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Relación entre conexión con la naturaleza y creencias ambientales

Relationship between connectedness with nature and environmental beliefs

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RESUMEN:
La conectividad con la naturaleza se define como un sentimiento de pertenencia al medio natural. Estudios sobre la relación entre conectividad y las creencias ambientales de la escala del nuevo paradigma ambiental muestran valores medios-bajos de correlación. El objetivo de esta investigación es comprobar si los niveles de relación son estructurales o se deben a un sesgo metodológico. Ha participado una muestra incidental de 459 universitarios. A nivel metodológico, se han estimado los niveles de conectividad y creencias ambientales a través de la Teoría de Respuesta al Ítem. Para ello se ha utilizado la librería "ltm" del programa R. Posteriormente se han correlacionado las estimaciones. Los resultados muestran valores medios de relación entre ambas variables. Este resultado, junto con los revisados en la literatura, sugiere que esta relación es estructural y no resultado de la metodología utilizada. Finalmente, se discute sobre las implicaciones educativas de estos resultados.

PALABRAS CLAVE: EDUCACIÓN, MEDIO AMBIENTE, TEORÍA DE RESPUESTA AL ÍTEM.

ABSTRACT:
Connectedness with nature is defined as a feeling of belonging to the natural environment. Studies on the relationship between connectedness and environmental beliefs from the New Environmental Paradigm Scale show medium-low correlation values. The aim of this research is to test whether the correlation levels are structural or due to a methodological bias. An indicental sample of 459 university students has been involved. At the methodological level, the levels of connectedness and environmental beliefs have been estimated through the Item Response Theory. For this, the R Package 'ltm' has been used. Subsequently, the estimates values have been correlated. The results show average relationship values between both variables. This result, together with those reviewed in the literature, suggests that the relationship is structural, and not the result of the methodology used. Finally, the educational implications are discussed.

KEYWORDS: EDUCATION, ENVIRONMENT, ITEM RESPONSE THEORY.

1 INTRODUCCIÓN

The concept of connectedness to nature was proposed by Schultz (2001) with the target to represent the way in which people take in the environment as a part of the cognitive representations of themselves.

Researchers such as Mayer and Frantz (2004) have highlighted the emotional character of this construct, arguing that people who are really engaged with the environment need to feel themselves as a part of nature. Initially, the Inclusion of Nature in Self (INS) Scale was proposed in order to measure the connectedness (Schultz, 2002). Later, Schultz, Shriver, Tabanico, and Khazian (2004) implemented the INS scale in a test of implicit association.

Mayer and Frantz (2004) developed the Connectedness with Nature Scale (CNS) in order to measure the different affective aspects of belonging to nature. This scale has been criticised regarding its validity. In this sense, Perri and Benassi (2009) suggest scale could be measured instead of emotional factors. These critics could be related with the verb "to feel", and its ambiguous meaning (to perceive and to experience an emotion). This problem disappears when the scale is adapted into Spanish language (see authors, 2012).

Mayer and Frantz (opus cit.) administered the CNS and the New Environmental Paradigm Scale (Dunlap y Van Liere, 1978) at the same time to the same sample of people in order to analyse the CNS's psychometric properties.

The New Environmental Paradigm Scale (NEP) measures the primitive environmental beliefs. It has been used widely to measure beliefs, values and attitudes, although its ambiguity to measure these constructs has been noticed, as well as lack of relation with the theoretical psychosocial structure of the attitudes (Vozmediano y San Juan, 2005).

This lack of relation could happen because primitive beliefs and its influence onto observed behaviour are mediated through a high number of variables (Gardner y Stern, 1996).

Another question is the scale's dimensionality. Although scale's authors found validity indications (Dulanp, Van Liere, Merting y Jones, 2000) there is not an agreement about if the scale is unidimensional or multidimensional (Cordano, Welcomer y Scherer, 2003).

On the other hand, Mayer and Frantz (opus cit.) hypothesized that the correlation between connectedness scale and new paradigm scale would be moderated, because every factor measures different constructs. Their results were supporting this hypothesis ($r=0.35$; $p<.01$; $n=62$). However, other researchers, such as Perrin and Benssi (opus cit.) have found higher correlations ($r=.45$; $p<.01$; $n=56$).

So far, the researches reviewed and exposed were developed with correlational methodology from direct data from surveys. The question is if a different system of estimating the constructs, instead of using direct responses to items, could shed light on the matter.

Then, the aim of this study is to estimate the levels from sample for every factor from the scales through the Item Theory Response, and then analyse the correlations between the estimated factors of the two scales. The final aim will be knowing if the correlations will be moderate/medium (as Mayer and Frantz predict) or higher (as Perrin and Benassi found) or any other case.

2 METHOD

2.1 Participants

Participants were 459 Spanish speakers. Demographic characteristics are summarized in table 1. Mean of the age was 21.31 (s.d.=5.073), with 76% of female. About economic average, 81.5% had median level, 16% low level, and 2.5% high level.

Table 1. Distribution of the sample by origin

University	Percentage%
University of Sevilla	41.66%
University of Almería	23.23%
Other Andalusian Universities	23.66%
Universities of Perú	10.30%
Without information	1.15%
University of Sevilla	41.66%

Chi-square statistic proof was conducted in order to identify differences between groups from different universities (gender, age and economic level). No significative differences were found except in age of whole Spanish group and the Peruvian group (Chi-square=238,573; f.g.=27; $p<0,001$). Mean age in Spanish group was 21.67 (s.d.=5.167) while of the Peruvian group age was 18.46 (s.d.=3.045).

2.2 Procedure

A survey design was conducted in order to reach the aim. A questionnaire was developed with Google Docs application in order to get the data through internet.

The Google Docs application form only were available on days, and hours indicated by the collaborator teachers from universities. Then, not controlled access to the form was avoided. Data were obtained during January and February 2011.

2.3 Instruments

The questionnaire included a Spanish version of CNS Scale by Mayer and Frantz (2004) in order to study connectedness, plus a NPA scale version by Vozmediando and San Juan (2005) in order to get data about beliefs.

CNS Spanish version scale has fourteen items, with five points of answers between 1 (very desagreement) to 5 (very agreement).

In another research with a universitary Spaniard sample (Authors, 2012), the scale obtained a Cronbach's alpha of .71, with four latent components (50% of explained variance).

2.4 Analyses

Data from items 4, 12 and 14 from connectedness scale, were inverted because their meaning is inverse, as authors mentioned (Mayer and Frantz opus cit.). Then, a Component Analyses was conducted in order to know the dimensionality of the scales.

The objective was to conduct the Item Response Theory with unidimensional groups of item, for facilitating interpretation from models.

The next step was the dichotomization of scores in order to conduct the Item Response Theory analyses. Some doubts may appear during the process of dichotomization of scales in impair responses regarding intermediate scores (neutral position or indecise position)

A priori, it could be recategorized as 0 point or as 1 point. In this case, the position from authors was mainly conservative, with the intention of clearly establishing the differences between proenvironmental profiles. So, option 3 or less points in the scale was recategorized as 0 and above as 1.

The trait latent models were developed with the variables selected from every scale. The

model with the best good-fitting was selected. Then levels of connectedness and beliefs of the sample were estimated.

A correlation analysis between connectedness and beliefs was conducted for each participants from the sample.

In this analyses the use of IRT is highlighted as an alternative to other statistical processes based on direct estimation from factorial structures.

The IRT is an area of development in Psychometry. This statistical strategy assumes that there is a link between a person's latent trait and his or her response. This link, that can be expressed in terms of probability, is represented with the item curve characteristic (ICC). The latent trait models basic assumptions are:

- Latent trait: the main assumption is there isn't an observed variable, but latent, that explains the responses from one person to an item.
- Unidimensionality: that is the item or the instrument measures only one trait.
- Local independence: that is, the response to an item is independent from other responses to other items. Then, the probability of obtaining correct responses in a set of items is equal to the product of the probabilities of every item that is correctly answered.

Some times, it is difficult to check the items local independence. It's usually to check the unidimensionality only with a factorial analysis, or with another similar statistic analysis.

Taking in account the number of parameters to estimate, three different models are distinguished in IRT:

- One-parameter model: It's named the Rasch's model. This model estimates one parameter only, the item difficult (b).
- Two-parameter model: It estimates the item difficult (b) and its discrimination (a).
- Three-parameter model: it's known as Birnbaum's model. Although it is included as part of IRT models, it may be considered as an alternative statistic technique in order to analyse tests. This model analyses the item difficult, the discrimination item and the chance to guess the correct answer to one item. It's the pseudo-azar parameter to overcome the item (c).

The phases to develop in order to analyse one test with IRT, and to estimate the trait levels from the test answers, are below:

a) Arrange the data for analysis.
b) Evaluate that the assumptions of IRT are satisfied.
c) Estimate the parameters of the selected model (one, two or three parameters) as well as the information levels. Elaborate the summaries and the graphics.
d) Analyse the model fit to data. If the fit is not good, return to previous phase using another model.
e) Estimate skill levels from participants.

In order to analyse data, the SPSS package statistical analyses version 19 (2010) was used, as

well as R program (R Development Core Team, 2011) specifically its ltm package (Rizopoulos, 2006).

3 RESULTADOS

Connectedness with Nature Scale (CNS)

A principal components analysis (PCA) was conducted on the scale to investigate the factor structure of the instrument. Firstly, the model assumptions were examined. The Keiser-Meyer-Olkin measure of sampling adequacy was acceptable, .882, and Bartlett's test of sphericity was significant, p<.0001 (Chi-square= 1410.503; fd= 91). This suggests that PCA is appropriate for these data. Results suggested that an one-component solution was the best. The signal factor explained 30.85% of the variance after extraction (table 2).

Table 2. Principal components from CNS

	Comp. 1	Comp. 2	Comp. 3
c11	0.795		
c9	0.689		
c2	0.663		
c10	0.662		
c6	0.635		
c8	0.629		
c5	0.607		
c7	0.595	-0.345	
c1	0.563		0.241
c3	0.531		
c12	-0.210	0.770	0.286

Although one component solution was efficient for whole items in the scale, in order to develop the IRT analyse only the items that charged in this component were used. Then, the unidimensionality was guaranteed (ítems c1, c2, c3, c5, c6, c7, c8, c9, c10 and c11).

Thereafter, the dichotomization of scores were done according the criterion exposed before (options 1, 2 and 3 were changed by 0, and options 4 and 5 by 1).

A Chi-squared test of association between pairs was developed. Given that the IRT analyse assumes that relations between items can be explained by the latent variables, if there is not relation found can indicate that this assumption is not satisfied. All association tests were not significants.

The one-parameter model was evaluated (Rasch's model) (annex III). The Bootstrap fitted likelihood test showed a non-significant value (p=.2) using Chi-square test. This suggests an acceptable fit between model and data. Nevertheless, a marginal residuals proof was conducted using the 3.5 value rule and numerous problems of adjustment between pairs of items were observed (annex IV).

The two-parameter model was conducted (annex V). The results showed an acceptable level of fit (annex VI). And the three-paramater model was conducted too, obtaining similar results (annex VII and annex VIII).

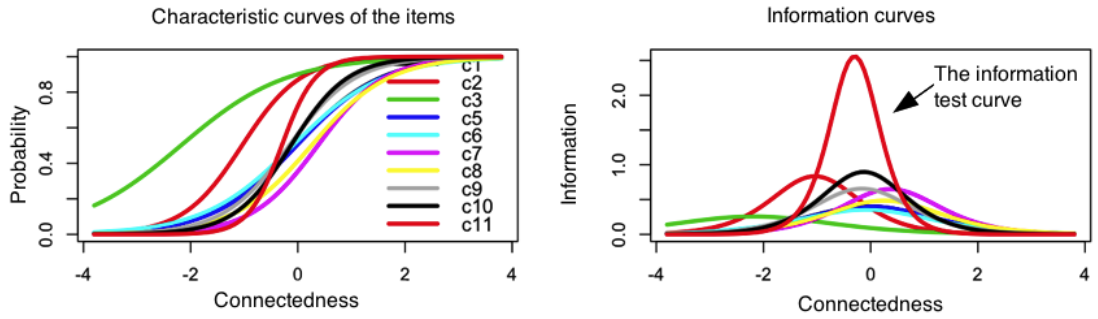
Between every pair of models an ANOVA test was conducted. The global results suggested to select the two-parameter model in order to estimate the parameter from data (table 3).

Table 3. Anova between IRT models of conectedeness

anova(mod_1.mod_3)						
	Likelihood Ratio Table					
	AIC	BIC	log.Lik	LRT	df	p.value
mod_1	5227.23	5268.52	-2603.62			
mod_2	5135.70	5218.28	-2547.85	111.53	10	<0.001
anova(mod_1.mod_4)						
	Likelihood Ratio Table					
	AIC	BIC	log.Lik	LRT	df	p.value
mod_1	5227.23	5268.52	-2603.62			
mod_3	5153.52	5240.23	-2555.76	95.72	11	<0.001
anova(mod_3.mod_4)						
	Likelihood Ratio Table					
	AIC	BIC	log.Lik	LRT	df	p.value
mod_2	5135.70	5218.28	-2547.85			
mod_3	5153.52	5240.23	-2555.76	-15.82	1	1

Note: mod_1= Rasch model; mod_2= Two parameters model; mod_3: Three parameters model

The information level between -4 to 4 connectedness score was 16.29 (Cronbach alpha= .791). The item characteristic curves and the information curves are exposed in graph 1.



Graph 1. Characteristic curves of the items from the two parameters model of the Connectedness scale

Table 4. Two parameters model from connectedness items

	value	std.err	z.vals
Dificulty c1	-0.0407	0.0966	-0.4208
Dificulty c2	-1.0411	0.1148	-9.0695
Dificulty c3	-2.1831	0.3449	-6.3301
Dificulty c5	-0.0226	0.0967	-0.2339
Dificulty c6	-0.0892	0.1007	-0.8858
Dificulty c7	0.3727	0.0896	4.1575
Dificulty c8	0.2536	0.0941	2.6940
Dificulty c9	-0.1623	0.0853	-1.9038
Dificulty c10	-0.1290	0.0789	-1.6354
Dificulty c11	-0.2994	0.0684	-4.3788
Discrimination c1	1.2689	0.1718	7.3860
Discrimination c2	1.8272	0.2609	7.0033
Discrimination c3	1.0147	0.1968	5.1565
Discrimination c5	1.2665	0.1708	7.4138
Discrimination c6	1.1927	0.1644	7.2528
Discrimination c7	1.6115	0.2133	7.5546
Discrimination c8	1.3927	0.1863	7.4757
Discrimination c9	1.6219	0.2092	7.7537
Discrimination c10	1.8941	0.2436	7.7749
Discrimination c11	3.2001	0.4988	6.4152

New Environmental Paradigm Scale (NEP)

Initially, a principal components analyses with varimax rotation was conducted in order to explore the latent structure from the data (KMO= .797; Chi-square= 1558.255; f.d.= 120; p<.0001) (table 5).

Table 5. Principal components of the NPA Scale

	Comp. 1	Comp. 2	Comp. 3
n9	0.719		
n11	0.682		
n10	0.664		
n7	0.575		
n4		0.709	
n3		0.707	
n2		0.664	
n1		0.601	
n6			0.759
n5		0.417	0.715
n8			-0.556
n12			
n13			
n15			
n16			
n14			
% Var. Explained	22.935%	14.790%	7.683%

The analyses suggests there are 5 components (58.64% of variance). The IRT analyse was developed with variables that charged in the first components from NEP (variables n7, n9, n10 and n11). The scores were dichotomised as the previouse case (1, 2 and 3 as 0 score, and 4 and 5 options as 1 score).

All the inter-pairs association Chi-square analyses were significant. The Bootstrap fit check showed a lack of fitting (p-value= .005) of the one-parameter Rasch model (annex IX). This lack of fitting was observed in the residuals analyses too (annex X).

The two-parameters and three-parameters models were developed (annex XI and XII). They had similar fits (annex XIII and annex XIV). An ANOVA analyses was developed with the three models in order to identify significant differences (table 6).

Table 6. Anova between IRT models of NPA Scale

anova(mod_1.mod_3)						
	Likelihood Ratio Table					
	AIC	BIC	log.Lik	LRT	df	p.value
mod_1	1734.37	1750.89	-863.19			
mod_2	1684.47	1717.51	-834.24	57.9	4	<0.001
anova(mod_1.mod_4)						
	Likelihood Ratio Table					
	AIC	BIC	log.Lik	LRT	df	p.value
mod_1	1734.37	1750.89	-863.19			
mod_3	1688.56	1725.72	-835.28	55.82	5	<0.001
anova(mod_3.mod_4)						
	Likelihood Ratio Table					
	AIC	BIC	log.Lik	LRT	df	p.value
mod_2	1684.47	1717.51	-834.24			
mod_3	1688.56	1725.72	-835.28	-2.08	1	1

Note: mod_1= Rasch model; mod_2= Two parameters model; mod_3: Three parameters model

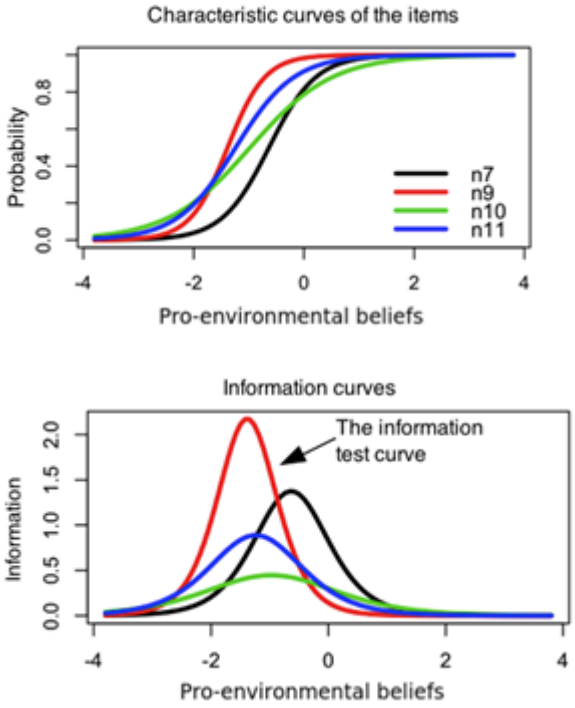
The total information level from variable in the analyses variable was 8.52 score (Cronbach's alpha= .653). The graphic 2 shows the information level and the characteristics curves from items.

Table 7. The coeficients of the two parameters model from the first component items in the NPA scale

	value	std.err	z.vals
Dificulty n7	-0.6338	0.0895	-7.0837
Dificulty n9	-1.3843	0.1281	-10.8033
Dificulty n10	-0.9762	0.1449	-6.7363
Dificulty n11	-1.2387	0.1415	-8.7541
Discrimination n7	2.3455	0.4926	4.7616
Discrimination n9	2.9500	0.7027	4.1983
Discrimination n10	1.3368	0.2355	5.6762
Discrimination n11	1.8848	0.3506	5.3765

Correlations between estimations for the first components from CNS and NEP

The correlation between first components estimated with IRT from the two scales was developed (R=.274; p=.01). The correlation power between both estimations was .999 (s.l.: .05) with a medium effect size (Cohen, 1988).



Graph 2. Characteristic curves of the items from the two parameters model of the NPA scale

4 DISCUSIÓN Y CONCLUSIONES

Regarding instruments used, the connectedness scale shows a three-dimensional structure. The first component highlights over the others. The first can be associated to the mood of being "connected to environment". The second and third components can

be linked to concept of "self-location in the environment" and the concept of "disconnected with nature" respectively.

About the New Environmental Paradigm scale, the structure is a little bit complex. The first component regard the pro-environment perspective items, plus items about

environmental degradation. The second component can be interpreted as the believe in the human capacity for controlling the environment. The third component would be linked to the people rights against nature (avoiding to use the expression humankind rights). The both last components can be linked to the conviction of limit from natural resources and the trust in the human to fix negative effects in the environment. Meanwhile the pro-environment beliefs internal consistent was a little bit lower.

On the other hand, the Pearson correlation between the connectedness estimation and pro-environment beliefs is low too (table 8). The size effect can be considered medium (Cohen, 1988). These results in whole, suggest the beliefs and the experience of being connected with nature are two realities linked but mediated by others factors.

Regarding the study aim, the results highlight the low relations between connectedness and primitive beliefs it is not by a methodological reason. Outcomes from IRT analysis under the light of outcomes from researches reviewed in the literature (Mayer y Frantz, 2004; Perrin y Bennassi, 2009; Gosling y Williams, 2010) support the hypothesis that the low relation between both, beliefs and connectedness, is an structural reality, and it is not a results from the methodological context in the studies.

Several classical theoretical perspectives, such as the cognitive dissonance (Festinger, 1957), the theory of reasoned action (Azjen and Fishbein, 1980), or even the rational emotive therapy (Ellis and Bernard, 2006), among others, highlighted the relation that have been found here. So, because the same phenomenon is highlighted from a diversity of theories, but none of them offers a satisfying explication, is necessary to develop new studies about the link of the pro-environment beliefs and the connectedness with nature.

This kind of studies are important because this relation could be linked with the display of several environmentally responsible behaviours.

This circumstance was already suggested by Mayer and Frantz (2004), however they focused on every factor independently, beliefs and behaviour in one side, and the connectedness in other side.

Continuing with this line of argument, the lack of correlation between beliefs and connectedness with nature suggests that the educational environmental programs and the pro-environmental media campaign must be designed taking in account that emotional factor, behavioural factor, and cognitive factor must be developed at the same time. Only then, it is possible to have warranties the three components of any educational intervention in environmental education, and in environmental psychology, are developed.

In sum, the results from this study and others from consulted literature, support the pro-environmental educational programs need to include elements in order to develop the emotional dimension, the cognitive dimension and behavioural dimension. It is because there is not warranty of a complete development of all dimensions in the person if the program is focused only in two or one of them, taking into account the lack of relation between environmental beliefs (cognitive dimension) and connectedness with nature (emotional and volitive dimension).

It must be highlighted that the sample is incidental. Then, the conclusions must be taken into consideration with some caution. Although, in the studies reviewed usually use samples of college students, another studies with representative samples must be encouraged. Results from them will illuminate the knowledge about the relation between beliefs, the connectedness perception and the responsible behaviours, and about some implications in environmental education.

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Annexes

Annex I

Escala del Nuevo Paradigma Ecológico. Versión de 16 ítems de Vozmediano y San Juan (2005)

n1.- La idea de que la humanidad va a enfrentarse a una crisis ecológica global se ha exagerado enormemente
n2.- El equilibrio de la naturaleza es lo bastante fuerte para hacer frente al impacto que los países industrializados le causan
n3.- Con el tiempo, los seres humanos podrán aprender lo suficiente sobre el modo como funciona la naturaleza para ser capaces de controlarla
n4.- El ingenio humano asegurará que no hagamos de la tierra un lugar inhabitable
n5.- Los seres humanos fueron creados para dominar al resto de la naturaleza
n6.- Los seres humanos tienen derecho a modificar el medio ambiente para adaptarlo a sus necesidades
n7.- Cuando los seres humanos interfieren en la naturaleza, a menudo las consecuencias son desastrosas
n8.- Las plantas y los animales tienen tanto derecho como los seres humanos a existir
n9.- Los seres humanos están abusando seriamente del medio ambiente
n10.- El equilibrio de la naturaleza es muy delicado y fácilmente alterable
n11.- Si las cosas continúan como hasta ahora, pronto experimentaremos una gran catástrofe ecológica
n12.- Nos estamos aproximando al número límite de personas que la tierra puede albergar
n13.- La tierra es como una nave espacial, con recursos y espacio limitados
n14.- A pesar de nuestras habilidades especiales, los seres humanos todavía estamos sujetos a las leyes de la naturaleza
n15.- La tierra tiene recursos naturales en abundancia, tan sólo tenemos que aprender a explotarlos
n16.- Para conseguir el desarrollo sostenible, es necesaria una situación económica equilibrada en la que esté controlado el crecimiento industrial

English translation:

New Ecological Paradigm Scale. 16 items Vozmediano and San Juan version (2005)

n1.- The idea that humanity will face a global ecological crisis has been greatly exaggerated
n2.- The balance of nature is strong enough to cope with the impact that industrialized countries will cause
n3.- Over time, humans can learn enough about how nature works to be able to control
n4.- Human ingenuity will ensure that we do not make the earth uninhabitable
n5.- Humans were created to dominate the rest of nature
n6.- Humans have the right to modify the environment to suit their needs
n7.- When humans interfere with nature, often the consequences are disastrous
n8.- Plants and animals have as much right as humans to exist
n9.- Humans are severely abusing the environment
n10.- The balance of nature is very delicate and easily alterable
n11.- If things continue as before, will soon experience a major ecological catastrophe
n12.- We are approaching the limit number of people the earth can hold
n13.- The earth is like a spaceship with limited resources and space
n14.- Despite our special abilities, humans are still subject to the laws of nature
n15.- The earth has natural resources in abundance, so we just have to learn to exploit
n16.- To achieve sustainable development, balanced in an economic situation which is controlled industrial growth is necessary

Annex II

Escala de conectividad con la naturaleza.
c1.- A menudo tengo un sentimiento de unidad con el mundo natural que me rodea.
c2.- Pienso en el mundo natural como una comunidad a la que pertenezco.
c3.- Reconozco y aprecio la inteligencia de otros organismos vivientes.
c4.- A menudo me siento desconectado de la naturaleza.
c5.- Cuando pienso en mi vida, me imagino ser parte de un proceso cíclico, más amplio, de la vida.
c6.- A menudo siento una afinidad con las plantas y los animales.
c7.- Siento que pertenezco a la tierra en la misma medida que ella me pertenece a mí.
c8.- Tengo una comprensión profunda de cómo mis acciones afectan el mundo natural.
c9.- A menudo me siento parte de la red de la vida.
c10.- Creo que todos los habitantes de la Tierra, humanos y no humanos, comparten una "fuerza vital" común.
c11.- Al igual que un árbol es parte del bosque, me siento parte de un mundo natural más amplio.
c12.- Cuando pienso en mi lugar en la Tierra, me considero en la parte más alta de una jerarquía existente en la naturaleza.
c13.- A menudo me siento simplemente como una pequeña parte del mundo natural que me rodea, y que yo no soy más importante que la hierba de la tierra o las aves de los árboles.
c14.- Mi bienestar personal es independiente del bienestar del mundo natural.

English transalation:

The connectedness with nature Scale.
c1.- often have a feeling of oneness with the natural world around me.
c2.- I think of the natural world as a community to which I belong.
c3.- greatly appreciate the intelligence of other living organisms.
c4.- I often feel disconnected from nature.
c5.- When I think of my life, I imagine being part of a broader cyclical process of life.
c6.- often feel an affinity with plants and animals.
c7.- feel I belong to the land to the same extent that it belongs to me.
c8.- have a deep understanding of how my actions affect the natural world.
c9.- I often feel part of the web of life.
c10.- I think that all the inhabitants of the earth, human and nonhuman, share a common "life force".
c11.- Like a tree is part of the forest, I feel part of a larger natural world.
c12.- When I think about my place on earth, I believe in the highest part of an existing hierarchy in nature.
c13.- I often feel just like a small part of the natural world around me, and that I am no more important than the grass of the earth or the birds in the trees.
c14.- My personal welfare is independent of the welfare of the natural world.

Annex III

R code in order to analyze the CNS Scale through IRT Models.

```
> DCNS<-Dat_cns
> descript(DCNS)
> mod_1<-rasch(DCNS, constraint=cbind(length(DCNS)+1,1))
> summary(mod_1)
> GoF.rasch(mod_1, B=199)
> margins(mod_1)
> mod_2<-ltm(DCNS~z1)
> summary(mod_2)
> margins(mod_2)
> mod_3<-tpm(DCNS, type="rasch", max.guessing=1)
> summary(mod_3)
> margins(mod_3)
> anova(mod_1, mod_2)
> anova(mod_1,mod_3)
> anova(mod_2,mod_3)
> information(mod_2, c(-4,4))
> factor.scores(mod_2, resp.patterns=DCNS)
> # Gráfico
> par(mfrow=c(2,2))
> plot(mod_2, legend=T, cx="bottomright", lwd=3, cex.main=1.5, cex.lab=1.3, cex=1.1)
> plot(mod_2, type="IIC", annot=F, lwd=3, cex.main=1.5, cex.lab=1.3)
> plot(0:1, 0:1, type="n", ann=F, axes=F)
> info_1_1<-information(mod_2, c(-4,0))
> info_1_2<-information(mod_2, c(0,4))
> text(0.5, 0.5, labels=paste("Información total:", round(info_1_1$InfoTotal, 3), "\n\nInformation in (-4,0):", round(info_1_1$InfoRange, 3), paste("(", round(100*info_1_1$PropRange, 2), "%)", sep=" "), "\n\nInformation in (0,4):", round(info_1_2$InfoRange,3), paste ("(", round (100* info_1_2$PropRange,2), "%)", sep=" ")), cex=1.5)
```

Annex IV

R code in order to analyze the NPA Scale through IRT Models.

```
> DNPA<-Dat_npa
> descript(DNPA)
> mod_1<-rasch(DNPA, constraint=cbind(length(DNPA)+1,1))
> summary(mod_1)
> GoF.rasch(mod_1, B=199)
> margins(mod_1)
> mod_2<-ltm(DNPA~z1)
> summary(mod_2)
> margins(mod_2)
> mod_3<-tpm(DNPA, type="rasch", max.guessing=1)
> summary(mod_3)
> margins(mod_3)
> anova(mod_1, mod_2)
> anova(mod_1,mod_3)
> anova(mod_2,mod_3)
> information(mod_2, c(-4,4))
> factor.scores(mod_2, resp.patterns=DNPA)
> par(mfrow=c(2,2))
> plot(mod_2, legend=T, cx="bottomright", lwd=3, cex.main=1.5, cex.lab=1.3, cex=1.1)
> plot(mod_2, type="IIC", items= 0, lwd=3, cex.main=1.5, cex.lab=1.3)
> plot(mod_2, type="IIC", annot=F, lwd=3, cex.main=1.5, cex.lab=1.3)
> plot(0:1, 0:1, type="n", ann=F, axes=F)
> text(0.5, 0.5, labels=paste("Total Information:", round(info1$InfoTotal, 3), "\n\nInformation in (-4,0):", round(info1$InfoRange, 3), paste("(", round(100*info1$PropRange, 2), "%)", sep=""), "\n\nInformation in (0,4): ", round(info2$InfoRange, 3), paste("(",round(100 * info2$PropRange, 2), "%)", sep="")), cex=1.5)
```