

Excessive Mobile Phone Use and Executive Functioning among Children Aged 6-12 Years in Hyderabad, India

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Abstract: Mobile phones are now a routine part of middle childhood, yet Indian evidence on how their use relates to children's cognition is limited. This cross-sectional study examined whether daily mobile-phone use is associated with attention, working memory and problem-solving in children aged 6–12 years, and whether parental mediation and educational content moderate these associations. Eighty children from eight English-medium private and government-aided schools in Hyderabad were classed from parent reports as low (<60 min/day), moderate (60–120 min/day) or excessive (>120 min/day) users and completed the Attention Network Test–Child version, Digit Span, the Corsi Block-Tapping Test and Raven's Coloured Progressive Matrices. Mean use was 103.8 min/day, and videos and games made up about 95% of reported time. After controlling for age, sleep and socio-economic status, excessive users showed poorer executive control ($d = 1.04$), shorter backward digit ($d = -0.93$) and Corsi spans ($d = -0.83$) and lower reasoning scores ($d = -1.47$) than low users; alerting and orienting did not differ. Parental mediation weakened only the association between use and backward digit span. Heavy, mainly recreational phone use was associated with weaker executive functioning; longitudinal research is needed to establish direction.

Keywords: Mobile phone use, Screen time, Executive function, Working memory, Parental mediation

1. Introduction

Children born in the last decade have grown up in homes where the smartphone is the main gateway to video, games, social contact and, increasingly, schoolwork. Unlike the television, the phone is portable, personal and algorithmically driven: it follows the child into the bedroom and the classroom. Remote schooling during the COVID-19 pandemic blurred the line between educational and recreational screen use further, and the Indian Academy of Pediatrics has since issued guidance on screen time and digital wellness for children and adolescents [1].

The years from six to twelve are a period of rapid growth in executive functions, the set of top-down processes that include inhibitory control, working memory and cognitive flexibility and that are supported by a still-maturing prefrontal cortex [2]. These skills underpin classroom learning and self-regulation, so any habitual activity that crowds out or competes with their exercise deserves careful study. At the same time, a phone is not a single kind of experience: an adaptive mathematics application and an endless short-video feed place very different demands on a child [3]. A useful study therefore needs to look not only at minutes of use but also at what fills them and how adults mediate that use.

This paper reports the quantitative strand of a mixed-methods study of children aged 6–12 years in Hyderabad, India. It examines how much and how children use mobile phones, whether heavier use is associated with poorer attention, working memory and non-verbal problem-solving, and whether parental mediation and educational content change these associations.

2. Literature Survey

2.1 Theoretical Framework

Four perspectives guided the study. The *displacement hypothesis* holds that screen time matters partly because of what it replaces, such as reading, outdoor play and face-to-face conversation, each linked to gains in language and executive function. Bronfenbrenner's *bioecological model* places phone use inside nested family, school and socio-economic contexts, so the same number of minutes may mean different things in different homes [4]. Vygotsky's *zone of proximal development* suggests that digital content can support development when it stretches a child just beyond what they can do alone, with appropriate scaffolding [5]. Finally, *dual-process accounts* propose that a diet of fast, rewarding stimuli may favour quick, automatic responding over the slow, effortful control on which executive functions depend.

2.2 Screen Time, Attention and Executive Function

Early cohort studies of television provided the first evidence. Early television exposure was associated with later attentional problems [6], and each additional hour of television at 29 months predicted lower classroom engagement and mathematics achievement in fourth grade [7]. In experimental work, nine minutes of a fast-paced cartoon temporarily lowered four-year-olds' executive-function performance compared with an educational programme or drawing [8]. Among adults, heavy media multitaskers were more easily distracted by irrelevant stimuli and less efficient at task switching [9]. Mobile phones, built around notifications and rapid switching between applications, offer precisely the kind of divided-attention environment these studies describe.

2.3 Neurobiological Evidence

Imaging and electrophysiological studies are beginning to fill in the mechanism. In an EEG study, a stronger tendency towards short-video addiction was associated with lower theta power during the executive-control component of the Attention Network Test, together with lower self-control [10]. Reviews of screen media in early childhood point to effects on attention and self-regulation, while noting that many associations are modest and confounded with family circumstances [11]; a review of reviews likewise found the evidence for many child outcomes, beyond adiposity and depressive symptoms, to be weak or inconsistent [12].

2.4 Content, Mediation and Context

Content and context consistently emerge as important moderators. Reviews note that pedagogically designed applications used for limited periods, with adult involvement, can support early literacy and numeracy, whereas passive entertainment does not [3]. Active parental mediation, in which parents discuss content with the child, has been linked with more favourable outcomes than unmediated viewing [13], and paediatric guidance encourages co-viewing and family media plans [14]. At the same time, large-sample analyses caution that the overall association between digital technology use and well-being can be small, and that moderate use may be harmless [15, 16].

2.5 Research Gaps

Most studies treat “screen time” as a single measure that combines television, computers and phones, despite the distinctive features of mobile phones. Much of the evidence comes from North America and Europe, with few Indian studies using standardised, norm-referenced cognitive tests with school-age children. Preschool samples dominate the executive-function literature, and the joint role of content type and parental mediation has rarely been examined in a single design. The present study addresses these gaps by focusing on mobile phones specifically, testing children aged 6–12 years with standardised measures, and examining parental mediation and content as moderators.

3. Problem Definition

Concern about children’s phone use is widespread among Indian parents, teachers and paediatricians, but the evidence needed to give clear, contextually appropriate advice is thin. The study therefore asked: *to what extent is daily mobile-phone use related to attention, working memory and problem-solving in children aged 6–12 years, after accounting for age, sleep and socio-economic status, and do parental mediation and educational content moderate these relationships?* The objectives were:

- 1) To describe the amount, content and context of daily mobile-phone use among urban primary school children in Hyderabad;
- 2) To compare low, moderate and excessive users on standardised tasks of attention, working memory and problem-solving; and

- 3) To test whether parental mediation and the share of educational content moderate the association between use and cognitive performance.

The following hypotheses were tested:

- **H₁:** Children who use mobile phones for more than two hours a day will score significantly lower on attention, memory and problem-solving tasks than children who use them for less than one hour a day.
- **H₂:** Daily mobile-phone use will be negatively associated with executive functions (attention control and working memory).
- **H₃(a):** Parental mediation will moderate the association between use and cognitive outcomes, so that the negative association is weaker when mediation is high.
- **H₃(b):** Educational content will moderate the association, so that the negative association is weaker when a larger share of use is educational.

4. Methodology

4.1 Design and Participants

A cross-sectional design was used. Schools were selected by stratified sampling across Hyderabad’s four zones (North, South, East and West) and two school types (private and government-aided), with school type serving as the indicator of socio-economic status (SES). This yielded eight English-medium schools, one of each type per zone, and ten children were randomly selected from the eligible pupils in each school, giving $N = 80$. An a priori power analysis had targeted 150 children; the final sample therefore had lower power, particularly for moderation effects. Children were included if they were aged 6–12 years, had no diagnosed neurodevelopmental condition, and had parental consent and their own assent. Children with uncorrected sensory deficits, those receiving treatment for a behavioural or emotional disorder, and those who had moved from another country in the previous 12 months were excluded.

4.2 Measures

Mobile Phone Usage Questionnaire (parent report): A 28-item questionnaire developed for the study and piloted with 30 parent–child pairs recorded phone access, age at first regular use, minutes of use on school and weekend days, minutes on each type of content, use before sleep, co-viewing, sleep duration and parental education. Daily use was computed as $(5 \times \text{weekday minutes} + 2 \times \text{weekend minutes}) \div 7$ and classed as low (<60 min/day), moderate (60–120 min/day) or excessive (>120 min/day). The educational share was the proportion of reported minutes spent on educational apps and online classwork.

Attention Network Test – Child version (ANT-C) : This flanker-based task yields alerting, orienting and executive-control (conflict) scores as differences between mean reaction times [17]. A larger conflict score indicates poorer executive control.

Digit Span (forward and backward): The Digit Span subtest of the Wechsler Intelligence Scale for Children – Fourth Edition, India (WISC-IV INDIA) [18] measured

verbal short-term memory (forward) and working memory (backward).

Corsi Block-Tapping Test: The longest correctly reproduced sequence indexed visuospatial working memory [19].

Raven's Coloured Progressive Matrices (RCPM): The total correct across Sets A, Ab and B (0–36) measured non-verbal reasoning and problem-solving [20].

Parental Mediation Scale (adapted): The Television Mediation Scale [21] was adapted for mobile-phone use. Its 15 parent-report items form three five-item subscales: active (instructive) mediation, restrictive mediation and co-use. Each item is rated on a four-point scale (never, rarely, sometimes, often), and the subscales were summed to give a total mediation score. In this sample, Cronbach's α for the total score, computed across the three subscale scores, was .72.

Mobile-Phone Addiction Scale (Child Version, parent-rated): This 10-item scale was developed by the author for the present study. Parents rated ten statements about their child's phone behaviour, such as using the phone for longer than planned or becoming upset when unable to use it, from 1 (strongly disagree) to 6 (strongly agree), giving totals of 10–60. Higher totals indicate more problematic use as perceived by parents, so the scale reflects parents' observations rather than the child's own report.

4.3 Procedure and Ethics

Permission was obtained from the principal of each school. Written informed consent was obtained from a parent or guardian, and every child gave assent (written assent for children aged 10 and over). Parents completed the questionnaires in person or through an encrypted online link. Trained research assistants tested each child individually in a quiet room at school between 21 July and 21 August 2026, during school hours, in two 25–30-minute blocks separated by a 10-minute break. Data were anonymised at collection using participant codes.

4.4 Data Analysis

Analyses were run in Python 3.13 using pandas, SciPy and statsmodels [22–24]. All tests were two-tailed with $\alpha = .05$. Normality was checked with the Shapiro–Wilk test, homogeneity of variance with Levene's test, and outliers with boxplots. Independent-samples *t*-tests compared use by gender and school type. H_1 was tested with one-way ANCOVA (covariates: age, sleep duration and SES), Bonferroni-adjusted pairwise comparisons and a planned excessive-versus-low contrast. H_2 was tested with Pearson and partial correlations (controlling for age and sleep), with Spearman correlations as a robustness check. H_3 was tested with hierarchical regression using mean-centred predictors; significant interactions were probed with simple slopes at ± 1 SD of the moderator [25]. Effect sizes were interpreted following Cohen [26].

5. Results and Discussion

5.1 Sample and Patterns of Use

All 80 children had complete data. Their mean age was 9.15 years ($SD = 2.08$); 51.3% were boys, and 88.8% used a shared family phone rather than their own (Table 1). The three usage groups were of similar size.

Table 1: Characteristics of the sample ($N = 80$)

Variable	Category	n (%)
Gender	Boys	41 (51.3)
	Girls	39 (48.8)
Age group	6–8 years	38 (47.5)
	9–10 years	24 (30.0)
	11–12 years	18 (22.5)
School type (SES)	Private	40 (50.0)
	Government-aided	40 (50.0)
Phone access	Own phone	9 (11.3)
	Shared family phone	71 (88.8)
Usage group	Low (<60 min/day)	27 (33.8)
	Moderate (60–120 min/day)	27 (33.8)
	Excessive (>120 min/day)	26 (32.5)

Note: Each of Hyderabad's four zones contributed 20 children. Percentages may not total 100 because of rounding

Children used a phone for a mean of 103.8 minutes a day ($SD = 59.1$; range 34.3–234.3), and weekend use exceeded weekday use by 48.2 minutes (138.2 vs 90.0). Use was overwhelmingly recreational: videos accounted for 48.5% and games for 46.3% of reported minutes, while educational apps and online classwork made up only 2.7%. Only eight children (10.0%) had any educational use, and none met the 50% threshold for mainly educational use. Thirty-one parents (38.8%) often or always co-viewed. Boys and girls used phones for similar amounts of time, $t(78) = -1.06$, $p = .292$, but government-aided school children used them for about 26.5 minutes a day more than private-school children (117.0 vs 90.5 min), $t(78) = -2.05$, $p = .044$, $d = -0.46$, even though only 1 of 40 had their own phone. Shared access, in other words, did not by itself cap a child's use.

5.2 Usage-group differences (H_1)

Table 2 shows a consistent gradient: on every executive measure, low users performed best and excessive users worst.

Table 2: Cognitive scores by usage group, M (SD)

Measure	Low (27)	Moderate (27)	Excessive (26)
ANT alerting (ms)	44.96 (15.47)	41.07 (14.15)	37.38 (14.95)
ANT orienting (ms)	28.33 (11.12)	30.56 (13.38)	31.96 (11.32)
ANT executive control (ms) ^a	54.78 (15.19)	65.00 (13.80)	71.04 (16.11)
Digit Span forward	5.56 (1.09)	5.11 (1.05)	4.73 (1.08)
Digit Span backward	4.00 (1.11)	3.70 (1.14)	3.04 (0.96)
Corsi span	4.59 (0.97)	4.41 (1.08)	3.73 (1.12)
RCPM total (0–36)	23.56 (4.41)	22.04 (4.79)	17.58 (3.66)

Note: Group sizes in parentheses. ANT = Attention Network Test; RCPM = Raven's Coloured Progressive Matrices. ^aHigher scores indicate poorer executive control; for all other measures higher scores indicate better performance.

ANT alerting and orienting and the RCPM were approximately normal; span scores departed from normality

because they take few distinct values, and daily use was positively skewed (skewness = 0.73). Levene's tests were non-significant for all measures (all $p \geq .20$), and ANCOVA was retained. After adjustment for age, sleep and SES, the groups differed on five of seven measures (Table 3). The largest effect was on the RCPM, $F(2, 74) = 26.73$, $p < .001$, partial $\eta^2 = .419$.

Table 3: ANCOVA results and excessive-versus-low contrasts

Measure	F(2, 74)	p	Partial η^2	d ^a
ANT alerting	1.52	0.226	0.039	—
ANT orienting	0.51	0.604	0.014	—
ANT executive control	7.79	<.001	0.174	1.04
Digit Span forward	8.44	<.001	0.186	-0.76
Digit Span backward	12.21	<.001	0.248	-0.93
Corsi span	10	<.001	0.213	-0.83
RCPM total	26.73	<.001	0.419	-1.47

Note: Covariates were age, sleep duration and SES. ^aCohen's d for excessive versus low users (pooled SD); all listed contrasts $p < .001$. A positive d on executive control indicates poorer control among excessive users.

In the planned contrasts, excessive users took 16.12 ms longer than low users to resolve conflict, recalled about one digit fewer backwards (-1.00), had a Corsi span 0.91 blocks shorter and scored 6.18 points lower on the RCPM (adjusted differences, all $p < .001$). Alerting and orienting did not differ (both $p > .22$). The disadvantage was therefore specific to executive attention rather than to attention in general. The moderate group generally fell between the other two. **H₁ was supported** for executive attention, working memory and problem-solving, but not for alerting or orienting.

5.3 Associations with Executive Functions (H₂)

Treating use as a continuous variable gave the same picture (Table 4). Associations became stronger once age and sleep were partialled out, because removing age-related variance in the span and RCPM scores made the link with use clearer. Spearman correlations led to the same conclusions (e.g., $\rho = .40$ with the conflict score and $\rho = -.31$ with backward span, both $p < .01$).

Table 4: Correlations of daily use (min) with cognitive measures

Measure	Pearson r	Partial r ^a
ANT executive control	.44**	.44**
Digit Span backward	-.33**	-.48**
Corsi span	-.30**	-.43**
RCPM total	-.49**	-.64**

Note: ^aControlling for age and sleep duration. ** $p < .01$.

Parent-rated scores on the Mobile-Phone Addiction Scale ($M = 29.38$, $SD = 10.25$) were unrelated to minutes of use ($r = -.11$, $p = .336$) or to any cognitive measure (all $|r| \leq .09$). Because the scale was completed by parents, it reflects their perception of the child's behaviour, such as becoming upset when the phone is taken away, which may depend more on parental attitudes and household rules than on actual minutes of use. In these data, reported minutes of use rather than parent-rated addiction-like behaviour tracked cognitive performance. **H₂ was supported**.

5.4 Moderation by parental mediation and content (H₃)

For the conflict score, daily use predicted performance beyond the controls ($\beta = .43$, $p < .001$; $\Delta R^2 = .166$), but the use $\times$ mediation interaction added almost nothing ($\Delta R^2 = .002$, $p = .668$). The RCPM showed the same pattern ($\Delta R^2 = .003$, $p = .447$). Backward digit span was different (Table 5).

Table 5: Hierarchical regression predicting backward digit span

Step / predictor	B	SE	β	p	ΔR^2
1) Age	0.356	0.047	0.65	<.001	0.481
Gender	-0.222	0.193	-.10	0.252	
SES	0.268	0.19	0.12	0.163	
Sleep duration	0.036	0.094	0.03	0.707	
2) Daily use	-0.007	0.002	-.34	<.001	0.111
Parental mediation	0.011	0.011	0.08	0.311	
3) Use $\times$ mediation	0.0005	0.0002	0.19	0.018	0.031

Note: Gender coded 0 = boy, 1 = girl; SES coded 1 = private, 0 = government-aided. Use and mediation were mean-centred before forming the interaction.

Among children with low parental mediation (-1 SD), each additional hour of use was associated with a drop of 0.63 digits in backward span ($p < .001$); among those with high mediation (+1 SD), the slope was -0.15 digits and non-significant ($p = .247$). Corsi span showed a similar trend that fell short of significance ($\Delta R^2 = .017$, $p = .085$). Because only eight children had any educational use (maximum share 37.1%), the content-type test had little to work with: no use $\times$ educational-share interaction was significant (all $p \geq .247$). Co-viewed children did not differ on any cognitive measure, but they used phones for about 30 minutes a day less (85.4 vs 115.4 min), $t(78) = -2.26$, $p = .026$, $d = -0.52$. **H₃(a) was partly supported** (backward span) and **H₃(b) could not be adequately tested**.

5.5 Discussion

The central finding is that heavier phone use went with weaker executive attention, working memory and reasoning, with large effects that held after accounting for age, sleep and SES. The attention effect was specific: excessive users were not generally slower or less alert, but had more difficulty suppressing conflicting information. This matches evidence that heavy media multitaskers are more vulnerable to irrelevant stimuli [9] and that fast-paced content can briefly lower executive performance [8]. Because the present study measured habitual use rather than the minutes after viewing, it suggests that the association is not confined to short-lived after-effects. It also parallels, at the behavioural level and in school-age children, the reduced theta activity reported among adults with stronger short-video addiction tendencies [10]; videos made up nearly half of reported use here.

Working-memory deficits appeared in both verbal (backward digit span) and visuospatial (Corsi) tasks, suggesting a general cost rather than a weakness in one modality. Backward span requires holding and manipulating information simultaneously, a core executive operation [2]. These tasks measure working memory over seconds, not long-term retention. The largest difference was on the RCPM, which was unexpected because fluid reasoning is often considered relatively stable. One explanation is that the RCPM, like the

conflict task, demands attention sustained across many items; another is reverse causation, in which children with weaker reasoning are given phones more often. Games made up 46% of use, yet no visuospatial advantage appeared, in contrast with reports of gains from certain interactive games [3].

The moderation of the working-memory effect by parental mediation is consistent with Vygotsky's idea of scaffolding [5] and with research on active mediation [13]: an adult who talks with a child about what they are watching asks the child to hold and use information in mind. Mediation did not protect executive attention or reasoning, although moderation effects are hard to detect with 80 children. Usage was unrelated to parent-reported sleep ($r = -.06$), and controlling for sleep did not weaken the associations, so lost sleep [27] does not appear to explain them here.

Several limitations apply. The cross-sectional design cannot establish causality, and reverse causation remains plausible. Use was parent-reported rather than logged, and shared phones make the child's share hard to estimate. The sample was modest and drawn from English-medium urban schools, clustering within schools was not modelled, SES was indexed by school type (though mean parental education was markedly higher in private-school families, $t(78) = 10.01$, $p < .001$, and adding it as a covariate left the results unchanged), and cognitive flexibility was not measured. The effects are large enough to take seriously but need replication [15].

Practically, the findings support a consistent daily limit for recreational use in this age group, with one to two hours as a reasonable upper bound, together with co-viewing, conversation about content and phone-free bedtimes. Schools can avoid setting homework that requires long phone sessions, and psychologists assessing attention or learning concerns can include a brief screen-use history. India-specific guidance for school-age children should take shared devices into account [1].

Conclusion

Among 80 children aged 6–12 years in Hyderabad, mobile-phone use was high and almost entirely recreational: one in three exceeded two hours a day, and educational use made up less than 3% of reported time. Heavier use was associated with poorer executive attention, verbal and visuospatial working memory and non-verbal reasoning, with large effect sizes after controlling for age, sleep and SES, while basic alerting and orienting were unaffected. Parental mediation weakened the association with working memory, but not with attention or reasoning. These findings show a clear association rather than proof of harm, and they should guide sensible limits and active parental involvement rather than either alarm or complacency.

Future Scope

Longitudinal designs that test the same children each year are needed to establish whether heavy use precedes weaker executive functioning or follows it. Objective measures such as device logs would reduce recall bias and handle shared phones better. Larger samples drawn from rural areas, regional-medium schools and other Indian cities would allow

moderation effects and school-level clustering to be modelled properly. Future work should separate short-form video, long-form video, games, social media and learning applications, and consider the pace of content as well as its label. Adding a cognitive-flexibility task, a delayed-recall measure and teacher ratings of classroom attention would broaden the assessment. Finally, a controlled trial of parent training in active mediation would show whether changing how families use phones improves children's attention and working memory.

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