

An Empirical Study on the Impact of Moral Interventions on Addictive Behavior and Psychological States in Mobile Applications

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Abstract

INTRODUCTION: With the widespread use of intelligent mobile devices, addictive design in mobile applications has increasingly influenced users' behavioral patterns and psychological well-being.

OBJECTIVES: This study examines the effects of addictive interface design and the feasibility of ethical intervention through a three-stage conceptual pathway of “addictive mechanisms–moral intervention–user response.”

METHODS: A five-day controlled experiment with 72 participants compared a standard interface containing addictive mechanisms with an otherwise equivalent interface incorporating duration reminders, excessive-reading prompts, and exit guidance. Behavioral logs, GAD-7 and short-form SAS scores, a post-experiment acceptance questionnaire, and semi-structured interviews with three domain experts were used for triangulation.

RESULTS: After Holm–Bonferroni correction, the intervention group showed significantly shorter usage duration, lower scrolling frequency, and lower anxiety and dependency scores than the control group; the corresponding effects were moderate to large. The intervention received a mean acceptance rating of 4.2 out of 5.

CONCLUSION: Mild, non-coercive interventions can reduce immersive use while preserving user acceptance, providing empirical and practical guidance for ethically responsible mobile interface design.

Keywords: Addictive Design, Moral Intervention, User Behavior, Mobile Applications, Digital Ethics

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1. Introduction

In recent years, with the rapid development of smartphones and mobile Internet, mobile applications have been deeply integrated into people's work and life. In order to increase user dwell time and activity, many product designers have consciously introduced a series of addictive interaction mechanisms, such as infinite scrolling, algorithmic recommendations, and continuous feedback. Although these designs can effectively improve product usage rates, they also subtly undermine users' self-control, leading to problems

such as time-wasting, decreased attention, and emotional fluctuations. These issues are particularly evident among adolescents and frequent users and have increasingly attracted the attention of public opinion and the academic community.

Previous studies have conducted preliminary analyses of addictive design from the perspectives of psychology, human-computer interaction, and behavioral design. However, most of them have focused on mechanism identification and risk revelation, lacking systematic discussions on ethical responses. At present, research on

moral intervention mostly remains at the level of normative discussion, lacking empirical analysis based on user behavior, and has not yet formed a generalizable intervention path. Therefore, how to introduce effective moral intervention strategies without sacrificing product experience has become an urgent problem in the field of digital design.

Starting from the user perspective, this paper develops a three-stage conceptual pathway of "addictive mechanisms—moral intervention—user response." The first two components represent the design dimensions being compared, whereas user response constitutes the behavioral, psychological, and attitudinal outcome layer. A mixed-methods approach combining a controlled experiment, post-experiment subjective feedback, and expert interviews is used to examine the effects and acceptability of moral intervention mechanisms in mobile applications.

This study not only enriches the theoretical discussion on addiction and ethical design in the field of mobile applications but also provides practical references for developers to balance efficiency and responsibility. It has practical significance for promoting the construction of a healthy and sustainable digital product ecosystem.

2. Related Work

This chapter reviews the current research achievements in the academic community on "addictive design" and "moral intervention," focusing on their theoretical foundations, practical applications, and research gaps. Through a literature review, this chapter provides theoretical support for the model construction and empirical path of this study.

2.1 Research Status of Addictive Design

With the rapid development of mobile Internet and the increasing competition in digital products, research on "addictive design" has gradually become a hot topic in the interdisciplinary field of human-computer interaction, behavioral psychology, and ethics. Addictive design refers to embedding specific mechanisms in products to reinforce operant conditioning, thereby encouraging continuous product use and even psychological dependence [1].

Variable reward mechanisms (such as likes, comments, and push notifications) can stimulate dopamine feedback, thereby increasing participation frequency [2]. Interface stickiness structures (such as pull-to-refresh and autoplay) stimulate users to continue operating through design delays and uncertainties [3]. Social comparison mechanisms (such as leaderboards and dynamic following) enhance social pressure and the need for immediate feedback [4]. These mechanisms are widely used to increase user stickiness and business retention [5].

Research has also found that these design strategies have a significant impact on adolescents and long-term users, potentially inducing information overload, distraction, and emotional fluctuations [6]. Fogg's "Behavioral Design Model" suggests that behavior occurs through the interaction of motivation, ability, and triggers, which is also one of the

explanations for addictive mechanisms [7]. In the domestic context, empirical studies have also found that short-video addiction is highly correlated with time loss of control, especially in information-dense interfaces [8]. Data-driven social design studies also show how unconscious behavior data can inform persuasive system design and prosocial behavior change [9].

2.2 Ethical Issues of Addictive Design

With the increasing prevalence of addictive design, ethical controversies have gradually emerged. Some studies have pointed out that such manipulative designs may weaken users' autonomous decision-making rights, especially for groups with weaker cognitive regulatory abilities, such as adolescents and the elderly [10].

Frequent use of social media and short-video platforms is often proven to induce anxiety, cognitive fatigue, and loneliness, and may even affect users' real-life social quality and psychological resilience [11]. This poses long-term risks to users' mental health [12].

Therefore, researchers have proposed that products should incorporate "soft-constraint mechanisms" such as informed choice, self-control, and usage-boundary reminders to achieve a balance between design ethics and user well-being [13]. These mechanisms emphasize users' subjective initiative, enabling them to maintain self-control and judgment even when induced by algorithms [14]. From an ethical design perspective, interdisciplinary work on the sharing economy further stresses that safeguards should preserve user autonomy while distributing benefits fairly [15].

2.3 Research Status of Moral Intervention

The concept of moral intervention has gradually emerged in recent years, advocating the introduction of behavior-limiting designs in the product development stage to counteract addictive mechanisms. For example, "non-deprivation design" suggests guiding users to use products moderately through reminders of usage duration and control of operation rhythm [16].

However, there are still significant limitations in the current research on moral intervention: most work is concentrated at the level of framework concepts or ethical principles, lacking systematic verification of specific interaction scenarios and user behavior responses. In addition, the impact of different prompting methods (such as language style and intervention timing) on user acceptance and behavior change is still unclear. Research has also found that some users may experience "prompt fatigue" after repeated exposure to prompts, and even develop resistance, thereby weakening the intervention effect [17].

3. Research Design and Methods

3.1 Research Model and Hypotheses

This study constructs a three-stage conceptual pathway centered on "addictive mechanisms–moral intervention–user response" to examine how embedding moral intervention mechanisms in mobile applications affects user behavior and psychological states. Within this pathway, addictive mechanisms and moral intervention constitute the two design dimensions, while user response is the outcome layer. Addictive mechanisms include infinite scrolling, variable rewards, and social feedback. Intervention mechanisms operate through duration reminders, excessive-reading prompts, and exit guidance. User responses are assessed at three levels: behavioral outcomes (usage duration and scrolling frequency), psychological outcomes (anxiety and dependency scores), and subjective attitudes (acceptance evaluation). Accordingly, the following hypotheses are proposed: H1: Moral intervention mechanisms significantly reduce users' immersive behavior; H2: Moral intervention mechanisms alleviate users' anxiety and dependency during use; and H3: Users demonstrate high subjective acceptance of moral intervention mechanisms.

3.2 Experimental Platform and Pre-test Validation

To test the above hypotheses, the research team developed a simulated news application featuring content browsing, recommendation algorithms, behavioral tracking, psychometric assessment, and questionnaire feedback functions. Two versions of the platform were designed: the control version included common addictive interface mechanisms such as infinite scrolling, algorithmic

recommendations, and social feedback (e.g., likes), while the experimental version retained these features and incorporated three additional intervention mechanisms: (1) timed usage reminders; (2) prompts after excessive continuous reading; and (3) exit suggestions accompanied by usage statistics and emotional indicators.

A total of 72 participants aged between 18 and 45 were recruited, including university students, office workers, and freelancers. After baseline registration and pre-test assessment, participants were assigned in a 1:1 ratio to the control group or the intervention group using a computer-generated random sequence with permuted blocks of six. This procedure produced 36 participants in each group while preventing self-selection into a study condition. All participants received the same standardized training on the platform's basic functions before the experiment.

This study employed the Generalized Anxiety Disorder 7-item scale (GAD-7) [18] and the short-form Self-rating Anxiety Scale (SAS) [19] as core instruments for psychological evaluation. Both are internationally standardized self-report measures with high reliability, validity, and cross-cultural applicability, and are suitable for use in non-clinical populations. They have been widely used to assess mental states in digital usage and network immersion contexts. The GAD-7 measures user anxiety experienced during platform interaction with a brief and user-friendly structure, while the short-form SAS evaluates psychological dependency on interface content, effectively capturing the self-regulation conflicts underlying immersive behavior.

Three categories of variables were assessed in this experiment: (1) behavioral variables – average usage time (minutes) and scrolling frequency (times); (2) psychological variables – GAD-7 and short-form SAS scores; and (3) subjective variable–user acceptance of intervention mechanisms rated on a 5-point Likert scale.

Table 1. Pre-test Data Comparison between Groups (n = 36 per group)

Indicator	Control Group	Experimental Group	t-value	p-value
Average usage time (minutes)	15.9±2.7	15.4±2.8	0.77	0.443
Scrolling frequency (times)	125±23	121±24	0.72	0.473
GAD-7 anxiety score	6.0±1.8	5.7±1.7	0.73	0.470
SAS dependency score	5.8±1.4	5.5±1.3	0.94	0.349

The pre-test comparisons in Table 1 showed no statistically significant baseline differences between the two groups for any primary outcome (all $p > 0.05$; absolute Cohen's d values ranged from 0.17 to 0.22), supporting baseline comparability.

3.3 Formal Experiment Procedure

During the formal experimental phase, participants completed one browsing session per day for five consecutive

days. Each session used 15 minutes as the reference duration, but participants could continue browsing or exit voluntarily so that the intervention's effect on actual usage duration could be observed. The platform automatically recorded daily usage duration and scrolling frequency, and five-day averages were calculated for analysis. Psychological measures were administered at baseline and immediately after the final session; the intervention group also completed the 5-point acceptance questionnaire after the experiment. Independent-samples t-tests were used for between-group

comparisons because the two groups contained different participants.

3.4 Expert Interview Design

To complement the experiment, three experts were recruited through purposive sampling: a senior UX designer with eight years of mobile-product experience, a psychologist with six years of research experience in digital behavior, and a digital-ethics scholar with more than ten years of research and teaching experience. None had participated in the platform development or quantitative analysis. Individual semi-structured interviews were conducted after the experimental results had been summarized. Each interview lasted 35–50 minutes and was audio-recorded with the participant's consent.

The interview guide addressed four dimensions: perceived mechanisms underlying immersive use; the likely effectiveness and intrusiveness of the three interventions; conditions affecting user acceptance; and principles for translating the intervention into commercial products.

Recordings were transcribed verbatim. Two researchers independently conducted open coding, compared their codes, resolved disagreements through discussion, and grouped the agreed codes into recurring themes. Expert evidence was used to interpret the experimental findings and derive design implications rather than to provide an additional statistical test of the hypotheses.

4. Results and Hypothesis Testing

This chapter reports the post-intervention behavioral, psychological, and subjective results used to test H1–H3. Table 2 summarizes the between-group comparisons. Independent-samples t-tests were conducted for the four primary behavioral and psychological outcomes. To control the family-wise Type I error rate, the four p-values were adjusted using the Holm–Bonferroni procedure. Cohen's d, calculated with the pooled standard deviation, was reported to indicate effect magnitude. All four comparisons remained statistically significant after adjustment.

Table 2. Post-intervention Group Comparison (n = 36 per group)

Indicator	Control Group	Experimental Group	t-value	p-value
Average usage time (minutes)	16.2±2.9	13.9±2.5	3.60	<0.001
Scrolling frequency (times)	128±24	102±20	4.99	<0.001
GAD-7 anxiety score	6.1±1.8	4.8±1.5	3.33	0.001
SAS dependency score	5.9±1.3	4.7±1.2	4.07	<0.001
Acceptance of intervention	—	4.2±0.6	—	—

4.1 Analysis of Behavioral Indicators

Behavioral variables represent the most direct evidence of the effectiveness of the intervention mechanism, encompassing two dimensions: average usage time and scrolling frequency, which respectively reflect the user's level of immersion and interaction intensity.

Experimental results show:

- The average usage time for the control group was 16.2 minutes (SD = 2.9), compared with 13.9 minutes (SD = 2.5) for the intervention group, $t(70) = 3.60$, raw $p < 0.001$, Holm-adjusted $p = 0.001$, Cohen's $d = 0.85$;
- The control group averaged 128 scrolls (SD = 24), whereas the intervention group averaged 102 (SD = 20), $t(70) = 4.99$, raw $p < 0.001$, Holm-adjusted $p < 0.001$, Cohen's $d = 1.18$.

These findings indicate that the intervention mechanisms reduced both time spent and interaction frequency on the platform. Scrolling frequency was approximately 20.3% lower in the intervention group than in the control group, and the corresponding effect size was large. Usage duration also

showed a large, standardized difference. Together, these results support H1. The duration reminder and excessive-reading prompt interrupted uninterrupted browsing, while the exit summary created an opportunity for reflective self-regulation.

4.2 Analysis of Psychological Indicators

Psychological indicators were assessed using two standardized self-report instruments: the GAD-7 scale and the short-form SAS scale, which evaluate anxiety levels and dependency tendencies, respectively. The core objective of this section is to test Hypothesis H2: whether the intervention mechanism has a regulatory effect on emotional states.

Statistical results indicate:

- GAD-7 anxiety score: 6.1 (SD = 1.8) for the control group and 4.8 (SD = 1.5) for the intervention group, $t(70) = 3.33$, raw $p = 0.001$, Holm-adjusted $p = 0.001$, Cohen's $d = 0.78$;
- SAS dependency score: 5.9 (SD = 1.3) for the control group and 4.7 (SD = 1.2) for the intervention group,

$t(70) = 4.07$, raw $p < 0.001$, Holm-adjusted $p < 0.001$, Cohen's $d = 0.96$.

Although participants were drawn from a non-clinical population and the mean scores remained in the mild range, both psychological outcomes differed significantly between groups after correction for multiple comparisons. The standardized effects were moderate to large, indicating that the differences were not limited to statistical significance. These findings support H2 while remaining limited to short-term changes observed in this five-day study. The pattern is consistent with the non-coercive "nudging" principle in behavioral economics [20], which emphasizes guidance without removing user choice.

4.3 Analysis of Subjective Acceptance and Perceived Effectiveness

In addition to objective metrics, subjective feedback variables were measured to assess user perceptions and attitudes toward the intervention mechanisms. A 5-point Likert scale was used, covering: perceived intrusiveness, helpfulness in self-regulation, desire to retain the intervention, and evaluation of prompt language and visual style.

The experimental group reported an average acceptance rating of 4.2 (SD = 0.6). Among participants, 86.1% selected "agree" or "strongly agree," while only 5.6% reported difficulty adapting. Most users considered the timing of prompts to be reasonable and the language to be mild, which did not disrupt the user experience and even triggered reflection. These results validate Hypothesis H3, suggesting that the intervention mechanisms are not only effective but also well-received by users.

4.4 Integrated Hypothesis Evaluation

Across the three outcome categories, the intervention group showed lower behavioral and psychological scores than the control group and reported high acceptance of the intervention. These results jointly support H1–H3. Because the present analysis is based on group-level comparisons and no individual-level correlation coefficients were estimated, no claim is made about correlations between changes in usage behavior and changes in psychological scores. Testing such relationships with Pearson correlations or multivariable models is reserved for future research.

Additionally, the interventions were intentionally designed to be mild and non-disruptive—avoiding forced logouts or extreme measures—thereby enhancing their applicability and potential for sustainable implementation in real-world digital platforms.

4.5 Summary

The results support the effectiveness of moral intervention mechanisms in regulating usage behavior, reducing short-

term psychological burden, and maintaining user acceptance in the experimental mobile application. H1–H3 were supported by the observed group differences and acceptance data. The Holm–Bonferroni procedure reduced the likelihood that significance resulted from multiple testing, and the reported effect sizes indicate moderate-to-large practical differences. These findings show that addictive design mechanisms can be ethically moderated and offer empirical guidance for responsible interface design.

5. Discussion and Design Implications

5.1 Summary and Interpretation of Core Findings

The controlled experiment showed that the intervention interface reduced usage duration and scrolling frequency relative to the control interface. The psychological measures followed the same direction, and the moderate-to-large effect sizes suggest practically meaningful short-term differences rather than significance driven only by sample size. The mean acceptance score of 4.2 out of 5 further indicates that participants generally accepted the intervention when it was mild and clearly communicated. These findings suggest that ethical intervention can alter the rhythm of interaction without relying on forced logout or content deprivation.

The expert interviews provided interpretive support for these quantitative findings. The thematic analysis converged on three themes: interventions should preserve user autonomy, prompts should be calibrated to the user's interaction rhythm, and ethical safeguards should be incorporated early in product development. A UX design expert summarized the first two themes as follows: "Users do not necessarily resist self-control; they often lack appropriate rhythm cues. The intervention mechanism helps them reconstruct a sense of time." The interviews are used here to explain the design implications of the experimental pattern rather than as an independent test of H1–H3.

5.2 Design Recommendations for Practice

Based on the experimental observations, participant feedback, and themes identified in the expert interviews, the following three recommendations are proposed for product design practice.

First, intervention mechanisms should aim to enhance users' self-regulation abilities rather than override their decisions. The data suggest that advisory or feedback-oriented prompts are better received, whereas coercive or interruptive designs may provoke user resistance. Designers are encouraged to use non-intrusive mechanisms such as visual statistics, duration progress bars, and staged reminders, allowing users to actively participate in the regulation process.

Second, the triggering conditions and frequency of interventions should dynamically adapt to users' usage

rhythm and mental states. Some users indicated that overly frequent prompts disrupted their cognitive flow, especially during high-focus tasks. Therefore, it is recommended to embed a 'rhythm control mechanism' in the interface system, using behavioral data to adjust thresholds and personalize reminder intervals.

Third, moral intervention strategies should be integrated early in the product design process rather than added post hoc. According to expert insights, early-stage intervention logic is more likely to be accepted by users. For instance, incorporating duration boundaries and pacing guidance during feature planning and prototyping stages not only avoids functional conflict later but also improves the natural integration and consistency of the user experience.

This chapter interpreted the principal findings and derived practical implications. The three recommendations—supporting rather than overriding user choice, adapting intervention timing to usage rhythm, and integrating ethical safeguards from the beginning of development—provide actionable directions for improving digital well-being and ethical responsibility in product interfaces.

6. Research Conclusion

This study focused on addictive interface mechanisms and moral intervention strategies, constructing a three-stage conceptual pathway of "addictive mechanisms–moral intervention–user response." Within this pathway, the first two components define the design comparison and the third captures behavioral, psychological, and attitudinal outcomes. The methodology combined platform development randomized experimental assignment, behavioral logging, psychological and acceptance measures, and semi-structured expert interviews.

Results from 72 participants showed that the intervention group had shorter usage duration, lower scrolling frequency, and lower anxiety and dependency scores than the control group. All four primary comparisons remained significant after Holm–Bonferroni correction, with Cohen's *d* values ranging from 0.78 to 1.18. The intervention received a mean acceptance rating of 4.2, and the expert interviews highlighted autonomy, rhythm-sensitive prompting, and early ethical integration as central design principles.

Taken together, the conceptual model, controlled experiment, participant feedback, and expert interpretation demonstrate the short-term feasibility, impact, and acceptability of mild moral interventions in mobile applications. The study therefore provides an empirical and practical basis for ethically responsible interface design while avoiding claims about long-term effects or individual-level behavioral–psychological correlations that were not tested.

7. Limitations and Future Directions

While the study indicates short-term regulatory effects of moral intervention, several limitations warrant further investigation. First, the experiment used a simulated news

application, which differs from commercial social-media and video platforms in interaction complexity, content dynamics, and social context. Second, the sample included adults aged 18–45 but did not cover adolescents or older adults, whose cognitive regulation and media literacy may differ. Third, the five-day observation period captures immediate responses rather than the durability of behavioral change. Fourth, the expert component involved only three purposively selected professionals; it was designed to interpret the experimental findings rather than to establish broad professional consensus. Finally, the available data supported group comparisons but not individual-level correlation or mediation analysis. Future studies should use longer follow-up periods, broader demographic samples, commercial-platform settings, larger expert panels, and person-level longitudinal models to examine sustainability, personalization, and the relationship between behavioral and psychological change.

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Ethics Statement

This study was reviewed and approved by the institutional ethics committee under approval No. YJY-EC-2025-401. All participants provided informed consent prior to participation, and the experimental procedures were conducted in accordance with applicable ethical principles for research involving human participants.

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