Framing biodiversity conceptions

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Abstract

Understanding biodiversity has become critical since findings regarding the consequences of climate change. However, it is a complex concept entailing both scientific and political aspects. The usage of analogies, especially metaphors, that have positive influences on the understanding of complex concepts, attitudes and behaviors, seems an interesting strategy to achieve this goal. Two studies were designed to investigate the biodiversity concept and metaphorical framing effects. Based on analogies elaborated by 259 participants, the first study aims to identify to which extent two important protective approaches are present among students in the biodiversity concept: preservationism which encourages humankind to limit their intervention on nature and conservationism which allows humankind to exploit nature with parsimony (Barroca-Paccard et al., 2018). The participants were asked to write an analogy to illustrate biodiversity. We analyzed their analogies using a lexicography analysis. Results highlight three major groups of analogies: a scientific dimension, a conservationist dimension, and a preservationist dimension. The second study investigates the effects of metaphorical framing on environmental attitudes and behaviors. 277 University students read a short text framing biodiversity with a preservationist or conservationist metaphor or without metaphor framing. A decision-making task and an environmental concern scale were then completed. Statistically significant results were found, showing an effect of the conservationist metaphor on the decision-making task. Limits and applications, particularly in education, are discussed.

Keywords: conceptual development; metaphorical framing; environmental attitudes; decision making; biodiversity

Introduction

Understanding biodiversity has become critical since the findings about the consequences of climate change. Moreover, human activity being responsible for the biodiversity crisis, a convinced society is necessary to efficiently implement preservation actions (Hanski, 2005; Trombulak et al., 2004).

However, the concept of biodiversity is relatively unknown: a Gallup Organization study (2010, as cited in Filho et al., 2016) showed that two-thirds of European citizens said being familiar with the word "biodiversity" but only 38% claimed to know its meaning and 34% had never heard the word. These results can be explained in part by the difficulty to apprehend the complex concept of biodiversity. Indeed, the word biodiversity was first used to communicate about living diversity at different levels (ecosystems, species, and genes) (e.g., Wilson, 2000) but, following the growing research on that topic in many fields (biology, ecology, economy, civic education, etc.) the word has acquired numerous definitions (Barroca-Paccard et al., 2018; Le Guyader, 2008).

Barroca-Paccard et al. (2018) identify two main dimensions that can be approached very differently: a scientific and political. The scientific dimension consists in listing the large diversity of species and studying the dynamics and evolution of ecosystems (Barroca-Paccard et al., 2018). The political dimension focuses on two different biodiversity protection perspectives: conservationism and preservationism (Barroca-Paccard et al., 2018). Derived from utilitarianism, conservationism suggests that environmental action can be based on a cost-benefit ratio. Therefore, biodiversity is perceived as a natural resource that humanity can exploit but sparingly to enjoy the natural resources as long as possible. In contrast, preservationism, a kind of deontology, sees biodiversity as a priceless value that humanity must preserve by moral obligation. In this perspective, humanity is a disruptor that unbalances nature and must limit its impact (Barroca-Paccard et al., 2018). Therefore, understanding biodiversity involves developing a complex concept that encompasses scientific perspectives as well as political considerations (Barroca-Paccard et al., 2018), as well as learning adequate behavioral responses to preserve biodiversity (Chawla et al., 2007).

Metaphors, a kind of analogy, (Gentner & Clement, 1988), are tools that can help the understanding of complex concepts and ideas through the mobilization of known concepts (Lakoff & Johnson, 2008). When a notion can't be experienced, it is comprehended through another concrete experience (Hofstadter & Sander, 2013; Lakoff & Johnson, 2008). In other words, a target, the unknown or partly known situation explained, is understood through the terms of the source, a well-known situation (Holyoak & Thagard, 1997). For example, global warming, which is difficult to understand as well as difficult to experience, is often

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compared to a greenhouse effect, more easily experienced and perceived. As the conceptual system constrains our functioning, the influence of metaphors can be found in our language, thoughts, and behaviors (Lakoff & Johnson, 2008). Therefore, conceptions can be grasped by the metaphors used by a person. For example, based on metaphors used by students, Niebert & Gropengiesser (2013) identified misunderstandings about global warming mechanisms and used metaphors to overcome them.

Besides their explanatory and communicative power, metaphors can also guide attitudes and behaviors (Thibodeau & Boroditsky, 2011; Thibodeau et al., 2016). Thibodeau and Boroditsky (2011) framed metaphorically the description of the criminality taking place in a fictive city. In one condition, the participants read a short text comparing criminality to a wild beast while another condition compared criminality to a virus. Participants had then to take fictive decisions. When criminality was explained through the virus metaphor, the participants' choices focused on prevention, which is a common way to face a virus issue. In contrast, when explaining criminality through the wild beast metaphor, participants preferred a repressive approach as would be the case during a wild beast attack.

Metaphorical framing not only can influence decision-making but also attitudes. Thibodeau et al. (2016) showed that participants showed different attitudes toward law enforcement depending on the metaphor used to describe law enforcement. Human behaviors being central in the biodiversity issue, attitudes that can have an important influence on behaviors (Ajzen & Fishbein, 1997; Vaidis, 2006), are of great interest.

Attitudes are evaluations associated with positive or negative feelings (Eagly & Chaiken, 2007). "Environmental attitudes" or "environmental concerns" are attitudes specific to the environmental context (Kaiser et al., 2013). Schultz (2001) defines three environmental concerns: Egoistic concerns – negative attitudes towards environmental issues that can impact oneself; such concern may lead to environmental behaviors if it is benefic for oneself; Altruistic concerns – negative attitudes to environmental issues that can impact other (family, neighborhood, or other social groups); such concern can drive environmental behaviors if it allows helping the social group. While egoistic and altruistic concerns reveal utilitarian reasoning, they are associated with environmental apathy and fewer preservation behaviors; Finally, Biospheric concerns – negative attitudes to environmental issues that can impact any life form. In contrast with egoistic and altruistic concerns, biospheric concerns see nature as priceless having to be protected for herself (Gagnon Thompson & Barton, 1994). While egoistic concerns barely result in ecological behaviors (Kaiser et al., 2013), biospheric concerns can lead to environmental actions. Therefore, it is encouraged to promote biospheric concerns by, for example, valuing nature for its own sake to facilitate significant environmental behaviors (e.g., Gagnon Thompson & Barton, 1994; Kaiser et al., 2013).

As highlighted earlier, metaphors can be an effective way to support the understanding of the complex and abstract notion of biodiversity. Moreover, as metaphorical framing can have an impact on attitude and behaviors, it appears to be an appropriate strategy to promote behaviors designated to preserve biodiversity.

In this research, analogies will be used first as an indicator of the concepts underlying biodiversity and then as a tool to transform biodiversity conception and study how this may impact attitudes and decision-making.

Study 1

The first study aims to investigate the conception of biodiversity among students. More precisely, we seek to identify the presence of preservationist and conservationist approaches in the analogies developed by the participants.

Methodology

Two open-ended questions were addressed in an online survey to 259 university students from the University of Geneva (81.9% female, age: M = 22.1, SD = 5.14). Participants were first asked to define biodiversity in their own words and then to illustrate it with an analogy. Because the biodiversity concept can be enlightened the analogies, in this work, we focus on the second question.

A lexicographical analysis was conducted to identify the relations between words based on their occurrences and co-occurrences (Guérin-Pace, 1997). A R interface, IRaMuTeq, was used to automatically perform the lexicography analysis (Arnoult, 2015). Then, a hierarchical descendent classification (HDC) was performed on the analogical responses, based on Chi2, grouping words that are related (co-occurrent) and separating words that aren't linked (not co-occurrent) (Reinert, 1983; Anoult 2015). Subsequently, a Factorial Correspondence Analysis (FCA) represented factors by their proximity in a dimensional space (Bart, 2011) and a similarity analysis within the clusters was performed to facilitate the interpretation. In the following, we first report the analyses on the two questions, and then, we focus on the factors highlighted by the FCA.

Results

The HDC analysis on the analogies identified five clusters that were distinguished by two axes in the CFA. The first axis differentiated: a first cluster assembling 11.44% of the total words and illustrated by words such as "take" (13 occurrences within the cluster), "care" (12 occurrences), often following the verb "have to" and the verb "protect" (11 occurrences); in this cluster, nature was compared to a precious (16 occurrences) treasure (6 occurrences) as well as to family member (baby, child, grandmother); A second cluster grouping 33.14% of the words as "different" (30 occurrences), "species" (27 occurrences) and "colors" (31 occurrences).

The second axis distinguished between the first cluster and 3 other close clusters partially overlapping in the dimensional

space. These 3 clusters included words such as "role" (14 occurrences), "animal" (17 occurrences), "vegetal" or "plant" (9 occurrences), "human" or "individual" (26 occurrences"), "to live" (17 occurrences) often followed by "with" or "together"; "to ameliorate" or "to change" (13 occurrences) and "to preserve" (10 occurrences). In this clusters, we also fund "heart "(5 occurrences) and "body" (8 occurrences).

Discussion

The analysis of the analogy answer revealed that the first cluster represents preservationism where nature is a precious treasure that must be taken care of and protected. This cluster is opposed, on the first axis, to a second cluster reflecting the numerical diversity aspect. Several analogies highlight the idea that biodiversity characterizes the importance and existence of an important number of different species. In this cluster, the word "colors" appeared several times as the importance and abundance of colors was a frequent metaphor used to illustrate this aspect. Then, the second axis differentiates between the preservationist cluster and the 3 close clusters. Given the closeness of the clusters, we considered them as one cluster evoking the idea that humankind must improve to coexist with nature. It was illustrated, for example, by comparing biodiversity with a heart that needs to be taken care of to have a well-functioning body. This suggests that the second axis represents the opposition between preservationism and conservationism.

Therefore, participants seem conscious of the diversity of species, but the FCA didn't highlight any evolution and dynamics dimension. This suggests that the students barely mention this dimension underlying the scientific notion of biodiversity. The protection approach is also present in the analogies. It can take the form of conservationism and, to a lesser extent, also preservationism (this cluster represented only 11.4% of the occurrences as mentioned in the Results section).

These findings are relevant because metaphors and analogies can underly different attitudes and behaviors and promote some decisions over others (Thibodeau & Boroditsky, 2011). An interesting perspective would be to study if the metaphors collected in this study could be used to explain the different aspects of biodiversity notion and promote environmental behaviors.

Study 2

This second study investigates the effects of metaphorical framing on environmental attitudes and environmental decision-making. The metaphors were selected from study 1 to explore the influence of spontaneous metaphors on attitudes and behaviors. They were chosen based on the frequency of appearance and their relevance to this current study. The analogy comparing biodiversity to an organ (e.g., "heart") was chosen to illustrate conservationism while the analogy comparing biodiversity to a child was chosen to illustrate preservationism.

Methodology

277 University students (84.5% female, age: M = 23.57, SD = 5.64) were asked several questions in an online survey set on the Limesurvey platform.

After some demographic questions, participants were asked to read a short text explaining biodiversity. At this point, participants were randomly assigned to three conditions: the first one represented preservationism and compared biodiversity to a "fragile child" as a fragile child is priceless and associated with protection duty. The second one, the conservationist condition, compared biodiversity to a "fragile organ" based on the idea that one takes care of organs because they are needed to live. Finally, the third condition did not use any metaphor and served as the control group (see https://cutt.ly/hHiBySS for more details on the short text). Each participant was randomly assigned to one of the conditions. Participants read 3 times the same short text at different times of the survey. After the first and third reading, a check question to verify the attention was asked (different each time). Between each reading, some open-ended questions regarding emotions, political opinion and a summary task were presented. However, for the purpose of this study, we will focus on the questions regarding behaviors and attitudes. Since our interest is in the behaviors and attitudes, in this section, we will only focus on the questions regarding a decision-making task and the attitudes.

After the third short text presentation, participants had to perform a decision-making task: Three different plant species (an inedible plant, a highly consumed plant and a stinging for human plant) were said to be endangered. The participants were asked to imagine receiving 10'000.- to invest in the plant and had to decide how much they wanted to give for the protection of each species. This scenario that constrains participants with limited resources was used to mirror real-life conditions and to give a reference value to participants. Finally, participants had to give an evaluation of their environmental concerns based on a scale developed by Schultz (2001). The scale consists in asking the participant to rate how much concern they feel toward environmental issues based on the consequences for 12 items (me, my health, my future, all people, children, my children, people in my country, plants, marine life, animals, birds). The items can be gathered in 3 subscales: the egoistic concerns, altruistic concerns and the biospheric concerns subscale. Each item is evaluated on a Likert scale of 7 points (1 = not important, 7 = extremely important).

We hypothesize that the preservationist metaphor and the conservationist metaphor will facilitate decision-making and environmental concerns consistent with the approach. framed. In other words, we hypothesize that when reading the child metaphor, participants would allocate as much money for each species following the preservationist statement that they all are valuable for their own sake. Moreover, as preservationism can lead to biospheric concerns, we expect a high rate of this subscale.

Table 1: Descriptive statistics of the inedible and stinging plant for each condition.

	Comestible plant		Stinging Plant		Inedible plant	
Condition	*M*	*SD*	*M*	*SD*	*M*	*SD*
1-Preservationism	4372.34	1407.68	2714.87	1004.43	2912.79	1152.99
2-Conservationsm	4524.93	1353.63	2686.71	900.71	2788.36	761.23
3-No metaphor	4062.51	1256.73	3089.40	1309.49	2848.09	872.75

Table 2: Pairwise comparison results.

	Comestible plant			Stinging Plant		
Condition comparison	*df*	*t ratio*	*p-value*	*df*	*t ratio*	*p-value*
1-2	274	-0.74	0.74	274	0.17	0.99
1-3	274	1.59	0.25	274	-2.31	0.06
2-3	274	2.41	0.04*	274	-2.53	0.03*

Note. 1 refers to the preservationist condition, 2 refers to the conservationist condition, and 3 refers to the no metaphor condition. Significant results (p <.05) *are highlighted by* *.

Table 3: Descriptive statistics of the Schultz's subscales for each condition.

	Egoistic concerns		Altruistic concerns		Biospheric concerns	
Condition	*M*	*SD*	*M*	*SD*	*M*	*SD*
1-Preservationism	5.00	1.37	5.84	1.12	5.95	1.20
2-Conservationsm	5.34	1.28	6.05	0.93	6.15	0.99
3-No metaphor	5.35	1.39	5.78	1.19	6.02	1.03

For the conservationist condition, we expect to see more utilitarian decisions: the comestible plant being more useful to humans than the inedible plant or the stinging plant, the participant would allocate more money to its protection. As suggested by the literature, we suppose that the conservationist metaphors will lead to less biospheric concerns.

Results

The first check question was answered correctly by 45.1% of the sample while for the second one 80.9% of the answers were correct. For each check questions, a one-way analysis of variance (ANOVA) showed no significant difference between the three conditions (check question 1: $F(2, 274)= 1.26$, $p>0.1$; check question 2: $F(2, 274)= 0.32$, $p>0.1$).

A one-way ANOVA was performed to compare the effect of the metaphors on the budget allowed for each plant. The one-way ANOVA revealed a statistically significant difference in the highly consumed plant (F (2, 274) = 3.07, p < .05) and the stinging plant (F (2, 274) = 4.09, p < .05) between at least two conditions. Therefore, pairwise comparisons with a multiplicity adjustment were conducted on the statistically significant results to identify more precisely the significant differences between the conditions. The results are presented in Tables 1 and 2. For the inedible plant, no difference was found between the three conditions.

Finally, for Schulz's scale, a one-way ANOVA of each subscale was conducted on the three conditions. The analysis shows no statistically significant difference between the conditions (See Table 3 for means and standard deviations).

Discussion

Results on the checking questions suggest that participants didn't pay much attention to the first reading of the text but were more precise after the second reading. With the environmental concerns and the decision-making task following the third reading, we can assume that at this point participants were well informed about the text content.

The analysis of the decision-making task revealed a significant effect of the conservationist condition. Participants gave significantly more money to save the comestible plant and less money to preserve the stinging plant. This result suggests that the metaphorical framing induces a preference for the useful plant species over the harmful one and thus that utilitarian reasoning took place when reading the conservationist text. This result implies that the "fragile organ" metaphor leads to a more utilitarian conception of biodiversity. Therefore, it seems that metaphorical framing can significantly influence an environmental decision-making

No significant effect of the preservationist metaphor nor of the no metaphorical framing condition was found on the decision-making task. The lack of evidence for a preservationist metaphor effect might be explained by a lack of relevance of our metaphor. Indeed, although several students used a metaphor comparing biodiversity to a family member (e.g., child, baby, uncle, grandmother) in the first study, the child metaphor may not lead others to the same inferences and thus, not vehicle the preservationist idea we expected to. Further study should identify a metaphor leading to greater preservationist inferences. Another explanation might come from the methodology used to induce the metaphors and their inferences. Reading a short text may not be enough to elaborate on the metaphor and to be able to make inferences. In addition, nowadays, preservationism is a less familiar approach than conservationism that encompasses sustainable development. Therefore, more reflection on the consequences of preservationist thinking may have been necessary. Thus, allowing the participant to elaborate more deeply on the metaphor could be a way to trigger changes in attitudes.

The analysis of the environmental concerns subscale in relation to the three conditions showed no effect. This result is surprising as we could expect that a behavior change would be accompanied with a change in attitudes (Liu et al., 2020). However, it should be noted that the items were quite highly rated. The survey was introduced explicitly as a study on biodiversity learning. The Schultz's scale being quite explicit, participants could try to satisfy the researcher's expectations by rating very high on each item. In another hand, literature has already reported an attitude-behavioral gap, especially in sustainable behaviors (Park and Lin, 2020). Other factors could influence the behaviors. For example, Carrigan and Attala (2001) highlighted that concerns about utilitarian benefits were important factors when purchasing ethical goods. Thus, the effect of the conservationist condition on the decision-making task and the absence of the preservationist condition could be better explained by this kind of utilitarian concern. Investigations on these factors should be addressed in future research.

General Discussion

This current research aims to explore and improve biodiversity conception to facilitate environmental attitudes and behaviors. More specifically, we first studied if scientific and protective approaches were present in the conception of biodiversity of students through analogies. Then, metaphors elaborated in the first study were used to investigate if they could influence environmental attitudes and behaviors.

The first study showed that analogies were useful to investigate biodiversity conception. Our analysis on the reported analogies revealed that some scientific, as well as preservationist and conservationist concepts, underlie biodiversity conception among students. In contrast, our results suggest that these conceptions show no evolution or dynamical representation. Development of the representation of biodiversity, especially on this aspect, seems necessary to build a more complete biodiversity understanding.

The second study supports the hypothesis that, under specific conditions, metaphorical framing is influent in the context of biodiversity. Indeed, when reading a short text framed metaphorically with a conservationist approach, participants made decisions in a congruent way: They decided to allocate more money to save a plant species that was useful for humankind and less money to preserve a plant species that was harmful to human. This is an important result with societal entailments since biodiversity issues are also a political matter. Nowadays, important environmental decisions are often submitted to the population. Thus, the metaphorical framing can facilitate the understanding of this complex subject and help decide adequately to cope with this problematic. However, the analysis revealed no effect on environmental attitudes. As mentioned above, a more implicit scale like the New Environmental Paradigm scale (Dunlap & Van Liere, 2008) and including another kind of concerns could be a good option to investigate how metaphorical framing influences environmental attitudes.

To sum up, an effect on decision-making was observed. Nevertheless, a step forward should be taken. Human activity being responsible for the biodiversity issue, further research should investigate how metaphors could also facilitate environmental behaviors that are needed to protect biodiversity.

This research could then lead to promising applications, notably in educational science. Indeed, since 1992, the Convention on Biological Diversity proposes concrete action to protect biodiversity using diverse means including education (Dreyfus et al., 1999; Navarro-Perez & Tidball, 2012). While biodiversity is already present in curricula of several countries (Barroca-Paccard, 2015), a major issue is to support a better understanding of this complex concept (Barroca-Paccard et al., 2018) and to teach concrete behavior to preserve biodiversity (Chawla et al., 2007). The usage of metaphors seems to be a promising strategy to achieve these goals. Indeed, metaphors have been already successfully used to support the learning of various disciplines and especially scientific domains (Aubusson et al., 2006). Combining metaphors framing to other devices such as outdoor education may increase connection with nature (Gagnon Thompson & Barton, 1994), which seems an interesting

perspective as this might help promote biospheric concerns as well as environmental behaviors.

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