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Factors associated with nature connection in children: A review, synthesis, and implications for practice within environmental education and beyond

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ABSTRACT

Nature connection has been found in previous research to be a predictor of pro-environmental attitudes and behaviours. For this reason, efforts to build children's nature connection through a variety of avenues, including environmental education, have been explored by practitioners and researchers alike. In this paper we undertook a purposive literature search of research looking at factors associated with children's nature connection. The resulting synthesis of 28 studies found demographic, dispositional, affective, familial, environmental, and experiential factors that are associated with children's nature connection that will be of interest to educators, parents, researchers, and policy makers. Recommendations are made for the implementation in environmental education programmes and beyond, in order effectively mobilise an integrated response that will foster a sustained connection to the natural world.

Keywords**:** children, childhood, connection to nature, ecopsychology, environmental education, environmental identity

Nature connection can be defined as the part of the self-concept that identifies with the nonhuman natural environment and its elements, as well as the individual's subjective evaluation of that relationship (Clayton, 2003; Restall & Conrad, 2015). Research on nature connection suggests that it is a multidimensional and stable trait, though subject to change through experience (Mayer & Frantz, 2004; Nisbet, Zelenski & Murphy, 2009). The term encompasses several broader constructs including an emotional affinity to nature, the inclusion of nature in the self, and connectedness with nature; as well as the extent to which people feel they are part of nature (Tam, 2013).

Research on nature connection has consistently shown that the its promotion leads to an increase in pro-environmental behaviours, including environmentally protective and self-sacrificing behaviour (Duron-Ramos, Collado, García-Vázquez, & Bello-Echeverria, , 2020; Frantz & Mayer, 2014; Mayer & Frantz, 2004; Salazar. Monroe, Jordan, C., Ardoin & Beery, , 2021; Schultz, 2011; Whitburn, Linklater & Abrahamse, , 2020), in addition to its benefits on wellbeing (Capaldi, Dopko & Zelenski, 2014; Pritchard, Richardson, Sheffield & McEwan,2020). Individuals with a stronger nature connection are more likely to engage with conservation of energy and water, reduced consumption political activism, or financial donations to environmental organisations (Whitburn et al., 2020).

It has been widely suggested that a globally greater emotional bond with nature would therefore be instrumental for environmental catastrophe mitigation and nature conservation (Barrable, 2019; Ives et al, 2018; Richardson et al., 2020). Environmental education has a key role to play in this and should focus on efforts to mobilise the most effective tools for fostering an emotional bond with nature (Frantz & Mayer, 2014; Whitburn et al., 2020). Though it

is necessary to educate the whole population, there is reason to purport that children's education should be regarded as a priority, based on practical, prospective as well as ethical grounds. The negative effects of children's greater disconnection with nature have been thoroughly documented (Edwards & Larson, 2020; Hughes, Richardson & Lumber., 2018; Larson et al., 2019; Soga et al., 2020), while efforts to reconnect children with nature have yielded positive outcomes (Barrable & Booth, 2020a; Cheng & Monroe, 2012; Frantz & Mayer, 2014; Pyle, 2002). Efforts for early nature connection seem to be more potent and long-lasting than in adults, and predict later higher nature connection levels as well as pro-environmental behaviour (Chawla & Cushing, 2007; Evans, Otto & Kaiser, 2018; Lieflander & Bogner, 2014; Lieflander et al., 2013).

Nature connection has been identified as having a distinct role in happiness and wellbeing (Zelenski & Nisbet, 2014), while other researchers have proposed that a positive relationship with the natural world is a basic psychological need for humans (Hurly & Walker, 2019). Moreover, several systematic reviews and meta-analyses have shown a robust and positive association between nature connection and wellbeing in adults (Capaldi, Dopko & Zelenski, 2014; Pritchard, Richardson, Sheffield & McEwan,2020) and in children (Arola, Aulake, Ott, Lindholm, Kouvonen, Virtanen & Paloniemi, 2023). These, as well as the afore-mentioned associations with pro-environmental behaviours have proposed it as a key goal for education (Barrable, 2019).

Some previous reviews have looked at nature connection in children, including Chawla (2020) and Barrable & Booth (2020). The two reviews had expressly different areas of focus and aims: the first one (Chawla, 2020) aimed at 'breadth of coverage' (Chawla, 2020; p. 620) and therefore giving a real overview, while the second one (Barrable & Booth, 2020) had a tighter focus only on interventions. This review has a different aim and focus, in that it looks to identify the *factors* that are associated with nature connection, and how those can inform ongoing efforts to improve nature connection in children.

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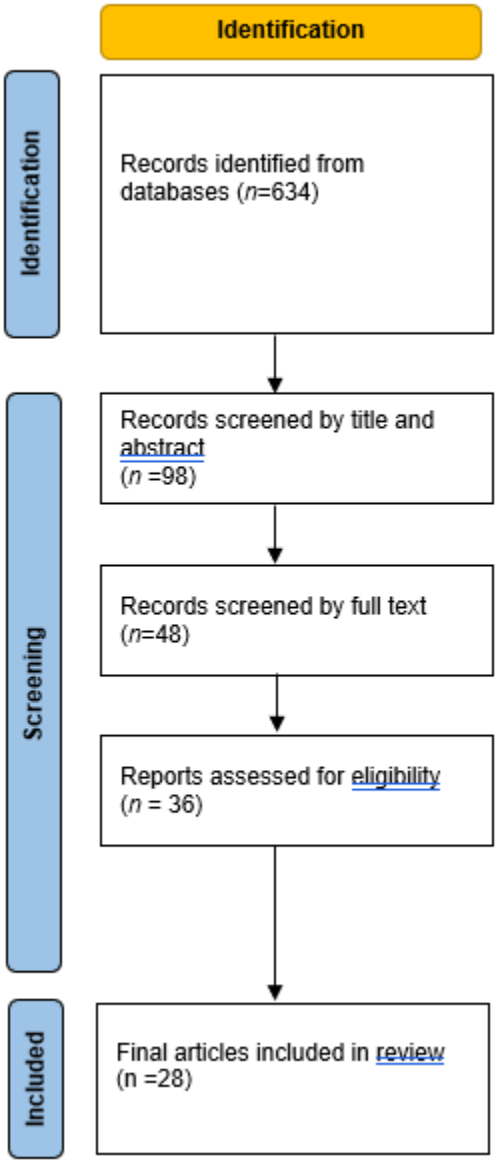
METHOD

An initial systematic search of the literature was undertaken through the databases Web of Science and PsycINFO (Beller et al., 2013). Key search terms were: (connection to nature OR biophilia OR environmental identity OR inclusion of nature in self OR love and care for nature OR nature relatedness OR inclusion of nature in self) AND (children OR childhood). No date limits were imposed. The articles found were scanned through title and abstract for relevance, and a further purposive sampling was undertaken in order to find the most effective educational tools for fostering an emotional connection to nature in children (Ames et al., 2019). A flowchart of the process is presented in Figure 1.

To sufficiently focus the search and find the most effective educational tools for fostering an emotional nature connection in children, only quantitative studies containing previously validated measures were considered. Articles were included if the following inclusion criteria were fulfilled: 1. was a full report published in a peer-reviewed journal; 2. used a validated measure ; 3. was published in English; 4. included children, defined as humans of 18 years of age or younger in its sample. A total of 28 articles fit the inclusion criteria and were chosen to be included in the synthesis; the summary of which can be found in Appendix A. The focus of the purposive sampling, using the above criteria was to "achieve conceptual and not statistical generalizability" (Ames, et al., 2019, p. 3) This means that although the initial methodology used was exhaustive and systematic, the final selection for inclusion into the synthesis was purposive, in order to meet the aims of usability and conceptual generalisability.

For the final synthesis, the articles were read and notes were made on the key factors that were reported on by the first author and their association (positive, negative or null) with nature connection in children. These were then synthesised into descriptive categories, or themes, using techniques of thematic synthesis created for use in reviews (Thomas & Harden, 2008). This process was undertaken by the first author initially, and then discussed and re-shaped through discussion with the second author, who also read the relevant full-texts. No specialist software was used for the analysis or synthesis processes. As described in Thomas and Harden (2008) the steps of the process were the generation of initial coding, the development of descriptive themes and finally the development of more analytic themes, through grouping together codes according to similarities or differences These are presented and explained fully in the results.

Figure 1: Flowchart of search, screening and inclusion

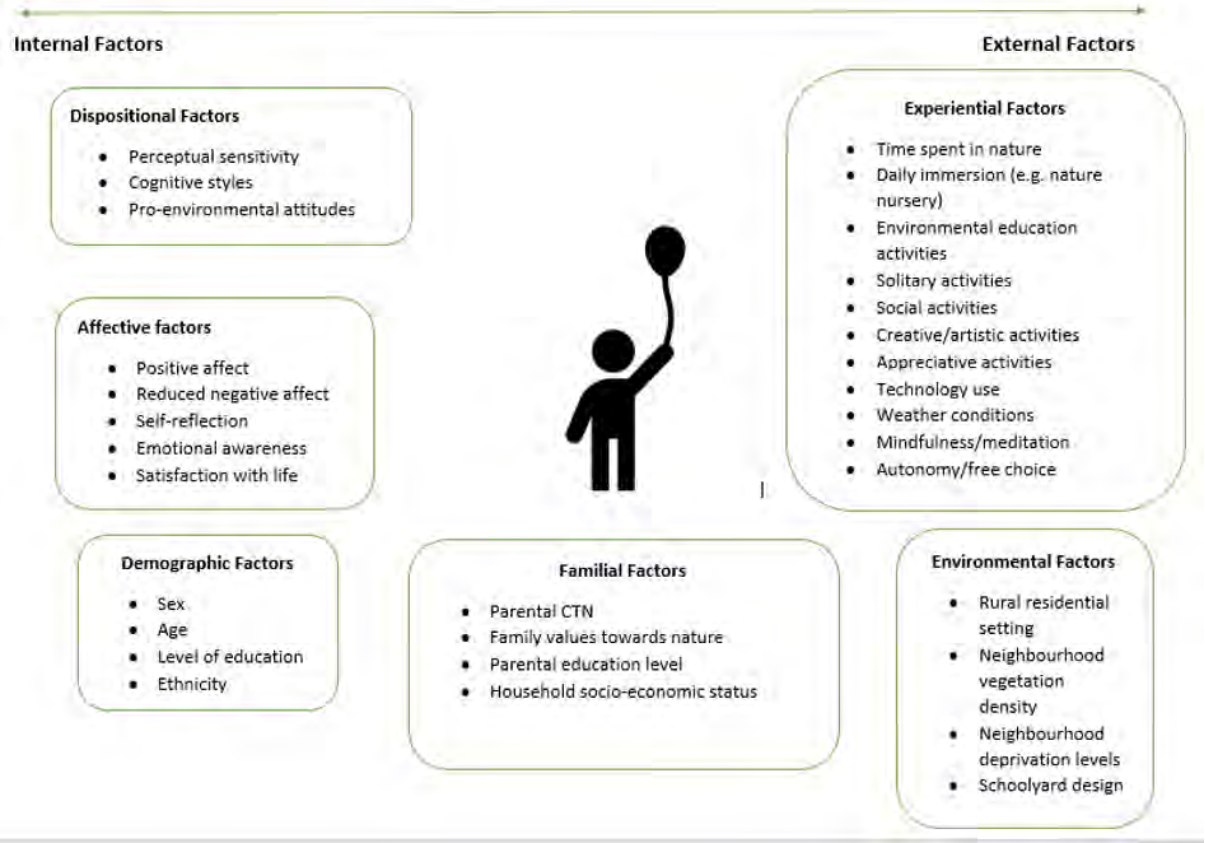


The two overarching labels of external and internal were chosen by the second author, not with the aim to separate two categories of factors, but to elucidate the potential interaction between the two. The terms internal and external were 'borrowed' from the language development literature (e.g. Kuvač-Kraljević, Blaži, Schults, Tulviste & Stolt, 2021; Sun, Steinkrauss, Tendeiro & De Bot, 2016). Internal factors refer to those coming from *within* the person, including motivations and dispositions, demographics and biological/genetic factors, while external are from *outwith* the person, mainly environmental and experiential factors. The categories are not precise but stand on a continuum, and are offered as suggestions and are intended to highlight the fact that factors that influence nature connection in children are not always simply environmental/experiential, and that there is a level of interaction between the internal and external factors.

RESULTS

Overall, a variety of factors were found to be associated with nature connection in children. Initial 'descriptive themes' can be seen in Figure 2. Six main themes were identified, and these will be looked at into detail in this section. It should be noted that there is some overlap between the groups, although some of the general themes are often correlated themselves, for example parental education and child education, or parental income and place of residence. There is also a possibility of other confounding factors not mentioned here, as well as interactions between these factors as seen here that are hard to untangle.

Figure 2. Internal and external factors that are associated with nature connection in children.



Demographic factors

Children's demographics have consistently been identified as predicting their development of a nature connection. Age, for example, was found to be inversely correlated with nature connection by Passmore et al. (2020). Age has also been identified as a factor affecting children's receptiveness to nature connection interventions (Larson et al., 2019; Lieflander et al., 2013) with younger children being more receptive or the changes being more long-lasting.

Two other demographic factors identified were children's ethnic background and sex (Larson et al., 2019). In this particular study they found that African American children had lower levels of nature connection to the other groups included in the study, namely Hispanic/Latino and other. . Several studies identified girls as having higher CTN than boys (Barrable & Booth, 2020b; Duron-Ramos et al.2020; Giusti,2019; Passmore et al., 2020) also found girls to have higher nature connection levels than boys, with various reasons hypothesised as responsible for this, including socialisation towards more empathetic and altruistic behaviours. Studies in adults have also suggested that men tend to have lower levels of connection than women (e.g. Barrable & Booth, 2022). It should be noted, however,

that other studies, such as Szczytko et al., (2019) did not find a significant difference between the sexes, nor between different ethnicities.

Dispositional factors

Considering nature connection lies at the crossroad between cognitive and affective domains of the self, other defining personal traits need to be considered when designing environmental education focused on developing this relationship to nature. For example, perceptual sensitivity was found by Bakir-Demir et al., (2019) to be a significant predictor of nature connection. Higher perceptual sensitivity was consistently, albeit weakly, linked to higher reported level of nature connection.

A correlation between cognitive styles and nature connection was reported in a study by Leong et al., (2014). They found a strong association between nature connection and both innovative and holistic thinking. Innovative thinking is characterised by creativity and a tendency to break out of the norm, while those strongly connected to nature also show an openness to new experiences and ideas and enjoy finding new and creative ways to spend time in nature. Holistic thinkers are able to understand the interconnectedness of interactions, such as between objects and people, or the relationships within ecosystems. The mediating explanations between nature connection and innovative and holistic thinking are not causally confirmed.

Other dispositional factors were studied by Solano-Pinto et al. (2020), who found pro-environmental behaviour, satisfaction with life, knowledge of waste management and circular economy, and empowering beliefs on pro-environmental behaviour all to be positively associated with nature connection. Pro-environmental behaviour and beliefs seem to develop in parallel with nature connection , though how their development interacts needs to be further examined.

Familial Factors

Although children spend a great deal of time in educational settings, which greatly influence their development, familial factors are clearly very salient. Barrable and Booth (2020b) found parental nature connection to be a predictor of the children's own connection over and above whether a child attended a nature preschool – although the two are probably highly correlated. This association of parental and child nature connection was also echoed in Passmore et al (2020). Cheng and Monroe (2012) report an association between family values towards nature and children's nature connection. There does seem to be a robust positive association between parental values/ nature connection and the child's connection, though the correlational nature of these studies does not allow us to draw causal conclusions. Other confounding variables could also be at play: parental nature connection and values may be influencing other variables, such as their choice of residential area, the child's outdoor behaviours, or the choice of school.

It could also be that parental demographic variables such as educational level and income may be influencing the child's development. Ahmetoglu (2019) found effects of parental educational background and household socio-economic status (SES) on the nature connection of a sample of Turkish children. The study found that low SES/household income was negatively associated with nature connection. Though requiring further investigation, the children of parents with high school degrees scored lower on measures of nature connection than the children of parents with college degrees.

Environmental factors

A variety of residential settings have been positively correlated with increased levels of nature connection. Research has identified higher levels of neighbourhood vegetation density or living in a rural areas were positively associated with higher levels of children's connection (Bakir-Demir et al., 2019; Cheng& Monroe, 2012; Duron-Ramos et al., 2020).

Other studies (e.g. Passmore et al., 2020) have not found the same effect, with neighbourhood green space reported as negatively associated with children's nature connection. Interestingly, in the same study deprivation levels were found to be positively associated with children's nature connection. Sedawi et al., (2020) present a much more complex picture, outlining how cultural and other elements may be stronger predictors of connection or disconnection from the natural world, rather than simply contact with nature through the living environment.

Schoolyard design, which directly predicts the amount of time children spend in contact with nature while at school, is another factor positively associated with higher nature connection. A study by Luis et al., (2020) compared the effects of three different types of schoolyards; one school had a central playing field with some surrounding trees on the perimeter, another had green areas in addition to a playing field, and the last had earthen areas, a vegetable garden, and three playing fields. The greener the schoolyard, the greater the resulting levels of connection. The highest levels of connection were observed in the greenest schoolyard, interpreted as a consequence of not only increased levels of vegetation, but also greater exposure to biodiversity from the vegetable garden. A variable not accounted for was the difference in school curricula; the greenest school also included a garden-based learning program, making the effects from teaching and schoolyard greenery indistinguishable.

Experiential factors

Time spent in nature, as well as visits to natural spaces is generally seen as, and often assumed to be, a predictive factor for nature connection in children. In a study by Larson et al., (2019) on children from rural South Carolina in the U.S. who were asked about the amount of time per day they spend outdoors, higher outdoor time was linked to a higher nature connection When fully immersed into a green environment, as for example when attending a nature preschool, children showed a higher nature connection (Barrable & Booth, 2020b). On top of that, the more time spent in the attendance of the outdoor preschool, the stronger the children's nature connection. Because of the young age of the participants, the answers were obtained from their parents through an altered version of the original scale. The effect sizes found were quite small, and the correlational nature of the study could also have led to the conclusion that parents with high connection could have influenced the child's nature connection, instead of the nature preschool itself. This is also a plausible explanation, considering the association between parental and child nature connection discussed earlier.

The limitations of contact alone should be noted, as seen in the large sample from England studied by Passmore et al. (2020), which found that frequency of visits *did not* predict nature connection in children. Although surprising, the authors highlight the importance of quality above quantity. This is seen in studies such as Dopko et al. (2019), where the activities and quality of time spent in the forest seemed to have a positive effect on nature connection.

Looking more closely at the activities themselves, and comparing social versus solitary outdoor activities, Szczytko et al. (2020) found that both foster nature connection, though solitary activities are the stronger predictors. Activities such as hunting, fishing, or meditation seem to be more beneficial than social activities like sports or camping. Solitary activities allow more space for attention towards the natural environment, even when accompanied by an adult. Creativity and the chance to feel an emotional connection through art may play a role in developing a positive relationship with the natural world (Gray & Birrell, 2015).

Hoover et al. (2020) distinguished between groups of outdoor activities differently - they proposed the distinction between appreciative, consumptive, and abusive activities - appreciative activities encompassed enjoying nature without alternation, such as hiking or rock climbing, consumptive activities included anything where one consumes from nature, such as hunting or fishing, and abusive activities included activities of degradation, such as snowmobiling or off-road driving. Adult participants were asked to retrospectively recall the outdoor activities they participated in as children. Only appreciative activities were found to be strong predictors. A limitation of the study is the retrospective nature of the data gathered; it is possible the participants did not accurately recall their childhood activities.

Crawford et al. (2017) investigated the role that technology could play when engaged in outdoor activities. Children participated in chaperoned tours through natural parks either with a mobile application, a paper map, or an

environmental educator. The app was designed to engage children with their surroundings, providing stimulating challenges such as “What does a spruce tree’s bark look like?”. All methods were found to be equally effective in fostering nature connection. In a similar study in young adults, using technology was not found to hinder nature connection (Barrable & Booth, 2019).

Environmental education (EE) programmes are often seen as an effective way of fostering nature connection (Ernst & Theimer, 2011; Lieflander et al., 2013; Mullenbach et al., 2019). In all these studies different EE were examined with most having been found to have a positive effect on children’s connection . Limitations in measurement, such as a ceiling effect, could be responsible for no positive results in some. The complexity of these make it difficult to identify which specific factors have a positive effect on nature connection, but on the whole longer programmes, such as the four-day water focused EE programme investigated by Lieflander et al. (2013) and a four-day camping programme investigated by Mullenbach et al. (2019) had a larger effect.

A sense of autonomy and agency may positively contribute to the building of the nature connection. A study by McCree et al., (2018) took a group of socially disadvantaged children with special educational needs into the local woodland each week for three years. Through this time, there were no fixed activities. Children were allowed to choose from a variety of activities each week; scavenger hunts, creative crafts, shelter building, tree climbing, running around, or any other activity they could think of. Their connection levels increased after participation, though the generalizability of the results is limited due to a low sample size.

Mindfulness and meditation have been associated with an increase in nature connection in three separate studies on children. In Kossack and Bogner’s (2012) programme children simply sat in a five-minute-long silence at the end of their one-day field trip, which may have contributed to the positive results. Szczytko et al. (2020) observed meditation was also positively associated with increased levels of nature connection in children, while Author et al (2021) present the positive effect of mindfulness exercises and mindful natural play.

Conditions within the environment may also play a role in nature connection development. In one particular study which looked at that during a four-day field program containing a multitude of activities different groups of children had varying experiences with the field trip, due to differing weather conditions (Talebpour et al., 2020). One group had to be evacuated a day early because of extremely heavy rainfall and imminent flooding, and another was not able to participate in some activities because of rainfall. The last group was fortunate enough to only experience intermittent periods of rain, enjoying mostly dry weather and clear skies. The group experiencing extremely disruptive weather conditions reported significantly lower levels of nature connection following the program. Mild weather did not significantly affect nature connection levels in any way, and the group experiencing positive weather conditions had higher levels of nature connection post-program. Supported by Sedawi et al. (2020), the affinity towards nature of indigenous children from the Negev desert was also strongly influenced by the weather conditions. Other studies (Barrable et al., 2021; Dopko et al., 2019) have also hypothesised that weather could have played a role in the development of nature connection. More specifically, Barrable et al., 2021 had three groups attend a nature reserve and undertake the same activities; the group which experienced wet and windy weather had no increase in nature connection, while the two groups that visited on a sunny day had a significant positive change.

Notably some EE programmes have also been reported to have non-significant effects on children’s nature connection (Giusti, 2019, Hammond, 2020 & Harvey et al., 2020). Giusti (2019) examined the Salamander Project, a voluntary nature conservation program where children interacted with two endangered species of local Swedish salamanders. First, the children were asked to localise them, then document their characteristics, and release them back into the wild every day throughout a 2-month period. No difference in nature connection was found between children who took part in the Salamander Project and those who did not. Hammond (2020) investigated the effect of bird feeders in a classroom setting over one month, and also found no difference in nature connection between groups of students who had a bird feeder present in class, and those who did not. It was proposed the presence of a bird feeder was not a strong enough intervention to influence sixth-grade students. Finally, Harvey et al., (2020) looked at the effect of a biodiversity-focused outdoor learning program. It continued over one school year and included both short lectures on birds, amphibians, insects, and trees as well as hands-on activities such as building

bird boxes or monitoring species. No significant effect on nature connection was observed on post-test measures. It is possible the results of these studies could all be attributed to the ceiling effect.

Affective factors

Affective elements of the experience, as well as internal affective characteristics may have a positive effect on nature connection in children. Pirchio et al. (2021) conducted four visits to a natural reserve with a group of children. The visits not only included multi-sensory, experiential activities such as searching for wild animal traces, listening to, and identifying sounds, but the program also incorporated an affective component. Along the walk, at each place, the children were asked how they were feeling. They were asked to map the emotions they were experiencing at that moment. After returning to class, they were then guided in sharing their emotions through drawings or other forms of artistic expression. The hands-on activities in combination with the reflection exercises resulted in significantly increased levels of nature connection.

Two studies have found an association between affective wellbeing and nature connection, namely increased levels of connection correlate with higher positive affect and lower negative affect (Barrable et al., 2021; Dopko et al., 2019). Moreover, a general sense of wellbeing, as in the case of life satisfaction has been associated with increased nature connection in some studies (Sedawi et al., 2020; Solano-Pinto et al. 2020). Satisfaction with life, or general wellbeing, is further confirmed by the findings of Sedawi et al. (2020), that only in stable political, social, and residential environments is there the necessary basis for developing a positive relationship to nature. The causality between nature connection and affective wellbeing, as well as life satisfaction is not causal, although in Barrable et al. (2021) we do see a pre- and post-measures and an increase in both. More research is needed to further elucidate the direction of this relationship.

DISCUSSION

The review found a multitude of tools, programmes, and other variables positively and negatively associated with children's nature connection. In general, nature connection is positively influenced by time spent in safe natural surroundings and performing enjoyable and expressive outdoor activities. More complex EE programs may also foster this connection. In both the school and household context, personal demographics as well as cognitive characteristics need to be considered before embarking on programmes and promoting activities that will foster a child's emotional nature connection

Crucially parental values and behaviour as well as the greater household environment seem to be critical players in the facilitation or disruption of a child's relationship with nature. As such, policymakers and programme designers should focus on ensuring that parental involvement can be facilitated, and programmes can look at the child within their family and social context. As such, looking at family-unit level interventions, rather than at the level of a single child may prove to be very impactful.

Recommendations for practice:

It is true that internal factors are often immutable (e.g. sex, race, family education levels) but there are several external factors that are easier to manipulate when planning and executing programmes designed to increase children's nature connection. Drawing conclusions from the above review, and acknowledging its limitations, we feel that the following recommendations could be made to support the growth of the field:

1) Consider family level interventions that can support the growth of nature connection of both parent/guardian and child. This may lead to longer-lasting changes and a potentially virtuous cycle of nature connection growth within the family.
2) Consider weather conditions as a factor that may play a role as to whether an intervention or programme will be successful. While the evidence is limited, there is some support to the idea that inclement weather may reduce the impact of a programme or experience on children's nature

connection. Consideration to appropriate shelter and clothing could be important in ensuring maximum impact.

3) Consider the potential of focusing programmes on those who may benefit the most or shape programmes with specific groups in mind (boys, older children etc). This is also a call to researchers to ensure that research activity is not focused on certain types of groups only.
4) Consider activities that may promote positive affect and enjoyment. Challenges and tensions arise here, as identified by Chawla (2020) in her review, of the ongoing environmental degradation and the need for education on the climate crisis on the one hand, and the important task of ensuring children build a lasting nature connection.

Limitations

There are several limitations of this review that need to be taken into account. In the first instance, the search terms could have been more inclusive, using for example the term 'adolescent' or 'young people'. While this was not done in the search we undertook, several studies with adolescent participants were included. Moreover, and by design, only quantitative research that used validated measurement tools was included in this review which potentially limits its scope. Qualitative methods, such as the use of interviews may be more sensitive and appropriate to measure nature connection, especially in younger children. Related to this, there is also a call for the development of more instruments of measurement, as well as further evaluation of the existing tools, especially those attempting to measure the nature connection of very young children (Salazar et al., 2021). It is also necessary to develop more culturally inclusive and fluid tools, applicable to a variety of social and cultural settings.

There is also the question of whether it is even possible to measure a connection, a feeling. A great challenge in this field may be the proper operationalization of the extent to which nature is embedded in the self and the strength of the human-nature relationship. It is necessary to further theoretically scrutinise the meaning of the self, nature, and the relationship between the two (Beery & Wolf-Watz, 2014). It is possible that the empirical research thus far has not questioned the framing of these concepts sufficiently enough, and perhaps a complete post-humanistically oriented change in the conceptualization of the self and its relations to the world is needed (Fletcher, 2017; Rautio et al., 2017).

Considering the high degree of heterogeneity among the types of environments used in the studies, as well as the often observational rather than experimental nature of the methodologies use it is difficult to draw generally applicable conclusions on causality, or of the impact of specific environments and activities of children's nature connection. However, we feel that the general recommendations measured above may provide an opportunity to focus practice on some areas that have shown promise.

Finally, this was not an exhaustive review of all the literature but was purposive in its scope and search methodology. As such, not all relevant studies may have been included.

CONCLUSION

Building a connection to nature in children seems to involve many factors, often interconnected and in interplay with each other. This paper proposes two overarching themes of internal and external factors, and wants to highlight that it is the interaction or interplay of the two that ultimately impacts nature connection in children.

As such, we propose a set of recommendations for practice, through EE programmes as well as less formal avenues. Moreover, we wish to highlight the role of parents, the bigger family unit and the community is key in achieving lasting positive changes in children's nature connection. For that to be achieved, sustained cooperation and communication of teachers, policymakers, and parents is needed in order to ensure the implementation of as many of the strategies as possible within their abilities and resources. Moreover, we propose that there EE should focus on equity of access to ensure all children, regardless of background have access to high quality nature experiences.

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Appendix A
Overview of Articles Included in the Review

	Article	Participant age range	Number of participants	Variables studied	Type of nature setting	Instrument used
1	Ahmetoglu (2019)	4-6	238	Socio-economic status, perceived importance of nature activity	Outdoor recreation, Turkey	BI
2	Bakir-Demir et al., (2019)	8-11	299	Perceptual sensitivity, amount of neighbourhood greenery	Residential area nature, Turkey	CNI, INS, NR
3	Barrable & Booth (2020b)	1-8	216	Parental nature connection, time spent in nature preschool	Nature preschool, Scotland	CNI-PPC (adjusted CNI)
4	Barrable et al., (2021)	9-10	74	Mindful engagement with nature	Nature reserve, Wales	NCI, INS
5	Cheng & Monroe (2012)	9-10	5 500	Family values, previous experiences, and knowledge about nature, nature near the home	EE program, USA	CNI
6	Cho & Lee (2018)	8-9	104	Knowledge and experience with nature	EE program, South Korea	INS, CNS
7	Crawford et al., (2017)	9-14	747	Knowledge and experience with nature	Park tour, Canada	INS
8	Dopko et al., (2019)	Unknown	80	Time spent in nature	Field trip to nature school, Canada	LCNS
9	Duron-Ramos et al., (2020)	9-12	400	Place of residence, gender	Neighborhood nature, Mexico	CNI
10	Ernst & Theimer. (2011)	8-13	385	Components of EE programs	EE programs, USA	CNI
11	Giusti (2019)	10	158	Experience with nature, gender	Salamander project, Sweden	CNI, INS
12	Gray & Birrell (2015)	12-14	19	Experience with nature combined with artistic expression	Art-focused EE program, Australia	NR

	Article	Participant age range	Number of participants	Variables studied	Type of nature setting	Instrument used
13	Hammond (2020)	11-12	148	Experience with nature	Classroom bird feeders, USA	NR
14	Harvey et al., (2020)	8-11	549	Knowledge and experience with nature	EE program, UK	CNI
15	Hoover (2020)	16-19	140	Appreciative experiences with nature	Outdoor experiences, USA	CNS
16	Kossack & Bogner (2012)	11-12	123	Knowledge and experience with nature, initial NATURE CONNECTION	Forest trip, Germany	INS
17	Larson et al., (2019)	11-14	543	Screen time, gender, ethnic background, age	Outdoor recreation, USA	NR, INS
18	Leong et al., (2014)	13-17	138	Cognitive styles	Unknown, Singapore	CNS, NR
19	Lieflander et al., (2013)	9-13	N1 = 304 N2 = 264	Age, educational track (Study 1), knowledge and experience with nature (Study 2)	Water-focused EE program, Germany	INS
20	Luis et al., (2020)	8-14	132	Experience with nature	Schoolyard greenery, Portugal	CNI
21	McCree et al., (2018)	5-10	11	Knowledge and experience with nature, autonomy	Forest school project, UK	CNI
22	Mullenbach et al., (2019)	10-11	163	Knowledge and experience with nature	Residential outdoor EE program, USA	C(C)NS (adjusted CNS)
23	Passmore et al., (2021)		209	Age, neighbourhood deprivation levels, parental NATURE CONNECTION		
24	Pirchio et al., (2021)	9-11	N1 = 154, N2 = 170	Knowledge and experience with nature (Study 1), emotional self-awareness (Study 2)	Field trip programs, Italy	CNS

	Article	Participant age range	Number of participants	Variables studied	Type of nature setting	Instrument used
25	Sedawi et al., (2020)	10-12	294	SES, time spent in nature, place of residence	Indigenous settlement, Israel	CNI
26	Solano-Pinto et al., (2020)	10-19	120	Pro-environmental behavior and beliefs, satisfaction with life, environmental knowledge	Rural residency, Spain	CNS
27	Szczytko et al., (2020)	9-12	1 285	Type of outdoor activity, gender, ethnicity	Outdoor activities, USA	CNI
28	Talebpour et al., (2020)	10-11	317	Knowledge and experience with nature, weather	Residential field program, USA	CNI

Note. Biophilia interview = BI (Rice & Torquati, 2013), Connectedness to nature scale = CNS (Mayer & McPherson Frantz, 2004), Connection to nature index = CNI (Cheng & Monroe, 2012), Nature Connection Index = NCI (Richardson et al., 2019), Inclusion of nature in self scale = INS (Schultz 2002), Love and care for nature scale = LCNS (Perkins, 2010), Nature relatedness scale = NR (Nisbet, Zelenski & Murphy, 2009), EE = environmental education. Variables coloured in red were not positively correlated with nature connection.