



## IS HUMAN MIND ATTUNED WITH GENERAL ECOLOGICAL PRINCIPLES?

Víctor Corral-Verdugo<sup>1</sup>

Fernanda Inéz García-Vázquez

Blanca Fraijo-Sing

César Tapia-Fonllem

University of Sonora at Hermosillo, Mexico

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### Abstract

Some scholars claim that similarities exist between human communities and ecosystems; also, that people can learn how to live sustainably from knowing the way ecosystems work. Yet, at the psychological level, the relationship between practicing sustainable behaviors and living in accordance with ecological principles has been barely studied. This article addresses such relationship, testing the idea that acting in accordance with ecological principles requires 1) a knowledge of ecological rules, 2) an affinity towards those rules, and 3) behaving accordingly (i.e., acting sustainably). We call this hypothetical construct the *Human Attunement with Ecological Principles* (HAEP), assuming that it implies the presence of a human predisposition to knowing, valuing and applying these principles. In developing the idea, the paper reviews relevant literature, aiming to find evidence that supports the HAEP hypothesis, and presents results of a study showing that HAEP significantly and saliently predicts engagement in sustainable behaviors.

### Key-words

Ecological principles, human attunement, sustainable behavior, sustainability.

### Resumen

Algunos estudiosos afirman que existen similitudes entre las comunidades humanas y los ecosistemas; también, que las personas pueden aprender a vivir de forma sostenible al conocer la forma en que funcionan los ecosistemas. Sin embargo, a nivel psicológico, la relación entre la práctica de comportamientos sostenibles y la vida de acuerdo con los principios ecológicos apenas ha sido estudiada. Este artículo aborda esta relación, probando la idea de que actuar de acuerdo con los principios ecológicos requiere 1) un conocimiento de las reglas ecológicas, 2) una afinidad hacia esas reglas, y 3) comportarse en consecuencia (es decir, actuar de forma sostenible). Llamamos a esta construcción hipotética la *Sintonización Humana con Principios Ecológicos* (HAEP), suponiendo que implica la presencia de una predisposición humana a conocer, valorar y aplicar estos principios. Al desarrollar la idea, el documento revisa la literatura relevante, con el objetivo de encontrar evidencia que respalde la hipótesis de HAEP, y presenta los resultados de un estudio que muestra que HAEP predice de forma significativa y sobresaliente la participación en comportamientos sostenibles.

### Palabras clave

Principios ecológicos, sintonía humana, comportamiento sostenible, sostenibilidad.

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<sup>1</sup> Correspondence about this article should be address to Victor Corral-Verdugo. Email: victorcorralv@gmail.com

## ¿ESTÁ LA MENTE HUMANA EN SINTONÍA CON LOS PRINCIPIOS ECOLÓGICOS GENERALES?

Environmental functioning is ruled by a series of principles that allow a balance among the elements that constitute the ecosystems; this also applies to human ecosystems. When one or more of those principles are disturbed, the balance is compromised and the system may collapse. Knowledge of ecological rules is vital to understanding how a particular setting works, how the environment can result damaged, and what to do in order to reintegrate the balance within a disturbed environment. In human ecologies, the maintenance of an environment and the survival of ecosystems depends on following ecological principles. Capra (2005) and Costa (2000) assure that humankind's survival and quality of life closely relate to "ecological literacy," i.e., the understanding of ecological rules and their adaptation to human communities. The basic principles of ecology are interdependence, cyclicity, association, flexibility and diversity. Environmental sustainability is a consequence of those principles (Capra & Pauli, 1995). In theory, ecological literacy serves the purpose of encouraging environmental conservation and maintenance of a positive environment for humans.

The *interdependence* principle lies on the premise that all components of an ecology are interconnected within a wide and complex net of relations. Grasping ecological interdependence means understanding these relations because from the perspective of ecological systems the interactions among their components are as (or are more) important than those elements or the whole ecosystem. Moreover, understanding the principle of interdependence implies accepting that changes in a part of the system will result in a domino effect, affecting other parts of the system (Nelson & Prilleltensky, 2005). The *cyclicity* principle refers to the fact that natural systems are open; their nutrients are recycled so that residuals are not produced. In nature, nothing is wasted; whatever a species discards is used by another species (Dimauro & De Manuel, 2010). Grasping the cyclicity principle leads people to understand that an ecosystem lost its balance when its cycles are not completed so that environmental deterioration results (San Martin, 1983). *Association* is the tendency of ecosystems to establish ties of cooperation, but also competition among its elements. Different species compete with each other for resources (inter-species competition), but also different individuals compete against other members of their same species (intra-species competition) for access to sexual mates, food, and other resources (Capra, 2005). Intra and interspecies cooperation is detected when members of the same or different species operate jointly to an outcome that is mutually beneficial. *Flexibility* manifests as the probability for an ecosystem to reach a balance after a period of significant changes. People ecologically literate know that flexibility is a criterion that determines the adaptability of an ecosystem. They also know that multifunctionality, a feature of flexibility, offers animals and plants more opportunities for obtaining environmental resources, unlike rigidity and super-specialization, which limit those practices (Capra, 2005). Finally, the *diversity* principle implies the presence of differences in the constitution of ecosystem; these differences manifest as variety of species, or genetic and individual differences (International Union for Conservation of Nature – IUCN, 2010). Individuals grasp diversity when they are able to appreciate the value of those differences. They understand that a diverse ecosystem is resilient because it includes many species overlapping ecological functions that may be partially substituted, in case that an ecological network experiences the loss of one or more elements.

Capra (2005) argues that we can and should learn from ecosystems the way to live sustainably. For more than three-thousand million years of evolution, the planet's ecosystems have managed to maximize their sustainability in subtle and complex ways. This "wisdom" of nature is the essence of ecological literacy. Capra also establishes that, based upon the knowledge of ecosystems, it is possible to formulate organizational principles that are fundamental to ecology. Using those principles, we could derive guides for building sustainable human communities (Orr, 1992). Ultimately, humankind's survival will depend on ecological literacy, according to Capra. In addition, Corral-Verdugo (2010) assures that every ecological principle has a corresponding psychological dimension, and such dimension has to be considered in studying people's sustainable behaviors. Pomier (2002) suggests that the essence of ecological literacy has to be found in learning the basic principles of ecology so that they may operate as moral references. Kramer (2003), in turn, establishes that ecological literacy means knowing the basic principles of ecology and their



sustaining sciences (chemistry, physics, biology, geology, etc.) but also means developing a spirit that questions the apparent truths, immutable decisions and established opinions.

In spite of the contribution that the concept of ecological literacy offers to sustainable development, we detect two limitations associated with it. On the one hand, there is no empirical test of its adequacy; in other words, regardless of its logical coherence, no study has been conducted to prove whether an ecological literacy construct can be assessed from observed indicators, and to see if ecological literacy predicts engagement in sustainable behaviors. On the other hand, this construct seems to miss a fundamental aspect of psychological experiences: the evaluative component of psychological life and its implicit emotional aspects. Ecological literacy emphasizes the cognitive-rational component of human mind: the knowledge, critical thinking, and moral judgment produced when people get in touch with ecological principles (Pomier, 2002; Kramer, 2003). This rational emphasis seems to assume that knowing and thinking of these principles (and its advantages) is sufficient to acting consequently in a pro-sustainable way. However, this idea puts aside the fact that, before behaving, individuals have to feel motivated to act, and their motivation may be based on evaluations emerging from their emotions, affects, and affinities towards objects they interact with (Vining & Ebreo, 2002). The meaning of this is that, in order to behave according to ecological principles, it is necessary to know those principles, but also to display affinity towards them (i.e., to positively value ecological principles), and then to apply them (i.e., behaving in a pro-sustainable way).

### **The human attunement with ecological principles**

This paper is aimed at introducing and testing the pertinence of a concept that -we claim- is more inclusive than the ecological literacy construct: the *human attunement with ecological principles*. Such idea implies the existence of a human predisposition to know, value, and apply those principles. If the proposal by Corral-Verdugo (2010), assuring that every ecological principle has a corresponding psychological representation, we should be able to find tendencies indicating that humans get in touch with those principles. Also, that those tendencies manifest as positive evaluation of ecological principles, in addition to their mere knowledge.

Concerning the interdependence principle, evidence exists showing the existence of a system of belief contained in a holistic and interdependent view of the world. This system, called the *New Human Interdependence Paradigm* (NHIP, Corral-Verdugo, Carrus, Bonnes, Moser, & Sinha, 2008) conceives people as needing natural resources and the environment as requiring people's environmental conservation effort. The NPIH predicts sustainable behaviors (Corral-Verdugo et al, 2008; Hernández, Suárez, Corral-Verdugo, & Hess, 2012). Moreover, *Connectedness to Nature* (CNS, Mayer & Frantz, 2004) a construct that implies a sense of connection and interdependence with the natural world, a sense of reciprocal belonging to earth and a feeling of mutual influence between people and their environment, also seems to reveal human attunement with the interdependence principle. Empirical research associates connectedness to nature with environmental conservation (Gosling & Williams, 2010; Mayer & Frantz, 2004).

*Affinity towards Diversity* (ATD) seems to be the corresponding dimension of human attunement with the ecological principle of diversity. According to recent studies, ATD manifests as liking or preferring biological (plant and animal), physical (climate and scenario), and social (culture, religion, gender, political) differences -rather than monotony- within people's environments (Corral-Verdugo, Tapia, Fraijo, Mireles, & Márquez, 2008). It is likely that such affinity responds to the fact that diversity is beneficial for human existence. A study by Corral-Verdugo, Bonnes, Tapia, Frías, and Fraijo (2009) showed that the higher people's ATD the more evident their environmental conservation effort was.

Attunement with association implies grasping and valuing the benefits of cooperation and competition within natural and human ecosystems. Cooperation is necessary, at the global level, for achieving the ideals of sustainability (Cafferatta, 2004). Moreover, in human societies, competition aimed at sustainability involves the development of efforts -both at the individual and group levels- for achieving a pro-sustainable goal, more effectively than and before other individuals can achieve such goal. Implementing processes of energy and water conservation, ecosystem protection, and natural resources conservation within the context of competition is an instance (Porter & Kramer, 2006). In these cases,

competition leads to positive results in innovating processes for solving environmental problems. Yet, no studies have been conducted investigating whether attunement with association leads to environmental conservation.

At the psychological level, flexibility is defined as capacity to adjust thoughts, feelings and behavior before changing, unpredictable and unfamiliar conditions. Flexible individuals react to change without rigidity, with agility and energy; they tend to be open-minded and tolerant before positions, ideas and beliefs that oppose their own. They are also willing to change ideas and behaviors if theirs are wrong. Flexible persons are more adaptable than rigid ones, and their flexibility conducts them to experience wellbeing. Versatility, one of the essential components of psychological flexibility highlights the idea of pro-environmental competency (Corral-Verdugo, 2010). Fraijo, Corral-Verdugo, Tapia and González (2010) demonstrate that more versatile (flexible) people are also more competent in solving environmental problems; such competency leads them to act more easily in a pro-sustainable way.

Although no studies showing explicitly a human attunement with the cyclicity principle are detected, the presence of people that accept and engage in recycling, reuse, composting and processes of re-utilization within industrial systems (Barr, Gilg, & Ford, 2005; Ojeda, Armijo & Ramírez, 2003) suggests the existence of a level of human attunement with this principle. Once again, research proving a human attunement with this principle still is to come.

The aim of our study was to perform a preliminary test of the hypothesis of a human attunement with ecological principles. If present, such attunement would manifest as knowledge, positive evaluation and practice of ecological principles. This means that significant interrelations between the cognitive, affective/evaluative and behavioral components of the human attunement with ecological principles should result, if the HEAP indeed exists among people.

## Method

### Participants

Two hundred seventy-seven individuals (163 females and 114 males) at the city of Hermosillo, Mexico, participated in this study. They were selected from areas representing the low, middle and high socio-economic strata of the city. The mean age for the total sample was 37 years ( $SD = 10.2$ ) and their average level of schooling was 13 years ( $SD = 3.6$ ).

### Instruments

The study used a previously validated instrument (Tapia, Corral-Verdugo, Fraijo, & Durón, 2013) measuring sustainable behavior (i.e., the set of actions aimed at protecting the socio-physical environment) that integrates four scales. The instrument includes a scale assessing *altruistic actions* that self-reports 12 behaviors aimed at assisting or helping others, such as visiting sick people at hospitals, economically helping the poor, supporting the Red Cross, etc. Corral-Verdugo et al (2010) reported the use of this scale, providing indications of its validity and reliability; the scale uses a 4-point response- option format (0=never...3=always engage in such an action). Another scale measured *pro-ecological behavior*, considering 14 items from Kaiser's (1998) General Ecological Behavior Scale; this instrument includes the report of actions such as reuse, recycling, energy conservation, etc., which are responded in a 0 (never) to 3 (always) scale. *Frugality* was assessed in actions such as buying the strictly necessary, the reuse of clothing, taking meals at home, etc., which were reported using a 5-point Likert-options format of response (0 = totally agree...4=totally disagree); this instrument was designed by Corral-Verdugo et al (2010). *Equity*, was measured also with the scale developed by Corral-Verdugo et al (2010), which included ten items indicating behaviors and descriptions of situations such as providing equal educational opportunities for girls and boys, and treating the rich and the poor as equals, etc., using response options from 0 (totally disagree) to 4 (totally agree).

Human Attunement with Ecological Principles (HAEP) was assessed with instruments that measured both the evaluative and cognitive aspects of the ecological principle (diversity, interdependence, flexibility, association and cyclicity) and the affinity towards them. Items measuring the cognitive HAEP component investigated knowledge, information, and normative aspects related to



ecological rules (for instance: “In an ecosystem, cycles are completed if the previously used resources are reintegrated”). In turn, items assessing the evaluative component investigated affection and appreciation towards ecological principles (for example, “I like the existence of different religions”).

Human attunement with *diversity* was assessed through the Affinity Towards Diversity Scale (ATD; Corral-Verdugo et al., 2009). This instrument encompasses 14 items indicating preference for physical (weather, scenarios) and biological (plants, animals) diversity, as well as human (ethnic, gender), and social (religious, social-class, political) diversity. Response options are 0 = “Does not apply to me”, 1 = “It almost does not apply to me”, 2 = “It partially applies to me”, and 3 = “It totally applies to me”. We used the Connectedness to Nature Scale (CNS, Mayer's and Frantz's, 2004) in order to measure attunement with the interdependence principle. The CNS includes 14 items and uses a 5-point likert type format of responses, which ranges from 1 = strongly disagree to 5 = strongly agree. Examples of items of the CNS scale include: “I feel as I belong to the Earth as equally as it belongs to me,” “My personal welfare is independent of the welfare of the natural world” and “I feel a sense of oneness with the natural world.”

The rest of the ecological principles (flexibility, association and cyclicity) were assessed by scales especially developed for this study. Human attunement with *Flexibility* was measured with 12 items indicating use or preference for change, and adaptation to different situations or environments. The scale includes statements like “Changes in the environment are the most normal thing in life” and “I like to adapt myself to new situations.” The attunement with the ecological principle of *cyclicity* was assessed through statements of liking or acceptance of practices such as reuse and recycling, and the knowledge of the idea of cyclicity in nature. The attunement with *association* scale measures both cooperation and competition, the defining characteristics of this principle; this scale includes items such as “To progress as a society we must cooperate with others” and “Competition between people and ideas is good for progress”. The items were responded using a 5-point likert-options scale (0 = totally and 4 = totally agree). Finally, questions about socio-demographic aspects: age, gender, educational level, marital status and family income of participants, were included.

### Data Analysis

Univariate (means, standard deviations) and reliability (Cronbach's alpha) analyses were performed on every scale used in the study. Parcels were computed from the items of every scale, so that they could be used as indicators for the factors in a structural model, using the EQS statistical package (Bentler, 2006). Comparisons by gender were performed on all the scales assessing the attunement with ecological principles and sustainable behaviors; and the likely influence of demographic variables (age, income, schooling) was tested correlating those variables with the HAEP and sustainable behaviors. Since the items addressing the cognitive (knowledge, information, critical thinking) aspects of the HAEP correlated highly (from  $r = .70$  to  $r = .87$ ) and significantly ( $p < .001$ ) with the items addressing its evaluative components (i.e., liking, affinity with ecological rules) within every ecological principle, we decided to merge both aspects in a single dimension (i.e., every human attunement with a particular principle). Therefore, the structural model was specified to contain five first-order factors of the HAEP: attunement with diversity, attunement with interdependence, attunement with flexibility, attunement with cyclicity, and attunement with association. These first-order factors were assumed to be significantly and highly interrelated so to produce a higher-order factor: the HAEP. In turn, four first-order factors of sustainable behavior were also specified: frugality, equity, altruism, and pro-ecological behavior; their interrelations were used to produce the second-order factor of sustainable behavior. The model assumed a high and significant association between the HAEP and sustainable behavior, as specified by the hypothesis stating that knowing and valuing ecological principles lead to pro-sustainably acting.

### Results

Table 1 shows the univariate statistics and Cronbach's alpha coefficients corresponding to the items of the scales assessing sustainable behavior: altruism (alpha = .73), pro-environmental behavior (alpha =

.74), frugality (alpha = .63) and equity (alpha = .60) reported by the participants. Since the range of responses to the scales of pro-ecological behavior and altruism was from 0 to 3, and the range of responses to the frugality and equity scales varied from 0 to 4, it was noticed that all variables presented averages that were above the midpoint of the scale responses: altruistic (mean = 1.77), pro ecological (mean = 1.52) and frugal behaviors (mean = 2.66); with the self-report of equity being the highest (mean = 3.4) amongst them. These results replicate findings from previous studies that used the scales utilized in the present study (Kaiser, 1998; Corral-Verdugo et al., 2010; Tapia et al., 2013, for instance).



**Table 1**  
*Internal consistency and univariate statistics of the Sustainable Behavior scales*

<i>SCALE/Items</i>	<i>Mean</i>	<i>SD</i>	<i>Min</i>	<i>Max</i>	<i>Alpha</i>
<b>ALTRUISM</b>					<b>.73</b>
Gives clothes to the poor	2.25	0.86	0	3	
Assists a person in need	2.40	0.73	0	3	
Contributes financially with the Red Cross	2.10	0.84	0	3	
Visits the sick at hospitals	0.98	0.87	0	3	
Helps a senior citizen crossing the street	1.80	0.94	0	3	
Guides persons asking for direction	2.37	0.78	0	3	
Gives money to the homeless	1.86	0.86	0	3	
Participates in fund-collection rallies	1.03	1.02	0	3	
Donates blood in response to campaigns	0.70	0.96	0	3	
Cooperates with colleagues	2.21	0.87	0	3	
<b>PRO-ENVIRONMENTAL BEHAVIOR</b>					<b>.74</b>
Waits until having a full load before doing laundry	2.23	0.91	0	3	
Driving at less than 100 km/h on fast roads	1.19	1.01	0	3	
Collects and recycles used paper	1.09	1.03	0	3	
Brings empty bottles to a recycling bin	1.00	1.02	0	3	
Has pointed out unecological behavior to someone	1.40	0.93	0	3	
Buys convenience food	1.48	0.72	0	3	
Buys products in refillable packages	1.37	0.82	0	3	
Buys seasonal produce (fruit and vegetables)	2.63	0.61	0	3	
Uses a clothes dryer	1.17	1.26	0	3	
Reads about environmental issues	1.11	0.90	0	3	
Talks with friends about environmental problems	1.12	0.85	0	3	
Killing insects with chemical insecticide	1.50	0.94	0	3	
Turns down the air conditioning when leaving home	2.59	0.80	0	3	
Looks for ways to reuse things	1.84	0.95	0	3	
Encourages friends and family to recycle	1.08	1.01	0	3	
Saves gas, by walking or bicycling	1.45	1.06	0	3	
<b>FRUGALITY</b>					<b>.63</b>
Does not buy a new car if old functions.	2.92	1.25	0	4	
Wears same clothing.	2.80	1.21	0	4	
Wouldn't buy jewelry.	3.06	1.24	0	4	
Buys lots of shoes.	2.28	1.30	0	4	
Buys more food than needed.	2.38	1.44	0	4	
Uses most earnings for buying clothing.	2.74	1.34	0	4	
Always takes meals at home.	3.07	1.18	0	4	
Rather walks than drives	2.81	1.39	0	4	
Reuse notebooks and paper	2.23	1.47	0	4	
Likes living lightly.	2.31	1.26	0	4	

Table 1 (continued)

<i>SCALE/Items</i>	<i>Mean</i>	<i>SD</i>	<i>Min</i>	<i>Max</i>	<i>Alpha</i>
<b>EQUITY</b>					<b>.60</b>
Wife has the same rights husband has at home	3.65	0.77	0	4	
At work, treats colleagues as equals	3.47	0.99	0	4	
Children have the same rights as adults in making Important decisions	2.08	1.50	0	4	
In my family, men and women have the same clean up chores.	3.34	1.09	0	4	
Treats Native Americans the same way that treats White people	3.66	0.71	0	4	
Treats rich and poor people equally	3.64	0.73	0	4	
In his/her family, girls and boys have the same educational opportunities	3.85	0.59	0	4	

Table 2 shows that the internal consistencies obtained for all the sub-scales of the HAEP instrument were acceptable; most of Cronbach's alpha coefficients resulted above .80, except for the diversity scale, which produced a lower score (.64). Considering that the possible response options for this instrument range from 0 to 4, (excepting diversity, ranging 0 to 3), moderate to high levels of human attunement with ecological principles were observed. The highest level of attunement was found with the principle of association (mean= 3.40), followed by cyclicity (3.33), flexibility (3.21), while the attunement with diversity (1.94) and interdependence resulted lower (2.44).





Table 2  
*Internal consistency and univariate statistics of the Human Attunement with Ecological Principles scales*

<i>SCALE/Items</i>	<i>Mean</i>	<i>SD</i>	<i>Min</i>	<i>Max</i>	<i>Alpha</i>
<b>DIVERSITY</b>					<b>.64</b>
Likes the existence of different religions	1.30	0.93	0	3	
Enjoys getting together with people of diverse ethnicity	2.12	0.90	0	3	
Sexual diversity is not bad	1.57	1.10	0	3	
Enjoys being with people of every social classes	2.43	0.78	0	3	
Likes only being with people of his/her age/generation	2.25	0.94	0	3	
Appreciates the existence of diverse political orientations	1.86	1.00	0	3	
Does not enjoy getting together with people not his/her gender	2.27	0.97	0	3	
Likes many kinds (species) of animals, not only a few	1.96	1.08	0	3	
Likes only one kind of plants in her/his garden	1.99	1.05	0	3	
Likes visiting zoos	2.12	1.01	0	3	
The more variety of plants exist, the better for her/him	2.30	0.90	0	3	
Likes only a few types of domestic animals	1.32	1.12	0	3	
Enjoys only one type of weather	1.80	1.04	0	3	
Could gladly live anywhere (forest, beach, desert, etc.)	1.68	1.09	0	3	
<b>CYCLICITY</b>					<b>.88</b>
Reusing things that still working is better than throwing them away	3.59	0.81	0	4	
Likes when people reuse things that are still useful	3.36	0.98	0	4	
Reuse of items such as cans, bottles, paper, etc. is a way to protecting the environment	3.61	0.78	0	4	
Likes the existence of business involved in recycling	3.64	0.78	0	4	
In an ecosystem, cycles are completed if the previously used resources are reintegrated	3.35	0.93	0	4	
Loves to know that, in nature, nothing is wasted: everything is returned to earth	3.40	0.90	0	4	
In nature, the remains of a life that ends are the origin of a new one	3.18	1.01	0	4	
In nature nothing is wasted, anything discarded by a species is used by another	3.19	1.03	0	4	
Loves to know that the end of a life in nature contributes to the maintenance of other(s).	3.28	0.96	0	4	
Recycling objects is a good way to protecting the environment	3.62	0.84	0	4	
Likes using inorganic waste, such as scraps of food or plants	2.48	1.36	0	4	
Likes the existence of plants for the treatment of wastewater	3.31	1.02	0	4	

Table 2 (continued)

<i>SCALE/Items</i>	<i>Mean</i>	<i>SD</i>	<i>Min</i>	<i>Max</i>	<i>Alpha</i>
<b>FLEXIBILITY</b>					<b>.81</b>
Likes changes in the environment wherein (s)he lives	2.72	1.22	0	4	
Changes in the environment are the most normal thing in life	2.71	1.21	0	4	
We must adapt to the situations of life, rather than waiting for them to become favorable	3.04	1.14	0	4	
Likes adapting to new situations	3.07	0.96	0	4	
It is wise to change your mind	3.59	0.85	0	4	
Likes to change his/her mind if I see that this can help her/him or help others	3.57	0.76	0	4	
Adjusting to others helps him/her reach his/her goals more easily	3.06	0.97	0	4	
Likes to start new projects	3.37	0.85	0	4	
Adapting to changes makes us stronger	3.40	0.95	0	4	
Likes people that is able to change if necessary.	3.44	0.87	0	4	
The best we can do is adjust to environmental changes that occur	3.08	1.09	0	4	
Likes people who are good at many tasks, instead of just one task	3.46	0.85	0	4	
<b>ASSOCIATION</b>					<b>.91</b>
To progress as a society we must cooperate	3.72	0.65	0	4	
Likes people who cooperate in common tasks	3.64	0.71	0	4	
Cooperating with others allows us to have a better quality of life	3.64	0.75	0	4	
Likes cooperating with others	3.62	0.77	0	4	
To solve problems in a community it is important to cooperate	3.69	0.65	0	4	
Likes to cooperate with members of community	3.48	0.82	0	4	
To achieve common goals, cooperating with others is better than working individually.	3.59	0.79	0	4	
Likes working with others more than individually	3.12	1.05	0	4	
Unity makes strength	3.75	0.63	0	4	
Likes working in a team because tasks become easier	3.43	0.86	0	4	
Competition between people and ideas is good	3.34	0.97	0	4	
Likes competition between people because better outcomes result	3.27	1.02	0	4	
Without competition there is not variety of solutions to the many problems we face	3.15	1.06	0	4	
Likes competition between people and ideas, because it generates more solutions	3.23	1.05	0	4	
It's good to compete because that makes us to use resources in a better way	3.09	1.08	0	4	
Competition is normal and necessary in all societies	3.21	1.01	0	4	
Competition is good because it makes us better	3.27	0.97	0	4	
Likes to compete because it makes him/her better	3.12	1.10	0	4	



Table 2 (continued)

<i>SCALE/Items</i>	<i>Mean</i>	<i>SD</i>	<i>Min</i>	<i>Max</i>	<i>Alpha</i>
<b>INTERDEPENDENCE (CONNECTEDNESS TO NATURE)</b>					<b>.80</b>
I often feel a sense of oneness with the natural world around me.	2.67	0.98	0	4	
I think of the natural world as a community to which I belong.	2.81	0.87	0	4	
I recognize and appreciate the intelligence of other living organisms.	3.33	0.74	0	4	
I often feel disconnected from nature.	2.12	1.21	0	4	
When I think of my life, I imagine myself to be part of a larger cyclical process of living.	2.46	1.05	0	4	
I often feel a kinship with animals and plants.	2.00	1.21	0	4	
I feel as though I belong to the Earth as equally as it belongs to me.	2.30	1.97	0	4	
I have a deep understanding of how my actions affect the natural world.	2.93	1.01	0	4	
I often feel part of the web of life.	2.52	1.11	0	4	
I feel that all inhabitants of Earth, human, and nonhuman, share a common 'life force'.	2.70	1.03	0	4	
Like a tree can be part of a forest, I feel embedded within the broader natural world.	2.57	1.06	0	4	
When I think of my place on Earth, I consider myself to be a top member of a hierarchy in nature	1.72	1.14	0	4	
I often feel like I am only a small part of the natural world around me.	1.94	1.34	0	4	
My personal welfare is independent of the welfare of the natural world.	2.06	1.23	0	4	

No significant differences were obtained between male and females in terms of their HAEP and sustainable behavior. The rest of demographic variables were slightly associated with those factors (See Table 3). Age positively and significantly (but slightly) correlated with austerity ( $r=.16$ ), altruism (.22), and the attunement with flexibility (.17), cyclicality (.12), association (.16) and interdependence (.16). Income resulted also positively and significantly associated with the attunement with diversity (.17), flexibility (.15), cyclicality (.19), and association (.12); but negatively correlated with austerity (-.16). Finally, schooling correlated positively with altruism (.15) and with the attunement with diversity (.13), flexibility (.22), cyclicality (.17), and association (.21), and was negatively associated to austerity (-.18).

Table 3

*Correlations between HEAP, sustainable behaviors, and demographic variables*

	<i>Age</i>	<i>income</i>	<i>schooling</i>
<i>Austerity</i>	.16*	-.16*	-.18*
<i>Equity</i>	-.09	.12*	-.09
<i>Altruism</i>	.22**	.04	.15*
<i>Proecological-Behav.</i>	.04	.04	.03
<i>Diversity</i>	-.01	.17*	.13*
<i>Flexibility</i>	.17*	.15*	.22**
<i>Cyclicity</i>	.12*	.19*	.17*
<i>Association</i>	.16*	.12*	.21**
<i>Interdependence</i>	.16*	.05	.09

\* $p < .05$ ; \*\* $p < .01$ 

Figure 1 shows the results of the model testing the plausibility of an association between HAEP and sustainable behavior. The set of relations at the left of this figure represents the measurement model (i.e, the relationships between the observed indicators and the first-order factors) of the HAEP construct. The five first-order factors of attunement with ecological principles emerged coherently from the interrelations among their (parcels) indicators. The factor loadings between each principle and their indicators resulted salient (from .40 to .89) and significant ( $p < .05$ ) in all cases. This result evidenced the convergent validity of the measures assessing attunement with diversity, interdependence, flexibility, ciclicity and association. High interrelations among these principles appeared within their correlation matrix, suggesting the presence of a second-order factor: the HAEP. The factor loadings between every ecological principle and this higher-order factor were significant ( $p < .05$ ) and ranged from .56 to .87, also evidencing construct validity for the HAEP assessment.

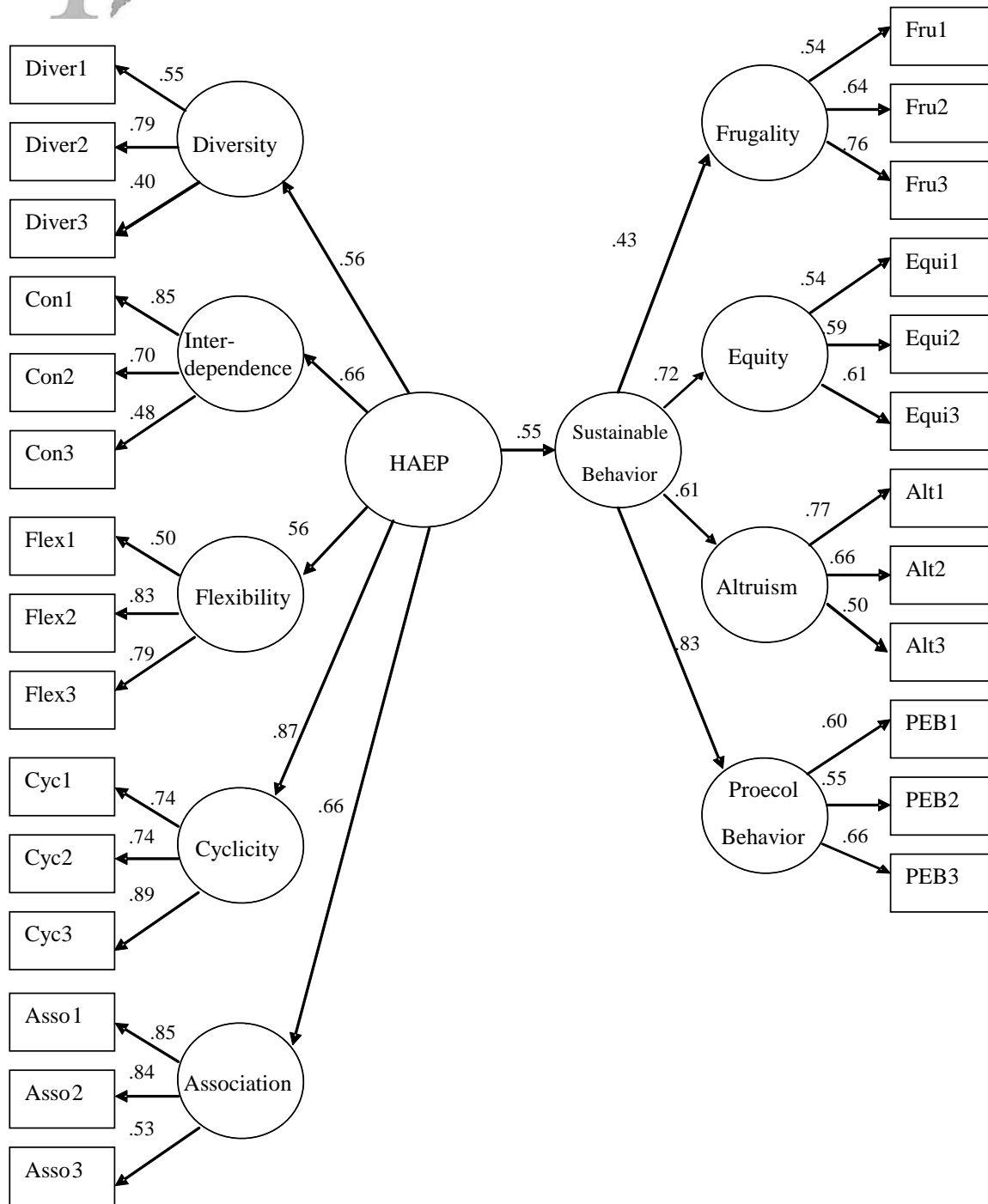


Figure 1. Model of the relationship between sustainable behavior and human attunement with ecological principles. All factor loadings and the structural coefficient are significant ( $p < .05$ ). Goodness of fit:  $Chi-squared=779.94$  (314  $df$ ),  $p < .001$ ;  $BBNFI=1.083$ ,  $CFI=1.000$ ;  $RMSEA=.000$ . Sustainable Behavior  $R^2=.30$ .

The measurement model of the sustainable behavior construct is exhibited at the right side of figure 1. As in the case of the HAEP higher-order factor, the four first-order factors of frugality, equity, altruism and pro-ecological behavior loaded highly and significantly on their observed indicators. This finding

provided evidence of convergent construct validity for their assessment. These four factors interrelated highly enough to produce the second-order factor of sustainable behavior.

The structural model tested the relationship between the HAEP and sustainable behavior. As this figure shows, such a relationship resulted high, positive and significant ( $p < .05$ ). The  $R^2$  of the model was = .30, indicating that a thirty percent of the variance in sustainable behaviors is explained by people's attunement with ecological principles. The values of the practical goodness of fit indicators of this model ( $BBNNFI=.1.083$ ,  $CFI=.1.00$ ;  $RMSEA=.000$ ) seem to support its pertinence.

### Discussion

The idea that a human attunement with general ecological principles exists seemed to be supported, at least partially, by our data. Moderate-to-high levels of knowledge and positive evaluations of these principles were detected among respondents in our study, and, very importantly, the higher this knowledge and the more positive the evaluations were, the higher resulted the participants' report of their involvement in sustainable behaviors. Such results are in agreement with our hypothesis establishing that the HEAP implies knowledge, appreciation for, and the practice of ecological rules.

Previous studies on the determinants of sustainable behavior stressed the importance that environmental knowledge has in the promotion of environmentally-protective behaviors. In order to effectively cope with environmental degradation, individuals and societies have to obtain relevant information and to develop skills to solve ecological problems (Edgerton, Mckechnie & Dunleavy, 2009; Laurian, 2003; Meinhold y Malkus, 2005, for example). The idea of ecological literacy is partially based upon such presumption. Yet, most studies regarding the positive influence of environmental knowledge on sustainable behavior have addressed the *knowledge of environmental problems and solutions* as their topic of interest, whereas ecological literacy implies the *knowledge of ecological principles* (Capra, 2005). No empirical studies investigating the effect of the knowledge of ecological principles on conservation behavior were detected in our review; therefore, we proceeded to conduct a research aimed at studying that kind of effect.

Moreover, we assumed that merely knowing ecological rules could prove insufficient to promote the practice of those rules. As a number of authors establish, one of the reasons explaining the limited success of pro-environmental interventions is the almost-exclusive emphasis they place on the cognitive (i.e., knowledge, information, skills) determinants of sustainable behavior (Pooley & O'Connor, 2000; Vining & Ebreo, 2002). Since people's evaluations and affections towards environmental objects, situations and actions are also required to instigate ecological conservation, it is necessary to consider evaluative/affective determinants of conservation behaviors when investigating those people-environment interactions (Bamber, Ajzen & Schmidt, 2003). When individuals make decisions (including those impacting on the environment) they base those decisions on both cognitive and affective factors, and none of these factors can be considered superior or predominant (Loewenstein & Lerner, 2003). As a consequence, we added an affective-evaluative component into the cognitive component of ecological literacy to study human attunement with ecological principles. In order to do so, and following Fridja's (1986) annotation, we used phrases and words as "I like," "enjoy," "appreciate" and similar ones, within the corresponding HAEP items, to instigate the evaluative/affective response to situations indicating ecological principles.

In our study, the most known and appreciated principle was association, followed by cyclicity and flexibility. Although we consider that the participants' responses reflected human attunement with ecological rules, it is also likely that a certain degree of social desirability may have pushed high the levels of knowledge and positive evaluations of these principles: In the case of association, respondents evaluated slightly more positively the cooperation component of association (mean = 3.57) than the competition one (mean = 3.21), probably because they are part of a collectivistic society which privileges (at least in theory) the interest of community and teamwork. The salient levels of information and appreciation towards cyclicity are perhaps, to some extent, responses to social campaigns promoting a more sustainable treatment of wastes and better use of natural resources. Yet, a surprising finding was the high levels of knowledge



and appreciation expressed in regard to flexibility, since they communicate the idea that change and adaptation are “normal,” and “good.” This preference for change was unexpected within a supposedly conservative society such as the Mexican one. Lower levels of attunement with the diversity and interdependence principles were detected, which does not mean that respondents were unknowledgeable of them or that they did not appreciate these ecological rules: Responses to the items assessing attunement with diversity and interdependence produced means that were above the midpoint of the scale responses.

Gender did not affect the HAEP; men and women were equally attuned with every ecological principle. Age, income, and educational level (schooling) resulted slightly associated to the HAEP (significant  $r$  values ranged from .12 to .16). Older individuals were a little more attuned with flexibility, cyclicality, association and interdependence than younger respondents were. The higher the income and the educational level, the higher the attunement with diversity, flexibility, cyclicality, and association; however, in spite of being significant ( $p < .05$ ) such relationship was low (from  $r = .12$  to  $r = .22$ ). We interpret this finding as meaning that life experience that comes from age and education is able to enhance human attunement with ecological principles (the correlation with income seems to be spurious, resulting from a common influence of schooling with both the HEAP and income). Yet, there is much more unexplained variance of the HEAP emerging from factors other than demographical ones, leaving room for the exploration of the main sources of human attunement with ecological principles.

We anticipated more differences in the responses to items assessing the cognitive and evaluative elements of the HEAP. The former were structured to measure knowledge, information, and normative aspects that people use to detect ecological principles, while the latter were intended to reveal appreciation, affinity or positive evaluation of a situation indicating some of those principles. Yet, when we correlated the sets of “cognitive” and “evaluative” items assessing each particular principle, we found high ( $r > .80$ ) and significant ( $p < .001$ ) associations between those sets. This seems to imply that the identification of an ecological principle highly corresponded with its positive evaluation. Similar findings have been reported previously when researchers correlate cognitive and affective factors involved in the instigation of pro-environmental behavior (Hinds & Sparks, 2008; Tapia, Corral-Verdugo, Gutiérrez, Mireles, & Tirado, 2010), although the value of the correlation between the cognitive and affective components of the HEAP in our study saliently exceeded the values found in those previous studies. It is likely that mere identification of an ecological principle might conduce to a positive evaluation; yet, at this time this is simply a hypothesis that deserves further consideration and empirical testing. The fact is that, as a consequence of this finding, we proceeded to combine those two sets into a single group of items indicating each particular attunement with an ecological principle.

Using parcels that combined the cognitive and evaluative components of each attunement with ecological principles, we were able to model five first-order factors identifying every HEAP. We repeated this operation with the four first-order factors identifying sustainable behaviors. High and significant factor loadings between the observed indicators (the parcels) and their corresponding factors provided evidence of convergent construct validity for each factor. Then, the interrelations among the factors of attunement with association, cyclicality, flexibility, diversity and interdependence produced the HAEP second-order factor. The same statistical treatment was implemented on the sustainable behavior second-order factor. The covariance between the HAEP and sustainable behavior was = .55, and the resulting  $R^2 = .30$ , meaning that a 30% variance in sustainable behavior was associated to HAEP.

Our study presents limitations that have to be considered in the discussion of its results. Although verbal reports of the cognitive component of HAEP may be considered valid indicators of human attunement with ecological principles, the evaluative component could be better assessed with the use of non-verbal responses (for example, implicit or psychophysiological responses). Also, the assessment of sustainable behaviors using self-reports could be biased, since people usually over-report engagement in conservation behaviors, guided by social desirability. Also, the sample investigated is by no means representative of human societies, even the Mexican ones. Therefore, further studies aimed at replicating the reported findings should consider those limitations in their research design, using methods alternative to self-reports, and considering ampler samples of participants in cross-cultural studies. A final potential limitation of the study is the lack of discrimination between the cognitive and evaluative sources of the

HAEP. This inability to discriminate could be due to the use of verbal responses, the wording of the items, but it is also possible that knowing and appreciating ecological principles may go together.

Our study was not intended at exploring the sources of the HAEP. We were just aimed at demonstrating that the knowledge and appreciation of ecological principles combine to shape a human attunement with those principles, and this attunement is able to predict sustainable behaviors. Regardless of the (cognitive/evaluative) sources of the HAEP, if our findings of an effect of this factor on sustainable behavior are replicated they will indicate that the attunement with ecological principles exerts a higher influence on the practice of those behaviors than the one produced by the knowledge of environmental problems and solutions. So far, this knowledge is barely associated with 6 to 9% increase in the practice of conservation behaviors (Hines, Hungerford & Tomera, 1986; Frick, Kaiser & Wilson, 2004), while the HEAP variance in our study resulted associated to a 30% variance in pro-sustainable practices. Therefore, if this is the case, providing information regarding ecological rules and promoting their appreciation would be a better educational approach than providing information regarding the source of specific environmental problems and the way those specific problems can be solved. Of course, a significant number of attempts aimed at identifying where the HAEP emerges from, the psychological structure of this factor (its cognitive and evaluative sources), and how such attunement might be enhanced, are required before attempting to promote a higher HAEP among people.

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Received: 07/06/2016  
Accepted: 11/22/2017