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Exposure to nature through an urban natural monument

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ABSTRACT

Society is experiencing a decrease in opportunities to connect with nature, a problem that is particularly acute during childhood. Numerous studies indicate that increasing the frequency of participation in nature-related activities in urban environments, through elements such as interpretive trails and sensory trails, improves important variables such as connection with nature (NC) and biodiversity awareness. Therefore, the objective of this study is to determine whether it is possible to foster NC and improve biodiversity awareness in children through a sensory trail in a natural urban environment. This study is part of a project carried out by an educational association that operates in three schools in the city in collaboration with the University of Córdoba, Spain. Therefore, the student population was determined by the association itself, with a total of 111 students aged 10 to 12 (48% female, 52% male). The study consisted of pre-post analyses, and the instruments used were the Cheng and Monroe NC scale and questions to determine children's knowledge of environmental biodiversity. Data analysis included descriptive statistics to determine correctly identified biodiversity, correlation analysis between variables, and nonparametric tests to determine significant differences. The results reveal a relationship, before completing the route, between NC and nature awareness, and that the intervention had a positive impact on all variables. It is concluded that sensory routes in urban green spaces are an excellent educational resource for fostering NC in children, and their knowledge about biodiversity.

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1. INTRODUCTION

Experiences involving contact with nature in everyday environments impact people's environmental awareness but are less and less common due to the urbanization of cities and people's disconnection with the natural world [1]. Pyle [2] termed this phenomenon, by which human beings are progressively less likely to come into contact with the natural environment, the "extinction of experience", with this having negative effects on those of all ages. Specifically, this phenomenon degrades people's health and well-being and reduces their environmental awareness [3], [4]. The extinction of experience is also related to a visual bias known as plant blindness, according to which people, despite having more contact with the plant world than with the animal world, do not perceive plants as living beings [5], which, in turn, results in disinterest in vegetation and natural areas.

This reality means that children develop in environments where access to nature is waning, giving them fewer opportunities for contact with it [6]. Since numerous studies indicate that direct contact with the natural environment during childhood and adolescence has positive effects in relation to the conservation of

biodiversity, depending on the way the interaction occurs [7], it is beneficial to take advantage of opportunities for experiences in green environments that are easily accessible, such as urban nature areas [8] and protected natural spaces [3], in ways that help bolster people's connection with and knowledge of nature. Thus, the educational intervention evaluated in this study is a sensory route based on environmental interpretation trails on which participants are guided, interpreting natural elements and resources while upholding environmental and cultural respect for the area [9]. In this case, the trail runs through an important enclave in the city of Cordoba: the Sotos de la Albolafia wetland, declared a Natural Monument in 2001. This area is located right in the city, in a space regularly frequented by a large part of the population. It is also important to highlight the social component of the intervention, forming part of one of the phases of a project being carried out by the city of Cordoba's Andalusian Association for Solidarity and Peace (ASPA: Asociación Andaluza por la Solidaridad y la Paz) with support from the El Brote environmental education association.

This research is important and innovative in terms of improving primary school students' contact with nature in an urban natural space for several reasons. First, it is a sensory itinerary where knowledge of biodiversity is not an essential requirement, so it can be carried out by education professionals without extensive knowledge of biodiversity. Second, the designed activities can be replicated in other natural contexts, adapting them to the specific landscape where they are carried out. Third and finally, students learn about biodiversity through experience, which facilitates learning. All of this helps students connect with nature through their sensory knowledge, fostering an appreciation for natural urban spaces.

2. THE COMPREHENSIVE THEORETICAL BASIS

Environmental awareness tends to oscillate during each phase of development, increasing during childhood, decreasing in adolescence and youth, and then rising in adulthood, also leading to more thorough knowledge of environmental issues [10]. This highlight the importance of addressing educational needs in terms of contact with nature at each different stage, especially during childhood, as this is when the first interactions occur. Specifically, during the second stage of development, between the ages of 6 and 12, young people undergo rapid intellectual growth related to symbolic, aesthetic, humanistic and scientific values, favored by inquiry and exploration through experiences in contact with nature, with these having benefits in the following developmental phases [11]. In fact, Zelenski and Desrochers [12] observed that there is a relationship between experiences in nature during childhood and positive effects in adulthood, later verified in research by Chawla [13] and Barrable *et al.* [14], yielding a greater tendency to adopt pro-environmental behaviors and attitudes. In addition, a wide range of studies and experiences among education professionals demonstrate the advantages of promoting contact with nature during childhood, with future repercussions including enhanced personal well-being [15] and improved health thanks to the biophysical ecosystem services it provides [8]. However, it is necessary to emphasize that these advantages do not arise in all cases, as some children experience negative feelings when coming into contact with nature, such that this exposure can, at times, be counterproductive to the promotion of pro-environmental behaviors [16], [17].

Many empirical studies, however, present positive results from connection-with-nature experiences [13], [18], with the incorporation of environmental education into formal education being key [19]. In these interventions, it is important to highlight emotional education to generate and reinforce affective bonds with the natural environment [16], as people care about what they feel an emotional connection with [20]. In addition, according to Carmi *et al.* [21], environmental emotions strengthen the relationship between knowledge and environmental behavior, with childhood being an essential stage to forge emotional connections with nature [13]. Put another way, spending time in nature fosters an emotional connection to it and, in turn, improves nature conservation-related attitudes and behaviors [18]. In this regard, sensory contact arouses emotions entailing natural conservation [22].

Despite the weak connection between environmental knowledge and pro-environmental behavior [23], [24], there is a certain tendency to consider the cognitive dimension when proposing interventions to favor contact with nature, which can have beneficial results depending on the type of experience produced. In the study by Profice *et al.* [7] featuring an interpretive path in Brazil, the educational intervention resulted in an increase in knowledge. Similar results were found in a 12-month study of 2,593 schoolchildren ages 7 to 10 in Barcelona (Spain) by Dadvand *et al.* [25], with a beneficial association being found between exposure to green spaces and cognitive development. Similarly, among 56 participants ages 8 to 17 in the study by Grenno *et al.* [11], subjects identified botanical and animal elements to a greater extent than human ones. Profice *et al.* [7] discovered that, after exposure to a nearby interpretive path in a natural environment, students ages 13 to 17 in Brazil provided more content-specific responses about the ecosystem visited.

The increases in knowledge produced by these studies are striking, since Ballouard *et al*. [26] found that children from countries around the world (Nepal, Italy, Turkey, France, Morocco, and Spain) had limited

knowledge of biodiversity, due, in part, to their disconnection from nature and the amount of time they spend inside using digital devices. The authors argue that this data stems from the scant time dedicated to direct observation of nature and the decrease in nature experiences among schoolchildren, which concurs with the study by Hughes *et al.* [27] in which children in England presented limited knowledge of nature and connection with it. This occurs especially in children living in urban areas [28]. Similar results can also be found in primary school students in Andalusia (Spain), coinciding with the context in which this study is carried out [29]. In contrast, when plant biodiversity is more present, study by Amprazis *et al.* [30] show that schoolchildren in daily contact with plants in their nearby environment have knowledge of local vegetation.

In any case, both boys and girls have an innate interest in exploring everything around them and prefer to spend more time outdoors and in contact with nature than indoors [13], which makes it easier for them to establish contact with the natural environment, improving their connections with nature and increasing their knowledge of biodiversity [31]. Studies discovered the effect of excursions into natural environments among schoolchildren ages 9 to 14, with the youngest being those who exhibited more connection with nature both before and after participating in the activities [32]. After a 2-hour tour of the local heathlands of Flanders, 484 students (ages 10-12) improved their connection with nature [33]. According to Otto and Pensini [23], in their study of 358 students, 4th to 6th graders, in Berlin, connection with nature can make people show more interest in learning about the natural environment. This is observed in the study by Barrable *et al.* [14], in which the feelings and emotions elicited during a visit to a protected area enhanced the learning of scholastic content related to nature. This is why nature experiences are so important for schoolchildren; according to Kuo *et al*. [18], nature must be an essential educational resource, since it increases, improves, and enhances academic learning and personal development, generating skills key in the century in which we live.

It is worth mentioning that for decades there have been studies indicating that women have a greater tendency towards pro-environmental attitudes and behaviors. Zelezny *et al.* [34] conducted a review of research conducted between 1988 and 1998, concluding that, among the reasons why females are more pro-environmental is due to their high levels of socialization, which makes them more responsible and empathetic towards other people. In some studies, the environmental gender gap indicates that women have greater environmental awareness, risk perception, and concern about the environment [35]. However, according to the systematic review by Chawla [13], various studies present inconsistent results as concerns gender differences and connection with nature among children.

The extensive literature and existing experimental studies reveal that, although experiences in contact with nature are more effective if carried out more frequently, short-term interventions are also positive [19]. Similarly, as concluded in the study by DeVille *et al.* [36], implementing certain activities that promote contact and interaction with nature, such as trails, improve results related to science and knowledge of nature, especially among children. On these trails, active sensory activities can be held to help participants understand, identify, and appreciate various natural elements. Incorporating wildlife observation, listening and photography are predictors of connection with nature [22]. Other elements that increase connection with nature are exploration, multi-sensory immersion; the promotion of interest in, empathy with and respect for living beings and natural elements by adults present at the time; and a feeling of tranquility and calm, among other elements [13]. The combination of increased frequency and the promotion of positive and sensory experiences in contact with nature, which decreases the extinction of this experience and increases opportunities for contact, can be facilitated by urban planning that includes green infrastructure and natural elements in local contexts, as well as increasing the quality of existing natural spaces in the urban environment [37], [38]. Therefore, the aim of this study is to determine whether it is possible to foster connections with nature and improve knowledge of biodiversity among primary school children through a sensory route in a natural urban environment. Thus, the research questions of the study are:

i) Is there a relationship between connection with nature and knowledge of biodiversity?
ii) Does completing a route in an urban natural environment increase one's connection with nature?
iii) Does completing a route in a natural urban environment increase one's knowledge of biodiversity?

3. METHOD

3.1. Participants

The number of participants and their characteristics are determined by the ASPA association, as this intervention is part of an educational project developed throughout the 2023-2024 academic year. For that purpose, the sample size is of sufficient size for the statistical tests addressed [39]. The total sample was comprised of 111 students, 53 female and 58 male, a population between the ages of 10 and 12 attending the 4th, 5th, and 6th grades (primary education) at three Early Childhood and Primary Education schools in Cordoba, distributed in the northern and southeastern districts of the city, which are inhabited by lower- and middle-class residents, a large number of whom are immigrants.

3.2. Educational intervention

The sensory route through the Los Sotos de la Albolafia natural monument in the city of Cordoba, Spain runs through a fluvial ecosystem. The itinerary consisted of five stops on a 1-hour and 30-minute tour given to groups of 15 to 18 students in which knowledge of the environment was promoted through all the senses. At each stop, the common name of certain species was indicated, not the scientific one. In the visual sphere, students were asked to identify some mammals, such as the domestic cat (*Felis silvestris catus*), the otter (*Lutra lutra*), and birds like the common kingfisher (*Alcedo atthis*), the grey heron (*Ardea cinerea*) and the black-crowned night heron (*Nycticorax nycticorax*). During the olfactory stop the students were blindfolded and asked to try to identify some aromatic plants, such as rosemary (*Salvia rosmarinus*) and thyme (*Thymus vulgaris*). The tactile part consisted of touching the leaves, trunks and branches of some trees typical of the riverside forest, such as the weeping willow (*Salix babylonica*). In the taste section, some adventitious plants previously used in cooking, today considered "weeds", were discussed, such as mallow (*Malva sylvestris*). Some toxic plants were also mentioned, and the students were cautioned not to collect mushrooms and fungi unless they are able to correctly identify them. Finally, the auditory stop is in a more immersive area of the riverside forest, surrounded mainly by poplars, where the students must identify three birds common in the area by their sounds, emitted through a portable speaker.

3.3. Measuring instruments

A questionnaire was designed to be completed on paper and consisting of the following parts and instruments. Here are the following questions to detect the students' knowledge of Sotos de la Albolafia's biodiversity:

- Name some of the birds that can be seen by the river.
- Write the names of some of the plants found by the river.
- Name some mammals that can be seen in or near the river.

Finally, the Spanish version of Cheng and Monroe's Connection to Nature Index (CNI) questionnaire [40]. The Cheng and Monroe's CNI was evaluated in Florida (United States) and it was used in many contexts in Europe as in Berlin [23] or United Kingdom [41] and also in the same language [42]. These countries are very similar in culture and context to Córdoba. The questionnaire consists of 16 items and four dimensions: enjoying nature (EN), empathy for creatures (EC), sense of identity (SI), and sense of responsibility (SR). Responses were measured on a 5-point Likert scale according to degree of agreement where 5 is "strongly agree", 4 is "agree", 3 is "neither agree nor disagree", 2 is "disagree," and 1 is "strongly disagree". Thus, answers closer to 5 indicated stronger connections with nature, while scores closer to 1 represented weaker ones. The reliability of the scale is high, with an excellent Cronbach's alpha value (α=0.9).

3.4. Data collection

The data collection took place at two different times, as it was a pre-post study. First, days before walking the route, the questionnaire was distributed during school hours to 111 students by the organization sponsoring the intervention (ASPA). Second, post-route data were collected after the walk on the same day by the educators responsible for the intervention (the same 111 students).

3.5. Ethical issues

Informed consent was solicited at three points in time. First, this was done through an informative letter on the project of which it forms part and the purpose of the study, sent to the schools' administrations. The second way was through an informative letter available to the families through the schools' educational platforms, informing them of their ability to object to their students' participation in the study. The third was the holding of a meeting for families at which the ASPA association explained the project and the purpose of the study, as well as providing detailed description of the letter supplied by the school, and reminding the parents, again, of their right to bar their children from participating in the study. Both in the pre and post phases of the data collection, the initials of the participants (name and surnames) and day and year of birth were requested. In this way, anonymity was guaranteed, since the data analysis was carried out by a person outside the school who did not know the identities of the participating population.

3.6. Data analysis

First, with respect to the biodiversity-related items, the total number of species indicated by the students (plants, birds, mammals), the total number of species correctly cited by them (i.e., those that inhabit the river marked 'OK'), and the total number of specific species they identified (the specific names of the mammals, indicated with SP as species, and not general references like grass, flowers, plants) were recorded. Total biodiversity was also recorded, this being the total sum of plants, birds, and mammals, indicated as Bio. For the data analysis, three types of tests were carried out: the description of the results, taking into account

the mean and the standard deviation, the correlations between the CNI scale and its dimensions with each item on biodiversity; and non-parametric tests to determine the significant differences, for which non-parametric tests were carried out, since the normality and homoscedasticity criteria were not met.

4. RESULTS

The mean (M) and standard deviation (SD) of each item before (Pre) and after (Post) the educational intervention offers a general idea of the results obtained, as shown in Table 1. In addition, Table 2 shows the correlation between the connection with nature index and its four dimensions: EN, EC, SI, and SR with each biodiversity item before the route. The Mann-Whitney U test reveals significant differences before and after the intervention in terms of the plants, birds, mammals, and elements of the river identified by the students, and on the CNI index and its four dimensions ($p<0.05$), as seen in Table 3. These values indicate a greater range after the completion of the route, except for the elements of the river.

Table 1. Descriptive statistics (mean and standard deviation) before (pre) and after the intervention (post)

Items	Type of answer	Pre		Post	
		M	SD	M	SD
Plants	Nº total	1.66	0.90	2.31	1.19
	OK	1.32	0.85	2.09	1.04
	SP	0.25	0.48	1.86	1.26
Birds	Nº total	2.20	1.21	2.78	1.58
	OK	1.99	1.19	2.76	1.58
	ESP	0.93	0.94	2.10	1.66
Mammals	OK	0.91	0.83	1.20	0.71
Bio	Nº total	3.73	2.30	5.45	3.01
	OK	2.99	1.97	5.09	2.87
Scale	DN	3.43	1.28	4.25	0.78
	EC	3.49	1.24	4.30	0.68
	SI	3.65	1.33	4.44	0.58
	SR	3.38	0.79	4.46	0.68
	Total	3.54	1.11	4.44	0.50

Table 2. Analysis of bivariate correlations prior to the intervention

	Pre	DN	EC	SI	SR	CN Scale
Plants_ Total	Pearson correlation	0.022	0.000	-0.019	-0.043	-0.040
	Sig. (2-tailed)	0.877	0.998	0.894	0.759	0.775
	N	53	53	53	53	53
Plants_ OK	Pearson correlation	-0.121	-0.146	-0.128	-0.026	-0.167
	Sig. (2-tailed)	0.387	0.297	0.361	0.856	0.231
	N	53	53	53	53	53
Plants_ SP	Pearson correlation	0.124	0.114	0.000	0.114	0.043
	Sig. (2-tailed)	0.378	0.416	0.999	0.416	0.760
	N	53	53	53	53	53
Birds_ Total	Pearson correlation	0.102	0.143	0.070	-0.133	0.078
	Sig. (2-tailed)	0.348	0.186	0.522	0.220	0.476
	N	87	87	87	87	87
Birds_ OK	Pearson correlation	0.077	0.124	0.066	-0.143	0.055
	Sig. (2-tailed)	0.476	0.254	0.545	0.185	0.611
	N	87	87	87	87	87
Birds_ SP	Pearson correlation	0.208	.265	0.202	0.095	.237
	Sig. (2-tailed)	0.053	0.013*	0.060	0.380	0.027*
	N	87	87	87	87	87
Mammals_OK	Pearson correlation	0.138	0.179	0.130	0.058	0.155
	Sig. (2-tailed)	0.255	0.139	0.284	0.635	0.200
	N	70	70	70	70	70
Total	Pearson correlation	0.053	0.076	0.002	-0.110	0.038
	Sig. (2-tailed)	0.596	0.441	0.987	0.266	0.699
	N	104	104	104	104	104
Total_ OK	Pearson correlation	0.057	0.085	0.027	-0.065	0.049
	Sig. (2-tailed)	0.566	0.394	0.785	0.512	0.625
	N	103	103	103	103	103

*. The correlation is significant at the 0.05 level (2-tailed)

Table 3. Mann-Whitney U-test for the pre-post variable

Items	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig (2-tailed)	Mean rank Pre	Mean rank Post
Plants_total	1343.500	2774.500	-3.483	0.000	52.35	74.55
Plants_ok	1136.500	2567.500	-4.544	0.000	48.44	77.24
Plants_sp	539.000	1970.000	-7.462	0.000	37.17	85.00
Birds_total	3457.500	7285.500	-2.600	0.009	83.74	103.77
Birds_ok	3072.500	6900.500	-3.673	0.000	79.32	107.58
Birds_esp	2439.000	6267.000	-5.451	0.000	72.03	113.85
Mammals_ok	2192.500	4677.500	-2.984	0.003	66.82	85.58
Bio_Total	3574.000	9034.000	-4.434	0.000	86.87	123.78
Total_ok	2861.000	8217.000	-5.996	0.000	79.78	129.51
DN	3757.000	9973.000	-5.059	0.000	89.85	133.15
EC	3764.500	9980.500	-5.043	0.000	89.91	133.09
SI	4112.000	10328.000	-4.346	0.000	74.18	148.82
SR	2017.500	8233.500	-8.775	0.000	74.18	148.82
CN_total	2849.000	9065.000	-6.926	0.000	81.67	141.33

a. Grouping variable: PREPOST

The increase in the students' identification of the specific biodiversity present in the environment after the visit is notable. Initially appearing are plants such as the fir (*Abies alba*) and tulip (*Tulipa spp*), along with birds such as the hummingbirds (*Trochilidae*), and mammals such as the fox (*Vulpes vulpes*), which are not native to the area. Following the intervention, the students cited species present in the environment, such as rosemary (*Salvia rosmarinus*), the weeping willow (*Salix babylonica*), the black nightshade (*Solanum nigrum*); birds such as the common kingfisher (*Alcedo atthis*), the great spotted woodpecker (*Dendrocopos major*), and Eurasian scops owl (*Otus scops)*, as well as mammals such as otters (*Lutra lutra*).

5. DISCUSSION

The correlation analysis reveals that there is a relationship before completing the sensory route, such that the identification of specific birds is correlated with EC and the total CN scale, with those having greater knowledge of species having a higher CN index and scoring higher in the EC dimension. After the intervention this does not occur, since the values increase more homogeneously, as seen in Table 1 and 2. This may be related to the study of Otto and Pensini [23], in which an increase in connection with nature generates interest in knowledge of biodiversity. This increase is similar in study by Larson *et al.* [43], which children who presented high ecological awareness, or ecoaffinity, scores had higher levels of environmental knowledge than those averse to being in nature. These results accord with previous studies [33], [44] as connection with nature increases more among students whose levels were low before walking the trail.

The significant differences indicate that the route had a positive impact on the students' biodiversity knowledge, as well as on their awareness of birds, plants and mammals, in a general and specific way. Increases in the identification and knowledge of plants among schoolchildren after participating in activities in contact with nature have been found extensively in different studies, such as the aforementioned study by Otto and Pensini [23] with students from Berlin (Germany). In fact, study by Beute *et al.* [45] show an association between the richness of species in urban green spaces and a greater connection with nature.

There is also an increase in specific knowledge of birds after completing an interpretative trail, according to studies such as that by Profice *et al.* [7] and Grenno *et al.* [11], where vertebrates were the most represented creatures in drawings in a specific and correct way, as occurred in our intervention. In the work by Cameron *et al.* [37], a sense of well-being increases in those spaces featuring greater avian biodiversity. This makes sense, according to White *et al.* [1], as people feel better when observing and feeding birds near their natural environments and listening to their singing increases their connection with nature.

The CN values also present significant differences on both the scale, in general, and in each of its dimensions. In contrast to the study by Hughes *et al.* [27], the children in this study showed good levels of connection with nature before the intervention, but these improved greatly after it. Previous studies suggest health benefits and higher levels of ecoaffinity identity immediately after people are in contact with nature [7]. Other studies also reveal improved connection with nature after people participate in activities in nature, such as Vanhöfen *et al.* [46], which suggests an increase in the protection of animals and their habitats. In our study, a route was analyzed taking into account the sensory component. Thus, a positive experience in nature was favored, producing positive results, as in other interventions that incorporate this component [41]. In similar experiences, in which interpretative routes incorporating the affective dimension have been carried out [47], an emotional impact during the visit to a protected area was observed. The participants' experience

in the work by Cameron *et al.* [37] also falls along this line, since the places with the greatest biodiversity, both real (as is the case of the Sotos de la Albolafia, where our study was carried out) and perceived, present better CN-related results. It is important to mention that in this study the gender variable does not present significant differences as regards knowledge of biodiversity, as in the study by Profice *et al.* [7], nor in terms of connection with nature, despite the fact that numerous studies have found gender-based variations in responses, though mostly among participants of older ages [48], [49]. As indicated by Chawla [13], among children the gender variable presents inconsistent results.

The highlighted educational implications can be summarized in two main ideas: a greater number of experiences in contact with nature through urban biodiversity and the collaboration of the educational community with external stakeholders. First, this research demonstrates how field trips to urban natural environments are a valuable educational tool, as they foster interest and respect for biodiversity through the senses. Students explore and understand the environment emotionally, motivating them to understand biodiversity through simple and accessible language. Second, cooperation with projects by external stakeholders, such as an association and the University of Córdoba in this study, generates positive results in the educational process of primary school students. Both features promote the acquisition of key competences focused on basic skills for lifelong learning and everyday life, included in the Common European Framework of Reference for Key Competences [50], such as: competence in mathematics and science, technology, and engineering through descriptor 5, "participates in scientifically based actions to promote health and preserve the environment and living beings, applying principles of ethics and safety and practicing responsible consumption"; personal, social, and learning to learn competence through descriptor 1, "is aware of one's own emotions, ideas and personal behaviors and uses strategies to manage them in situations of tension or conflict, adapting to changes and harmonizing them to achieve their own objectives"; citizenship competence through descriptor 4, "understands the systemic relationships between human actions and the environment, and begins to adopt sustainable lifestyles, to contribute to the conservation of biodiversity from both a local and global perspective"; and, finally, the competence in cultural awareness and expression through descriptor 4, "creatively experiment with different media and supports, and various plastic, visual, audiovisual, sound, or body techniques, to develop artistic and cultural proposals."

To conclude the discussion of results, this type of activity facilitates the integration of theoretical curricular content through practice and experience, fostering the construction of scientific knowledge through observation and interpretation [29], [31]. This experience is a way to meet the demand of recent decades for reconnection with nature in childhood [42].

6. CONCLUSION

The results obtained answer the research questions posed in a satisfactory manner. Firstly, the significant differences show that the intervention had a positive effect, increasing knowledge of biodiversity (P.I.1) and connection with nature (P.I.2). Second, the correlation between the CN scale, the EC dimension, and knowledge of biodiversity before the intervention, indicates that connection with nature and empathy influence knowledge of birds in a specific way in children, which answers the third question (P.I.3). Ultimately, both the correlation analysis and the significant differences reveal that the educational intervention increased connections with nature and knowledge of biodiversity. The literature corroborates the results obtained, concluding that sensory routes with primary-level schoolchildren are an educational element that tends to improve their connections with nature and their knowledge of biodiversity. That is why this study underscores the importance of taking advantage of opportunities for contact with nature through urban green spaces, in particular those rich in biodiversity, implementing routes and active interpretive paths where primary school students can inquire, observe, listen, and enjoy a natural environment close to where they live. Therefore, the combination of the natural space and the pedagogical project undertaken have a satisfactory impact on the students, and repeated contact with these natural spaces could improve the results.

However, it is worth mentioning some limitations and future lines of research. First of all, the type of natural space in this particular study boasted excellent characteristics, as it is a site very much present in the life of the city, and one featuring a great diversity of living beings and natural and cultural elements. Therefore, it would be appropriate to analyze whether other types of green spaces, such as parks, gardens and/or urban gardens, produce the same positive impact. Secondly, this experience is sporadic, and it would be desirable to increase the number of trips to natural environments in order to verify their effects on the variables studied. Thirdly, it would be advisable to expand the evaluation instruments by incorporating qualitative methods, such as focus groups, interviews, and/or drawing analysis to delve deeper into and contextualize the quantitative responses obtained. Lastly, a longitudinal study could be conducted to verify and analyze whether knowledge of biodiversity and the CN results persist after the intervention. Finally, the recommendations are made for future research. First, longitudinal studies were conducted to analyze the persistence of connection with nature and its dimensions after a period of time has passed since the study was

conducted. Second, the types of urban green spaces should be expanded to observe the impact of different types of parks based on their type and biodiversity. Third, the quantitative study should be complemented with qualitative studies through focus groups to delve deeper into the reasons that lead children to connect with nature.

In conclusion, the novelty of this study lies in the improvement of primary school students' contact with nature and knowledge about biodiversity through a sensory itinerary in an urban green space. Its main characteristics are: it is replicable in other contexts; extensive knowledge about biodiversity on the part of teachers is not essential; and finally, it improves students' knowledge of urban green spaces close to their daily lives, providing meaningful learning for life. In short, it highlights the importance of valuing urban green spaces as educational spaces.

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Jerónimo Torres-Porras					✓	✓				✓	✓	✓		

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author, [IMM-G], upon reasonable request.

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