. I often feel emotionally close to nature.	159.94	157	.4195
7. When I spend time in unspoilt nature I feel that my day- to-day worries seem to dwindle away in the face of the wonder of nature.	233.57	205	.0833
8. Protecting the wellbeing of nature for its own sake is important to me*.			
9. I feel spiritually bound to the rest of nature.	181.74	176	.3673
10. I feel a personal sense of interconnectedness with the rest of nature.	188.92	179	.2908
11. I often feel a sense of awe and wonder when I am in unspoilt nature.	223.31	187	.0357
12. I often feel a strong sense of care towards the natural environment*.			
13. I need to have as much of the natural environment around me as possible.	205.11	197	.3309
14. When in natural settings I feel emotionally close to nature.	228.23	167	.0012
15. I enjoy learning about nature.	222.89	176	.0096

*Items corresponding to "care for nature" eliminated from this analysis .

To determine whether there is local independence (LI) - that is, if there is no additional systematic covariance to the covariance between the underlying construct and the item - LD χ^2 was calculated, with $\chi^2 = 42.8$ being found for Items 9 and 10. This means that the presence of both items in the scale is redundant since they measure the same aspect of the construct. For this reason, we decided to remove Item 10 from the scale, as its fit was slightly lower.

We then performed a second analysis, in which we included the remaining ten items, whose difficulty and discrimination parameters are shown in Table 2. This table shows that the remaining items have high discrimination indices, as well as difficulty indices that increase with the response categories.

Table 2: *Estimates of the parameters of the ten items of the graded response model*

Ítem	*a*	*s.e.*	b_1	*s.e.*	b_2	*s.e.*	b_3	*s.e.*	b_4	*s.e.*	b_5	*s.e.*	b_6	*s.e.*
1	2.43	0.12	-2.67	0.14	-1.59	0.07	-0.75	0.05	-0.02	0.04	0.85	0.06	-1.59	0.07
2	2.77	0.14	-2.49	0.12	-1.57	0.07	-0.85	0.05	-0.14	0.04	0.79	0.05	-1.57	0.07

3	3.34	0.16	-1.99	0.08	-1.08	0.05	-0.48	0.04	0.20	0.04	1.05	0.06	-1.08	0.05
4	2.91	0.14	-2.11	0.09	-1.07	0.05	-0.37	0.04	0.30	0.04	1.14	0.06	-1.07	0.05
5	3.25	0.16	-2.18	0.09	-1.06	0.05	-0.33	0.04	0.34	0.04	1.10	0.06	-1.06	0.05
6	3.16	0.15	-1.90	0.08	-0.78	0.04	-0.13	0.04	0.63	0.05	1.47	0.07	-0.78	0.04
7	1.80	0.09	-2.63	0.14	-1.47	0.07	-0.86	0.06	-0.02	0.05	0.96	0.07	-1.47	0.07
9	2.46	0.12	-1.94	0.09	-0.79	0.05	0.14	0.04	0.84	0.06	1.73	0.08	-0.79	0.05
11	1.86	0.10	-2.98	0.17	-1.81	0.09	-1.11	0.06	-0.23	0.05	0.84	0.06	-1.81	0.09
13	2.16	0.10	-2.17	0.10	-0.86	0.05	-0.05	0.05	0.71	0.06	1.70	0.09	-0.86	0.05

After eliminating the three items, the -2LL value of the scale was 29587.67. We then calculated the coefficient of determination, which reports the proportion of reduction of variance relative to the original scale, obtaining a value of $R^2 = 0.2171$. In other words, eliminating items 10, 14 and 15 from the scale would reduce the residual variance by 21.71%.

Taking into account the unidimensionality suggested by the parallel analysis and the theoretical two-dimensional nature of the scale proposed in the previous study, the fit indices (Table 3) and the item weights (Table 4) were compared in both models.

Table 3: Goodness-of-Fit Indices for the 10 items of Love for Nature (n = 1071)

Group	χ^2 (df)	ΔSB-χ2 (df)	CFI	RMSEA	R	Standardized Cronbach's alpha	Ω	GLB
M1	220.92** (35)	---	.96	.07		.90	.91	.93
M2	202.91** (34)	13,65 (1) = <.01	.96	.07	.96	.87 / .69	.88 / .73	.90 / .73

Note: M1 = Unidimensional model; M2 = Bidimensional model; χ2 = Chi-square fit statistic; df = degrees of freedom; Δχ2 = Satorra-Bentler scaled chi-square difference test; r = Factors Correlation; Ω = McDonald's Omega; GLB = Greatest lower bond to reliability; ***p <.01.*

Table 4: Comparison between the factor weights between the one- and two-dimensional models of the 10-item of Love for Nature.

	Unidimensional	Bidimensional	
	"Love"	"Well-being"	"Conexion"
Item 1	.741	.749	
Item 2	.785	.790	
Item 3	.846		.853
Item 4	.821	.825	
Item 5	.848	.849	
Item 6	.846		.862
Item 7	.673	.677	
Item 9	.773		.794
Item 11	.672	.677	
Item 13	.745	.749	

Both models had adequate fit indices (CFI > .95 and RMSEA < .80). In the two-dimensional model, the correlation between the two factors was .96. With regard to reliability, the unidimensional model yielded indices of above .90, while in the two-dimensional model, the greatest lower bond to reliability (GLB) was only higher than .90 in the first factor but .73 in the second. Following the criteria of Tabachnick, Fidell and Ullman (2007), the weighting was excellent in the unidimensional model and excellent/very good in the two-dimensional model. Satorra-Bentler's likelihood ratio (ΔSB-χ2) (Satorra and Bentler, 2010) seemed to indicate that the two-dimensional model provides a better fit than the unidimensional model.

Although Satorra-Bentler's likelihood ratio might suggest the two-dimensional model is more appropriate, given that a) both models had adequate goodness of fit, b) the correlation between the two factors is higher than .95, and c) the reliability indices and factor weights are higher in the unidimensional model, we conclude that the unidimensional model is more adequate.

Furthermore, we can conclude that the love of nature dimension of the LCS comprises the above-mentioned 10 items with good psychometric properties.

4. STUDY 3

Having shortened the LCS by means of the analyses conducted in study 1 and study 2, it was necessary to verify whether the new scale Love for Nature Scale (LNS) provides adequate reliability and validity. To this end, we conducted the following study.

4.1 METHOD

4.1.1 Participants and Instrument

A total of 151 individuals from the general population of Madrid (Spain) participated in this study. Mean age was 40.96 years (*SD* = 12.50); 53.6% were female. All participants completed a self-administered questionnaire. This consisted of the LNS; the CNS 7 items version (Pasca et al., 2017); and the Environmental Apathy Scale (EAS) created by Amérigo et al. (2012). Finally, participants provided their sociodemographic data.

4.2 RESULTS

In order to verify the reliability of the new version of the LNS, we conducted a reliability analysis, using Cronbach's alpha, which yielded adequate reliability (α = 0.951). Furthermore, to analyze the convergent and discriminant validity, we calculated the correlations between the LNS and the CNS-7 (r = 0.676, p < 0.001, n = 151) and EAS (r = -0.479, p < 0.001, n = 151). These results provide support for the convergent and discriminant validity of the new scale.

5. GENERAL CONCLUSIONS

Interest in the study of the relationship between humans and nature has led to the development of a number of measures, including the LCS designed by Perkins (2010). This scale measures the emotional component of the connection between human beings and nature, with reference to two different terms: love and care for nature. These two terms have been differentiated in the literature (e. g. Lumber et al., 2017) as well as the items on the LCS themselves. Therefore, it was considered necessary to study whether this differentiation was observed when the participants classified the items according to the content to which they referred. In addition, due to the importance of obtaining a reliable measure of the emotional relationship, an exhaustive conceptual and psychometric analysis of the scale was deemed necessary.

In the first study conducted for the present work, when the participants were asked to put the 15 items of the LCS into categories, they separated them into three different groups. The first of these contained five items referring to "connectedness with nature" a sense of oneness with the natural world. The second group comprised eight items related to the "well-being" that contact with nature generates. Finally, the participants grouped together two items alluding to "care" for nature. Due to the under-representation of this

component, we decided to continue the analyses without taking it into consideration and hence the "care" component was dropped from the name of the scale. This separation of both terms is necessary when operating the scale measurement object, since, as Muñíz and Fonseca-Pedrero (2019) point out, it is just as important to take into account what the instrument measures as what it does not measure.

The other two components "connectedness" and "well-being" are included in the sense of the first definition of love in the Oxford Dictionary: "A feeling or disposition of deep affection or fondness for someone, typically arising from a recognition of attractive qualities, from natural affinity, or from sympathy and manifesting itself in concern for the other's welfare and pleasure in his or her presence; great liking, strong emotional attachment; (similarly) a feeling or disposition of benevolent attachment experienced towards a group or category of people, and (by extension) towards one's country or another impersonal object of affection". The object of love, in our case, is nature, which can be understood as a concept with two components. One of these – connectedness – is understood as a benevolent attachment towards nature, while the second – well-being – refers to the pleasure that the presence of nature brings. Consequently the resulting scale groups the two components into the same cluster.

Taking into account the items alluding to love for nature, we analyzed the 13-item scale using IRT modeling. The results showed that the 10-item scale presented adequate overall psychometric properties. As for the remaining three, it is noted that the fit for two of them was not sufficiently good for them to be maintained in the scale. Furthermore, two of the items presented collinearity, meaning their presence in the scale was redundant, so one of them was removed. The latter had also been observed in the cluster obtained in the first study. Consequently, these ten items compose the "Love for Nature Scale" (LNS).

Furthermore, following the parallel analysis, the scale was observed to be psychometrically unidimensional. However, a confirmatory factor analysis was conducted to determine whether the scale could comprise two factors as suggested in the first study. The results show that the two factors are highly correlated, which reflects the relationship between the two variables – connectedness and well-being – evidenced in the literature (e.g., Mayer, Frantz, Bruehlman-Senecal and Dolliver, 2009; Pasca, 2018).

In light of the findings of the present study, we can conclude that the Love for Nature Scale (LNS) comprises the above-mentioned 10 items with good psychometric properties, as well as convergent and discriminant validity. This is configured by the dimensions of connectedness and well-being, which, despite their differentiation, are so closely related that they could well be treated as a whole.

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