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Self-regulation skills as statistical predictors of environmental awareness and consciousness in preschool children: a cross-sectional study

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This cross-sectional study examined the extent to which self-regulation skills (attention, inhibitory control, and working memory) statistically predict sustainable environmental behaviors (consciousness and awareness) in 224 preschool children aged 61–72 months. The Self-Regulation Skills Scale (Teacher Form) and the Environmental Sustainability Scale for Children 60–72 Months Old were administered. All three components were entered as candidate predictors in stepwise regression analyses stratified by age and gender; inhibitory control did not meet the entry criterion ($p < 0.05$) in any model and was therefore retained in exploratory zero-order analyses only. Attention statistically and positively predicted environmental consciousness across the full sample ($R^2 = 0.041$, $p = 0.002$) and in 6-year-olds ($R^2 = 0.057$, $p = 0.007$) and predicted environmental awareness in 5-year-old girls ($R^2 = 0.099$, $p = 0.024$) and in all children ($R^2 = 0.021$, $p = 0.030$); however, no model met the Bonferroni-corrected threshold (adjusted $\alpha = 0.00625$), so all findings are reported as exploratory. Formal moderation analyses revealed that gender did not significantly moderate the attention–environment relationship. These findings identify attentional self-regulation as a specific cognitive pathway to environmental sensitivity in early childhood, consistent with Bandura's Social Cognitive Theory. Curriculum implications and directions for confirmatory longitudinal research are discussed.

KEYWORDS
attention, early childhood development, environmental awareness, environmental consciousness, executive function, preschool education, self-regulation, sustainable behavior

1 Introduction

The accelerating deterioration of global ecosystems makes the cultivation of environmental consciousness in the earliest years of human development not merely a pedagogical aspiration but a societal imperative. Early childhood—spanning birth to approximately 8 years of age—represents a period of extraordinary neuroplasticity during which cognitive, emotional, and behavioral patterns are established with lasting consequences (Borg et al., 2017; Otto et al., 2015).

According to the Turkish Language Association (Turk Dil Kurumu, n.d), consciousness is defined as the individual's ability to recognize themselves and their environment. Environmental consciousness thus encompasses the processes of making

sense of environmental stimuli, internalizing norms regarding nature conservation, and consistently exhibiting sustainable behaviors. This process cannot be explained solely by cognitive knowledge acquisition; it necessarily involves the self-regulatory capacity to evaluate environmental demands, control impulses, and regulate behaviors by considering long-term consequences (Duckworth et al., 2016).

This study is grounded within Bandura's (2001) Social Cognitive Theory (SCT), which posits that human behavior is shaped by the reciprocal interaction of cognitive, environmental, and behavioral factors—the principle of triadic reciprocal determinism. Applied to environmental development, this model implies a self-reinforcing cycle: attentional capacity enables selective processing of environmental cues → this processing supports the formation of environmental consciousness → consciousness motivates environmental behavior → environmental behavior generates further attention-engaging environmental experience. Within this cycle, self-regulation—particularly the capacity to direct and sustain attention—functions as the cognitive engine that initiates and maintains environmentally relevant learning (Ernst and Burcak, 2019).

Self-regulation is defined as the individual's capacity to plan, monitor, and control their emotions, thoughts, and behaviors to achieve their goals (McClelland and Cameron, 2012). The behavioral dimension of self-regulation operates through three fundamental mechanisms: (1) Attention—the capacity to focus on relevant stimuli and suppress irrelevant ones (Deodhar and Bertenthal, 2023; İvrendi and Erol, 2018); (2) Working Memory—the ability to hold and process information in mind (Diamond, 2013); and (3) Inhibitory Control—the ability to stop a dominant response and select a more appropriate behavior (Carlson, 2005). All three components were entered as candidate predictors in the present study; their differential predictive contributions are examined empirically.

Systematic reviews indicate that environmental education research long neglected the early childhood period and that the empirical, and especially intervention-based, evidence base for young children remains limited (Ardoin and Bowers, 2020; Davis, 2009; Guler Yıldız et al., 2021). Research directly examining the relationship between executive functions and environmentally relevant beliefs and behaviors is also scarce and has been confined largely to adult samples (Colombo et al., 2023).

The present study addresses this gap by examining whether the three components of self-regulation—entered simultaneously as candidate predictors—statistically predict environmental consciousness and awareness in preschool children, and whether these statistical relationships differ by age and gender. Subgroup analyses are treated explicitly as exploratory, and formal moderation tests are used to evaluate gender differences.

1.1 Research questions

- Do self-regulation components (attention, inhibitory control, working memory) significantly statistically predict environmental consciousness and awareness in preschool children?
- Which components emerge as significant predictors in stepwise models, and what is the rationale for the inclusion/exclusion of each?
- Does gender significantly moderate the relationship between attentional self-regulation and environmental outcomes (formal interaction test)?
- Do these relationships differ by age group (5- vs. 6-year-olds) in exploratory subgroup analyses?

2 Materials and methods

2.1 Research design

This research employed a quantitative, cross-sectional correlational survey design. The cross-sectional design allows identification of statistical associations between variables at a single point in time but does not permit causal inference. The term 'statistical predictor' throughout this manuscript refers exclusively to the variable's role within the regression model and not to a causal mechanism.

2.2 Study group

The study group consists of 224 children aged 61–72 months (see Table 1) (126 girls, 57%; 98 boys, 43%) attending preschool education institutions in Türkiye. Age distribution: 98 children (44%) in the 5-year-old group (61–66 months); 126 children (56%) in the 6-year-old group (67–72 months). Convenience sampling was employed from a single geographic region of Türkiye, which limits generalizability. Participation was voluntary; written informed consent was obtained from the parents of the children.

2.3 Data collection tools

2.3.1 Self-Regulation Skills Scale (Teacher Form)

The scale developed by İvrendi and Erol (2018) consists of 22 items across three subdimensions: working memory, inhibitory control, and attention ($\alpha = 0.94$ in the original validation). In the current sample, the general internal consistency coefficient was $\alpha = 0.96$ (subdimensions 0.86–0.93). McDonald's omega ($\omega = 0.97$) confirmed composite reliability.

TABLE 1 Participant demographic information.

Variable	Group	n (%)
Gender, *n* (%)	Female	126 (57)
	Male	98 (43)
Age group, *n* (%)	5 years (61–66 months)	98 (44)
	6 years (67–72 months)	126 (56)
Total, *n* (%)		224 (100)

A confirmatory factor analysis (CFA) was conducted on the current sample to verify construct validity. The three-factor model showed an acceptable fit: $\chi^2/df = 1.84$, comparative fit index (CFI) = 0.94, root mean square error of approximation (RMSEA) = 0.062 (90% CI: 0.048–0.076), and standardized root mean square residual (SRMR) = 0.065.

2.3.2 Environmental Sustainability Scale for Children 60–72 Months Old

Özkan et al. (2019) developed this 20-item scale with two dimensions (Awareness and Consciousness; $\alpha = 0.92$). In the present sample, confirmatory factor analysis (CFA) confirmed the two-factor structure, with $\chi^2/df = 2.11$, CFI = 0.92, RMSEA = 0.071 (90% CI: 0.055–0.087), and SRMR = 0.072. McDonald's omega: $\omega = 0.93$.

2.4 Data collection process

Scales were completed by preschool teachers following a minimum of 4 weeks of naturalistic classroom observation during the 2024–2025 academic year. All scale forms were anonymously coded. A key limitation is that both the predictor and the outcome variables were measured through teacher report, introducing the risk of common method/rater bias (Podsakoff et al., 2003). Future research should supplement teacher ratings with direct behavioral observation or performance-based measures.

2.5 Ethical approval

This study was approved by the Sinop University Human Research Ethics Committee (Protocol No. E-57428665-050.04-330537, 14 February 2025). All procedures complied with the Declaration of Helsinki. Written informed consent was obtained from parents and teachers.

2.6 Data analysis

Before analyses, normality was confirmed through skewness and kurtosis coefficients (all within ±1.0). Pearson zero-order correlations were first computed among all three self-regulation components (attention, inhibitory control, and working memory) and both environmental outcomes (consciousness and awareness) for the full sample and all subgroups.

Stepwise multiple regression analyses were then conducted with both self-regulation components entering as candidates. The entry criterion was $p < 0.05$; the removal criterion was $p > 0.10$ (Cohen, 1988). Components not meeting the entry criterion were automatically excluded by the algorithm; this exclusion is an empirical outcome and not an *a priori* decision.

Subgroup analyses (by age: 5-year-olds, 6-year-olds; by gender: girls, boys; combined age × gender cells) are treated as exploratory. To control the familywise Type I error rate across the eight regression models, a Bonferroni correction was applied: adjusted $\alpha = 0.05/8 = 0.00625$ (Lakens, 2022). Both uncorrected (p) and Bonferroni-corrected significance levels (p (Bonf.)) are reported in Tables 4–10.

To formally test whether gender moderated the relationship between attentional self-regulation and environmental outcomes, hierarchical moderation regressions were conducted in the full sample: Step 1 entered attention and gender (dummy-coded: girls = 1); Step 2 added the Gender × Attention interaction term. Significant interaction would indicate differential slopes; non-significant interaction would indicate that the subgroup differences observed should not be overinterpreted.

All analyses were conducted using SPSS 22.0 (IBM Corp.) with $\alpha = 0.05$ (uncorrected) and adjusted $\alpha = 0.00625$ (Bonferroni-corrected for multiple models).

3 Results

3.1 Descriptive statistics and normality

Table 2 presents descriptive statistics and normality analysis findings. All skewness (range: −0.661–0.939) and kurtosis values (range: −0.975–0.806) were within the ±1.0 range, confirming suitability for parametric analyses.

3.2 Zero-order correlations among all predictors and outcomes

Table 3 presents Pearson zero-order correlations between the three self-regulation components and the two environmental

TABLE 2 Normality analysis.

Variable	Sub-dimension	n	Skewness	SE	Kurtosis	SE	Min–Max
Self-regulation	Inhibitory control	224	0.939	0.163	−0.122	0.324	28–39
	Attention	224	−0.648	0.163	−0.975	0.324	28–40
	Working memory	224	0.566	0.163	−0.954	0.324	17–25
	Total	224	−0.661	0.163	−0.657	0.324	81–98
Env. behaviors	Consciousness	224	−0.281	0.163	0.806	0.324	30–39
	Awareness	224	0.543	0.163	0.584	0.324	30–50
	Total	224	−0.093	0.163	0.530	0.324	62–86

SE, standard error.

outcome variables. Attention was significantly positively correlated with both environmental consciousness ($r = 0.20$, $p = 0.002$) and environmental awareness ($r = 0.15$, $p = 0.025$). Working memory showed weak non-significant correlations with consciousness ($r = 0.08$, $p = 0.22$) and awareness ($r = 0.06$, $p = 0.37$). Inhibitory control was not significantly correlated with consciousness ($r = 0.09$, $p = 0.18$) or awareness ($r = 0.07$, $p = 0.29$). These zero-order correlations constitute the empirical basis for inhibitory control's non-entry into any stepwise regression model.

TABLE 3 Zero-order Pearson correlations between self-regulation components and environmental outcomes ($N = 224$).

Variable	1	2	3	4	5
1. Attention	—				
2. Working memory	0.41**	—			
3. Inhibitory control	0.38**	0.44**	—		
4. Environmental consciousness	0.20**	0.08	0.09	—	
5. Environmental awareness	0.15*	0.06	0.07	0.52**	—

*$p < 0.05$; **$p < 0.01$.
Inhibitory control (Variable 3) was not significantly correlated with either outcome and did not meet the stepwise entry criterion ($p < 0.05$) in any regression model.

3.3 Stepwise regression analyses

Tables 4–10 present the stepwise regression results. Each table reports uncorrected p-values alongside Bonferroni-corrected values (adjusted $\alpha = 0.00625$). Superscript letter "a" refers to the table footnote explaining the model's status relative to the corrected threshold.

3.4 Gender moderation analysis

Table 11 presents the hierarchical moderation regression results testing whether gender moderated the attention–environmental

TABLE 4 Regression analysis: attention predicting environmental consciousness in 6-year-old children.

Variable	*B*	SE	*β*	*t*	*p*	*p* (Bonf.)	*R*	R^2
Attention	0.091	0.033	0.238	2.732	0.007	0.056[a]	0.238	0.057

[a]Approaches Bonferroni-corrected threshold (0.00625). Exploratory finding. SE, standard error.

TABLE 5 Stepwise regression: attention and working memory predicting environmental consciousness in girls.

Variable	*B*	SE	*β*	*t*	*p*	*p* (Bonf.)	*R*	R^2
Step 1								
Attention	0.101	0.035	0.252	2.908	0.004	0.032	0.252	0.063
Step 2								
Attention	0.170	0.077	0.423	2.225	0.028	0.224	0.267	0.071
Working memory	−0.120	0.118	−0.193	−1.013	0.313	1.000		

Neither model survives Bonferroni correction (adjusted $\alpha = 0.00625$). Exploratory finding only.

TABLE 6 Stepwise regression: attention predicting environmental consciousness in all children.

Variable	*B*	SE	*β*	*t*	*p*	*p* (Bonf.)	*R*	R^2
Attention	0.081	0.026	0.202	3.075	0.002	0.016[a]	0.202	0.041

[a]Significant at uncorrected $\alpha = 0.05$; does not survive Bonferroni correction but represents the most replicable finding in the study.

TABLE 7 Regression analysis: attention predicting environmental awareness in 5-year-old girls.

Variable	*B*	SE	*β*	*t*	*p*	*p* (Bonf.)	*R*	R^2
Attention	0.281	0.121	0.315	2.325	0.024	0.192	0.315	0.099

Does not survive Bonferroni correction. Exploratory finding.

TABLE 8 Regression analysis: attention predicting environmental awareness in 5-year-old children.

Variable	*B*	SE	*β*	*t*	*p*	*p* (Bonf.)	*R*	R^2
Attention	0.180	0.082	0.218	2.190	0.031	0.248	0.218	0.048

TABLE 9 Regression analysis: attention predicting environmental awareness in girls.

Variable	*B*	SE	*β*	*t*	*p*	*p* (Bonf.)	*R*	R^2
Attention	0.184	0.084	0.193	2.204	0.029	0.232	0.193	0.037

TABLE 10 Regression analysis: attention predicting environmental awareness in all children.

Variable	*B*	SE	*β*	*t*	*p*	*p* (Bonf.)	*R*	R^2
Attention	0.128	0.059	0.145	2.180	0.240	0.240	0.145	0.021

TABLE 11 Hierarchical moderation regressions: gender × attention interaction predicting environmental consciousness and awareness ($N = 224$).

Outcome	Predictor	*B*	SE	*β*	*t*	*p*	R^2
Consciousness	Step 1: attention	0.081	0.026	0.202	3.075	0.002	0.041
	Step 1: gender	0.214	0.183	0.071	1.168	0.244	
	Step 2: gender × attention	0.047	0.041	0.109	1.146	0.254	0.044
Awareness	Step 1: attention	0.128	0.059	0.145	2.180	0.030	0.021
	Step 1: gender	0.318	0.247	0.082	1.288	0.199	
	Step 2: gender × attention	0.038	0.049	0.072	0.774	0.441	0.025

Gender coded: girls = 1, boys = 0. Neither interaction term was significant, indicating that gender does not moderate the attention–environment relationship.

outcome relationships. For environmental consciousness, the Gender × Attention interaction was not statistically significant ($B = 0.047$, SE = 0.041, $p = 0.254$), indicating that attention predicts consciousness equivalently for boys and girls. For environmental awareness, the interaction was also non-significant ($B = 0.038$, SE = 0.049, $p = 0.441$). These findings indicate that the apparent subgroup differences observed in Tables 5, 7–9 should not be interpreted as evidence of gender moderation.

4 Discussion

This cross-sectional study examined the statistical predictive role of self-regulation components on environmental consciousness and awareness in 224 preschool children. The central finding is consistent across all models that survive scrutiny: attentional self-regulation is the primary cognitive gateway through which young children develop environmental sensitivity. Inhibitory control and working memory did not emerge as independent predictors, and gender did not significantly moderate these relationships.

4.1 Attentional self-regulation as the primary predictor

Attention significantly predicted environmental consciousness in 6-year-olds and the full sample and environmental awareness in 5-year-olds and the full sample. These findings are theoretically coherent: attention constitutes the selective filter through which environmental stimuli are encoded and processed (Deodhar and Bertenthal, 2023; Gibson and Rader, 1979). A child who can sustain focus on environmental cues—the wilting plant, the overflowing bin—is better positioned to construct the perceptual-cognitive representations from which environmental consciousness emerges.

Consistent with Bandura's (2001) SCT, attentional capacity initiates the triadic cycle linking person, behavior, and environment: attention enables observational learning from environmental stimuli, which forms the cognitive basis for environmental norm internalization (Mayer and Frantz, 2004), which, in turn, motivates conservation behavior. The finding that attention—not working memory—drives this process is consistent with SCT's emphasis on observational and vicarious experience as the primary mechanisms of self-regulatory learning in early childhood.

4.2 The non-significance of inhibitory control

A substantively important finding is that inhibitory control was not significantly correlated with either environmental outcome ($r = 0.07$–0.09, $p > 0.18$) and did not enter any regression model. This is not a methodological artifact but an empirical result with theoretical implications. Inhibitory control may be a less proximal predictor of environmental attitude formation than attentional engagement in this age range: suppressing a dominant response (inhibition) is less foundational to environmental sensitivity than the ability to notice and sustain attention toward environmental stimuli (Barkley, 2001; Hofmann et al., 2012). Future research should examine whether inhibitory control becomes a more important predictor in older children, as behavioral self-regulation in

environmental contexts (e.g., resisting littering) may depend more heavily on inhibition (Barkley, 2001; Hofmann et al., 2012).

4.3 Gender differences revisited

The original subgroup analyses appeared to show stronger attention–environment associations for girls. However, the formal moderation analyses (Table 11) indicate that gender does not significantly moderate the attention–consciousness or attention–awareness relationship. The apparent subgroup differences are therefore likely attributable to statistical noise amplified by sample splitting and not to genuine gender moderation. This finding underscores the importance of formal interaction testing rather than subgroup comparison for evaluating moderation (Gelman and Loken, 2014).

4.4 Practical implications

These findings carry concrete implications for early childhood education. If attentional self-regulation is the cognitive gateway to environmental consciousness, then attention-focused pedagogical practices can serve simultaneously as self-regulation interventions and as environmental education activities. Specifically: (1) nature-based observation activities (structured walks, garden projects, water-table play) build attentional capacity while exposing children to environmental stimuli; (2) mindfulness-based classroom routines support sustained attention; and (3) teacher professional development programs that build the understanding of executive functions in environmental contexts can equip educators to scaffold both cognitive and environmental development simultaneously (Ernst et al., 2021; Ernst et al., 2022; Madanipour et al., 2025). These evidence-based recommendations are particularly relevant for Turkish preschool curricula, where environmental education standards are evolving.

4.5 Methodological considerations and limitations

Several methodological limitations must be explicitly acknowledged. First, the R^2 values range from 0.021 to 0.099, indicating that attention explains 2%–10% of variance in environmental outcomes. These modest effect sizes are expected: sustainable environmental behavior is multiply determined by family socialization, nature exposure, cultural values, and peer influence—none of which were modeled here. A single cognitive predictor is not expected to explain large proportions of variance in such a construct. Second, although Bonferroni correction was applied across the eight regression models, only two findings (full-sample attention → consciousness, and full-sample attention → awareness) remained significant at the uncorrected level, and neither met the corrected threshold; all subgroup-specific findings should be considered exploratory and require confirmatory replication with preregistered hypotheses and larger samples. Third, both predictor and outcome variables were assessed through teacher report, introducing common method/rater bias. Future research should use direct behavioral observation or performance-based executive function tasks. Fourth, the convenience sample from a single Turkish region limits generalizability. Fifth, the cross-sectional design precludes causal inference; the directionality of the attention–environment relationship requires longitudinal or experimental investigation.

4.6 Conclusions and future directions

Attentional self-regulation is identified as a specific, modifiable cognitive pathway to environmental consciousness and awareness in preschool children. Gender does not significantly moderate this relationship. These conclusions are robust for the full-sample models; subgroup findings are exploratory. The integration of attention-building, nature-based activities into preschool curricula represents a pedagogically efficient strategy for simultaneously advancing cognitive and environmental development. Future research should employ longitudinal designs, multivariate structural equation models incorporating family-level contextual variables, and performance-based measures of executive function to build on these preliminary findings.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by the Sinop University Human Research Ethics Committee (Protocol No. E-57428665-050.04-330537, 14 February 2025). The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

TA: Methodology, Writing – original draft, Conceptualization, Validation, Writing – review & editing, Formal analysis, Data curation, Investigation, Resources, Visualization. MNT: Conceptualization, Writing – review & editing, Methodology, Validation, Formal analysis, Writing – original draft, Supervision.

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Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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