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Jeroen Dennis Merlijn Weermeijer[1] MSc; Martien Wampers[1] PhD; Lena de Thurah[1] MSc; Rafaël Bonnier[1] MSc; Maarten Piot[2] MSc; Peter Kuppens[2] PhD; Inez Myin-Germeys[1] PhD; Glenn Kiekens[1] PhD

[1]Center for Contextual Psychiatry KU Leuven Leuven BE
[2]Quantitative Psychology and Individual Differences KU Leuven Leuven BE

Corresponding Author:
Jeroen Dennis Merlijn Weermeijer MSc
Center for Contextual Psychiatry
KU Leuven
Herestraat 49 ON5B bus 1029
Leuven
BE

Abstract

Background: Although mental health problems occur in interaction with the natural environment, bringing this contextualized information into the therapy room is challenging. The experience sampling method (ESM) may facilitate this by assessing clients' thoughts, feelings, symptoms, and behavior as they are experienced in everyday life. However, ESM is still primarily used in research settings with little uptake in clinical practice. One aspect that may facilitate clinical implementation concerns the use of 'ESM protocols', which involves providing practitioners with ready-to-use ESM questionnaires, sampling schemes, visualizations, and training.

Objective: This pilot study's objective was to evaluate the usability of an ESM protocol in clinical practice using a mixed-methods approach.

Methods: In this pilot study, we created an ESM protocol and tested its usability in clinical practice. The ESM protocol was tailored to the m-Path software platform, consisting of a dashboard for practitioners and an app for clients. The dashboard was used to configure an ESM questionnaire template we designed. Additionally, the dashboard contained custom data visualizations that were made based on end-user feedback. The app was used for completing ESM assessments. A total of 8 practitioners and 17 clients used ESM in practice between December 2020 and July 2021. Usability was assessed using questionnaires, ESM compliance rates, and semi-structured interviews.

Results: The usability was overall rated reasonable to good by practitioners (Mean scores to usability items ranging from 5.33 [SD = 0.91] to 6.06 [SD = 0.73] on a cale from 1 to 7]). However, practitioners expressed difficulty personalizing the template and reported insufficient guidelines on how to use ESM in clinical practice. On average, clients completed 55% (SD=25%) of the ESM questionnaires. They rated the usability as reasonable to good but slightly lower and more variable than the practitioners (mean scores to usability items ranging from 4.18 [SD = 1.7] to 5.94 [SD = 1.5] on a cale from 1 to 7). Clients also voiced several concerns over the piloted ESM template, with some indicating no interest in the continued use of ESM.

Conclusions: The findings suggest that using an ESM protocol may facilitate the implementation of ESM as a mobile health assessment tool in psychiatry. However, further adaptions should be made prior to further implementation. Adaptions include training on personalizing questionnaires, adding additional sampling scheme formats, and creating a dynamic data visualization interface. Future studies should also identify factors determining the suitability of ESM for specific treatment goals among different client populations.

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Usability of the experience sampling method in specialized mental healthcare: A pilot study

Jeroen Weermeijer (MSc)[1], Martien Wampers (PhD)[1], Lena De Thurah (MSc)[1], Rafaël Bonnier (MSc)[1], Maarten Piot (MSc)[2], Peter Kuppens (PhD)[2], Inez Myin-Germeys (PhD)[1], Glenn Kiekens (PhD)[1,3,4].

1 Center for Contextual Psychiatry, KU Leuven, Leuven, Belgium

2 Quantitative Psychology and Individual Differences, KU Leuven, Leuven, Belgium

3 Research Unit of Clinical Psychology, KU Leuven, Leuven, Belgium

4 Department of Medical and Clinical Psychology, Tilburg University, Tilburg, The Netherlands

Correspondence concerning this article should be addressed to Jeroen Weermeijer, KU Leuven, ON5 Herestraat 49 - box 1029, 3000 Leuven, Belgium. Email: jeroen.weermeijer@kuleuven.be

Abstract

Background

Although mental health problems occur in interaction with the natural environment, bringing this contextualized information into the therapy room is challenging. The experience sampling method (ESM) may facilitate this by assessing clients' thoughts, feelings, symptoms, and behavior as they are experienced in everyday life. However, ESM is still primarily used in research settings with little uptake in clinical practice. One aspect that may facilitate clinical implementation concerns the use of 'ESM protocols', which involves providing practitioners with ready-to-use ESM questionnaires, sampling schemes, visualizations, and training.

Objective

This pilot study's objective was to evaluate the usability of an ESM protocol for using ESM in a specialized mental healthcare setting.

Method

We created the ESM protocol on the m-Path software platform and tested its usability in clinical practice. The ESM protocol consisted of a dashboard (i.e., including the setup of the template and data visualizations) for practitioners and an app for clients (i.e., for completing ESM questionnaires). A total of 8 practitioners and 17 clients used ESM in practice between December 2020 and July 2021. Usability was assessed using questionnaires, ESM compliance rates, and semi-structured interviews.

Results

The usability was overall rated reasonable to good by practitioners (Mean scores to usability items ranging from 5.33 [SD = 0.91] to 6.06 [SD = 0.73] on a scale from 1 to 7]). However, practitioners expressed difficulty personalizing the template and reported insufficient guidelines on how to use ESM in clinical practice. On average, clients completed 55% (SD=25%) of the ESM questionnaires. They rated the usability as reasonable to good but slightly lower and more variable than the practitioners (mean scores to usability items ranging from 4.18 [SD = 1.7] to 5.94 [SD = 1.5] on a scale from 1 to 7). Clients also voiced several concerns over the piloted ESM template, with some indicating no interest in the continued use of ESM.

Conclusion

The findings suggest that using an ESM protocol may facilitate the implementation of ESM as a mobile health assessment tool in psychiatry. However, further adaptions should be made before further implementation. Adaptions include training on personalizing questionnaires, adding additional sampling scheme formats, adding an open-text field, and creating a dynamic data visualization interface. Future studies should also identify factors determining the suitability of ESM for specific treatment goals among different client populations.

Keywords: Experience Sampling, Ecological Momentary Assessment, Implementation, digital mental health

Word count: 382

Introduction

Mental problems are inextricably linked to daily life, meaning they do not exist in a vacuum but are influenced by our everyday activities, environments, and social interactions. For example, for individuals diagnosed with schizophrenia spectrum disorder, work-related activities may decrease

hallucinatory intensity over time [1]. In contrast, paranoid ideation may develop in response to the social environment [2] or stress [3]. This indicates that mental health problems can best be understood when they are investigated in the context in which they occur: a client's daily life. Unfortunately, however, practitioners are confined to the brick-and-mortar walls of their therapy room and must rely on the clients' ability to retrospectively report their feelings, thoughts, and behaviors. This approach may provide only partial insights due to selective or incomplete recall biases [4], as one cannot expect clients to accurately remember and share all relevant daily life experiences and associated emotions or symptoms. Therefore, complementary tools that can aid clients in reliably sharing their daily life experiences with their practitioners could be valuable for clinical practice. For instance, such tools may benefit therapy by increasing insight into the contextual variability of mental health problems as they are observed across different contexts in people's daily life. While this was not feasible for many decades due to practical restrictions, the facilitation of smartphone technologies can now enable practitioners and clients with new digital tools to bring this highly relevant information into the therapy room.

The Experience Sampling Method (ESM; [5][6][7]) is a structured diary technique that involves using smartphone apps to assess thoughts, feelings, symptoms, and behavior in clients' daily environments. Individuals are prompted to complete a brief questionnaire multiple times a day for several consecutive days. The questionnaire is completed 'in the moment' and typically contains questions about people's momentary thoughts, feelings, symptoms, behavior, and situational circumstances (e.g., 'Who are you with?', 'Where are you?'). Individuals may also be asked to rate sleep quality in the morning or evaluate the day in the evening.

The ESM may have value for clinical practice for several reasons. First, the real-time assessment of ESM questionnaires implies that the risk of recall bias is reduced compared to traditional assessment methods such as clinical interviews or retrospective questionnaires [8][9]. Second, through self-monitoring multiple times per day, ESM may increase self-insight and

emotional self-awareness [10]. In a similar vein, ESM may also help identify protective factors in the environment that may facilitate resilience, such as social networks that can provide support in moments of high distress [11]. Third, ESM may help practitioners explore and develop hypotheses about the underlying factors for mental health problems. Similarly, ESM could be used to evaluate whether the provided treatment has the desired effects on clients' everyday lives (e.g., improved mood and reduced symptoms), and, if required, to make changes to the treatment plan collaboratively with clients [6].

Emerging evidence shows that mental health practitioners and clients recognize ESM's potential advantages and are generally interested in using it in clinical practice [12][13], although some findings also suggest that practitioners may not adopt ESM more readily than traditional assessment tools [14]. However, clients might be more favorable toward the actual use of ESM in clinical practice than practitioners [15]. For instance, meta-analyses found good compliance rates to ESM questionnaires — above 75% on average — among clinical samples [16]. However, implementing ESM in mental healthcare has proven challenging as implementation attempts so far have failed to instigate continued or far-reaching use [15][17][18][19]. One possible reason for this may be that the ESM software in use was originally designed for research purposes without the involvement of input from practitioners and clients. This can lead to usability problems when implementing the software in clinical practice. For instance, previous studies have highlighted that practitioners found the ESM software to be too time-intensive and not intuitive, making it challenging to effectively utilize ESM data for clinical purposes [19]. These findings suggest that an in-depth investigation into end-user software requirements may be necessary before using ESM as a clinical tool in mental health care becomes feasible.

In response to the lack of end-user perspectives on clinical ESM software requirements, we recently conducted a qualitative focus group study with mental healthcare practitioners to understand better how they wanted to use ESM and which elements this would require [20]. One important

finding that emerged was the need for 'ESM templates' detailing the ESM questionnaire content and sampling schedule so practitioners do not need to develop this for each client. At the same time, practitioners stressed that personalization should still be possible, such as creating new ESM items or tailoring a client their schedule. Furthermore, they recommended using intuitive data visualizations such as line graphs depicting mood variability over time or pie charts displaying the frequency of contact with others (e.g., family vs. friends). Finally, practitioners expressed a need for training and guidelines on using ESM templates, personalization, and data visualizations. Similar findings were recently found in a survey among 89 practitioners [13].

While these initial findings offer some insights into the requirements of software for clinical ESM applications (e.g., templates, intuitive data visualization) and the implementation strategies more generally (e.g., need for user training), it is important to consider that practitioners had no prior experience with using ESM in clinical practice. Therefore, whether accommodating these identified needs will make ESM effectively usable in routine mental health care (i.e., intended versus actual use) remains to be investigated. Hence, a practical next step is to create an *ESM protocol* based on these recommendations and evaluate end-user experiences by piloting the ESM protocol with practitioners and clients before wider dissemination [21]. Such a multi-tiered approach provides meaningful information about experienced barriers, facilitators, and requirements for future ESM implementation efforts. To this end, we designed a protocol called IMPROVE ('IMplementing Personalized Real-time mOnetoring in eVeryday life), in which ESM templates containing scheduled ESM questionnaire content and sampling schedules can be tailored to the needs of clients who self-monitor for a week using the ESM app. The collected information is automatically visualized through intuitive visualizations on the practitioner their dashboard. The dashboard and app were made in collaboration with the m-Path software platform [22], and the user training and guidelines were based on previous work [12][20].

Objective

This pilot study's objective was to evaluate the usability of IMPROVE. Specifically, we were interested in whether the IMPROVE dashboard and app were considered acceptable and easy to use and whether practitioners and clients were satisfied with the user-interface design. For clients, and while thresholds are somewhat arbitrary [23], we also wanted to investigate whether they would complete at least one-third of the assessments. Additionally, we were interested in practitioners' and clients' perspectives on the ESM items and sampling scheme, options for personalization, the design of the dashboard and data visualizations, and the training material. To accomplish these objectives, we used a mixed-methods approach for which the analysis plan was pre-registered [24].

Methods

Participants

The study targeted mental health professionals working at KU Leuven's University Psychiatric Centre in the Flanders region of Belgium. Practitioners were recruited exclusively via email due to COVID-19 restrictions at the time of recruitment. To be eligible for participation, practitioners had to be either certified psychiatrists or psychologists working with clients suffering from mental health problems and have good Dutch language proficiency. Practitioners recruited clients into the study based on their assessment of whether IMPROVE would be helpful for the presented client. Clients were only required to be 18 years or older, receive residential or ambulant mental health care, have good Dutch language proficiency, and own a smartphone with at least 3G coverage. We employed these broad selection criteria to ensure a comprehensive and realistic assessment of the usability of IMPROVE across clients presenting with different mental health problems and at different treatment stages.

Procedure

Practitioners first provided written informed consent and completed an enrolment questionnaire assessing sociodemographic information. Following this, practitioners received a

manual on how to use ESM. The manual included creating an account on the ESM dashboard, setting up their account to access the ESM questionnaire content and sampling schedule, enrolling a client, adjusting or creating questionnaires/sampling schemes, and visualizing data paired with interpretation examples. Additionally, practitioners could join a one-hour online training session with a research team member, which covered the same topics as the manual. Once practitioners were familiar with using the ESM dashboard, we requested them to use it with several clients in their clinical practice.

The practitioners informed clients about the study, and if a client showed interest, they asked them to read and sign the informed consent form (as the research team was not allowed access to the hospital due to the COVID-19 pandemic). Following informed consent, clients completed enrolment questionnaires that assessed demographic and clinical variables. Afterward, clients installed the m-Path smartphone app, which was used to trigger the ESM questionnaires. The practitioners could personalize the ESM questionnaires for the client using the m-Path dashboard. After one week of ESM, practitioners and clients were requested to discuss visualizations of the client's data during the subsequent clinical session utilizing the dashboard. To assess any operational difficulties or bugs, we phoned practitioners bi-weekly for routine check-ins during which they could report technical problems or difficulties with using the software.

At the end of the implementation period, clients and practitioners were provided with questionnaires assessing the usability of IMPROVE software and invited to participate in a semi-structured interview. The interview allowed us to capture more rich information about the experiences of practitioners and clients regarding the use of ESM. The pilot study took place between December 2020 and July 2021 and was in accordance with the Ethical Principles of the American Psychological Association [25].

Materials

IMPROVE dashboard, app, and training material

The IMPROVE Protocol used m-Path's ESM software platform [22], which consists of an app to deliver ESM questionnaires and a dashboard on which ESM questionnaires can be made and data visualized. Specifically, making use of the custom-made 'ESM template' feature (developed by m-Path for this project), we provided practitioners with an ESM template that contained a ready-to-use ESM questionnaire that followed a predefined sampling scheme (i.e., 10 ESM assessments per day for six days + morning/evening assessment). The ESM monitoring period started one day after a client had downloaded the ESM app and registered with their practitioner. In addition, the template could be personalized as practitioners could add a maximum of three ESM questions from a library, adjust existing multiple-choice options to include more answer options (e.g., Who are you with?), and modify the sampling schedule to fit sleep-wake patterns. The ESM content consisted of a morning questionnaire assessing sleep quality and motivation to start the day, an evening questionnaire evaluating people's day overall, and an ESM questionnaire containing questions on mood, location, and activity (Table 1.). While the morning and evening questionnaires were assessed once daily, clients received the ESM questionnaires ten times per day for six consecutive days between 7:30 am and 10:30 pm by default [26]. Five minutes after receiving a beep without a response, a reminder was sent to fill out the ESM questionnaire. The app was synchronized with the dashboard, and responses were automatically visualized on the dashboard. Implementation strategies included a user manual with guidelines, including video links on using the dashboard and one-on-one online training sessions.

Table 1.

Content of the ESM template[1]

Morning questionnaire

1. At what time did you go to sleep yesterday? [Numeric input]
2. How long did it take you to fall asleep [Less than 10 minutes / Less than 30 minutes / Less than 1 hour / More than 1 hour]
3. How many times did you wake up last night? [I slept uninterrupted / One time / Two times / More than two times]
4. I slept well.
5. At what time did you wake up this morning? [Numeric input]
6. How long did you lie awake before you got up? [Less than 10 minutes / Less

than 30 minutes / Less than 1 hour / More than 1 hour]
7. I am excited to start the day.
8. How many hours did you sleep last night? [I could not sleep / Between 1 and 2 hours / … / Between 9 and 10 hours / More than 10 hours]

ESM questionnaire

1. I feel lonely.
2. I feel anxious.
3. I feel stressed.
4. I feel sad.
5. I feel insecure.
6. I feel satisfied.
7. I feel cheerful.
8. I feel excited.
9. I feel relaxed.
10. What am I doing? [Leisure – active (e.g. playing games, sports) / Leisure – passive (e.g. watching television, reading) / School or work / Everyday chores (cooking, cleaning, shopping) / Travelling / Eating or Drinking / Social contact / Something else / Nothing]
11. I like doing this.
12. I'd rather do something else.
13. Where am I? [At home / At a friend of family member's home / At work / Public transport / Somewhere else outside / Somewhere else inside]
14. Who am I with? [Nobody / Family / Friends / Colleagues / Other familiar people / Unfamiliar people]
15. a. [condition: alone] I like being alone
15. b. [condition: with others] I would rather be with others
15. c. [condition: with others] I like this company
15. d. [condition: with others] I would rather be alone
16. [Optional example] To what extent have you experienced discomfort or discomfort since the last beep because of compulsions?

Evening questionnaire

1. I thought this was a normal day
2. I thought this was a nice day
3. What was the most NEGATIVE event of the day for you? [Open text]
4. How unpleasant was this event?
5. How enjoyable was this event?
6. Completing the questionnaires on this app has influenced my mood throughout the day

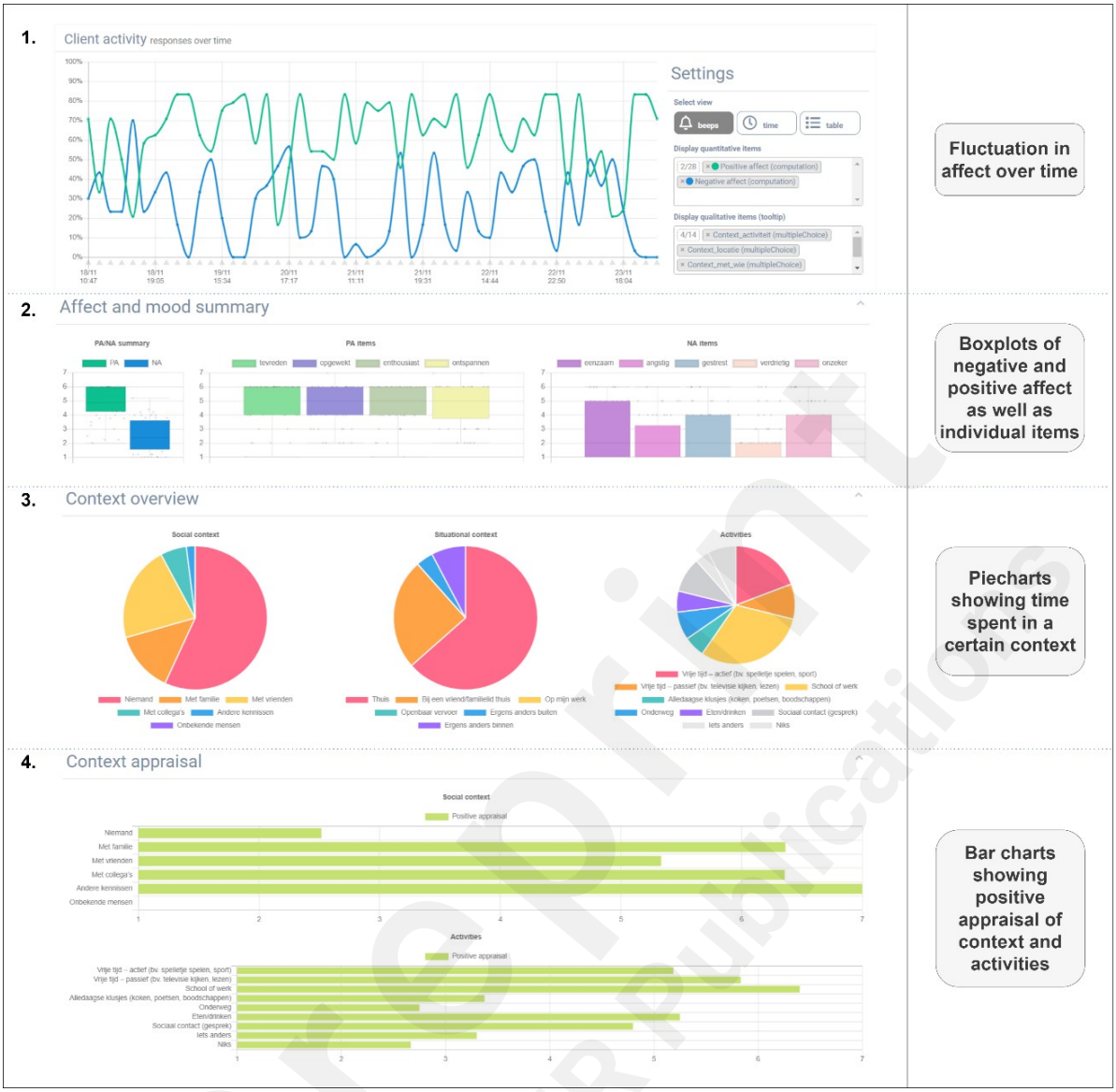
[1]Unless specified otherwise, items were answered on a scale ranging from 1 'not at all' to '7 'very much'. For additional content, please see our preregistration page.

ESM data visualizations

The data collected with the ESM app were displayed on the online dashboard using a series of custom-made visualizations. These visualizations were based on end-user input on existing visualization methods for ESM data [20], including information on general psychological

functioning (i.e., boxplots of positive and negative emotions) and contextual information across the ESM period (e.g., pie-charts expressing the distribution time alone vs. with others face-to-face or online, activities in daily life), fluctuations over time (e.g., time-series graphs of negative affect), and qualitative text tables with descriptions of the most pleasant event of the day. For the time series plot, it was also possible to zoom in on a single measurement point and relate the data point of interest to contextual information (e.g., with whom someone was, where they were, and what they were doing). The frequency (pie)charts could also be made conditional on contexts or activities to provide insight into the contextual determinants of mental health problems (e.g., symptom frequency at home vs. symptom frequency at work). Figure 1 provides examples of visualization used in IMPROVE.

Figure 1.
Examples of visualizations used in IMPROVE



Quantitative measures

Sociodemographic information.

At enrolment, clients and practitioners provided age and gender. In addition, practitioners provided information on their profession (e.g., psychiatrist, clinical psychologist).

Compliance

Compliance with the ESM protocol was assessed as the percentage of completed versus scheduled ESM assessments.

Questionnaires on Usability

To evaluate the usability of the ESM app and dashboard, we used an adapted version of the

mHealth app usability questionnaire (MAUQ; [27]). The MAUQ assesses different usability elements, such as whether clients and practitioners found the app and dashboard easy to use or were satisfied with the user interface (e.g., 'I found it easy to learn to use the dashboard.'). Items were rated using a 7-point Likert scale from 1 to 7, with higher scores indicating higher usability of the app for clients and dashboard for practitioners, respectively. Given that these statements assess different meaningful usability aspects, we interpreted individual items and did not calculate a composite score. For practitioners, we differentiated between the usability of the dashboard during a clinical session and overall usability. We made this decision as practitioners could use IMPROVE several times with multiple clients, whereas clients only used IMPROVE with one practitioner.

Qualitative measures

Practitioners and clients were invited to participate in a semi-structured interview after using IMPROVE. The interview assessed in-depth experiences on using ESM in practice, provided training material, the ESM items and sampling scheme, personalization options, data visualization, and suggestions for improvement. Interview guides were developed and divided into thematic sections (e.g., expectations regarding ESM implementation in mental health care, technical feasibility, and the ESM template), with each section starting with a short introduction to the topic. Sections were composed of broad questions followed by more specific prompt questions. The interviewers were allowed to make minor changes to the phrasing of the questions to make them more natural but were instructed not to change the content and meaning of the questions.

Data analysis

Quantitative data analysis

Concerning compliance, we evaluated whether clients provided sufficient data for making reliable interferences of automated data analysis at the intra-individual level (cf. [28]). While thresholds are somewhat arbitrary [23], we assessed whether clients could complete a minimum of 33% of all provided questionnaires. For the adapted MUAQ, scores of individual items that assessed usability were visualized and interpreted using heat maps (Annex 1-3).

Qualitative data analysis

The audio recordings of the interviews were transcribed and analyzed based on inductive data-driven thematic analysis [29]. This involves several consecutive steps. First, the first author familiarized himself with the data by re-listening to the audio recordings. Second, the transcripts were reread and divided into meaningful text segments. Third, these segments were labeled with short summarizing and comprehensible sentences (i.e., open coding approach). Afterward, the labeled segments were grouped into sub-themes. Subsequently, these sub-themes were grouped into overarching themes. How the different segments were grouped into sub- and overarching themes was refined through collaboration with co-authors. Additionally, we included a second coder to evaluate the reliability of the results. The second coder was provided with 10% of the unlabeled segments of the first author (randomly selected) and was asked to label them and group them into sub-themes and overarching themes. Afterward, we compared coding and evaluated the labeling and grouping agreement to assess interrater reliability. Cohen's Kappa was subsequently calculated as the percentage of agreement.

Drop-outs & missing data

Given that drop-outs may indicate poor usability, the number of drop-outs is reported for clients and practitioners.

Ethical considerations

Practitioners and clients were requested to provide written informed consent, and the study was approved by the Medical Ethics Committee of KU Leuven (Leuven, Belgium, identifier S64244). To align with real-world conditions, no remuneration was provided to practitioners and clients for participating in this study. Participants were given aliases on all transcriptions of recordings. Personal information obtained from interviews was never linked to individual identities. Any written or printed documents containing information on the identity of participants, such as informed consent forms, were stored in a locked archiving room. All data presented in this paper contains no real names or any information that reveals the identity of the participants. No generative AI was used in any portion of the manuscript writing.

Results

Participants

We invited 142 practitioners to participate in the study, of which 12 initially agreed to participate, and 11 followed the optional online training session. Eight of these 12 practitioners used the IMPROVE protocol with clients in therapy. The four practitioners who did not use the IMPROVE protocol mentioned the excessive burden of trying out novel instruments amid the COVID-19 pandemic and/or clients not showing up for scheduled appointments as reasons for not using IMPROVE.

Practitioners invited 29 clients to participate (mean = 2.42 clients per practitioner), 24 agreed to participate, and 17 completed the study. Drop-out occurred at various points: one client decided to quit during baseline data collection, and six clients ended the ESM week but did not attend the clinical feedback session or did not complete the usability questionnaires. Table 2 provides the

demographic information of the practitioners and clients who participated in the pilot study.

Table 2.
Demographic information on clients and practitioners.

	Users (n practitioners = 8, n clients =17)	Drop-outs/non-users (n practitioners = 4, n clients = 12)
Practitioners		
Age	45,57(SD=6,11) years	43,5(SD=17,5) years
Gender	87,5% female	25% female
Profession	Clinical psychologist: 5 Mental health nurse: 2 Neuroscientist: 1	Clinical psychologist: 1 Psychiatrist: 3
Clients		
Age	34,93(SD=11,27) years	36.67(SD=13,47) years
Gender	64,71% female	62,5% female

Quantitative analysis

Practitioner ratings on the usability of the dashboard

Usability of the dashboard during a clinical session

Regarding the usability of the ESM dashboard during a clinical session, mean responses to individual items ranged from 5.33 (SD = 0.91) to 6.06 (SD = 0.73). Practitioners reported the lowest agreement to the statement *'When I made a mistake, I could correct it easily and quickly.'*, whereas the highest agreement was reached for the statement '*I felt comfortable talking to my client about the data that was visualized on the dashboard.'*. When inspecting the heat map of responses (Annex 1), we observe saturation around '*6 - agree*' for all statements apart from responses to the statement '*The information on the dashboard was well organized, I could easily find what I needed for this session.*', for which responses were saturated around '*5 - somewhat agree*'.

Overall usability of the dashboard

Regarding the usability of the ESM dashboard overall, mean responses to individual items ranged from 4.00 (SD = 1.91) to 6.14 (SD = 0.69). The lowest and highest level of agreement was reached for the statements '*It was easy for me to learn to use the dashboard.*' and '*I would use the dashboard again.*' respectively. In the plotted heat map (Annex 2), we observe saturation for 8 out of

11 usability statements labeled '*5 - Somewhat agree*', '*6 - Agree*', or '*7 - Strongly Agree*'. The three usability statements that deviate from this pattern were '*It was easy for me to learn to use the dashboard.*', '*It was easy for me to create questionnaire content.*', and '*It was easy for me to (re)schedule questionnaires.*'

Client ratings on the usability of the ESM app

Mean responses to the app usability statements varied between 4.18 (SD = 1.7) and 5.94 (SD = 1.5), with the lowest and highest level of agreement with the statements' *The app had all features and capabilities I expected of it.*' and '*I felt comfortable talking to my clinician about the data collected with the app.*'. For nine out of 12 statements, the largest percentage of responses consisted of *'5 - Somewhat agree*', *'6 - Agree'*, or *'7 - Strongly Agree'*. The remaining three statements — which mainly concerned the design and user interface of the app — were characterized by a large degree of variation. For example, 35.3% of clients answered '*Agree'* to the statement '*From the start, I found the app easy to use.*', whereas 23.5% answered '*Disagree*' (Annex 3).

Compliance to scheduled ESM assessments

On average, clients completed 55% (SD=25%; range 18%-93%) of the ESM questionnaires (excluding morning/evening questionnaires). However, five clients did not reach the predefined threshold of 33% (range 18-31%), indicating limited feasibility for reliable inference. In addition, one client stated unwillingness to share their ESM data with the research team.

Qualitative data analysis

The overarching themes were using ESM in clinical practice, training material, ESM content, personalization, data visualization, and suggestions for improvements. For each of these themes, sub-themes were identified. Figure 5 summarizes the results, and Annex 4 includes example quotes.

Figure 2.
Summary of the results from thematic analysis on usability.

Theme	Practitioner perspective	Client perspective
Using ESM	1. ESM may have added value [+] 2. Not universally applicable [-]	1. ESM may have added value [+] 2. Sometimes burdensome [-] 3. Sometimes inappropratie (e.g., group therapy) [-]
Training material	1. Manual insufficient [-] 2. Online training too brief [-]	1. Practitioner appeared unsufficiently trained [-]
ESM questionnaire content and sampling scheme	1. Default ESM questionnaire liked [+] 2. Add-on questionnaire not satisfactory[-] 3. Sampling format too burdensome [-]	1. ESM content liked [+] 2. improves self-insights [+] 3. improves self-awareness [+] 4. Artificial to complete [-]
Personalization	1. Personalization valued [+] 2. Implementation difficult [-] 3. Considered time-intensive [-]	1. Personalization valued [+]
Data visualization	1. Mixed opinion on usability: meaningful vs. overcluttering [+-]	1. Mixed opinion on usability: impressive vs. difficult to interpret [+-]
Suggestions for improvement	1. Alternative sampling formats [o] 2. Additional training [o] 3. Elaborate add-on questions [o] 4. Adjustable visualization window [o]	1. Alternative sampling formats [o] 2. Novel add-on questions [o] 3. Open questions [o] 4. Color/Highlighting [o]
[+] positive point [-] negative point [o] neutral point		

Using ESM in clinical practice

Practitioners appeared engaged with the software, with multiple practitioners expressing a desire for continued use (e.g., annex 4, quote 1). However, practitioners mentioned that several clients declined to participate because they considered a week of ESM with the default sampling scheme too burdensome or had no smartphone or internet (annex 4, quote 2). Some clients who did participate also voiced these concerns and indicated that the ESM sampling scheme was too burdensome or that the noise/vibration from a notification was disturbing in some situations, such as during a group therapy session or relaxation exercise (annex 4, quotes 3-4). Additionally, one client reported that it felt artificial to reduce emotions and cognitions to ratings on a scale and felt that they were expected to show variation in their responses (annex 4, quote 5).

The training material

The training material we provided was generally considered useful but not practical. One

practitioner, for example, indicated difficulties following the online training on a tablet, indicating a preference for group training with colleagues present (annex 4, quote 6). Another practitioner mentioned that the manual we provided would take too much time to go through and instead relied on learning from a colleague also enrolled in the study (annex 4, quote 7). Similarly, one client said they felt confused about the necessity of the repetitive nature of ESM (annex 4, quote 8) – indicating insufficient briefing by the practitioner before the implementation of ESM.

The ESM items and sampling scheme

Mixed opinions existed on the usability of the predefined ESM questionnaire. Practitioners found the default ESM items (e.g., questions on emotions, context, and activities) relevant but were skeptical toward some of the add-on items, stating they were unsatisfied with the phrasing (e.g., a focus on 'burden' in the assessment of OCD symptoms; annex 4, quote 9). Similarly, some practitioners found a single week of ESM too brief to detect meaningful changes and indicated that brief periods of intensive ESM might be more appropriate during the initial stages of therapy (annex 4, quote 10). Similar to practitioners' views, clients generally found the default ESM content relevant and mentioned that it increased insight and made them more aware of their feelings and behaviors (annex 4, quote 11).

Personalization of the ESM questionnaire

Practitioners generally found the options for personalization valuable (annex 4, quotes 12-13). However, most practitioners mentioned that they rarely personalized the ESM questionnaire, which was perceived as too complex and time-consuming (annex 4, quote 14). One practitioner, for example, stated that they might need assistance in customizing the ESM questionnaire as they were 'not good with technology' (annex 4, quote 15).

Data visualization of collected ESM data

While some practitioners liked the visualizations and indicated that they helped them and their clients to concretize the contextual nature of mental health problems (annex 4, quotes 16-17),

others found it initially overwhelming and indicated the need for practice to make sense of the different visualizations (annex 4, quote 18). Similarly, while some clients considered the data visualizations informative (annex 4, quote 19), others found it overwhelming and challenging to know what was relevant (annex 4, quote 20). To illustrate, one client reported that they would not use ESM without a practitioner to help them understand how to interpret and give meaning to the results (annex 4, quote 21).

Suggestions for improvement

Practitioners and clients made suggestions for improvement related to different elements of the ESM protocol. First, regarding the ESM template, practitioners and clients indicated the need for alternative sampling formats compared to a single observation period with ten beeps daily. For instance, a practitioner suggested using ESM at different periods in the therapy to evaluate progress (annex 4, quote 22). Relatedly, clients indicated sampling one week a month with fewer beeps to make it less burdensome (annex 4, quote 23). Second, practitioners reported that additional training is necessary, which could include more case descriptions and mock sessions (annex 4, quote 24). Third, concerning the ESM content, some clients found that the ESM questionnaires were too generic and suggested using open questions and responses (annex 4, quotes 25-26). Relatedly, additional add-on questions were requested by practitioners and clients to monitor a broad range of experiences related to substance abuse, obsessive-compulsive disorder, stress, and physical health. Fourth, covering data visualizations, some practitioners expressed the desire for adjustable visualizations, such as making it possible to annotate and adjust visualizations (annex 4, quote 27). Finally, clients said using more color or highlighting important parts of a question might be worthwhile to make filling out the ESM questionnaire less monotonic and more time efficient (annex 4, quotes 28-29).

Discussion

Despite the potential benefits of ESM to make clients more actively involved and better

match treatments to their needs [6][10][11], ESM is still primarily used in research settings with little uptake in clinical practice. In this study, we piloted the usability of an ESM template in a specialized mental healthcare setting for psychiatric clients. This consisted of ready-to-use ESM questionnaires, sampling schemes, visualizations, and add-on materials. The ESM template was implemented through a dashboard for practitioners (i.e., including the setup of the template and data visualizations) and an app for clients (i.e., for completing ESM questionnaires). Our results indicate that working with ESM templates can facilitate usability, but suggest that a single generic template will be insufficient to capture clients' needs and address clinical goals in practice.

Although clients were somewhat less favorable than practitioners, we observed that the technical usability of the piloted software was considered sufficient by practitioners and clients. However, two findings warrant further discussion. Firstly, while practitioners found the template easy to use and expressed a willingness to use it again, they also encountered difficulties when attempting to utilize more advanced features, such as personalization, and when displaying and interpreting data visualizations. For instance, some practitioners reported feeling overwhelmed when presented with multiple data visualizations, not knowing where to focus their attention. Interestingly, this feeling was also observed in some clients who found it challenging to understand what was relevant. One possible solution to address this issue could involve presenting a limited number of visualizations per web page or implementing a dynamic visualization interface that allows users to (de)select specific visualizations for viewing. Secondly, from the client their perspective, several individuals mentioned that the tool lacked expected features, with the inability to provide additional momentary information in an open text field being the most noteworthy deficiency. Specifically, the desire for open text fields may indicate that clients found it challenging to recall qualitative daily life experiences solely based on quantitative daily life data. For instance, when a practitioner wants to discuss an observed peak in mood (whether positive or negative), it might be difficult for the client to recall the specific contextual details of that moment during a therapy session, even when provided

with contextual clues (e.g., who they were with). Hence, this finding may reflect a limitation in our ESM template in capturing information clients consider essential for recollection and attributing meaning to relevant data points. Therefore, future implementation studies could benefit from considering the incorporation of an open-text field at the end of an ESM questionnaire.

Despite technical usability being sufficient, clinical usability was not self-evident. Overall, a need was expressed for more personalization. Even though practitioners stressed the importance of personalization, and the software provided the opportunity to adapt the content and sampling scheme, practitioners rarely used this possibility. There may be two possible explanations for this finding. First, it may be too complex from a technical point of view, as practitioners indicated that personalization was too difficult and time-consuming. This aligns with prior research suggesting that future implementation must strike a balance between the need for personalization and the clinical reality of the limited time practitioners have during clinical sessions [30][13]. Second, a lack of personalization may also be explained because it is not straightforward to operationalize clinical questions in ESM templates [31]. This suggests that future implementation work should provide a better understanding of how personalization might help practitioners translate specific clinical questions into ESM templates that fit clients' individual needs. In a similar vein, the clinical usability of the data visualizations will depend on pre-specified clinical applications. When ESM is used with a clear application in mind, higher clinical utility and acceptability might be reached [18][32]. Defining what such applications should entail is a challenging task. However, some recommendations for further implementation work can be made. For example, in a recent implementation study with individuals suffering from bipolar disorder, one suggestion made by clients and practitioners was to use ESM for studying the effects of medication or lifestyle changes on daily life functioning [33]. Relatedly, in individuals suffering from depression it may be worthwhile to focus on using ESM to provide feedback relating to positive affect — as this type of feedback has been suggested to benefit reduction of depressive symptoms [34].

In contrast to recent findings [18], which found generally high compliance among voice-hearing patients (100% above the 33% cut-off), the level of compliance in our study was substantially lower (69% above the 33% cut-off). The lower compliance in our study might be tied to the fact that the ESM setup might not have always resulted from a collaborative process between clients and practitioners (i.e., limited use of personalization features). This may help explain why the ESM protocol did not always meet client expectations and was sometimes perceived as burdensome. This corroborates earlier work and stresses the importance of actively involving clients in goal-setting and the setup of ESM templates [31], which will be necessary to increase patient engagement and empower clients to take an active role in their recovery process. Taken together, the findings of this ESM pilot study in specialized mental health care suggest that using a generic ESM template may be less practical as the collaborative clinical goal will determine the ESM content, schedule, and visualizations in practice.

Our findings have several implications for future research and implementation work. First, to guide further software development, more work is needed to determine how clinical goals translate into specific ESM questionnaires and sampling schemes. For example, during the initial stages of treatment, it may be more beneficial to have a detailed summary of daily life experiences to identify patterns or contextual determinants of a client's mental health problem (i.e., the hypotheses-generating phase of diagnostic assessment). In such cases, intensive sampling for a week may be required. In contrast, there may be less need for such a dense sampling schedule when a client has been in therapy for an extended period, and the goal is to evaluate treatment and/or prevent relapse (i.e., hypotheses-confirming evaluation and prognosis). This is also in line with recent work [12][35], which suggested that other formats of ESM may be required for clinical use. Second, we identified a need for additional items to personalize ESM content to the needs of individual clients. While future work could resort to items used in academic research [36], exploring co-designing items with practitioners and clients that match the experiences they want to capture outside the therapy room

may also be worthwhile. Third, although compliance is one indicator of burden [37], future research is needed to investigate under what circumstances ESM is perceived as less burdensome. Fourth, we identified the need for other training compared to our one-hour online training sessions. For instance, as suggested by the practitioners in our study and elsewhere [13], including group training with mock clients might help increase usability. However, addressing the abovementioned issues will be a prerequisite in developing practical and concrete training programs that match clinical complexity. Such training programs could already be introduced into higher education programs that take a dimensional and recovery-based perspective on mental healthcare.

Limitations

Several limitations should be considered when interpreting the results of this pilot study. First, and as mentioned elsewhere [38], there are numerous ways to define and measure a mobile health application's usability, and not all of these elements were studied. Hence, other usability elements may still need to be studied (e.g., phone battery constraints). Second, we experienced a challenging recruitment procedure due to the unforeseen and unique circumstances of the COVID-19 pandemic. However, participant numbers (i.e., 12 out of 142 invited) exceed what usability experts consider as sufficient and recommend for pilot testing in an iterative user-centered design [39][40]. Third, our sample consists of early adopters who may not be representative of the entire population of practitioners and clients. Fourth, we did not implement any strategies to increase user engagement, such as gamification [41], which may be beneficial to consider in future work.

Conclusion

In this pilot study we designed and implemented a protocol for using an ESM template in a specialized mental healthcare setting. Our findings suggest that the ESM template and used software are easy to use, indicating that practitioners and clients are capable agents for using ESM in clinical

practice. Yet, clients' readiness to use (or keep using) ESM was limited due to limitations in perceived usefulness. Hence, the piloted ESM protocol should not be readily implemented and substantial adaptions are necessary. These may include providing additional sampling scheme formats, personalization through co-developed items, adding an open-text field item, and a dynamic data visualization interface. To optimize the usability of ESM protocols as a mobile health assessment tool in recovery-focused psychiatry, we encourage scientists and implementation experts to focus more on collaborating with practitioners and clients in every phase of the design, evaluation, and implementation process to make meaningful translations of clinical questions into ESM templates that truly benefit and meet the specific needs of individuals.

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Data availability

The data collected in this study are available from the corresponding author upon request.

Author contribution

All authors contributed to the writing of this manuscript.

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Declaration of competing interest

Nothing to declare.

References

[1] Delespaul, P., DeVries, M., & van Os, J. (2002). Determinants of occurrence and recovery from hallucinations in daily life. *Social Psychiatry and Psychiatric Epidemiology, 37*(3), 97- 104. https://doi.org/10.1007/s001270200000

[2] Collip, D., Oorschot, M., Thewissen, V., Van Os, J., Bentall, R., & Myin-Germeys, I. (2011). Social world interactions: How company connects to paranoia. *Psychological Medicine, 41*(5), 911-921. doi:10.1017/S0033291710001558

[3] Myin-Germeys, I., & van Os, J. (2007). Stress-reactivity in psychosis: evidence for an affective pathway to psychosis. *Clinical psychology review, 27*(4), 409-424. https://doi.org/10.1016/j.cpr.2006.09.005

[4] Colombo, D., Suso-Ribera, C., Fernández-Álvarez, J. et al. Affect recall bias: Being resilient by distorting reality. *Cognitive Therapy and Research, 44*(5), 906–918 (2020). https://doi.org/10.1007/s10608-020-10122-3

[5] Csikszentmihalyi, M, Larson, R., & Prescott, S. (1977). Flow experience in the daily lives of older adults: An analysis of the interaction between flow, individual differences, serious leisure, location, and social context. *Journal of Youth and Adolescence, 6*, 281–294. https://doi.org/10.1017/S0714980810000395

[6] Myin-Germeys, I., Kasanova, Z., Vaessen, T., Vachon, H., Kirtley, O., Viechtbauer, W., & Reininghaus, U. (2018). Experience sampling methodology in mental health research: new insights and technical developments. *World Psychiatry, 17*(2), 123- 132. https://doi.org/10.1002/wps.20513

[7] Myin-Germeys, I., & Kuppens, P. (Eds.). (2022) *The open handbook of experience sampling methodology: A step-by-step guide to designing, conducting, and analyzing ESM studies* (2nd ed.). Leuven: Center for Research on Experience Sampling and Ambulatory Methods Leuven.

[8] Stip, E. (1996). Memory impairment in schizophrenia: perspectives from psychopathology and

pharmacotherapy. *The Canadian Journal of Psychiatry, 41*(8), S27-S34. https://doi.org/10.1177%2F070674379604100822

[9] Vrijsen, J. N., van Amen, C. T., Koekkoek, B., van Oostrom, I., Schene, A. H., & Tendolkar, I. (2017). Childhood trauma and negative memory bias as shared risk factors for psychopathology and comorbidity in a naturalistic psychiatric patient sample. *Brain and Behavior, 7*(6), e00693. https://doi.org/10.1002/brb3.693

[10] van Os, J., Verhagen, S., Marsman, A., Peeters, F., Bak, M., Marcelis, M., ... & Simons, C. (2017). The experience sampling method as an mHealth tool to support self-monitoring, self-insight, and personalized health care in clinical practice. *Depression and Anxiety, 34*(6), 481-493. https://doi.org/10.1002/da.22647

[11] Bjørlykhaug, K. I., Karlsson, B., Hesook, S. K., & Kleppe, L. C. (2021). Social support and recovery from mental health problems: A scoping review. *Nordic Social Work Research*, 1-32. https://doi.org/10.1080/2156857X.2020.1868553

[12] Bos, F. M., Snippe, E., Bruggeman, R., Wichers, M., & van der Krieke, L. (2019). Insights of patients and practitioners on the promise of the experience sampling method for psychiatric care. *Psychiatric Services, 70*(11), 983-991. https://doi.org/10.1176/appi.ps.201900050

[13] Piot, M., Mestdagh, M., Riese, H., Weermeijer, J., Brouwer, J. M., Kuppens, P., ... & Bos, F. M. (2022). Practitioner and researcher perspectives on the utility of ecological momentary assessment in mental health care: A survey study. *Internet Interventions, 30*, 100575. https://doi.org/10.1016/j.invent.2022.100575

[14] Ellison, W. D., Trahan, A. C., Pinzon, J. C., Gillespie, M. E., Simmons, L. M., & King, K. Y. (2020). For whom, and for what, is experience sampling more accurate than retrospective report?. *Personality and Individual Differences, 163*, 110071. https://doi.org/10.1016/j.paid.2020.110071

[15] Frumkin, M. R., Piccirillo, M. L., Beck, E. D., Grossman, J. T., & Rodebaugh, T. L. (2021). Feasibility and utility of idiographic models in the clinic: a pilot study. *Psychotherapy Research*, *31*(4), 520-534. https://doi.org/10.1080/10503307.2020.1805133

[16] Rintala, A., Wampers, M., Myin-Germeys, I., & Viechtbauer, W. (2019). Response compliance and predictors thereof in studies using the experience sampling method. *Psychological Assessment*, *31*(2), 226. https://psycnet.apa.org/doi/10.1037/pas0000662

[17] Bastiaansen, J. A., Meurs, M., Stelwagen, R., Wunderink, L., Schoevers, R. A., Wichers, M., & Oldehinkel, A. J. (2018). Self-monitoring and personalized feedback based on the experiencing sampling method as a tool to boost depression treatment: a protocol of a pragmatic randomized controlled trial (ZELF-i). *BMC Psychiatry*, *18*(1), 1-11. https://doi.org/10.1186/s12888-018-1847-z

[18] Bell, I. H., Rossell, S. L., Farhall, J., Hayward, M., Lim, M. H., Fielding-Smith, S. F., & Thomas, N. (2020). A pilot randomised controlled trial of a brief coping-focused intervention for hearing voices blended with smartphone-based ecological momentary assessment and intervention (SAVVy): Feasibility, acceptability and preliminary clinical outcomes. *Schizophrenia Research*, *216*, 479-487. https://doi.org/10.1016/j.schres.2019.10.026

[19] Daniëls, N. E., Hochstenbach, L. M., van Bokhoven, M. A., Beurskens, A. J., & Delespaul, P. A. (2019). Implementing experience sampling technology for functional analysis in family medicine – A design thinking approach. *Frontiers in Psychology, 10*, 2782. https://doi.org/10.3389/fpsyg.2019.02782

[20] Weermeijer, J., Kiekens, G., Wampers, M., Kuppens, P., & Myin-Germeys, I. (2023). Practitioner perspectives on the use of the experience sampling software in counseling and clinical psychology. *Behaviour & Information Technology*, 1-11. https://doi.org/10.1080/0144929X.2023.2178235

[21] Hwang, W., & Salvendy, G. (2010). Number of people required for usability evaluation: the 10±2 rule. *Communications of the ACM*, *53*(5), 130-133. https://doi.org/10.1145/1735223.1735255

[22] Mestdagh, M., Verdonck, S., Piot, M., Niemeijer, K., tuerlinckx, f., Kuppens, P., & Dejonckheere, E. (2022, January 25). m-Path: An easy-to-use and flexible platform for ecological momentary assessment and intervention in behavioral research and clinical practice. https://doi.org/10.31234/osf.io/uqdfs

[23] Weermeijer, J., Lafit, G., Kiekens, G., Wampers, M., Eisele, G., Kasanova, Z., ... & Myin-Germeys, I. (2022). Applying multiverse analysis to experience sampling data: Investigating whether preprocessing choices affect robustness of conclusions. *Behavior Research Methods*, *54*(6), 2981-2992. https://doi.org/10.3758/s13428-021-01777-1

[24] Weermeijer, J. D. M., de Thurah, L., Bonnier, R. A. M., Teixeira, A., Kuppens, P., Myin-Germeys, I., … Kiekens, G. (2021, August 11). Feasibility of experience sampling software designed for mental healthcare: a mixed-methods pilot study. Retrieved from osf.io/fq69x

[25] American Psychological Association. (2017). Ethical principles of psychologists and code of conduct (2002, amended effective June 1, 2010, and January 1, 2017). http://www.apa.org/ethics/code/index.html

[26] Myin-Germeys, I., Peeters, F. P. M. L., Havermans, R., Nicolson, N. A., DeVries, M. W., Delespaul, P. A. E. G., & Van Os, J. (2003). Emotional reactivity to daily life stress in psychosis and affective disorder: an experience sampling study. *Acta Psychiatrica Scandinavica*, *107*(2), 124-131. https://doi.org/10.1034/j.1600-0447.2003.02025.x

[27] Zhou, L., Bao, J., Setiawan, I. M. A., Saptono, A., & Parmanto, B. (2019). The mHealth APP usability questionnaire (MAUQ): development and validation study. *JMIR mHealth and uHealth*, *7*(4), e11500. https://doi.org/10.2196/11500

[28] Kimhy, D., Delespaul, P., Corcoran, C., Ahn, H., Yale, S., & Malaspina, D. (2006). Computerized experience sampling method (ESMc): assessing feasibility and validity among individuals with schizophrenia. *Journal of Psychiatric Research*, *40*(3), 221-230. https://doi.org/10.1016%2Fj.jpsychires.2005.09.007

[29] Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77-101. https://doi.org/10.1191/1478088706qp063oa

[30] Ellison, W. D. (2021). An initial study of practicing psychologists' views of the utility of ecological momentary assessment for difficult psychotherapy cases. *Administration and Policy in Mental Health and Mental Health Services Research*, *48*(4), 597-607. https://doi.org/10.1007/s10488-020-01093-4

[31] Daniëls, N. E., Hochstenbach, L. M., van Bokhoven, M. A., Beurskens, A. J., & Delespaul, P. A. (2019). Implementing Experience Sampling technology for functional analysis in family medicine–a design thinking approach. *Frontiers in Psychology*, 10, 2782. https://doi.org/10.3389/fpsyg.2019.02782

[32] Kiekens, G., Claes, L., Schoefs, S., Kemme, N. D. F., luyckx, K., Kleiman, E., … Myin-Germeys, I. (2023). Research protocol of the Detection of Acute rIsk of seLf-injurY (DAILY) Project: An ecological momentary assessment study among treatment-seeking individuals. Retrieved from psyarxiv.com/qx9hg

[33] Bos, F. M., Snippe, E., Bruggeman, R., Doornbos, B., Wichers, M., & van der Krieke, L. (2020). Recommendations for the use of long-term experience sampling in bipolar disorder care: a qualitative study of patient and clinician experiences. *International Journal of Bipolar Disorders, 8*(1), 1-14. https://doi.org/10.1186/s40345-020-00201-5

[34] Kramer, I., Simons, C. J., Hartmann, J. A., Menne-Lothmann, C., Viechtbauer, W., Peeters, F., ... & Wichers, M. (2014). A therapeutic application of the experience sampling method in the treatment of depression: a randomized controlled trial. *World Psychiatry, 13*(1), 68-77.

https://doi.org/10.1002/wps.20090

[35] Bos, F. M., von Klipstein, L., Emerencia, A. C., Veermans, E., Verhage, T., Snippe, E., ... & Riese, H. (2022). A Web-Based Application for Personalized Ecological Momentary Assessment in Psychiatric Care: User-Centered Development of the PETRA Application. *JMIR Mental Health, 9*(8), e36430. https://doi.org/10.2196/36430

[36] Kirtley, O. J., Hiekkaranta, A. P., Kunkels, Y. K., Eisele, G., Verhoeven, D., Van Nierop, M., & Myin-Germeys, I. (2020, October 1). The Experience Sampling Method (ESM) Item Repository. https://doi.org/10.17605/OSF.IO/KG376

[37] Eisele, G., Vachon, H., Lafit, G., Kuppens, P., Houben, M., Myin-Germeys, I., & Viechtbauer, W. (2022). The effects of sampling frequency and questionnaire length on perceived burden, compliance, and careless responding in experience sampling data in a student population. *Assessment*, *29*(2), 136-151. https://doi.org/10.1177/1073191120957102

[38] Thirumalai, M., Rimmer, J. H., Johnson, G., Wilroy, J., Young, H. J., Mehta, T., & Lai, B. (2018). TEAMS (Tele-Exercise and Multiple Sclerosis), a tailored telerehabilitation mHealth app: participant-centered development and usability study. *JMIR mHealth and uHealth, 6*(5), e10181. https://doi.org/10.2196/10181

[39] Rubin J, Chisnell D. *Handbook of usability testing: how to plan, design, and conduct effective tests*. New York, NY: John Wiley & Sons; 2008.

[40] Turner, C. W., Lewis, J. R., & Nielsen, J. (2006). Determining usability test sample size. *International Encyclopedia of Ergonomics and Human Factors, 3*(2), 3084-3088.

[41] Sage, A., Roberts, C., Geryk, L., Sleath, B., Tate, D., & Carpenter, D. (2017). A self-regulation theory–based asthma management mobile app for adolescents: a usability assessment. *JMIR Human Factors*, *4*(1), e7133. https://doi.org/10.2196/humanfactors.7133

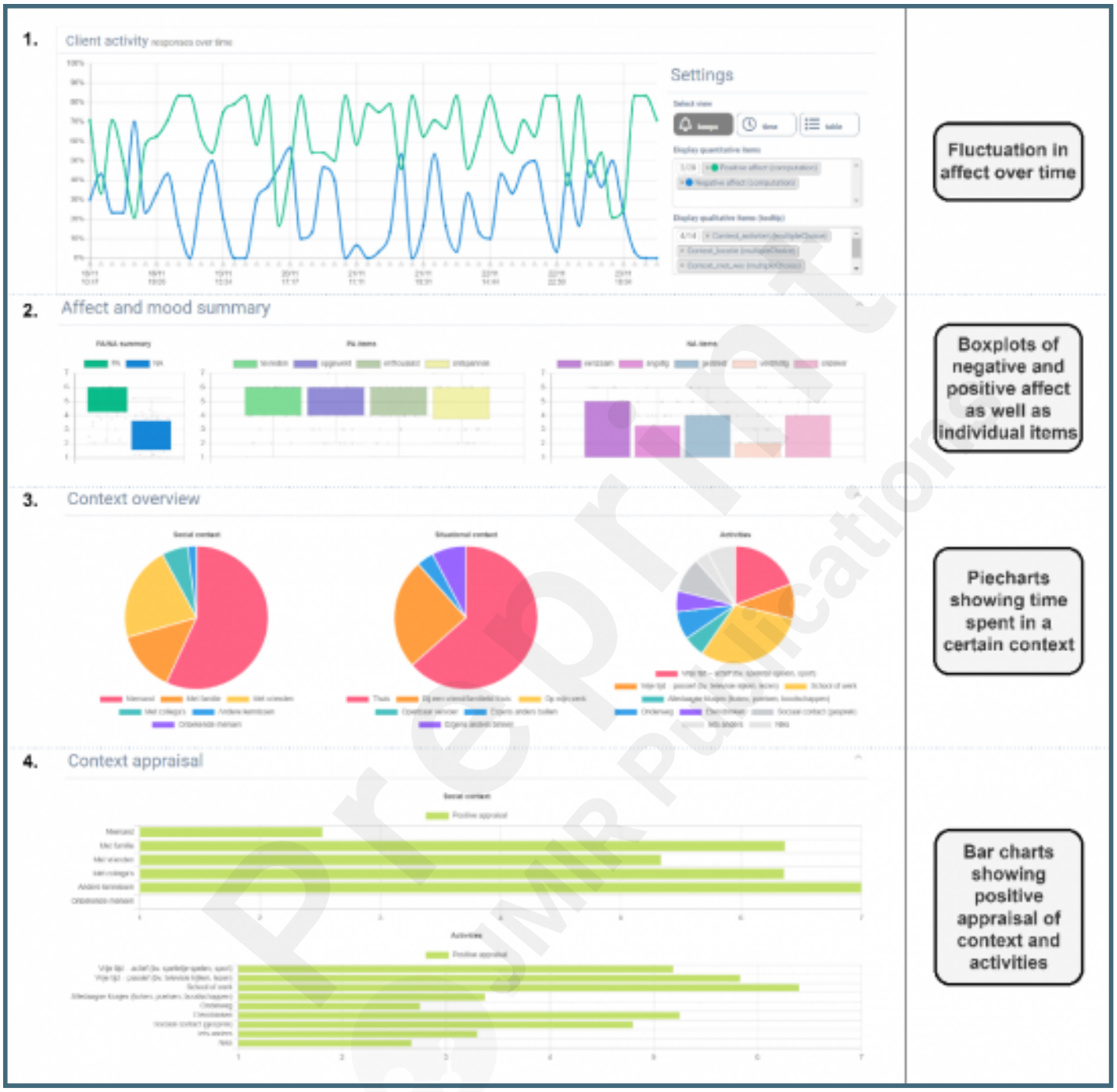
Supplementary Files

Figures

Summary of the results from thematic analysis on usability.

Theme	Practitioner perspective	Client perspective
Using ESM	1. ESM may have added value [+] 2. Not universally applicable [-]	1. ESM may have added value [+] 2. Sometimes burdensome [-] 3. Sometimes inappropratie (e.g., group therapy) [-]
Training material	1. Manual insufficient [-] 2. Online training too brief [-]	1. Practitioner appeared unsufficiently trained [-]
ESM questionnaire content and sampling scheme	1. Default ESM questionnaire liked [+] 2. Add-on questionnaire not satisfactory[-] 3. Sampling format too burdensome [-]	1. ESM content liked [+] 2. improves self-insights [+] 3. improves self-awareness [+] 4. Artificial to complete [-]
Personalization	1. Personalization valued [+] 2. Implementation difficult [-] 3. Considered time-intensive [-]	1. Personalization valued [+]
Data visualization	1. Mixed opinion on usability: meaningful vs. overcluttering [+-]	1. Mixed opinion on usability: impressive vs. difficult to interpret [+-]
Suggestions for improvement	1. Alternative sampling formats [o] 2. Additional training [o] 3. Elaborate add-on questions [o] 4. Adjustable visualization window [o]	1. Alternative sampling formats [o] 2. Novel add-on questions [o] 3. Open questions [o] 4. Color/Highlighting [o]
[+] positive point [-] negative point [o] neutral point		

Examples of visualizations used in IMPROVE.



Multimedia Appendixes

Annex 1 - Usability of the dashboard during a clinical session.
URL: http://asset.jmir.pub/assets/83228dfacd34ede198684f72d28b5719.pdf

Annex 2 - Overall usability of the dashboard.
URL: http://asset.jmir.pub/assets/b8161dcd4c4fe3be07c418dbb0adc5bd.pdf

Annex 3 - Overall usability of the dashboard.
URL: http://asset.jmir.pub/assets/33ac3e565663fbedcacbb7c4e00e8148.pdf

Annex 4 - Example quotes for practitioners and clients.
URL: http://asset.jmir.pub/assets/333c8699b2501b3855812333cb8e9ab4.pdf