

A Comparative Analysis of Screen Time and Attentional Control Among Indian Secondary School Students

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Abstract: *This empirical investigation evaluated and compared voluntary attentional control dimensions- Attentional Focusing and Attentional Shifting- among secondary school students with low versus high recreational screen exposure in India. During adolescence, the prefrontal cortex undergoes active synaptic pruning and myelination, rendering executive functions vulnerable to habitual environmental stimulation. A quantitative, comparative, and correlational cross-sectional survey design was implemented. A sample of 100 secondary school students across Grades 8 through 12 (aged 13–18 years; 53% female, 47% male) completed a Demographic Schedule and the standardized 20-item Attentional Control Scale. Participants were categorized via median split into Low Screen Time (≤ 2 hours/day; $n = 59$) and High Screen Time (> 2 hours/day; $n = 41$) cohorts. Independent samples t -tests demonstrated that students with low recreational screen use scored significantly higher in Attentional Focusing ($t(98) = -2.684, p = .009, d = -0.546$), Attentional Shifting ($t(98) = -2.636, p = .010, d = -0.536$), and composite Total Attentional Control ($t(98) = -2.853, p = .005, d = -0.580$). Bivariate Pearson correlations revealed significant negative associations between daily recreational screen hours and total attentional control ($r = -0.220, p = .028$). High recreational screen exposure is associated with diminished voluntary focus and cognitive flexibility during secondary education.*

Keywords: Recreational screen time, attentional control, attentional focusing, attentional shifting, cognitive flexibility

1. Introduction

Adolescence constitutes a critical neurodevelopmental period marked by substantial structural and functional refinement within the central nervous system. Structural neuroimaging demonstrates that the human cerebral architecture matures asynchronously; while primary sensory and motor cortices mature comparatively early, the prefrontal cortex (PFC)—the neural substrate governing executive functioning, working memory, and sustained voluntary attention—undergoes protracted development well into early adulthood [1], [2]. A key cellular mechanism during this phase is activity-dependent synaptic pruning, wherein under-utilized excitatory synaptic junctions are eliminated and active pathways undergo progressive axonal myelination [1], [3]. Consequently, the adolescent brain displays heightened neural plasticity and pronounced vulnerability to high-frequency environmental stimuli [2].

Concurrent with this biological window, the interface connecting youth with digital technology has transitioned from static broadcasts to algorithmically curated, handheld mobile environments [4], [5]. Contemporary secondary school students engage extensively in Recreational Screen Time (RST)—defined as voluntary, non-academic digital interactions including algorithmic short-form video streaming, social messaging, and online gaming [4], [6]. Unlike traditional media, modern mobile applications utilize continuous-scroll feeds and variable-ratio dopamine reinforcement schedules that deliver instantaneous sensory gratification while requiring minimal sustained mental effort [7], [8]. This steady stream of fragmented stimulation encourages rapid sensory-driven

orienting reflexes rather than top-down, deliberate concentration [9], [10].

2. Literature Survey

Epidemiological and laboratory studies have consistently linked heavy digital media engagement with adverse cognitive and psychological outcomes. Moitra and Madan [6] observed that urban Indian adolescents spend between 4 and 7 hours daily on recreational screens, with elevated screen use significantly predicting compromised sleep quality and elevated depressive symptomatology. Large-scale investigations by Twenge and Campbell [11] similarly identified a dose-response relationship wherein adolescent digital media use exceeding four hours daily predicted marked reductions in curiosity, self-regulation, and task persistence.

At the neurocognitive level, chronic exposure to digital interruptions induces a state of continuous partial attention [12], [13]. Grounded in the Limited Capacity Model of information processing, the human cognitive architecture possesses finite resources for encoding and manipulating representations [14]. Frequent multitasking between entertainment media and scholastic tasks overwhelms executive filtering mechanisms [12]. Furthermore, experimental work demonstrates that the mere physical presence of a smartphone induces a "brain drain" effect, sapping working memory capacity because active executive control is required simply to suppress the urge to check the device [15].

Electrophysiological (EEG) studies by Yan et al. [5] confirmed that heavy consumers of short-form video content display significant reductions in P300 component amplitudes and prolonged response latencies during visual vigilance tasks, indicating attenuated neural resource allocation and slowed processing speed. Additionally, functional magnetic resonance imaging (fMRI) reviews reveal hypoactivation within the dorsolateral prefrontal cortex (dlPFC) and anterior cingulate cortex (ACC) during inhibitory control paradigms among youth exhibiting problematic device use [16]. In India, while smartphone ownership is widespread, empirical studies assessing specific dimensions of voluntary attentional regulation—such as focusing and task-shifting—across varying screen exposure tiers remain scarce [17], [18].

3. Problem Definition

Secondary education (Grades 8–12) requires sustained mental focus, conceptual reasoning, and cognitive flexibility to navigate academic curricula and standardized examinations. However, the ubiquity of affordable mobile internet has made heavy digital leisure common among Indian youth [6], [19]. While international literature notes associations between heavy screen use and executive difficulties [11], [13], empirical research evaluating how daily recreational screen hours relate to voluntary attentional focusing and shifting within an Indian secondary school demographic remains limited. The present investigation addresses this gap by comparing voluntary attentional control dimensions between secondary students with low versus high recreational screen exposure and evaluating the linear relationship between continuous screen hours and attentional performance.

4. Methodology/ Approach

4.1 Sample and Participant Selection

The study evaluated an audited sample of 100 secondary and senior secondary school students across India. Participants were recruited between February and September 2026 using non-probability convenience and purposive snowball sampling across institutional school networks, parent-educator forums, and academic groups. The cohort comprised 53 female students (53.0%) and 47 male students (47.0%) aged 13 to 18 years, distributed across Grade 8 (17.0%), Grade 9 (13.0%), Grade 10 (23.0%), Grade 11 (24.0%), and Grade 12 (23.0%).

Inclusion criteria required: (a) age between 13 and 18 years; (b) active enrollment in Grades 8–12 across recognized educational boards; (c) regular access to an internet-enabled digital screen device; (d) functional English literacy; and (e) affirmative participant assent with parental consent. Exclusion criteria eliminated individuals with diagnosed ADHD, Autism Spectrum Disorder, Specific Learning Disabilities, or those taking daily prescribed psychoactive/sedative medications.

4.2 Research Design and Variables

A quantitative, non-experimental, comparative, and correlational cross-sectional survey design was employed.

- **Independent Variable:** Daily Recreational Screen Time (RST), evaluated continuously (hours/day) and categorically via an empirical sample median split into Low Screen Time (≤ 2 hours/day; $n = 59$) and High Screen Time (> 2 hours/day; $n = 41$) cohorts.
- **Dependent Variables:** Attentional Focusing score, Attentional Shifting score, and composite Total Attentional Control score.

4.3 Assessment Tools

- 1) *Socio-Demographic and Recreational Screen Time Schedule*: Recorded chronological age, biological gender, current academic grade, affiliated educational board, clinical screening criteria, and average daily hours spent on recreational screen devices (excluding online classes and academic homework).
- 2) *Attentional Control Scale (ACS; Derryberry & Reed, 2002)*: A standardized 20-item psychometric inventory measuring voluntary attentional regulation [20]. It comprises two distinct factors: *Attentional Focusing* (12 items; assessing sustained concentration and distractor suppression) and *Attentional Shifting* (8 items; assessing cognitive flexibility across alternating operational demands) [20]. Items are rated on a 4-point Likert scale (1 = Almost Never to 4 = Always). The 11 negatively phrased items (1, 2, 3, 7, 8, 9, 12, 14, 16, 17, and 19) were reverse-coded using:

$$\text{Scored Value} = 5 - \text{Raw Score} \quad (1)$$

Higher cumulative scores represent greater attentional efficiency (scale range: 20–80). Within the analyzed sample, Cronbach's alpha demonstrated acceptable-to-high internal consistency: Total Scale ($\alpha = .808$), Attentional Focusing ($\alpha = .784$), and Attentional Shifting ($\alpha = .732$).

4.4 Data Collection and Ethics

Data were collected digitally via Google Forms with mandatory response validation to prevent missing values. Ethical standards were maintained: informed assent from adolescents and affirmative consent from parents/guardians were obtained digitally. Participation was entirely voluntary with full withdrawal rights, and participant data were anonymized using alphanumeric identification codes (P01–P100).

5. Results and Discussion

5.1 Results

Statistical computations were conducted using JASP (Version 0.19.3). Univariate normality was satisfied across all continuous dimensions via the Shapiro-Wilk test: Attentional Focusing ($W = 0.9908$, $p = .731$), Attentional Shifting ($W =$

0.9869, $p = .428$), and Total Attentional Control ($W = 0.9858$, $p = .362$).

Table 1 presents the independent samples t -test comparisons between secondary school students in the Low Screen Time (≤ 2 hours/day) and High Screen Time (> 2 hours/day) groups.

Table 1: Independent Samples t-Test Comparing Attentional Control Dimensions Between Screen Time Groups

Variable Dimension	Screen Time Group	n	Mean (M)	SD	SE	t (df = 98)	p-value	Cohen's d
Attentional Focusing	Low (≤ 2 hrs/day)	59	31.95	4.855	0.632	-2.684	.009**	-0.546
	High (> 2 hrs/day)	41	29.24	5.103	0.797			
Attentional Shifting	Low (≤ 2 hrs/day)	59	21.36	3.782	0.492	-2.636	.010**	-0.536
	High (> 2 hrs/day)	41	19.29	3.945	0.616			
Total Attentional Control	Low (≤ 2 hrs/day)	59	53.31	8.033	1.046	-2.853	.005**	-0.58
	High (> 2 hrs/day)	41	48.54	8.486	1.325			

* $p < .05$, $p < .01$ (Two-tailed)

As detailed in Table 1, students in the Low Screen Time group achieved significantly higher Total Attentional Control scores ($M = 53.31$, $SD = 8.033$) compared to the High Screen Time group ($M = 48.54$, $SD = 8.486$), $t(98) = -2.853$, $p = .005$, $d = -0.580$. Students with low screen use also demonstrated significantly higher Attentional Focusing ($M = 31.95$, $SD = 4.855$) than students with high screen use ($M = 29.24$, $SD = 5.103$), $t(98) = -2.684$, $p = .009$, $d = -0.546$. Similarly,

Attentional Shifting scores were significantly higher in the Low Screen Time cohort ($M = 21.36$, $SD = 3.782$) than in the High Screen Time cohort ($M = 19.29$, $SD = 3.945$), $t(98) = -2.636$, $p = .010$, $d = -0.536$.

Table 2 presents the bivariate Pearson product-moment correlation matrix.

Table 2: Pearson Correlation Matrix for Recreational Screen Hours and Attentional Subscales ($N = 100$)

Variable Dimensions	1. Daily RST Hours	2. Attentional Focusing	3. Attentional Shifting	4. Total Attentional Control
1. Daily RST Hours Numeric	—	-.214* ($p = .032$)	-.197* ($p = .050$)	-.220* ($p = .028$)
2. Attentional Focusing		—	.756*** ($p < .001$)	.953*** ($p < .001$)
3. Attentional Shifting			—	.920*** ($p < .001$)
4. Total Attentional Control				—

* $p \leq .05$, *** $p < .001$ (Two-tailed)

Continuous daily recreational screen hours demonstrated statistically significant inverse correlations with Total Attentional Control ($r = -0.220$, $p = .028$), Attentional Focusing ($r = -0.214$, $p = .032$), and Attentional Shifting ($r = -0.197$, $p = .050$).

5.2 Discussion

These findings confirm that elevated recreational screen exposure is systematically associated with reduced attentional self-regulation among secondary school students. The observed moderate-to-large effect size in composite attentional control ($d = -0.580$) aligns with Attentional Control Theory [20]. Attentional regulation depends on equilibrium between a top-down, goal-directed prefrontal network and a bottom-up, stimulus-driven sensory network [20]. Modern digital entertainment platforms- characterized by infinite-scroll algorithms, short-form video pacing, and push notifications- strongly stimulate bottom-up orienting responses [7], [8]. Chronic exposure conditions neural assemblies toward stimulus-driven capture, attenuating top-down prefrontal control needed for academic tasks [16], [21].

Regarding Attentional Focusing, the significantly lower scores among high screen consumers ($p = .009$, $d = -0.546$) indicate heightened susceptibility to extraneous distractions and intrusive mind-wandering. Rapid audiovisual transitions in short-form media precondition the nervous system to expect

constant sensory stimulation [22]. In low-stimulation academic environments (e.g., textbook study, mathematical derivation), the absence of rapid novelty triggers cognitive restlessness and attentional decay [4], [18]. These findings parallel electrophysiological observations of attenuated P300 component amplitudes and slowed target processing in heavy short-form media users [5].

Furthermore, the decrement in Attentional Shifting ($p = .010$, $d = -0.536$) challenges the assumption that digital multitasking fosters cognitive flexibility. Alternating rapidly between entertainment feeds, messaging applications, and academic assignments promotes continuous partial attention [12], [13]. This rapid switching leaves cognitive residues in active memory, elevating switch costs and producing attentional inertia when attempting to refocus on schoolwork [12]. The negative correlations across screen duration support the Limited Capacity Model [14] and the "brain drain" hypothesis [15], illustrating that resisting device-checking urges expends finite executive resources.

6. Conclusion

- Secondary school students engaging in more than two hours of daily recreational screen exposure exhibit significantly lower overall attentional control compared to peers with restricted screen use ($p = .005$, $d = -0.580$).

- High recreational screen consumption is associated with measurable reductions in Attentional Focusing ($p = .009$), indicating greater vulnerability to distractibility during structured study tasks.
- Heavy screen engagement does not enhance mental flexibility, but rather is associated with reduced Attentional Shifting capacity ($p = .010$).
- Daily recreational screen duration demonstrates a statistically significant inverse linear relationship with voluntary cognitive control dimensions.
- Implementing balanced daily screen boundaries (≤ 2 hours/day) and device-free study periods represents a practical approach to protect adolescent cognitive functioning during secondary education.

7. Future Scope

- **Methodological Limitations:** The study utilized a cross-sectional design, which precludes causal inference. Furthermore, screen duration and attentional parameters were self-reported, which may be vulnerable to recall biases. Unmeasured lifestyle covariates (such as objective sleep duration and physical activity) were not statistically controlled.
- **Directions for Future Research:** Future studies should employ multi-wave longitudinal designs tracking adolescents across schooling years to assess developmental trajectories. Incorporating objective continuous performance tests (CPT), eye-tracking metrics, and neuroelectric recordings (EEG/ERP) would provide deeper biological validation. Finally, evaluating structured school-based digital literacy programs and device-free interventions can help determine whether observed attentional decrements are reversible.

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