



Testing Targeted vs. Blanket Prompting Strategies and Small Immediate Incentives to Support Daily Health Habit Adherence in Autistic Children

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1. Study Information

1.1 Title

Testing the effects of targeted versus blanket prompting strategies and small incentives on daily health habit adherence in autistic children.

1.2 Research Questions

This pilot study investigates how different digital prompting strategies and immediate incentives affect adherence to daily health habits among autistic children using a mobile application. Specifically, we examine whether:

- 1) Targeted reminders for high-motivation habits produce spillover effects to other tracked habits.
- 2) Blanket reminding across all habit lapses creates alert overload and reduces engagement.
- 3) Small, immediate incentives enhance adherence and interact with prompting strategy.

2. Hypotheses

2.1 Primary Hypotheses

H1 (Targeted Prompts & Spillover Effect): When a child rates high motivation (>4 on a 5-point scale) for a specific habit, delivering a single targeted reminder only when that high-motivation habit lapses will increase adherence to that habit and produce spillover effects to the other two tracked habits through heightened awareness and momentum effects.

H2 (Alert Overload Hypothesis): Delivering reminders for every lapse across all three habits will result in alert fatigue, leading to decreased engagement (higher rates of notification ignoring and muting) and reduced overall adherence compared to targeted prompting, consistent with the principle that behavior change interventions should avoid overwhelming users with excessive prompts (Fogg, 2009).

H3 (Incentive Enhancement Hypothesis): Providing a small, immediate incentive for achieving adherence across all three habits on a given day will improve overall adherence rates in both targeted and blanket prompting conditions. The effect size may be larger in the targeted prompting condition due to reduced alert fatigue, aligning

with behavioral momentum theory and Fogg's behavior model emphasizing the importance of motivation and ability working in concert.

2.2 Theoretical Framework

This study draws on Fogg's Behavior Model, which suggests that behavior occurs when motivation, ability, and a prompt converge at the same moment. We theorize that:

- Targeted prompts leverage existing high motivation while minimizing cognitive load
- Blanket prompts may exceed users' ability to respond due to alert fatigue
- Immediate incentives boost motivation at critical decision points

Additionally, we draw on behavioral momentum theory (Nevin & Grace, 2000) to predict spillover effects, wherein successful completion of one habit increases the likelihood of engaging in other positive behaviors.

3. Methods

3.1 Participants

Sample size: N = 10 autistic children

Age range: 8-14 years old

Inclusion Criteria:

- Formal diagnosis of autism spectrum disorder (ASD)
- Access to a smartphone or tablet capable of running the study application
- Ability to provide assent with parent/guardian consent
- Basic literacy and numeracy skills sufficient to interact with app interface

Exclusion Criteria:

- Medical conditions preventing participation in daily exercise or dietary changes
- Current participation in other intensive behavior intervention studies

Recruitment: Participants will be recruited through autism support organizations, clinical referrals, and community advertisements. All families will provide informed consent and children will provide informed assent according to ethical guidelines for research with minors.

Baseline Assessment: Prior to study enrolment, we will collect information on:

- Communication supports currently used
- Reading level and comprehension abilities
- Sensory sensitivities relevant to notification design
- Baseline health habits and routines

3.2 Target Behaviors

Three daily health habits will be tracked:

- 1) Water Intake: Consume >2 liters of water daily
- 2) Fruit and Vegetable Consumption: Consume >5 servings daily
- 3) Physical Exercise: Engage in >30 minutes of physical activity daily

These habits were selected based on established health guidelines and feasibility of tracking through self-report and objective measures (World Health Organization, 2020).

3.3 Study Design

Design Type: Sequential crossover within-subject design with counterbalancing.

Rationale: Given the small sample size typical of pilot studies with clinical populations, a within-subject design maximizes statistical power while allowing each participant to serve as their own control (Barlow, Nock, & Hersen, 2009).

Study Phases: Each participant will complete five consecutive 30-day phases:

- Baseline (B): Habit tracking only, no reminders, with morning motivation/ability ratings
- Phase A (Targeted Prompts): Reminders sent only for lapses on habits rated as high motivation ($\geq 4/5$)
- Phase C (All-Lapse Prompts): Reminders sent for every lapse across all three habits
- Phase A+I (Targeted + Incentive): Targeted prompts plus SGD\$1 incentive for achieving all three habits
- Phase C+I (All-Lapse + Incentive): Blanket prompts plus SGD\$1 incentive for achieving all three habits

Counterbalancing: Participants will be randomly assigned to one of two sequences to control for order effects:

- Sequence 1 (n=5): B $\rightarrow$ A $\rightarrow$ C $\rightarrow$ A+I $\rightarrow$ C+I
- Sequence 2 (n=5): B $\rightarrow$ C $\rightarrow$ A $\rightarrow$ C+I $\rightarrow$ A+I

Washout Period: A 2-day buffer period (tracking only, no reminders) will be implemented between phases to minimize carryover effects.

Total Duration: Approximately 18 weeks per participant (including buffer periods)

3.4 Intervention Components

3.4.1 Morning Motivation and Ability Assessment

Each day between 07:00 - 9:00, participants will rate their motivation and perceived ability for each of the three habits on 5-point Likert scales:

- Motivation: "How much do you want to do [habit] today?" (1 = Not at all, 5 = Very much)
- Ability: "How easy do you think [habit] will be today?" (1 = Very hard, 5 = Very easy)

These daily assessments capture dynamic variations in motivation and ability, key constructs in Fogg's Behavior Model (Fogg, 2009).

3.4.2 Lapse Definition and Checkpoint System

Water Intake:

Checkpoint 1 (12:00): ≥ 1 liter consumed

Checkpoint 2 (19:00): ≥ 2 liters consumed

Fruit/Vegetable Consumption:

Checkpoint (19:00): >5 servings consumed

Exercise:

Checkpoint (19:00): >30 minutes completed (via wearable device integration or manual log)

A "lapse" is defined as failing to meet the checkpoint criterion at the designated time.

3.4.3 Prompting Rules by Phase

Phase A (Targeted Prompts):

- If morning motivation rating ≥ 4 for a habit AND that habit's checkpoint is missed $\rightarrow$ send one gentle reminder shortly after checkpoint time
- Timing: 12:05 for water checkpoint 1; 17:00 for exercise/fruit-veg if still at zero
- Maximum one reminder per habit per day
- No reminders for habits rated < 4 motivation

Phase C (All-Lapse Prompts):

- For any missed checkpoint on any habit $\rightarrow$ send one reminder per habit
- Maximum three reminders per day (one per habit)

Overload Protection (All Phases):

- Daily maximum reminders = 3
- If ignore rate exceeds 80% for two consecutive days, auto-throttle to maximum 1 reminder the following day

This adaptive approach aligns with user-centered design principles for autism accommodation (Spiel, Frauenberger, Hornecker, & Fitzpatrick, 2017)

3.4.4 Incentive System

Phases A+I and C+I only:

- End-of-day check (20:00-20:30): If all three habits achieved (3/3 adherence) $\rightarrow$ immediate incentive delivered
- Incentive value: SGD\$1 equivalent
- Reward options: Stationery items or candy (child chooses preferred type during setup)
- Delivery: Digital credit or physical reward based on family preference

The immediate nature of the incentive aligns with principles of effective reinforcement for children with autism (Leaf et al., 2016).

3.4.5 Notification Design (Autism-Friendly)

Following accessibility guidelines for autistic users (Spiel et al., 2017):

- Plain language messages

- Predictable timing aligned with checkpoint system
- Visual supports (icons representing each habit)
- No surprise sounds or animations
- Caregiver configuration screen for customization
- Child choice in notification style and reward type

3.5 Outcome Measures

3.5.1 Primary Outcomes (Daily Assessment)

Adherence Metrics:

- Binary adherence per habit (achieved = 1, not achieved = 0)
- Overall daily adherence (all three habits achieved = 1, otherwise = 0)
- "All-green days" percentage (proportion of days with 3/3 adherence)

Spillover Index:

- Change in adherence for non-reminded habits (Y and Z) on same day and next day following a reminder for habit X

3.5.2 Engagement and Overload Indicators

- App opens per day
- Check-ins completed (morning surveys and habit logging)
- Notification ignore rate (no tap within 10 minutes of delivery)
- Snoozes and mutes per phase
- Changes to notification settings
- Time to respond to notifications

3.5.3 Self-Report Measures

Daily (Optional Evening Re-Rating):

- Motivation and ability ratings for each habit (1—5 scales) End-of-

Phase Mini-Survey:

- Fatigue: "How tired did the reminders make you feel?" (emoji scale 1-5)
- Usability: "How easy was the app to use?" (emoji scale 1—5)
- Helpfulness: "Did the reminders help you?" (emoji scale 1—5)

3.5.4 Safety and Feasibility

- Adverse events log (parent-reported)
- Frustration incidents (in-app reporting option)
- Parent feedback comments (weekly brief surveys)
- Data completion rates

- Technical issues log

3.6 Data Collection and Management

Application Features:

- Quick-tap tiles for habit tracking (water in mL, servings as counts, exercise in minutes)
- Child-friendly dashboard showing streaks and progress
- Caregiver dashboard with weekly summary reports (view-only, no retroactive editing permitted)

Data Storage:

- On-device storage with encrypted cloud synchronization
- All data de-identified with study ID codes
- Secure server storage compliant with data protection regulations

Data Export Format:

CSV file containing: child ID, date, phase, adherence flags (3 binary variables), motivation ratings (3 variables), ability ratings (3 variables), reminders sent (by habit), app opens, taps, ignore/mute flags, incentive earned (binary)

3.7 Analysis Plan

3.7.1 Unit of Analysis

Child-day observations approximately 1,280 child-days across N=10 participants and 128 intervention days each)

3.7.2 Primary Analysis

Hypothesis 1 (Spillover effect):

Mixed-effects logistic regression model:

- Outcome: Adherence to habits Y and Z (binary)

Hypothesis 2 (Alert overload)

Compare Phase C over Phase A on:

- Overall adherence rate (mixed-effect logistic regression)
- Notification ignore rate (mixed-effects Poisson or linear models)
- Mutes and notification setting changes (descriptive statistics and paired comparisons)
- App opens per day (mixed-effects linear model)

Model specification:

- Outcome: Ignore rate, adherence, or engagement metric

Hypothesis 3 (Incentive effects)

Compare incentive phases to non-incentive phases:

- A+I vs. A: Change in all-green days percentage, per-habit adherence, engagement
- C+I vs. C: Change in all-green days percentage, per-habit adherence, engagement

Mixed-effects models:

- Outcome: All-green days (binary), individual habit adherence (binary)

3.7.3 Secondary and Exploratory Analyses

Single-Case Analysis:

For each child, compute Tau-U non-overlap indices comparing:

- Phase A vs. Baseline
- Phase C vs. Baseline
- Aggregate across participants and assess individual variability

Effect Size Estimation:

All effects will be reported with 95% confidence intervals using standardized effect size metrics:

- Odds ratios for binary outcomes
- Cohen's d for continuous outcomes
- Tau-U for single-case comparisons

Descriptive Analyses:

- Phase-by-phase adherence trajectories (individual and group-level plots)
- Temporal patterns in motivation and ability ratings
- Relationship between morning motivation/ability and same-day adherence

3.7.4. Missing Data

Multiple imputation will be used if missing data exceeds 10% and data are determined to be missing at random.

Sensitivity analyses will compare complete-case analysis with imputed results.

3.7.5. Pilot Study Reporting

Following CONSORT guidelines adapted for pilot studies (Eldridge et al., 2016), we will report:

- Feasibility metrics: proportion of days with completed check-ins, missing rates
- Acceptability metrics: fatigue scores, usability ratings, retention rates
- Preliminary effect estimates with 95% confidence intervals
- Variance estimates to inform future sample size calculations

3.8 Success Criteria

Feasibility Benchmarks:

- $\geq 80\%$ of study days with completed morning check-ins
- $< 20\%$ of days flagged as "overloaded" (exceeding ignore rate threshold)
- $\geq 80\%$ participant retention through all study phases
- Signal Detection:
 - Point estimates favor Phase A over Phase C for engagement metrics
 - Phase A shows equal or better adherence than Phase C
 - Incentive phases (+I) show increased all-green days in both prompting conditions

Acceptability:

- Median fatigue rating <2 on 5-point scale
- $\geq 80\%$ of participants indicate willingness to continue using app
- No serious adverse events or significant frustration incidents

3.9 Ethical Considerations

Ethics Approval: This study will be submitted for ethics review by [Institution IRB] prior to participant recruitment.

Informed Consent/Assent:

- Parents/guardians will provide written informed consent
- Children will provide age-appropriate informed assent
- Ongoing assent will be monitored; children may withdraw at any time without consequence

Autism-Specific Considerations:

- De-emphasis on perfection; celebration of partial successes (e.g., 20 minutes of exercise acknowledged as progress)
- Framing as "skills building" rather than compliance monitoring
- Child agency prioritized: ability to customize notification preferences and choose reward types
- Predictable routines maintained throughout study
- Visual supports and plain language in all communications
- Data Privacy:
 - Minimal identifiable information collected
 - Data encrypted in storage and transmission
 - Parents can view but cannot retroactively edit child entries
 - Data access limited to research team

Risk Mitigation:

- Auto-throttling to prevent notification overload
- Parent monitoring dashboard to identify distress
- Established protocol for discontinuation if child shows signs of stress
- Regular check-ins with families

4. Timeline

Study Preparation: Weeks 1-8

- Ethics approval
- App development and testing
- Pilot testing with 2 families (not included in final sample)

Recruitment and Baseline: Weeks 8-12

- Participant recruitment
- Consent/assent process
- Baseline assessment and app setup

 Intervention Period: Weeks 12-40

- Staggered enrolment with rolling start dates
- Active data collection across all phases
- Weekly family check-ins Data

Analysis: Weeks 40-44

- Data cleaning and validation
- Statistical analyses
- Single-case and group-level summaries

Dissemination: Weeks 44-50

- Manuscript preparation
- Results shared with participating families
- Presentation at relevant conferences

5. Sampling Plan

5.1 Justification for Sample Size

This pilot study employs $N = 10$ participants, consistent with recommendations for feasibility studies in clinical populations (Billingham, Whitehead, & Julious, 2013). With approximately 128 intervention days per participant across four intervention phases (A, C, A+I, C+I), this design yields approximately 1,280 child-day observations for analysis. This sample size provides adequate precision to:

- Estimate effect sizes and variance components for future definitive trials
- Assess feasibility and acceptability metrics
- Detect moderate-to-large effects using within-subject comparisons
- Conduct individual-level (single-case) analyses supplementing group-level inferences The within-subject crossover design substantially increases statistical power compared to between-subjects designs with equivalent sample sizes (Barlow et al., 2009).

5.2 Stopping Rules

Early Termination Conditions:

- If more than 50% of participants withdraw during the first two phases
- If serious adverse events occur that are plausibly related to study procedures
- If technical failures prevent reliable data collection for >30% of study days

Individual Withdrawal:

- Participants may withdraw at any time without providing justification
- Data collected up to withdrawal will be included in intention-to-treat analyses where appropriate

6. Other

6.1 Conflicts of Interest

The author declares that there are no conflicts of interest related to this study. The author has no financial, personal, or professional relationships that could be perceived as influencing the research design, data collection, analysis, or interpretation.

6.2 Funding

At the time of submission, this study has not received external funding. The author is actively seeking funding to support application development, participant incentives, and data management. The study design, hypotheses, and analysis plan have been specified independently of any funding source. Any future funding obtained will be disclosed in subsequent stages of the registered report.

6.3 Pre-Registration Status

This study is pre-registered prior to data collection. Any deviations from this protocol will be documented and reported in resulting publications. Registration DOI: OSF.IO/VSGJE

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