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Routine experiences of nature in cities can increase personal commitment toward biodiversity conservation

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ABSTRACT

This study examines individual commitment to biodiversity during adulthood. We studied the interrelations between everyday experiences of nature, knowledge about biodiversity, connectedness with nature, and implementation of specific pro-biodiversity practices, through a survey covering 473 adults in Paris surroundings (France). More specifically, we showed that people involved in experiences of nature in which attentiveness to biodiversity is explicit (citizen science, nature watch association, environmental association) have more knowledge about biodiversity and conservation than both people involved in experiences of nature in which attention to biodiversity remains implicit (community garden, allotment, community-supported agriculture), and people without such kinds of experience of nature. However, we found that people experiencing nature as part of a daily routine, whatever the type of experience, were more connected to nature and more likely to implement active pro-biodiversity practices. With this interdisciplinary study that links conservation biology and conservation psychology, we help understand more precisely the levels of commitment of urban and sub-urban adults toward biodiversity conservation.

1. Introduction

Historically focused on the protection of wilderness for itself, the conservation of biodiversity has progressively highlighted the importance of individual behaviors and lifestyles in addressing the biodiversity crisis (Howard, 2000). Indeed, many individual practices have a direct impact on biodiversity, including consumption choices (Koger and Winter, 2010) and the management of private gardens (Gaston et al., 2005). Other individual practices have indirect consequences because they become part of social processes that can support conservation, such as voting (Koger and Winter, 2010).

The understanding and promotion of individual changes in behaviors have been the subject of numerous studies in social sciences, including in environmental and conservation psychology (see e.g., Clayton, 2012). A wide diversity of individual and social factors has been shown to influence significantly the adoption of individual pro-environmental behaviors (see review in Gifford and Nilsson, 2014), including age and gender, personal values and identity, attitudes and knowledge, collective norms, context, and ease or difficulty of implementing the behaviors (Stern, 2000). One component of the individual identity that encourages pro-environmental behaviors is the level of connectedness with nature (see review in Tam (2013)), i.e. an individual's trait level of feeling emotionally connected to the natural world (Mayer and Frantz, 2004). Knowledge about environmental issues is correlated with attitudes and behaviors (e.g., Frick et al., 2004). However, knowledge “must be regarded as a necessary but not sufficient condition for salutary decision-making” (Gifford and Nilsson, 2014: 142). For instance, Liefländer et al. (2013) showed that education at school can increase pupils' connectedness with nature, but only in the very short term. In particular, it is worth noting that individual motivation and willingness to implement new behaviors cannot make individuals change their practices without appropriate social and contextual conditions. For instance, Cialdini and Goldstein (2004) highlighted the influential role of conformity in individual choices, i.e. the motive to “change one's behavior to match the responses of the others” (p. 606). Uren et al. (2015) highlighted in Australia the role of

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social world visions and myths in the design of private gardening practices.

Individuals construct their identity mostly during childhood, and many studies have confirmed the link between children's nature-based activities and further involvement toward nature. For instance, Guiney and Oberhauser (2009) showed that ecovolunteers developed a connection to nature during their childhood. More generally (see review in Chawla, 1998), significant life experiences during childhood, including time spent in nature, presence of role models, and nature book reading, foster individual connection and further involvement toward nature (Stevenson et al., 2014). Other authors, such as Giusti et al. (2014), showed the importance of regular access to ordinary nature during childhood (so-called “nature routines”) in the construction of connectedness with nature.

Educating and providing nature experiences to children is therefore of prominent importance. However, because becoming a nature-connected child does not mean staying a nature-connected adult, and because the biodiversity crisis will hardly wait for one or two more generations, initiatives to connect adults with nature should be also encouraged. Some qualitative and isolated studies suggest that adults can also increase their interest toward the biodiversity in their neighborhood and adopt pro-conservation practices. For instance, Cosquer et al. (2012) showed that participation in a butterfly's dedicated citizen science program can induce changes in gardening practices, toward more biodiversity-friendly practices. Van Heezik et al. (2012) showed that people that agreed to include their garden in a scientific ecological protocol progressively increased their knowledge and changed their attitude toward biodiversity, due to regular communication and exchanges with scientists.

Yet, despite the increasing understanding of pro-environmental behaviors, three gaps still need to be closed to address the biodiversity crisis: behaviors specifically addressing biodiversity issues are rarely specified; the types of experiences of, or contact with, nature are rarely detailed; and most studies relate to children. In this study, we aimed to close these gaps, and studied how individual everyday experiences of nature in adulthood are correlated with 1) knowledge about biodiversity, 2) a personal sense of connectedness with nature, and 3) practices toward biodiversity (referred to here as “conservation practices”).

Following Clayton et al. (2017), we defined the experience of nature as a “process including interactions between individuals and natural entities; social and cultural context; and consequences for new skills, knowledge, or behavioral changes” [notably toward nature] (Clayton et al., 2017: 2). We compared people who do not experience nature in their everyday lives, people engaged in experiences of nature with explicit attention to biodiversity (i.e., taking part in a nature citizen science program, being a member of a nature watch association or environmental association), and people engaged in experiences of nature with implicit attention to biodiversity (i.e., involvement in community supported agriculture, in a community garden or using an allotment). Among the different kinds of knowledge (see Kaiser and Fuhrer, 2003), we assessed the so-called “declarative knowledge” about biodiversity, i.e., according to the ecosystems' functioning and conservation issues. Among the numerous existing scales of individual connectedness with nature (Tam, 2013), we used the Inclusion of Nature in Self (INS) developed by Schultz (2002). Finally, based on expert-based assessments, we explored six different conservation practices that have a positive impact on biodiversity: 1) nest boxes, which may attract birds (Gaston et al., 2005); 2) maintaining wild-flower patches, which are more biodiversity-rich than cultivated flower or vegetable beds (Lindemann-Matthies and Marty, 2013); 3) consumption of organic products, because organic agriculture favors biodiversity in rural areas (Winqvist et al., 2012), 4) consumption of seasonal products, because growing fruits outside of their natural growing seasons can have adverse effects on both climate and the environment (Tobler et al., 2011); 5) composting, because its effects are both local, as it reduces the use of chemical products and/or provides habitats for biodiversity in gardens (Gaston et al., 2005), and global as it reduces domestic waste quantities (Cox et al., 2010); and 6) voting intentions based on candidates' positions on conservation issues, because this is considered by some scholars as one of the most powerful individual commitments to preventing environmental problems (Koger and Winter, 2010; S. Clayton, personal communication).

We tested three hypotheses: a) experiences of nature and knowledge about biodiversity are closely correlated; b) connectedness with nature is positively correlated with experiences of nature; c) individual pro-biodiversity practices are interrelated with experiences of nature, knowledge about biodiversity, and connectedness with nature. We included in all the analyses the following individual characteristics: gender, age, urbanization level of current habitat, and socio-professional category. We conducted this study in a Western urban context, by means of a survey based on a questionnaire completed by 473 adults living in Paris (France) and its urbanized surroundings.

2. Materials and methods

We conducted a questionnaire survey from May to August 2010. The questionnaire was presented as an interdisciplinary scientific study to assess opinions about biodiversity. The questionnaire could be completed online or through face-to-face interviews. For the online responses, we used the snowball sampling technique (Biernacki and Waldorf, 1981). In the face-to-face interviews, we presented the questionnaire to adults encountered in urban public areas (e.g., urban parks, railway stations) in Paris (France) and its periphery. In addition, we made specific contacts with people involved in the six everyday experiences of nature in which we were interested, in the places where these experiences were occurring (gardens, nature watch trips). A total of 275 adults filled in the questionnaire in the face-to-face interviews, and 375 adults did so online. However, because some forms were incomplete, we ultimately obtained 473 different questionnaires (217 online and 256 from face-to-face interviews) to use in our subsequent analyses (Table 1).

2.1. Questionnaire

The questionnaire was designed to elicit four types of information, as follows: knowledge about biodiversity; individual connectedness with nature; individual practices toward biodiversity; and individual characteristics.

Table 1
Number of questionnaires collected according to the different everyday life experiences of nature, (together with their categorization). The numbers in brackets represent the number of questionnaires collected on line and face-to-face.

Everyday life experiences of nature	Explicit/implicit attention	Number
Member of a naturalist association	Explicit	35 (15–20)
Volunteer in a citizen science program	Explicit	43 (43–0)
Member of a nature conservation association	Explicit	28 (21–7)
Mixed group: Naturalist + nature conservation association	Explicit	24 (19–5)
Total explicit		130 (98–32)
Allotment gardener	Implicit	68 (0–68)
Member of a Community garden	Implicit	45 (0–45)
Member of Community Supported Agriculture (CSA) group	Implicit	56 (6–50)
Mixed group: Allotment + member of a CSA group	Implicit	25 (25–0)
Total implicit		194 (31–163)
Control group		149 (88–61)

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2.1.1. Knowledge about biodiversity

Declarative knowledge about biodiversity was separated into two parts. First, knowledge about how biodiversity functions was evaluated on the basis of the following eight major fields in ecological science (Begon et al., 2006): food webs, decomposition cycles, parasitism, primary production, competition, intraspecific diversity, evolutionary characteristics of biodiversity, and the concept of biodiversity. Two questions referred to each of these fields, to make up 16 items on biodiversity functioning. Secondly, knowledge about human-biodiversity interactions was evaluated according to expert-based definitions of ecosystem services and conservation issues. Four items concerned ecosystem services as defined in the Millennium Ecosystem Assessment (2005): pollination, water purification, climate regulation and cultural services. An additional five items concerned five of the major direct threats to biodiversity, as follows: habitat destruction, resource over-exploitation, climate change, pollution, and invasive species (Maxwell et al., 2016). Two questions referred to each of these nine fields, to make up 18 items on human-biodiversity interactions. In total, declarative knowledge about biodiversity was thus assessed through 34 statements. In order to find the most accurate formulation of all these statements, we first asked twelve scientists and biodiversity conservation experts to approve our wording. Items with no consensual answer were modified.

The 34 statements were presented randomly in the first part of the questionnaire under the heading “Your opinion”. Respondents were asked to evaluate the accuracy of each of the 34 items by ticking one of the following declarations for each: “Strongly disagree”, “Disagree”, “Agree”, “Strongly agree”, or “I don't know”. We then assigned a score of “3” to the answer “I don't know”; a high score (e.g., 5 or 4) to correct answers as approved by scientists and experts, and a low score (e.g., 1 or 2) to the incorrect responses.

In order to increase the internal consistency of the answers (Barnette, 2000), the questionnaire included bidirectional items, so that 15 of the 34 statements provided a scientific-accurate proposition and 19 an inaccurate one.

We then computed an individual knowledge score by averaging the answers to all the statements, after confirming the reliability of the measurement (Cronbach's alpha = 0.76). Missing values were excluded from the calculation of individual knowledge about biodiversity.

2.1.2. Connectedness with nature

This was measured using a derived version of the Inclusion of Nature in Self Scale (Schultz, 2002). Respondents were asked to describe their relationship with the natural environment by selecting a degree of overlap between two circles representing themselves and nature (Fig. 1). Connectedness with nature was scored from 1 for non-overlapping circles (i.e., disconnection) up to 6 for completely overlapping circles (i.e., strong connection).

In order to check for the validity of this scale in our sample, we assessed also the urbanization level of the childhood habitat of the respondents, on a 4-level scale from rural to urban. Connectedness with nature was indeed negatively correlated with the urbanization level of childhood habitat (rank Spearmen correlation: rho = 0.09, $p = 0.04$).

2.1.3. Individual conservation practices (entitled “Your Practices”)

We used an innovative two-step evaluation of the six studied conservation practices (see Table 2): first, the respondents quantified their involvement in these practices using dedicated 5-level scales. Then, for all practices except the final one (voting), we asked the respondents to explain their choices by selecting two possible reasons (as described in Table 2). We then scored their first answer according to these reasons, in a 3-level scale: 1) if the reasons selected showed an inability to implement the practices (i.e., no garden or no space), we excluded these actions for the respondents concerned. 2) If the reasons did not reflect a concern for biodiversity, we kept the Likert score as the final score. 3) If the reasons reflected a concern for biodiversity conservation, we multiplied the Likert score by 2 (Table 2).

Table 2
Reasons given to explain five of the six individual practices and associated scores (Likert-scale responses to these questions were multiplied by this score).

Individual practice	Reasons given	Score
Percentage of a garden managed as a wild-flower patch	- Because it is not aesthetic	1
	- To avoid attracting wild animals	1
	- Fear of insects	1
	- Because it is aesthetic	1
	- Because it is easy/not necessary to manage	1
	- For pollinating insects	2
	- For wild fauna/flora	2
	- No space/garden	Excluded
Presence of a bird nest box?	- It would need cleaning	1
	- Birds bore me	1
	- I do not see the use of nest boxes	1
	- I believe that nest boxes are not	1
	aesthetic	1
	- Birds nest elsewhere	1
	- I like observing birds	1
	- I believe that nest boxes are pretty	
	- To avoid hunting by pets	2
	- To offer a reproduction site for	2
	bird species	2
	- Birds are useful in my garden	
	- No space/garden	Excluded
Presence of compost?	- Afraid of the smell/insects	1
	- Disgust	1
	- I do not see the point	1
	- To recycle organic waste	2
	- To make compost for a garden	2
	- To reduce the quantity of domestic waste	2
	- No space/garden	Excluded
Purchase of organic food	- Difficult to find	1
	- Expensive	1
	- Uninteresting taste	1
	- Particular taste	1
	- No impact on health	1
	- Good for health	1
	- No impact on the environment	1
	- Good for the environment	2
Purchase of strawberries in winter	- I do not like strawberries	1
	- They are expensive	1
	- They have no taste	1
	- I love strawberries	1
	- It is fun to eat strawberries when nobody else is eating them	1
	- Winter is not their growing season	2

2.1.4. Individual characteristics

Finally, we collected the following personal information:

- Gender;

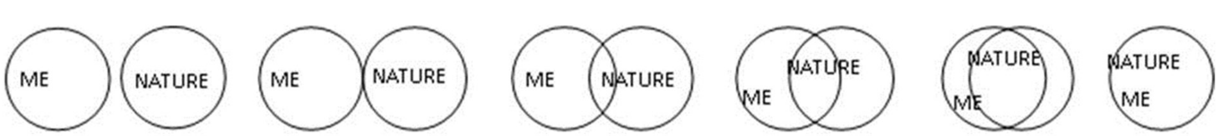

Fig. 1. Adapted version of the Inclusion of Nature in Self (INS) scale.

- Age (considered as quantitative variable);
- Socio-professional category: we asked the respondents to report their socio-professional category (SPC) based on the 10 official unranked categories published by the French National Statistics Office (INSEE, https://www.insee.fr/fr/information/2406153). We then classified the responses into three categories: high socio-professional status (SPC+), low socio-professional status (SPC−), and individuals without professional activity (i.e., students, unemployed and retired people).
- Urbanization of current habitat, as assessed by the respondents' perceptions based on a 4-level scale from rural to urban;
- Participation in one or more of the six experiences of nature we wanted to explore (see Table 1).

2.2. Classification of respondents according to their experiences of nature

We considered six different formal opportunities for experiencing nature in everyday life: being a member of a nature watch group, being involved in a nature citizen science program, being a member of an environmental association, growing an allotment, participating in a community garden and supporting Community-Supported Agriculture.

Whatever the context in which the questionnaire was completed, the respondents were asked to say whether they were involved in one or more of these six experiences of nature. According to her/his answers, each respondent was eventually affiliated to one of the six experiences. However, because of multiple answers, we defined two more groups: member of both a nature watch group and an environmental association, and member of both a community garden and a Community-Supported Agriculture group. People who declared they engaged in none of the six nature experiences were assigned to the "control group".

In parallel, we classified these six nature experiences into two categories, according to whether they involve explicit or implicit attention to biodiversity (Table 1). Some were grouped into the same category (i.e., with explicit or implicit attention to biodiversity) even though we were aware of their differences: for instance, nature watch activities may involve a higher level of attention to biodiversity than participation in a citizen science program. However, both involve explicit attention to biodiversity, compared to allotment gardening, where attention to biodiversity is not the main goal of the activity (e.g., Church et al., 2015).

In the end, respondents were thus assigned to one of three categories: experience of nature with explicit attention to biodiversity (*explicit*), experience of nature with implicit attention to biodiversity (*implicit*), and control group (*control*).

2.3. Statistical analysis

We performed all of the statistical analyses in R.3.0.1 (R-Development-Core-Team, 2010). All the quantitative variables were first standardized.

To verify our first hypothesis, i.e. experiences of nature and knowledge about biodiversity are closely correlated, we used a linear model with mean level of knowledge about biodiversity as the response variable, and individual characteristics (i.e., gender, age, socio-professional category, urbanization of current habitat) and assignment to the three categories of experiences of nature (i.e. *control*, *explicit*, *implicit*) as explanatory variables.

To test our second hypothesis, i.e. connectedness with nature is positively correlated with experiences of nature, we used ordinal modelling because the response variable (connectedness with nature) was assessed through a 6-level scale (see above). Again, explanatory variables were individual characteristics and the three categories of experiences of nature. We used the package "ordinal" in R.

Our third hypothesis was that individual pro-biodiversity practices are interrelated with experiences of nature, knowledge about biodiversity and connectedness with nature. We modelled the involvement in each of the six individual conservation practices separately, based on the low reliability of individual scores for the 6 conservation practices (Cronbach alpha = 0.4). We considered the individual scores for each conservation practice as ordinal variables, and thus used ordinal modelling. We tested the effects of individual characteristics, knowledge about biodiversity, connectedness with nature and the three categories of experiences of nature on the score of each conservation practice separately.

Before conducting the analyses, we checked for non-collinearity of the explaining variables: the correlations between quantitative variables (Age, urbanization level of the current habitat, knowledge and connectedness with nature) were between 0.05 and 0.21, making the collinearity low enough to include these variables together in the same model. The variance inflation factors between the qualitative variables (method of administration of the questionnaire, gender, socio-professional category and type of experience of nature) were all below 2 (corvif function, Zuur et al., 2007), which allowed us to include all of them in the same model.

For all the analyses, we used a step-based model selection based on AIC. In all the models, the method of administration of the questionnaire was included as an explanatory factor. We assessed the explanatory power of each selected model by computing Mac Fadden's pseudo R^2 (Smith and McKenna, 2013). We analyzed the respective effects of each variable with Type II Anova (library "car" in R), which assesses the effect of each variable by taking all the other ones into account.

3. Results

3.1. Descriptive results

Among the 473 respondents, 258 (54.5%) were women and 215 were men. They were between 18 and 85 years old (mean age: 45). One hundred thirty two people declared a low socio-professional category, 181 people declared a high one and 160 people declared another one. Based on the distributions of gender, age and socio-professional categories, our sample did not differ from the adult population living in the Paris region.

In our sample, 87.5% people lived in urban and moderately urbanized areas (n = 297 and n = 117 respectively), although 45 and 14 people described living in moderately rural and rural areas respectively. This distribution is consistent with the study area (close to Paris, France).

3.2. Knowledge about biodiversity is positively correlated with involvement in experiences with explicit attention to biodiversity (hyp. a)

3.2.1. Preliminary results

We did not find any significant difference in knowledge between men and women ($p = 0.5$). However, individuals living in more urbanized areas had more knowledge than people living in less urbanized areas ($p = 0.031$); older people had less knowledge than younger people ($p = 0.02$); and people from different socio-professional categories differed in their knowledge ($p < 10^{-5}$). More specifically, people from higher socio-professional categories knew more about biodiversity than those in the two other categories (SPC+ vs control: $p = 0.002$; SPC− vs control: $p = 0.1$, Table 3).

3.2.2. Test of the hypothesis a

Taking these previous variables into account, the level of knowledge about biodiversity was strongly correlated with the type of experience of nature ($p < 10^{-6}$; Fig. 2). More specifically, individuals involved in experiences of nature with implicit attention to biodiversity did not significantly differ in their knowledge about biodiversity from people in the control group ($p = 0.5$). However, people involved in nature experiences with explicit attention to biodiversity have significantly

Table 3
Summary of results for the correlation models. Dependent variables were knowledge about biodiversity, connectedness with nature and each of six pro-biodiversity practices. Individual practices are listed from those best explained by our variables to those not well explained (all quantitative variables have been scaled). The beta coefficient and standard errors of significant variables are presented, together with the *p*-value of the associated *t*-test. For factorial variables, control variables were respectively women for gender; others for Socio-professional categories (SPC); control for nature experiences. Cells in grey represent untested variables.

	Knowledge	Connectedness with nature	Compost	Organic food	Vote	Wild-flower patch	Seasonal food	Nest-box
No respondents	473	472	260	471	469	256	471	310
McFadden's pseudo R^2	0.12	0.04	0.11	0.07	0.07	0.04	0.03	0.02
Gender (men)	–	0.50 + −0.09 (p = 0.003)	–	–	–	–	−0.70 + −0.21 (p = 0.001)	0.55 + −0.21 (p = 0.008)
SPC+	0.31 + −0.10 (p = 0.002)	–	–	0.58 + −0.22 (p = 0.009)	–	–	–	–
SPC−	–	–	–	0.47 + −0.23 (p = 0.04)	–	−0.73 + −0.28 (p = 0.009)	–	–
Urbanization of current habitat	0.10 + −0.05 (p = 0.03)	–	−0.61 + −0.19 (p = 0.001)	–	–	–	–	–
Age	−0.12 + −0.05 (p = 0.02)	–	0.39 + −0.17 (p = 0.02)	−0.28 + −0.11 (p = 0.009)	−0.33 + −0.10 (p = 0.0006)	–	–	0.32 + −0.11 (p = 0.004)
Knowledge about biodiversity			–	0.57 + −0.09 ($p < 10^{-5}$)	0.64 + −0.10 ($p = 3.10^{-10}$)	0.59 + −0.14 ($p = 4.10^{-5}$)	0.30 + −0.12 (p = 0.01)	–
Connectedness with nature			0.43 + −0.15 (p = 0.005)	0/18 + −0.09 (p = 0.05)	0.20 + −0.09 (p = 0.02)	–	–	0.34 + −0.11 (p = 0.002)
Nature exp. with implicit attention	–	1.10 + −0.121 ($p < 10^{-5}$)	1.80 + −0.47 (p = 0.0001)	1.86 + −0.25 ($p < 10^{-10}$)	1.13 + −0.24 ($p < 10^{-5}$)	1.04 + −0.36 (p = 0.004)	0.72 + −0.27 (p = 0.007)	–
Nature exp. with explicit attention	0.74 + −0.11 ($p < 10^{-10}$)	1.57 + −0.23 ($p < 10^{-10}$)	–	0.70 + −0.25 (p = 0.005)	0.61 + −0.25 (p = 0.01)	0.85 + −0.37 (p = 0.02)	0.53 + −0.29 (p = 0.07)	–

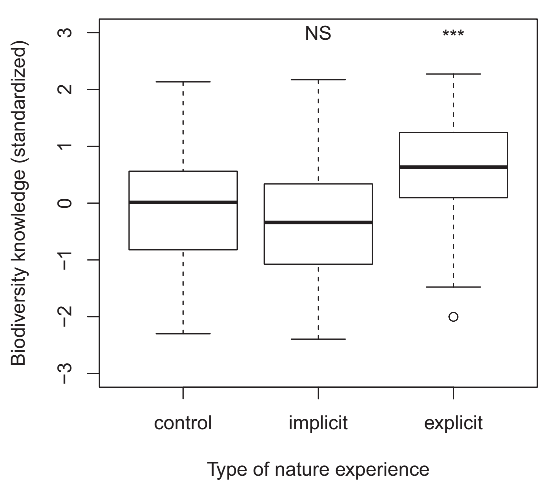

Fig. 2. Knowledge about biodiversity according to the type of nature experiences. The degree of significance is provided compared to the control group. NS: Non significant - ***$p < 10^{-5}$.

greater knowledge about biodiversity than people in the control group ($p < 10^{-5}$).

3.3. Individual connectedness with nature is stronger for people engaging in any kind of experience of nature (hyp. b)

3.3.1. Preliminary results

We did not find any significant correlation between people's connectedness with nature and their age ($p = 0.7$) or their socio-professional category ($p = 0.2$). In addition, individuals living in more or less urbanized areas did not differ in their connectedness with nature ($p = 0.4$). However, men showed a stronger connectedness with nature than women ($p = 0.003$).

3.3.2. Test of the hypothesis b

Taking these previous variables into account, individuals engaging in experiences of nature expressed a significantly stronger connectedness with nature than individuals from the control group, for both types of attention toward biodiversity ($p < 10^{-10}$, Table 3). Connectedness with nature was even stronger for individuals involved in experiences of nature with explicit attention to biodiversity (Fig. 3).

3.4. Individual conservation practices are closely linked to knowledge and experiences of nature (hyp. c)

Because all respondents did not record all practices (especially those that required having a garden), the number of data differed for each of

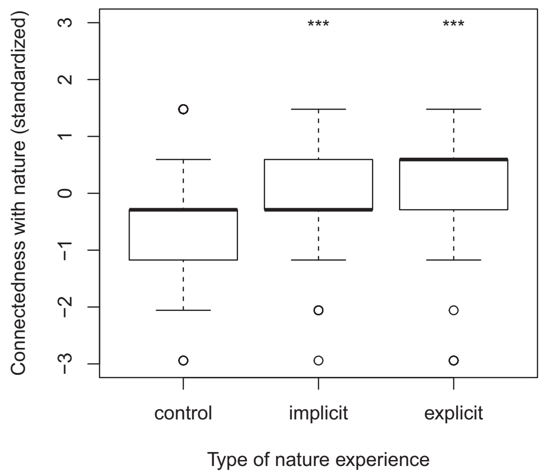

Fig. 3. Connectedness with nature according to the type of nature experiences. The degree of significance is provided compared to the control group. ***$p < 10^{-5}$.

the six studies activities (see Table 3). For greater clarity, we present a summary of results according to the explanatory variables.

3.4.1. Preliminary results

We found no significant effect of gender on individual practices, except for nest boxes ($p = 0.009$) and seasonal product consumption ($p = 0.0009$). Similarly, we found no significant effect of age on maintaining wild-flower patches in gardens ($p = 0.8$), having nest-boxes ($p = 0.09$) or on consuming seasonal products ($p = 0.6$). However, composting increased significantly with age ($p = 0.02$). Consuming organic food and voting for biodiversity-related reasons decreased significantly with age ($p = 0.02$ and $p = 0.004$ respectively).

Four out of the six individual practices analyzed did not differ significantly among socio-professional categories (voting, composting, having nest boxes and consuming seasonal products). However, people who work (from both SPC+ and SPC−) purchased significantly more organic food than those who were unemployed ($p = 0.02$). Maintaining wild-flower patches also differed significantly among socio-professional categories ($p = 0.02$).

The degree of urbanization of people's habitat did not influence any of the six individual practices studied except composting ($p < 10^{-3}$): individuals living in more urbanized habitats produced less composting than the others.

3.4.2. People with more knowledge about biodiversity implement more four out of six pro-biodiversity practices

Knowledge about biodiversity was very positively correlated with four individual practices studied (Table 3): organic food consumption ($p < 10^{-5}$), voting ($p < 10^{-5}$), maintaining a wild-flower patch ($p < 10^{-3}$), and consuming seasonal products ($p = 0.02$). We did not find any significant correlation between knowledge about biodiversity and the last two individual practices: composting ($p = 0.8$) and nest-boxes ($p = 0.2$).

3.4.3. People more connected with nature implement more four out of six pro-biodiversity practices

We found positive correlations between connectedness with nature and organic food consumption ($p = 0.03$), voting with biodiversity-related reasons ($p = 0.02$), composting ($p = 0.007$) and having nest boxes ($p = 0.03$,). Purchasing seasonal products and maintaining wild-flower patches did not differ significantly with individual connectedness with nature ($p = 0.9$ and $p = 0.3$ respectively).

3.4.4. People engaged in experiences of nature implement all pro-biodiversity practices but one

Except for nest boxes ($p = 0.5$), all the individual practices studied differed significantly between individuals engaging in the three categories of experiences of nature (Table 3): individuals engaging in nature experiences implemented more pro-biodiversity practices than individuals who did not. More surprisingly, people engaging in experiences of nature where attention to biodiversity is *implicit* (i.e., allotments, community gardens, community supported agriculture) seemed to implement significantly more pro-biodiversity practices than those whose experiences of nature with *explicit* attention to biodiversity (i.e. citizen science, nature watch and environmental associations).

4. Discussion

In this study, we explored interrelations between different types of everyday experiences of nature and knowledge about biodiversity, connectedness with nature, and specific pro-biodiversity practices. We discuss here how our three working hypotheses were confirmed or not.

4.1. Only experiences of nature with explicit attention to biodiversity are positively correlated with knowledge about biodiversity (hyp. a)

Our results showed that declarative knowledge about biodiversity and about conservation issues significantly decreased with the age of the respondents but increased with the urbanization level of their current habitat, and that it was higher for people from a higher socio-professional category. The decreasing effect of age could be due to our sampling design, which could have favored students in ecology or conservation sciences among young respondents. The higher knowledge for urban and from high socio-professional category was expected, because the level of education is positively related to peoples' knowledge (European Commission, 2013; Gifford and Nilsson, 2014), and because people are on average more educated in urban areas.

However, our results highlighted a difference in individuals' knowledge about biodiversity according to the types of experiences of nature in which they are involved: people involved in experiences of nature know more about biodiversity and conservation only if these experiences of nature are explicitly devoted to biodiversity (i.e. citizen-science, nature watch and environmental NGOs). This result expands previous studies on citizen science programs, that showed that volunteers in such programs may increase their knowledge about biodiversity (Bonney et al., 2009; Brossard et al., 2005). However the fact that these experiences provide more knowledge about biodiversity than others, even after having taken education-based individual variables into account, suggests that these experiences of nature with explicit attention to biodiversity are specific components of socio-ecological contexts that help the volunteers to gather information and knowledge about biodiversity. Indeed, volunteers are in interactions with biodiversity, but also with the social group they interact with. They are therefore engaged in so-called "situated learning" dynamics (Lave, 1991), where knowledge about biodiversity is closely related to the social experiences in which it is delivered. These groups also provide repeated opportunities to experience nature, and learning there becomes a contextualized, socially constructed and continuous activity; all these features have been shown to be effective part of any knowledge acquisition (e.g., Barab and Roth, 2006).

4.2. Both types of experiences of nature gather people that are connected with nature (hyp. b)

Our results showed that the connectedness to nature did not differ between respondents living in differently urbanized habitats, nor between respondents from different socio-professional categories. However, it was significantly higher for people having grown up in more rural habitats. This result confirms that connectedness with nature is mostly built during childhood (Chawla and Derr, 2012).

The fact that people engaged in experiences of nature were more connected with nature than people that are not engaged, could be due to the fact that individuals who have constructed a high personal connectedness with nature during their childhood are more prone to engage in experiences of nature in their adult daily routines. However, several recent studies showed that people engaged in such initiatives (e.g. community gardening) were not all previously connected with nature (e.g., Torres et al., 2017). Yet, experiencing nature in daily routines such as allotments or community gardens has been repeatedly shown to foster environmental attitudes and commitment (Bendt et al., 2013; Krasny and Tidball, 2012; Torres et al., 2017). With our study, we confirm therefore the evidence that these collective initiatives may foster pro-environmental commitment; moreover, we add the information that specific pro-biodiversity practices are encouraged.

4.3. People involved in experiences of nature are more prone to implement pro-biodiversity practices (hyp. c)

Our results showed that implementation of pro-biodiversity practices sometimes depends on individual characteristics that are not directly linked with nature: for instance, urban people make compost less often than others; working people purchase more organic food than people not working; people from lower socio-professional categories have fewer wild-flower patches in their gardens than the others; older people purchase less organic food and perform less their votes in relation to ecology than younger people, but they have more nest boxes and they compost more. Referring to the theory of planned behavior, individual behaviors are implemented not only if they are intentional, but also if the context is favorable (Ajzen and Dasgupta, 2015). For instance, people living in large cities may be more prone to have smaller gardens and thus fewer possibilities to produce compost than people living in less urbanized areas. Ajzen and Dasgupta (2015) also highlighted the importance of unconscious activation of beliefs, for instance through social desirability. This can explain partly the intentions to vote of older people in our study.

Yet, all these variables being taken into account, our results confirmed our last hypothesis: people with more knowledge about biodiversity, with a higher level of connectedness with nature, and with higher involvement in everyday experiences of nature, do implement more pro-biodiversity practices in general than the others. This confirms the importance of knowledge and connectedness with nature in pro-environmental behaviors (Chawla, 1998; Gifford and Nilsson, 2014). However, we showed that personal experiences of nature in everyday life are also of prime importance to personal commitment to biodiversity conservation, whether these experiences are explicitly devoted to biodiversity or not. This result is consistent with previous studies, that link for instance urban gardening, stewardship and pro-biodiversity practices in private gardens (Mumaw, 2017).

In these experiences, people are in physical and immersive contact with nature. These "hands on" experiences have been shown to influence cognitive processes (e.g., Duerden and Witt, 2010), and act complementarily with more formal education (Saugstad, 2013). Besides procedural knowledge, Kaiser and Fuhrer (2003) added three more types of knowledge: procedural knowledge, when people learn how to implement a particular technique (e.g. how to compost in a community garden); effectiveness knowledge, when people learn about the consequences of their behavior in conservation (e.g., wild-flowering and insect conservation); and social knowledge, when people learn what is socially (within their community) or morally accurate and acceptable. Moreover, these experiences of nature display some characteristics of informal learning (e.g., Marsick and Watkins, 2001), such as being part of a daily routine, being not devoted to highly conscious learning about biodiversity, and being pursued socially. In addition, these experiences are freely chosen but nevertheless constraining. For example, being a member of a community-supported agriculture group requires financial advances, a limited choice of vegetables, and a limited time in which to pick up the box; growing vegetables in an allotment requires regular care for the garden. According to the commitment theory (Kiesler, 1971), participating in these experiences may produce a sense of commitment toward nature (and conservation).

4.4. Limits of the study

The main limitation of this study is based on the methodology, which required self-reports, which can always be biased because of social desirability. However, whatever the reality of what people do, what people say they do is already informative about the level of individual concern toward biodiversity. In addition, we assessed only statistical correlations, and causal effects are only interpretations of our results. However, we computed our questionnaire following a classical hypothetico-deductive methodology, and adequately selected the variables included in our models. Finally, our statistical models explained a relatively low proportion of the total variance of the data. However, note that the value of the McFadden pseudo-R^2 is always much lower than the common ordinary least-square regression (OLS) R^2 (Smith and McKenna, 2013); indeed, in our linear model explaining knowledge, the McFannel pseudo-R^2 was equal to 0.12, compared to OLS $R^2 = 0.29$. Moreover, we are aware that we are trying to detect very small effects, and that individual human behaviors will never be fully explained by a limited numbers of factors. We consider therefore that the explanatory powers of our statistical models were acceptable.

5. Conclusion

With this original study on pro-biodiversity commitment, we confirmed the close interrelation between routine experiences of nature and pro-environmental behaviors. However, we added several novel specificities concerning biodiversity conservation. First, contrary to most studies on pro-environmental behaviors, we specified six individual practices, five of which were shown to be positive for biodiversity, according to conservation experts. More, we valued individuals' willingness to protect biodiversity when implementing these behaviors. We therefore provide results that are directly of interest for conservationists. Secondly, to our knowledge, we provide for the first time a comparison between experiences of nature explicitly and implicitly devoted to biodiversity, in the biodiversity commitment: we showed that biodiversity-focused experiences are connected with increased theoretical knowledge about biodiversity; but we also showed that all kinds of experiences of nature are connected with the implementation of pro-biodiversity practices. These results can help conservationists to define their education designs according to their objectives. In particular, encouraging nature practices such as gardening, even without any biodiversity-related education, can have positive consequences for biodiversity. Finally, our results strongly suggest that experiences of nature in the life-routines, even during adulthood, can help implementation of pro-biodiversity practices. Providing nature experiences dedicated to adults could therefore become a worthwhile direction in conservation education programs.

With this study, we highlighted the strength of interdisciplinary studies linking conservation biology and conservation psychology, to give some concrete recommendations to address the growing disconnection of urban dwellers from the natural world: we strongly recommend encouraging opportunities and possibilities for people to freely commit to daily experiences of nature, especially in urban contexts; by designing more natural landscape and green infrastructures, but also by encouraging more hands-on experiences in environmental awareness-raising projects.

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