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Transforming Children's Live Experiences with Species into Conservation Willingness: The Mediating Roles of Biodiversity Knowledge and Affective Attitudes

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Abstract: The loss of direct experiences with nature among today's children is of concern as it affects their conservation willingness (CW). While little is known about the influence of live experiences on CW, much less is known about how these events are related. This study aimed to examine the serial mediating effects of biodiversity knowledge (BK) and affective attitudes (AA) on the relationship between live experiences with species and CW. An online questionnaire was administered to 429 school children (11-12 years) in the Maldives. A two-serial mediation analysis revealed that live experiences exerted significant negative direct and positive indirect effects on CW. Thus, although a predictive sequential pathway from live experiences to BK to AA to CW was confirmed, partial mediation involving other mediators or moderators is likely. The direct effects of live experiences on BK and AA and of BK on AA suggest that experiential learning that stimulates AA is necessary to achieve overall positive impacts on CW. Therefore, educators and policymakers are critical in providing first-hand experiences to instill positive biodiversity conservation traits in children, enabling successful education for sustainable development and long-term biodiversity conservation.

Keywords: *Affective attitudes, biodiversity knowledge, children, conservation willingness, live experiences.*

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Introduction

Direct nature experiences (DNEs), or first-hand sensory engagements with nature (Gaston & Soga, 2020; Longbottom & Slaughter, 2016), in children and their consequences, are of interest to researchers for several reasons (e.g., Charles et al., 2018; Hughes et al., 2018; Muslim et al., 2019; Soga & Gaston, 2016; Zhang et al., 2014). This interest is increasingly grounded in the long-term effects of childhood DNEs on conservation-related traits in adulthood (Asah et al., 2018; Beery & Jørgensen, 2018; Brom et al., 2020; Sugiyama et al., 2021). Because human actions are responsible for much of the biodiversity loss, transformative behavioral changes are critical to successful biodiversity conservation (Bowie et al., 2020; Schultz, 2011). Moreover, achieving the Sustainable Development Goals (SDGs) of the 2030 Agenda depends directly or indirectly on biodiversity conservation (Blicharska et al., 2019). Indeed, the success of SD relies heavily on education (Navarro-Perez & Tidball, 2011; Selby, 2017) to strengthen attributes such as knowledge, attitudes, and behaviors related to biodiversity conservation (Leicht et al., 2018). As a result, there is a considerable effort to instill in children, through education, traits that promote biodiversity conservation (Laurie et al., 2016; Selby, 2017). However, to effectively establish such change, it is necessary to increase children's DNEs in education for sustainable development programs (Selby, 2017). Therefore, it is important to understand how DNEs influence conservation behaviors.

Literature Review

The literature frequently reports on the effects of the frequency of DNEs on outcomes (e.g., Collado et al., 2015; Muslim et al., 2019; Soga et al., 2016). Less explored are the effects of the types or modes of experiences, which can be personal, simple, or complex and occur in various contexts ranging from domestic settings to wild, pristine ecosystems (Charles et al., 2018). These contexts can influence outcomes (Adams & Savahl, 2015; Collado et al., 2015).

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DNEs may influence children's conservation-related behaviors, including willingness to conserve biodiversity, hereafter referred to as conservation willingness (CW) (Soga et al., 2016; Zhang et al., 2014). Results show that certain characteristics of animals, such as their aggressive appearance (Prokop & Fančovičová, 2017) and the nature of the experience, can negatively influence children's CW. The latter is evident, for example, in children's preferences for conserving exotic species over native wildlife due to more frequent vicarious experiences (Ballouard et al., 2011). In the context of this study, live experiences with physical contact are particularly important because they can increase children's CW, including their willingness to protect unpopular animals such as snakes (Ballouard et al., 2012) and bees (Schönfelder & Bogner, 2018), as well as their intention to feed birds (White et al., 2018). There are exceptions, however, as some live experiences do not produce the expected behavior. One example is the lack of improvement in willingness to protect animals among Slovak children after activities with woodlice (Fančovičová & Prokop, 2018). Although several factors may influence conservation priorities (Pam et al., 2021; Shapiro et al., 2016), negative conservation behaviors suggest alienation from nature, which may pose special challenges for biodiversity conservation among children growing up in an increasingly technology-driven world (Truong & Clayton, 2020). Plant CW, in particular, is rare in the literature.

DNEs are known to positively impact children's species-related biodiversity knowledge (BK) (Barthel et al., 2018; Bartoszeck et al., 2015; Fančovičová & Prokop, 2018; Otto & Pensini, 2017; San Jose & Nelson, 2017). In particular, live, personal experiences are associated with species identification (Albo et al., 2019; Almeida et al., 2018; Cornelisse & Sagasta, 2018; Jaun-Holderregger et al., 2022; White et al., 2018). Observing birds in children's everyday lives (Bartoszeck et al., 2018) also contributes to their knowledge of birds, including their identification. Similarly, everyday experiences with plants can help children identify them (Bartoszeck et al., 2015). Lack of live experiences with local biodiversity can lead to insufficient knowledge about it (Ballouard et al., 2011; Binoy et al., 2021; Genovart et al., 2013), which can affect children's willingness to protect species (Ballouard et al., 2011; Pam et al., 2021). Meanwhile, a lack of knowledge can negatively influence attitudes toward conservation (Ballouard et al., 2012; Pam et al., 2021; Soga et al., 2020).

Numerous studies illustrate the positive effects of DNEs on various measures of affective attitudes (AA) (Cheng & Monroe, 2012; Collado et al., 2015; Soga et al., 2016; Zhang et al., 2014). AA involves emotions (Albarracín et al., 2005) that can be long-lasting (Barthel et al., 2018; San Jose & Nelson, 2017). Moreover, such emotions underpin motivation (Hughes et al., 2018; Yli-Panula et al., 2018) and reasoning (Jayasinghe & Darner, 2020) behind biodiversity conservation. Many studies report positive shifts in children's AA, including biophilic tendencies toward commonly unpopular species, in response to their first-hand experiences. Examples include increased empathy toward salamanders (Barthel et al., 2018) and spiders (Albo et al., 2019), lowered fear of woodlice, snails, mice (Randler et al., 2012), amphibians (Giusti, 2019; Tomažič, 2011), snakes (Ballouard et al., 2012; Ferreira, 2012), and spiders, as well as decreased aggressive feelings toward spiders (Albo et al., 2019). However, while some experiences reduce disgust toward some animals through interactions (Giusti, 2019; Randler et al., 2012; Tomažič, 2011), this reduction is not always evident (Fančovičová & Prokop, 2018). Live interactions with pets (Hawkins & Williams, 2017; Prokop & Tunnicliffe, 2010) have also improved attitudes toward both popular and unpopular animals, while such experiences with birds (White et al., 2018) enhance children's attitudes toward them. Other findings link increased negative attitudes toward invertebrates to a lower incidence of DNEs (Cornelisse & Sagasta, 2018; Soga et al., 2020). Nonetheless, experiential contexts must be considered as they can influence attitudes toward biodiversity (Collado et al., 2015; Mulder et al., 2009; Pam et al., 2021).

There is clear evidence that greater knowledge about animals positively influences attitudes toward them (Cornelisse & Sagasta, 2018; Genc et al., 2018; Schlegel et al., 2015; Soga et al., 2020). For example, Albo et al.'s (2019) study demonstrated that increased knowledge about spiders was accompanied by a marked reduction in children's perceptions of fear and an improvement in attitudes toward the animals. An earlier study also showed that children's attitudes toward inconspicuous native species became more positive the more they knew about them (Lindemann-Matthies, 2005). Because many dimensions of attitude involve learning (Meidenbauer et al., 2019; Schlegel et al., 2015; Yli-Panula et al., 2018), appropriate knowledge about species acquired through experience could change attitudes toward them (Ballouard et al., 2012; Soga et al., 2020). Thus, experiential learning could realign feelings (Ballouard et al., 2012), biases, prejudices (Breuer et al., 2015), and negative cultural influences (Schlegel et al., 2015) toward biodiversity. There is also evidence that knowledge and attitudes influence behavior (Otto & Pensini, 2017).

Undoubtedly, experiences with the species can influence CW in many ways. The literature clearly demonstrates that AA mediates the positive effects of increased frequency of DNEs on animal CW (Soga et al., 2016; Zhang et al., 2014) and other conservation-related behaviors (Cheng & Monroe, 2012; Collado et al., 2015; Duron-Ramos et al., 2020; Otto & Pensini, 2017) in children. It is also known that BK has a mediating effect on conservation behavior (Cheng & Monroe, 2012; Otto & Pensini, 2017). However, there is a lack of evidence of direct or mediated effects of live experiences on CW. Given the interrelationships among the variables discussed, it is logical to postulate a sequential pathway from live experiences to CW, mediated sequentially through BK and AA. This pathway is significant when considering the role of experiential learning in attitudes and behavior. This study advances understanding of the influences of DNEs on children's willingness to protect biodiversity by focusing on live experiences and the mediating role of BK and AA in this relationship, which is lacking in the literature. This understanding can help develop educational pedagogies that successfully elicit positive behavioral changes related to conservation.

In this study, the contextual basis of learning through DNEs is underpinned by the modified theory of experiential learning (Morris, 2019) and the model of modes of experiencing nature and modes of learning in childhood development (Kellert, 2005). The relationships among variables are based on the Environmental Competency Model (ECM) (Kaiser et al., 2008; Roczen et al., 2014), which proposes that environmental knowledge and CTN (attitudes) together determine environmental behaviors. The application of these theories in the context of DNEs, particularly live experiences, is not evident in the literature. Therefore, this study extends their application to understanding the relationship between live nature experiences and CW. Based on the literature discussed, this study aimed to examine the serial mediation effects of biodiversity knowledge and affective attitudes in the relationship between live experiences with species and conservation willingness. It was hypothesized that biodiversity knowledge and affective attitudes would sequentially mediate the relationship between live experiences with species and willingness to conserve species. The null hypothesis stated that there would be no effects.

Methodology

Research Design

A survey questionnaire was used to collect data on the variables as part of a larger, in-depth study. The questionnaire included large color photographs of twenty animals and ten plants that children may encounter on their islands. The measures and scales are detailed below (points 1 to 4).

1. Live Nature Experiences with Species:

Live nature experiences with species (NES) examined whether children had seen the species alive. To assess this variable, children were asked to tick off one box that best describes their experience with each organism in the 30 photographs. Four options were provided, one of which was "seen the animal/plant alive only." Each "yes" response was scored (+1). These scores, i.e., the *Seen-Alive-Only (SAO) Score*, ranged from 0 to 30. The scale had good internal consistency (Kuder Richardson 20 test score =.93). A similar method was used by Almeida et al. (2018) to determine live experiences.

2. Biodiversity Knowledge

To measure biodiversity knowledge (BK), children were asked to name each organism in the photographs. Correct identifications were scored as (+1). The mean score, or the *Biodiversity Knowledge (BK) Score*, ranged from 0 to +30 per child for the 30 items. The scale had good internal consistency (Kuder Richardson 20 test score =.87). Similar methods have been used earlier to assess animal identification (Almeida et al., 2018; Schlegel et al., 2015).

3. Affective Attitudes

Affective attitudes (AA) towards biodiversity measured feelings towards species. For this purpose, three questions were posed for each organism in the photographs, and the responses were scored on a 3-point scale as *like* (2), *no feelings* (1), and *dislike* (0). The mean score of these items ranged from 0 to 60 and was represented as an *Affective Attitude (AA) Score*. This method was adapted from Soga et al. (2016). The Cronbach alpha coefficient for the scale was .96, indicating excellent internal consistency.

4. Conservation Willingness

Conservation willingness (CW) measured children's willingness to protect biodiversity by asking them whether they would like to protect the animal or plant shown in the photographs. Their responses were scored on a 3-point scale as *like* (2), *no feelings* (1), and *dislike* (0). The sum of the scores is represented as a *Conservation Willingness (CW) Score*, ranging from 0 to 60 per child. The Cronbach alpha coefficient for the scale was .94, indicating excellent internal consistency. The method is also adapted from Soga et al. (2016).

Validity of the Instrument

Before administering the instrument, four independent experts used a rating tool to assess its content validity, i.e., adequacy of coverage of the content domain (Cohen et al., 2018). Additionally, construct validity, i.e., matching of instrument measures with proposed constructs (Cohen et al., 2018), was established by running the Kaiser-Meyer-Olkin (KMO) test as recommended (see Massey, 2019).

Sample and Data Collection

The sample included 429 public school children consisting of 195 males (45.5%) and 234 females (54.5%) (M = 11.8 years; SD = 0.42) recruited from seven different island environments (IEs), or islands in the Maldives. Because of the large differences in the number of children on each island, a proportionately stratified random sample was drawn, with each island forming a stratum or subgroup. This method ensures that each stratum is adequately represented (Cohen et al., 2018; Creswell & Plano Clark, 2018; Daniel, 2012). In addition, a power analysis using G*Power 3.1 with the

prescribed settings (F-test family for multiple linear regression with three predictor variables; $\alpha = .05$; power = .80; effect size = medium ($f^2 = 0.15$)) (Ahmad et al., 2018; Murray et al., 2021) was conducted to determine the sample size required for statistical analysis in this study. This analysis recommended a minimum sample size of 77 and found that the sample size of this study, 429, was sufficient for medium effect size.

Formal ethics protocols of the Maldives and University Sains Malaysia were approved before data collection. The survey was conducted in an online classroom at a time determined by the teachers of each school, as COVID-19 was subject to restrictions. After the purpose of the survey was explained by Author 1 (via video), children were given a link to the questionnaire. Author 1 and the teachers remained online until the children completed the questionnaires to provide instructions, address potential problems, and ensure reliable data collection in a safe environment.

Data Analysis

Data were analyzed using IBM SPSS Statistics for Windows v26. Descriptive statistics were applied to each variable. Tests for normality of the data (skewness and kurtosis tests (cut-off value of ± 1), the Kolmogorov-Smirnov test, and the Shapiro-Wilk test ($p > .5$), as well as visual inspection of a histogram) showed that the SAO scores violated the assumption of normal distribution (see Cohen et al., 2018; Pallant, 2016; Tabachnick & Fidell, 2013). Therefore, Spearman's Rho correlation coefficient was used to determine the variables' relationship.

To determine the mediating effects of BK and AA in the relationship between live experiences and CW, a mediation analysis was conducted using Hayes' two-serial multiple mediation model (Model 6) PROCESS (Version 3.5) macro. Although such relationships are typically analyzed using structural equation modeling, Hayes PROCESS provides a simplified method of mediation analysis for models based only on observed variables yielding essentially similar results (Hayes et al., 2017). Hayes PROCESS examines direct effects (causal influence of X on Y, without the intervention of the mediator) and indirect effects (outcomes of mediators in the relationship between X and Y) using a regression-based bootstrapping approach to mediation analysis. Bootstrapping is preferable because, unlike normal theory approaches, it does not assume a normal distribution of the data while allowing for robust testing of hypotheses (Demming et al., 2017; Hayes, 2018). Before analysis, the suitability of the variables for mediation was verified. Mediation analysis assumes that all outcome variables are continuous and that errors in estimation meet the statistical assumptions of OLS regression, i.e., normality, linearity, homoscedasticity, and independence of observation (Hayes, 2022; Kane & Ashbaugh, 2017).

Assuming a valid causal chain linking mediators in the specified direction, the two-serial mediation model assumes a sequential influence of two mediators on the relationship between X and Y (Hayes, 2018, 2022). The two-serial mediation model tested in this study is shown in Figure 1. According to this model, controlling for demographic factors and IEs, biodiversity knowledge (mediator 1) and affective attitudes (mediator 2) are predicted to mediate the relationship between live NES (IV) and conservation willingness (DV), in that order. To test this model, a mediation analysis was conducted with 10,000 bootstrap samples at a 95% confidence interval at $p = .05$, generating a bootstrap CI. This bootstrap CI must not contain zero to have a statistically significant indirect effect (Demming et al., 2017; Hayes, 2018).

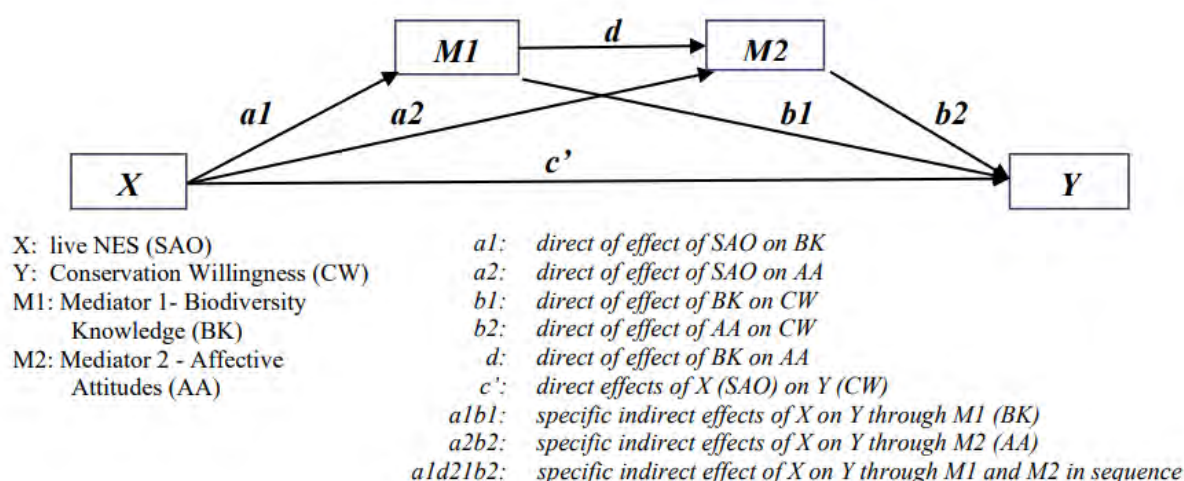


Figure 1. Hypothesized Mediation Model Depicting the Relationships Among DNE, BK, AA, and CW

Results

Correlation

The means, standard deviations, and the results of Spearman's Rho correlation coefficient test of the study variables are shown in Table 1. As seen in Table 1, each variable was positively correlated with the other. The correlation was significant except between SAO and CW scores.

Table 1. Descriptive Statistics and Correlation Analysis Results

Variables	Mean	SD	1	2	3	4
1 SAO (Live) Experiences	14.38	8.60	-			
2 Total Biodiversity Knowledge Scores	17.15	5.55	.297**	-		
3 Mean Attitude Score	34.01	10.72	.165**	.215**	-	
4 Total CW Score	41.37	13.08	.063	.158**	.766**	-

Note: ** Correlation is significant at the $p < .01$ level (2-tailed). $N = 429$ small (r between 0.10 – 0.29); medium (r between 0.30 – 0.49), large (0.50 to 1.0)

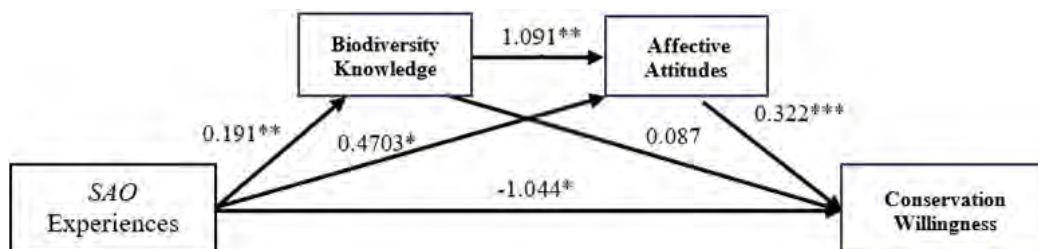
Effects of BK and AA in the Relationship between Seen-Alive-Only (Live Experiences) and CW

The results of the mediation analysis are presented in Table 2. Figure 2 illustrates the relationships among the variables, non-standardized beta (b) values, and the significance levels associated with the relationships.

Table 2. Serial Mediation Effects of Biodiversity Knowledge and Affective Attitudes on Relationship between SAO experiences and Conservation Willingness

Path	Model Pathways	Coefficient b	SE	t	p	95% CI	
						LL	UL
a1	Direct effect of SAO on BK	0.19	0.03	6.38	.000***	0.13	0.25
a2	Direct effect of SAO on AA	0.47	0.18	2.56	.011*	0.11	0.83
d	Direct effect of BK on AA	1.09	0.28	3.84	.000***	0.53	1.65
b1	Direct effect of BK on CW	0.09	0.07	1.17	.244	-0.06	0.23
b2	Direct effect of AA on CW	0.32	0.01	25.71	.000***	0.30	0.35
c'	Direct Effects (SAO on CW)	-1.04	0.05	-2.19	.029*	-1.98	-0.01
c	Total Model Effects (SAO on CW)	0.13	0.07	1.78	.076	-0.01	0.27
		Effect	Boot SE			Boot LL	Boot UL
a1b1	Indirect effect: SAO → BK → CW	0.02	0.01			-0.01	0.05
a2b2	Indirect effect: SAO → AA → CW	0.15	0.06			0.03	0.28
a1d21b2	Indirect effect: SAO → BK → AA → CW	0.07	0.02			0.03	0.12
	Total Indirect Effects (SAO → CW)	0.23	0.07			0.12	0.36

Note. * Pathway significant at $p < .05$. ** pathway significant $p < .01$; *** pathway significant at $p < .001$. Significant pathways are noted boldly (95% CI does not cross zero). All pathways are unstandardized. Indirect effects were computed using 10,000 bootstrap samples. SAO: Seen-Alive-Only, BK: Biodiversity Knowledge, AA: Affective Attitudes, CW: Conservation Willingness



Note. SAO: Seen-Alive-Only. *Pathway significant $p < .05$. ** pathway significant $p < .01$. *** pathway significant at $p < .001$

Figure 2. Two Serial Multiple Mediation of BK and AA in the Relationship between SAO and CW with Non-Standardized Beta (b) Values

The mediation analysis demonstrated significant, but negative direct effects of SAO (live experiences) on CW ($t(425) = -2.19, p = .029, b = -1.04, SE = 0.05, 95\% CI [-0.20, -0.01]$). However, SAO exerted significant, positive direct effects on BK,

($t(427) = 6.38, p < .001, b = 0.19, SE = 0.03, 95\% CI [0.13, 0.25]$) and AA ($t(426) = 2.56, p = .011, b = 0.47, SE = 0.19, 95\% CI [0.11, 0.83]$). While the direct effect of BK on AA was significant and positive ($t(426) = 3.84, p < .001, b = 1.09, SE = 0.28, 95\% CI [0.53, 1.65]$), its direct effect on CW was not significant ($t(425) = 1.17, p = .244, (b = 0.09, SE = 0.07, 95\% CI [-0.06, 0.23])$). However, AA had significant and positive direct effects on CW ($t(425) = 25.71, p < .001, b = 0.32, SE = 0.01, 95\% CI [0.30, 0.35]$) (See Table 2 and Figure 2).

The indirect effect of SAO on CW mediated through BK was not statistically significant (effect = 0.02, 95% CI [-0.01, 0.05]). However, the indirect effect of SAO on CW mediated through AA only was statistically significant and positive (effect = 0.15, 95% CI [0.03, 1.28]). The serial mediation effect from SAO to CW, through BK and AA in series, was also statistically significant (effect = 0.07, 95% CI [0.03, 0.12]). The total indirect effects of SAO on CW were significant (effect = 0.23, 95% CI [0.11, 0.36]). However, the total model effects of SAO (sum of direct and indirect effects) on CW were not significant ($t(427) = 1.77, p = .076, (b = 0.13, SE = 0.07, 95\% CI [-0.01, 0.27])$).

Discussion

The present study examined the serial mediation effects of biodiversity knowledge and affective attitudes in the relationship between live experiences with species and conservation willingness. The results support the hypothesis that biodiversity knowledge and affective attitudes have significant and positive mediation effects on the relationship between live experiences and conservation willingness in this sequential manner. This causal, sequential, and indirect influence of live experiences on willingness for species conservation through biodiversity knowledge and affective attitudes is lacking in the literature on childhood DNEs.

Correlation results showed a non-significant but positive relationship between live experiences, i.e., seen-alive-only (SAO), and conservation willingness. However, mediation analysis demonstrated significant but negative direct effects of live experiences on conservation willingness. The negative results were unexpected, considering the reports of improved conservation willingness with increased purposeful live experiences in children (e.g., Ballouard et al., 2012; White et al., 2018). While these findings appear to contradict studies that have not demonstrated direct effects of the frequency of DNE on the conservation willingness of animals (Soga et al., 2016; Zhang et al., 2014), they suggest the importance of the type of experience in influencing outcomes. Previous studies document negative emotional responses such as disgust (Ballouard et al., 2012; Fančovičová & Prokop, 2018; Giusti, 2019; Randler et al., 2012) and fear (Albo et al., 2019; Ballouard et al., 2012; Giusti, 2019; Randler et al., 2012) toward unpopular animals during initial live encounters that change with experience. It is also known that the appearance of species, such as their aggressiveness, negatively influences children's conservation behavior (Prokop & Fančovičová, 2017). Thus, immediate reactions to photographs may not elicit the same emotions as live experiences. Furthermore, this study included response to plants as well.

Consistent with several other studies (Albo et al., 2019; Almeida et al., 2018; Barthel et al., 2018; Jaun-Holderregger et al., 2022; White et al., 2018), this study found positive associations between live experiences and biodiversity knowledge. In addition, the results confirmed significant, positive direct effects of live experiences on biodiversity knowledge that are not common in the literature. This study also demonstrated significant positive correlations between biodiversity knowledge and conservation willingness, reflecting other similar findings (Ballouard et al., 2011; Cornelisse & Sagasta, 2018; Otto & Pensini, 2017; White et al., 2018). However, results do not support the significant direct effects of biodiversity knowledge on conservation willingness or the indirect (i.e., independent mediating) effects of biodiversity knowledge on the relationship between live experience and conservation willingness. A few studies support the direct (Cornelisse & Sagasta, 2018) and mediating (Otto & Pensini, 2017) effects of knowledge on behavior. Still, their contexts (planned experiences) and measures differ from the present study.

In line with other studies (Albo et al., 2019; Ballouard et al., 2012; Barthel et al., 2018; Tomažič, 2011), the present results showed significant positive associations between live experiences and affective attitudes. This study also found significant direct effects of live experiences on affective attitudes. Although direct effects of DNE frequency on affective attitudes have been reported (Collado et al., 2015; Soga et al., 2016; Zhang et al., 2014), such evidence in the context of live experiences in children is not evident in the literature.

The analysis established that, in contrast to biodiversity knowledge, affective attitudes exerted significant and positive direct effects on conservation willingness as well as independent and significant positive mediating effects in the relationship between live experiences and conservation willingness. Although not specifically in the context of live experiences, affective attitudes have been shown to mediate the effects of DNEs on several conservation-related behaviors (Cheng & Monroe, 2012; Duron-Ramos et al., 2020; Otto & Pensini, 2017; Soga et al., 2016; Zhang et al., 2014). It has been suggested that increased DNEs may enhance children's willingness to protect animals by nurturing biophilia towards wildlife (Zhang et al., 2014). These ideas are supported by findings such as those of Ballouard et al. (2012). They found that children's fear and disgust of snakes and their willingness to protect them changed positively after live experiences with the animals. Although the causal implications of these findings are uncertain, direct effects of experience on the conservation willingness or mediating effects of attitudes are possible. Related studies show that DNEs can directly or indirectly influence behavior, depending on the context (Collado et al., 2015).

Like several other studies (Albo et al., 2019; Cornelisse & Sagasta, 2018; Schlegel et al., 2015; Soga et al., 2020), this study confirmed significant positive associations between biodiversity knowledge and affective attitudes. Further analysis revealed that biodiversity knowledge had significant positive direct effects on affective attitudes and was thus a significant positive predictor of affective attitudes. This finding is important given the lack of literature on these specific direct effects. The positive associations reported in the studies may well be related to the direct effects of biodiversity knowledge on affective attitudes. Live experiences may produce these effects by alleviating numerous biophobic tendencies (Albo et al., 2019; Soga et al., 2020; Tomažič, 2011) or prejudices and myths (Breuer et al., 2015) through experiential learning. The literature supports that experiential learning (Meidenbauer et al., 2019; Yli-Panula et al., 2018) and understanding of species (Ballouard et al., 2012; Soga et al., 2020) can change attitudes. It is plausible that biodiversity knowledge mediates the effects of DNEs on attitudes. Therefore, environmental education must improve knowledge in ways that foster positive attitudes (Albo et al., 2019; Soga et al., 2020).

Although live experiences exerted significant negative direct effects on conservation willingness, their overall indirect effects were significant and positive. This combination of direct and indirect effects with opposite signs supports a competitive partial mediation, i.e., the influence of live experiences on conservation willingness can only be partially explained by biodiversity knowledge and affective attitudes. Such a situation suggests that other mediators with opposite signs to the existing mediators or important moderators may be involved, limiting the tested model to specific contexts. Failure to consider such factors could lead to erroneous conclusions (Demming et al., 2017). When considering the total model effects, the live experiences did not significantly influence conservation willingness. The overall positive indirect effects of these experiences on conservation willingness possibly offset the significant negative direct effects.

Conclusion

In this study, live DNEs influenced conservation willingness through multiple pathways, involving biodiversity knowledge and affective attitudes. Results support that affective attitudes have a stronger influence on children's conservation willingness than biodiversity knowledge. Since affective attitudes have both direct and indirect effects on conservation willingness, while biodiversity knowledge exerts neither, this emphasizes that stimulating attitudes is more important than simply communicating knowledge. However, appropriate biodiversity knowledge is necessary, as the results support sequential mediation in which live experiences indirectly influence conservation willingness through the direct effects of biodiversity knowledge on affective attitudes in sequence. The findings have important implications for educators and policymakers, who should work together to provide contextualized environmental education that actively engages children in various nature-based activities to elicit appropriate emotions in formal and informal ways.

Recommendations

Based on the findings, it is recommended that children be encouraged to interact with species in contextual ways that promote experiential learning to make positive connections with and behaviors towards biodiversity. Given the restrictive world in which children live today, it is recommended that educators play a key role in providing them with frequent and meaningful direct experiences with nature. We recommend a systems-thinking or place-based approach to education to help children make personal connections that enhance understanding and promote long-term effects. Future research should examine the mediating effects of biodiversity knowledge and attitudes on conservation behaviors in response to physical contact or interactions with species using pre-post studies. Live experiences can alter the outcomes of sensory engagements. Because some dimensions of attitudes, such as fear and disgust, are distinct emotions for particular animals rooted in prejudice or culture (Breuer et al., 2015), they need to be studied separately. In addition, the influences of moderators and other mediators need to be better explored to understand the effects of live experiences on conservation-related behaviors.

Limitations

Despite providing significant insights into how live experiences with species influence children's conservation willingness, some limitations must be noted. Most importantly, online data collection may compromise children's self-reports, although every effort possible was made to ensure the reliability of the data collection process. Also, limited to pictures, the responses may not truly capture sensory reactions to actual live experiences.

Authorship Contribution Statement

Abdullah: Concept and design, data acquisition, data analysis/interpretation, drafting manuscript, critical revision of manuscript, statistical analysis, securing funding, administration. Ishak: Concept and design approval, review data analysis/interpretation, critical revision of manuscript, technical support, supervision, final approval. Ahmad: Concept and design approval, review data analysis/interpretation, critical revision of manuscript, technical support, supervision, final approval.

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