

Adherence to a 6-Week Study of Wearable Digital Mood and Cognitive Assessments in Depression: Qualitative Insights

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Background

Digital technology has promise in delivering insights into psychiatric conditions such as depression by enabling assessment of mood and cognitive symptoms in a patient's daily life. The utility of these methods may be limited by patient adherence with frequent testing or wearing of sensing technology. Here we describe qualitative data that aimed to enhance our understanding of participants' experiences of longer term use of digital cognitive assessments with wearable technology. We explored why participants choose to engage with digital health assessments, and motivations and factors influencing adherence to a daily testing regimen over 6 weeks.

Methods

Participants: Thirty adults aged 19-63 with mild-to-moderate single or recurrent major depressive episode(s) prescribed antidepressant monotherapy were enrolled (baseline characteristics in Table 1).

Study Design: A single-arm, 6-week prospective observational feasibility study, designed to assess the feasibility and compliance with a novel method for assessing mood and cognition in participants with major depressive disorder. A schematic of the study procedures and assessments is shown in Figure 1.

Daily Assessments:

Brief cognitive (Cognition Kit n-back) and mood assessments were administered through the Cognition Kit application on Apple Watch (Figure 2).

Full-length Assessments:

- Web-based (weeks 1, 3, and 6):** Cognitive performance measured with CANTAB working memory (SWM) and attention (RVP) tests. Patient-reported outcomes (PRO) included measures of depression symptom severity (Patient Health Questionnaire - PHQ-9), social function (UCLA-Loneliness Scale), and perceived cognitive difficulties (Perceived Difficulties Questionnaire).

Qualitative Interviews:

- On-site (week 1) and home-based (week 6):** Semi-structured interview examined participants' experiences with wearable assessments, why they chose to engage with the study, and motivations and factors influencing adherence.

Data Analysis:

- Thematic analysis was completed in three stages using an interpretative phenomenological analysis (IPA)¹ framework: (1) data familiarization; (2) identification of key issues and concepts; (3) clustering and organizing themes, defining the main concepts and mapping the ways in which different parts of the data relate to each other.

Figure 2: Cognition Kit study materials



Daily Cognitive Assessment (up to 3x day)
The Cognition Kit n-back test asked participants to respond by touching the watch face when they see a symbol that matches the one presented two trials previously (2-back).
• Average daily n-back score (d-prime) was obtained.

Daily Mood Assessment (1x day)
Participants are asked: "How much have the following problems bothered you over the past day?"
• Lack of interest or pleasure in doing things
• Feeling down, depressed or hopeless
• Trouble concentrating on things (e.g., newspaper, TV)
• Scores for individual items are from 1 (no problem) to 4 (greatly)
• Scores are summed to produce a Total Mood Score.

Top watch image: example of cognitive assessment; bottom: mood assessment

Results

Patient Characteristics

Table 1: Participant demographic characteristics at baseline

| | N | % | Mean | SD | Min | Max |
|--|-------|--------|------|------|-----|-----|
| Sex (female) | 19/30 | 63% | | | | |
| Age | 30 | | 37.2 | 10.4 | 19 | 63 |
| PHQ-9 score | 30 | | 9.1 | 3.1 | 5 | 15 |
| Comorbid anxiety | 20/30 | 66.7% | | | | |
| Time on medication (months) | 30 | | 9.9 | 9.5 | 0.4 | 94 |
| Previous antidepressant medication switch | 24/30 | 80% | | | | |
| Current medication type | N | (%) | | | | |
| Serotonin antagonist and reuptake inhibitor (SARI) | 1 | 3.30% | | | | |
| Serotonin and norepinephrine reuptake inhibitor (SNRI) | 5 | 16.70% | | | | |
| Selective serotonin reuptake inhibitor (SSRI) | 20 | 66.70% | | | | |
| Tricyclic antidepressants (TCA) | 4 | 13.30% | | | | |

Compliance With Daily Assessment

Compliance results are shown in Figures 3 and 4, plotting individual participants (y axis), by daily compliance during the 6-week study period (x-axis); yellow squares show days with completed assessments, black squares show where they are missed.

Daily Mood Assessments:

- Self-reported mood was available to complete once per day.
- 50% of participants achieved 100% compliance, completing all assessments; overall compliance was 94.6%.

Daily Cognitive Assessments:

- Participants completed up to three Cognition Kit n-back sessions per day. A median of two assessments were completed daily.
- 70% of participants achieved 100% compliance. Overall, cognitive assessment was completed on 96% of study days.
- In week 5, compliance reached 100%, with all study participants completing at least one n-back session daily.

Figure 3: Mood: individual participant compliance

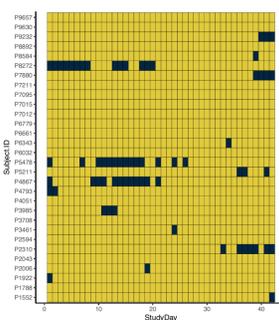
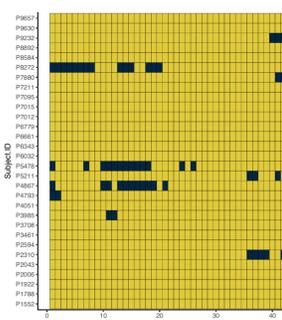


Figure 4: Cognition: individual participant compliance



Qualitative Insights

- Participants adhered to the testing regimen with varying degrees of ease, enjoyment, and perceived benefit. We identified four main themes contributing to participants' continued adherence. These included: (1) Context (2); Motivation; (3) Study features; and (4) Impact (Figure 5).
- Adherence was influenced by contextual factors including moods, daily routines, and social and physical environment.
- Many patients expressed personal motivations of enhancing knowledge of depression or gaining self-insight. The in-app feedback functionality, which displayed scores after each cognitive assessment, supported this aim of self-insight and served as a motivator.
- Participants were motivated by the luxury status of the device, although short battery life was an obstacle to adherence. The technology was experienced as discreet, quick, and easy to use.
- Assessment burden was deemed acceptable over the 6-week time-frame, helped by the brevity of each individual assessment.
- Study participation had diverse effects on participant well-being, with some feeling increased anxiety, whereas others report a sense of accomplishment. The extent to which people reported a benefit was overall linked to their expectations for self-insight, behavior change, and their personal use of the trial data.

Figure 5: Themes emerging from the IPA analysis of the semi-structured interviews and examples of specific participant experiences.

| Theme | Sub-themes |
|----------------|---|
| Context | <ul style="list-style-type: none"> Habit formation Mood Testing environment |
| Motivation | <p>Intrinsic factors:</p> <ul style="list-style-type: none"> Increase self-knowledge Alternative treatments Self-accomplishment <p>Extrinsic factors:</p> <ul style="list-style-type: none"> Device prestige Financial remuneration Fixed endpoint Scientific commitment |
| Study features | <ul style="list-style-type: none"> Study entry session Apple Watch Device notifications Assessment frequency Cognition n-back task Mood questionnaire |
| Well-being | <ul style="list-style-type: none"> Participant benefit Anxiety |

Context: Participant P3708 paired their study sessions with existing daily routines: waking up, eating lunch, and going to bed. They managed to complete most tasks at the same time each day, with low mood levels and a "hectic" household being the biggest barriers to motivation and adherence.

Motivation: Participant P1788 felt constrained by the Apple Watch due to its battery life, large size, and the way it constantly connected them online. The mood questions were also burdensome, a daily reminder of their depression. However, their motivation was sustained by seeing, and then wishing to maintain, improvement with the two-back task, along with their commitment to the study, both of which contributed to high levels of compliance.

Study features: For participant P2006, the n-back task was quick and engaging, making it easy to complete three times a day. The variety of different stimuli used also "refreshed" an otherwise repetitive task. They appreciated how the mood questions prompted self-reflection, and wanted to see as much personal data as possible in their end-of-study report. Together, these features helped to sustain motivation and adherence over the 6-week study.

Well-being: Participant P6779 found that the daily tasks brought a new and welcome routine, igniting their alertness in the mornings, and drawing them out to be more engaged during the day. It made the participant feel that they could have an impact in daily life, even distracting them away from their depression and lifting their mood.

Conclusions

- Our study suggests good acceptance of wearable cognitive and mood assessment technology using the Apple Watch.
- The qualitative themes identified show some overlap with previous research in smartphone-based digital health assessments, with discretion of the wearable technology as well as desirability of the smartwatch providing additional motivation in the current study.
- Usability of health technology has been noted as a major contributor to engagement, and a primary predictor of drop-outs. Optimizing the balance between assessment burden and a monitoring schedule that captures the measures and processes of interest is of importance for supporting adherence in high-frequency assessment studies. The current results have implications for digital health development and design, identifying factors and features supporting patient adoption, motivation, and engagement.

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