Supplementary Materials for:

Development of an experience sampling methodology to assess the key features of rumination

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Table S1

ESM Items in English and French

Item	Item FR	Translation EN	Anchors FR	Anchors EN
Perseverance	A quel point avez-vous passé du temps à penser à une ou plusieurs expériences émotionnelles ?	How much time did you spend thinking of one or more emotional experiences?	A aucun moment vs. Tout le temps	None / All the time
Criticism	A quel point vos pensées ont-elles été critiques envers vous-même ?	To what extent were your thoughts self-critical?	Pas du tout critiques vs. Extrêmement critiques	Not at all / Extremely
Negativity	A quel point vos pensées ont-elles été négatives ?	To what extent were your thoughts negative?	Pas du tout negatives vs. Extrêmement négatives	Not at all / Extremely
Brooding	Dans quelle mesure avez-vous pensé aux causes et aux conséquences d'expériences émotionnelles ?	How much did you think about the causes and consequences of emotional experiences?	Pas du tout vs. Tout à fait	Not at all / Absolutely
Replaying	A quel point avez-vous rejoué dans votre esprit des parties d'expériences émotionnelles que vous avez vécues ?	To what extent have you mentally replayed emotional experiences that you've had?	Pas du tout vs. Tout à fait	Not at all / Absolutely

Table S2

ESM Items tooltips in English and French

Item	Tooltip FR	Tooltip EN
Perseverance	Cette question se réfère à combien de temps vous étiez pris dans vos pensées, soit à penser à des émotions, à des problèmes, ou quelque chose qui vous est arrivé, plutôt que d'être absorbé par ce que vous faisiez.	This question refers to how much time you spent lost in your thoughts, thinking about emotions, problems, or something that happened to you, instead of being absorbed by the activity you were doing.
Criticism	On parle ici "d'auto-critique". Cela se réfère donc à des pensées envers vous-même lorsque : vous êtes mécontent de ce que vous faites ou comment vous agissez, mécontent de qui vous êtes, lorsque vous vous mettez des objectifs mais que vous vous critiquez si vous ne les avez pas encore atteints... A l'inverse, des pensées non critiques envers vous-mêmes sont des encouragements, de la compassion envers vous-même, un discours positif (p. ex., "je n'y suis pas arrivé maintenant mais je finirai par y arriver".)	This question refers to 'self-critical' thinking, meaning thoughts you have about yourself when: you're dissatisfied with what you're doing or how you're reacting, you're unhappy with who you are, or when you have goals in mind, but you criticize yourself that you haven't attained them yet... In contrast, thoughts about yourself that are not 'self-critical': these are encouragements, self-compassion, positive thinking (for ex.: "I wasn't able to do it now but I'll get there at some point").
Negativity	Se réfère au contenu de vos pensées : par exemple une situation négative, des événements négatifs, un mauvais souvenir, des sensations désagréables, des pensées décourageantes, des pensées par rapport à des émotions négatives (stress important, anxiété, colère)...	This refers to the content of your thoughts: for example if you're thinking of a negative situation, negative events, bad memories, unpleasant sensations, discouraging thoughts, thoughts about negative emotions (intense stress, anxiety, anger), ...
Brooding	Si vous pensez aux causes ou aux conséquences d'une ou plusieurs expériences émotionnelles (positives ou négatives) actuelles ou passées. Quelques exemples : se demander ce qui a causé une dispute avec son/sa conjoint(e); réfléchir aux conséquences d'un appel de téléphone énervant; se demander pourquoi on a des	This refers to if you think of the causes or consequences of one or several emotional experiences (which could be positive or negative) that are either currently ongoing or in the past. A few examples: wondering what caused an argument with your partner; thinking about the consequences of a frustrating phone call; wondering why you have difficulty concentrating; trying to figure out why you feel bad or stressed;

	difficultés à se concentrer; pourquoi vous vous sentez mal ou stressé(e); penser à pourquoi vous avez raté une certaine tâche; penser aux causes et conséquences d'avoir raté un examen ou une interview pour un job; etc.	thinking about why you messed up a particular task; thinking about the causes and consequences of having failed an exam or a job interview; etc.
Replaying	Il s'agit de savoir si vous avez revécu en images certaines scènes d'un ou plusieurs expériences émotionnelles ou si vous avez rejoué l'événement en pensées, peu importe si c'était positif ou négatif.	This refers to whether you relived certain scenes from emotional experiences, or 'replayed' an event in your mind (regardless of whether it was a positive or negative experience).

Note. We used these tooltips (i.e., text boxes appearing on top of questions) instead of a study manual to provide readily available explanations of the ESM items to the participants. They were accessible at any time during the completion of the ESM survey: a simple touch or click on the questions would render the tooltip.

Description of pilots

We conducted two pilots that allowed us to test and improve the ESM items we had developed and the ESM protocol created using *formr*. We tested two different frequency possibilities across these two pilot studies to arrive at one that was frequent enough for our analyses but not too burdensome for participants.

Eight participants answered the ESM items five times daily for three days in the first pilot. At each time point, we asked participants to think of a specific emotional event that happened since the last time point and answer the rumination items about that event. Based on qualitative feedback from the participants of this first pilot, answering five times a day was considered too burdensome, and thinking of a specific emotional event at each time point was considered too difficult. Hence, we modified the prompts and the frequency of the ESM survey and conducted a second pilot.

In this second pilot, seven new participants answered the ESM items four times a day (9 AM, 1 PM, 5 PM, and 9 PM). When answering, participants had to think about everything that had happened since they woke up (for the first survey) or since the previous questionnaire (for the following surveys). Moreover, we modified the introductory text of the ESM surveys to promote reflection when answering the ESM with the following instructions: "*There is no right or wrong answer. It is your experience and only your experience that we*

are interested in. Please take a few moments for yourself to reflect on the hours that have passed and answer these questions". Because this second pilot was successful, we used these ESM items in a study with a community sample—the data used to validate the psychometric properties of the items in this paper.

Additional information about the ESM protocol

Summary of the briefing

The participants had an individual virtual briefing with the first author. During this briefing, the first author presented the study and the ESM items, and sent a personalized study link to the participant. We asked them to open the link during the briefing session, enter their phone number and email address in the form and submit it. In this way, we verified that each participant could receive the alerts via text message. We told participants they would receive text messages with the link to the survey. As this link remained the same throughout the study, they could copy-paste it and answer from their computer each time they received a text message if they wished to do so.

Briefing canvas

First, we verified the inclusion and exclusion criteria with each participant at the start of the video call. Then, we reminded the participant of the study's goal and explained the ESM protocol in detail. For example, we mentioned the time the participant had to answer the ESM questionnaires (2 hours). We also specified that it was always better to try to respond immediately after receiving the alert to avoid forgetting to reply. Then, we opened a test version of the ESM questionnaire (through screen sharing), so the participant could familiarise themselves with the layout and the questions. We explained each item and made sure that the participant understood them. We filled in the questionnaire together once to have practice. We indicated that it is impossible to answer precisely in the middle of the 0 to 100 scale (to ensure they answer the survey). And we asked the participant to take their time to answer each question: "It is natural to take your time answering questions. Sometimes you might be able to answer them quickly; sometimes, it will take you more time. We are used to remembering what we have done in the last hour, but it can be harder to remember what we have thought about, or sometimes we remember a vague impression. Lastly, please don't answer randomly; sometimes you may forget to answer, or you might not have time to

answer: in those cases, it is better not to answer rather than answer randomly or too quickly because it could distort the data."

After explaining the study, we explained how and when we sent the text messages. We specified that the participant could directly contact the first author through text message if they encountered an error or had a question, as this would allow the first author to respond promptly.

Next, we asked the participant whether he would agree to have a quick phone call in the next few days to ensure everything is going well and to answer any questions they might have. During this call, we asked the following questions: "Have you been able to fill in many of the diary entries?; How many do you think you have filled in?; Is there anything that's stopping you from filling them in?; Do you have any questions regarding the survey's items?; Would you like to ask me any questions?; Is there anything you are unsure about?"

In the next part of the briefing, we briefly explained the study's goal to the participants so they could understand the study's usefulness and that their efforts serve a bigger purpose. We presented the study this way: "In psychological sciences, studies often only use one measurement, which is thus a snapshot of people's symptoms, behaviors, and thoughts. Thus, this study is important because, in the psychological sciences, there is a severe lack of longitudinal studies with multiple measurement points. This study could, therefore, have interesting results and help us understand how our thoughts fluctuate over two weeks. In a second step, a better understanding of how our thoughts fluctuate and are related may allow us to improve existing therapies to make them even more effective. In addition, although your answers are anonymized, your contribution is appreciated as the more you answer, the more our statistical analyses will be reliable."

We then created a personalized anonymous formr.org link for the participant and sent it to them. We waited for them to fill in the first few demographics questions to ensure they enrolled without hiccups.

We finished the briefing with some important comments: "Before ending this call, let me summarise the main points. Please keep your usual daily routine but try to always have your phone with you. Try to answer the ESM surveys as soon as you receive the text message with the link; otherwise, it can be easy to forget. You will thus have to answer seven questions four times a day for 14 days. At the end of the 14 days, you will have four

questionnaires to fill in. I will then contact you back for the next part of the study. Finally, do not hesitate to contact me by email or phone if you encounter a problem."

Additional features of the ESM procedure with Formr

We customized formr to improve user experience and participant compliance. First, instead of giving participants a study manual explaining the study and the items, we added "tooltips" to the questions: participants could tap on a question at any time, and a text box would appear with more information and explanation. Second, the page displayed a summary of the participant's progress for the day at the end of each ESM questionnaire. Participants saw how many questionnaires they answered today, how many they failed to respond to, and how many were left to answer. After the last daily ESM questionnaire, when they were waiting for the next day to start, participants saw a thank you message and their progress in the study (how many days had passed and how many days were left).

Moreover, suppose the participant answered less than two questionnaires that day. In that case, they saw the following text: "We notice you answered less than two questionnaires today: do not hesitate to contact me (email of the researcher) if there are any difficulties with the study." If the participant had a completion rate above 70% for the day, then a text showed up saying, "Today, you had a completion rate of xx%! This is great; thank you for taking this research seriously". Third, we added precisely timed encouragement texts within the surveys to increase compliance (see *Table S3*). For example, at the end of the 8th day, participants would see this text upon completing the ESM survey: "*This is remarkable. You have completed more than half of the study! Your experience and your involvement in this research directly enhance the quality of this research. Thank you for your commitment!*". Participants saw these messages on the webpage at the end of the day to motivate them to continue answering well and give them a sense of progress. Fourth, the default answer on each ESM question was 50. Participants had to enter any other value for their response to be valid. Only when they answered all the questions would the submit button appear. We did this to ensure participants would not forget or avoid answering a question before submitting the ESM survey. Lastly, we also customized the visual appearance of the formr surveys (we provide the CSS code we used in the formr RUN file on the OSF repository).

ESM survey timeout details

Once the participant had opened the questionnaire (i.e., the participant opened the ESM survey in a browser), it would time out and become unavailable if participants had not

submitted their answers within 70 minutes or would timeout in 10 minutes after the 2-hour access window (e.g., in case the participant forgot or failed to submit his answers after opening the survey).
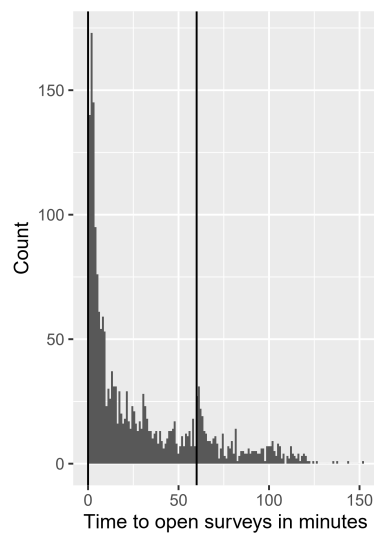
Table S3

Timed Encouragement Texts

| Day	Text
1st	"Thank you for your participation! Please do not hesitate to let us know of any difficulties you may encounter in completing the questionnaires or participating in this study: researcher's email"
4th	"Already four days! We want to thank you and encourage you to continue. As simple as it may seem, each answer you provide improves the quality of this study, helps us better understand our thoughts in our daily lives, and, above all, contributes to the advancement of psychological research. Thank you for your involvement throughout these four days. Please do not hesitate to send us your questions or concerns about the questionnaires (email). This study is unique, and so is your participation."
8th	"This is remarkable. You have completed more than half of the study! Your experience and involvement in this research directly enhance the quality of this research. Thank you for being so committed!"
11th	"Only three days left; it's the final stretch! Every answer matters and allows us to make our statistical analysis more reliable."
13th	"The end of the study is near; only one day left!"

Figure S1

*Time to open the ESM survey in minutes*

Note. The first vertical line represents the moment an alert was sent by text message. The second vertical line is when a reminder was sent out (60 minutes after the first alert). The y axis represents the number of observations.

Figure S2

Response time to complete and submit answers to the ESM items
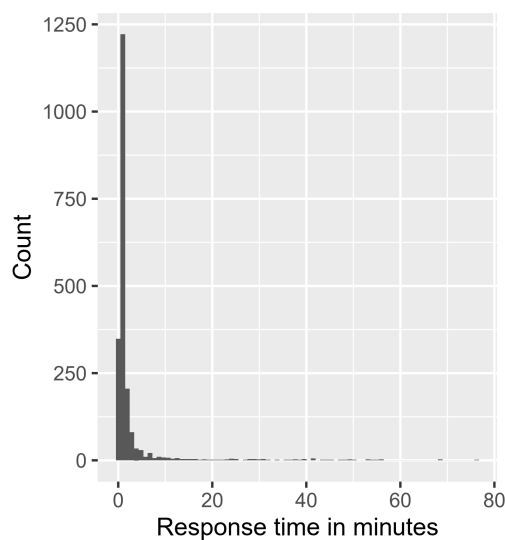
Note. The outliers are either because some participants left the web page open and only submitted their answers after realizing they forgot to press the "submit" button or because some participants started answering the survey but only finished answering later.

Figure S3

Frequency of response rate
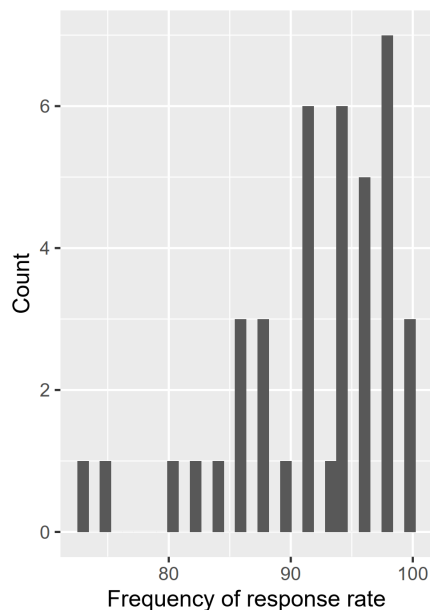
Note. The frequency of participants' compliance rate (in %)

ESM feedback

After the study, participants were asked by email to answer an optional survey (on Qualtrics) containing questions about the ESM items and how they experienced the study. In a series of questions using Likert scales, we asked participants to what extent they understood the questions (i.e., whether they were clear enough), to what extent they felt each question could capture the daily fluctuations it aimed to measure, and whether they could easily translate their everyday experience when answering the question (i.e., whether the continuous scale and the survey were easy to use and to express nuances). Participants could add additional comments for each item to nuance their quantitative answers. We also asked participants whether they used their phone, computer, or both to answer the questionnaires. Next, we asked participants a series of open-ended questions to get a wide range of qualitative feedback. And finally, we asked participants whether they would recommend the study to somebody else, whether they experienced COVID-related anxiety during the study, and to what extent this anxiety had influenced their answers. As this feedback questionnaire was optional, not all participants answered it; 5 participants dropped out. In the results section, we summarize the qualitative and quantitative feedback from the participants (n = 35) regarding their experience during the ESM study.

We provide descriptive statistics of the quantitative answers of participants' feedback in *Table S4*. Overall, participants' feedback indicated that the items sufficiently captured daily fluctuations (except brooding and self-criticism scoring the lowest) and that participants could understand them and answer them well enough (brooding scored the lowest, with a median of 3/7). This suggests that the briefing should perhaps include a more thorough explanation of brooding. Next, regarding the open-ended questions (see section "Qualitative assessment of the ESM items" for more details), the answers indicate that most participants considered that the study was not burdensome and that their participation did not hinder their family or work life (although it should be noted that all but one participant were students). Interestingly, as mentioned in the results section, some participants highlighted that 9 AM might be too early (as nothing much had happened yet) and that 9 PM might be too late to answer ESM surveys. However, one participant said they also ruminated at night and that the ESM surveys did not consider this—a few participants reported similar observations during informal exchanges with the first author. Indeed, our ESM protocol did not cover nighttime rumination because of how we set up the questionnaires. Moreover, 94% of the participants exclusively used their phones to answer the surveys; the others used a computer from time to time (by copy-pasting the link and bookmarking it in their web browser). Lastly, participants were neutral about recommending this study to other participants (*median* = 4) and had only a little COVID-related anxiety (*median* = 3), which did not have a significant impact on their answers during the study (*median* = 2).

Table S4

Descriptive statistics of participants' answers to quantitative feedback questions

Question	M	SD	Median
ESM items			
Ease of understanding			
Perseveration	3.66	1.11	4
Negativity	3.54	0.82	4
Criticism	4.09	1.07	4
Brooding	3.34	1.21	3
Replaying	3.60	1.14	4
Ease of answering the question & translating their experience			
Perseveration	3.94	1.28	4
Negativity	3.83	1.07	4
Criticism	4.43	1.27	5
Brooding	2.89	1.16	3
Replaying	3.29	1.30	3
Adequately capturing daily fluctuations			
Perseveration	4.06	1.37	4
Negativity	4.91	1.31	5
Criticism	3.43	1.12	3
Brooding	2.91	1.12	3
Replaying	4.40	1.31	5
Additional questions			
Would you recommend this study to somebody else?	3.66	1.16	4
Did you feel covid-related anxiety or a bad mood (COVID-related) during this study?	2.77	1.57	3
To which extent did this anxiety or bad mood influence your answers?	2.80	1.86	2

Note. Questions were rated on a Likert scale from 1 (not at all) to 7 (absolutely).

Qualitative Assessment of the ESM items (open-ended questions)

Perseveration

One participant said that as they went through various emotional phases during the four last hours, they tended to answer according to the last 30 minutes. For another participant, it was hard to know whether stress had to be part of this question as they did not see it as an emotional experience because they were constantly stressed about their exams. Finally, one participant sometimes did not know whether they had to refer to emotional experiences experienced during the day or emotional experiences they thought of during the day (i.e., it's both).

Negativity

Some participants had trouble evaluating to which extent their thoughts were negative.

Self-criticism

Some participants highlighted that their answers for negativity and self-criticism were similar. One participant said self-criticism could be positive and negative (although we specifically asked to answer regarding negative unconstructive self-criticism).

Brooding

Two participants found that answering this question took more time.

Replaying

For a few participants, this question was too similar to the question about perseveration. However, one specified that reading the explanation provided in the tooltip helped answer and distinguish the questions.

Qualitative Assessment of the overall experience of the ESM study (open-ended questions)

Did you experience any technical difficulties in participating in this study, and if so, what were they?

A majority of participants did not encounter any technical difficulties. Those who did is because they did not have access to their phone at some moments.

Did you experience any negative emotions while participating in this study, and if so, which ones?

Most participants did not experience negative emotions. Some found that the study forced them to think about unpleasant experiences and was strongly focused on negative questions. Some thought the study was a burden that added to the stress of exams. One participant said it led to negative thoughts that were not present at first, and one said they realized they had too many negative thoughts.

Were you hindered, even partially, by the daily burden this questionnaire imposes?

Some participants thought of the study as homework to do and thus saw it as an inconvenient burden when they were busy, but overall, most participants answered no.

Has it been difficult to combine family/work life with participation in this study?

Other than a few cases in which they forgot or couldn't answer the questions, participants said that it did not hinder their family/work life.

To what extent did you consider your daily participation in this study a burden?

Some participants found it annoying when a reminder or an alert arrived during a calm or important moment. Some did not see it as a burden, although they always had to keep it in mind. A few participants found that four times a day was too much.

Did you feel that your answer in your head was perfectly captured when you answered using the slider? If not, why not?

About half of the participants found the slider convenient for answering the questions. Other participants said they would have preferred a shorter scale (e.g., 1 to 5 or 1 to 10) as they considered the scale to be too precise.

Do you have any comments about the general interface of the questionnaire? Is the tool easy to use?

Many participants here highlighted the ease of use and that they liked the interface of the questionnaire.

"Did you find the system of sending the link to the questionnaire (the SMS) annoying?"

All participants answered no to this question.

Would you have preferred to be sent an email rather than a text message?

All participants but one said they preferred text messages. The one participant that preferred receiving emails said so because it would have allowed them to not keep their phone next to them while working.

What did you think of the times the surveys were sent (9 AM, 1 PM, 5 PM, and 9 PM)? Would you recommend different times? If so, why?

Some participants highlighted that 9 AM (as they did not have the time yet to think about many things) was a bit early and that 9 PM could be a bit late sometimes.

To answer, you had to think back to the hours that had passed since you woke up or since the previous questionnaire. (a) Did you find this exercise difficult given the questions? (b) Do you have any examples of questions where this exercise was much more complicated to complete?

Only a few participants said it was hard to remember what happened during the hours between the surveys or that it required a lot of introspection. Some also noted that the morning questionnaire was harder to answer if they woke up around nine or later as nothing much had happened yet.

Do you have other comments and/or suggestions about this study or the questionnaire?

One participant suggested to consider the hours during the night as well because sometimes they ruminated the most during the night.

What did you like about participating in this study?

Overall, participants liked the introspection, that is, how the study made them more conscious of their thoughts and emotions over several days.

How to use this ESM tool

The detailed instructions and the code to use this ESM tool or replicate this study can be found on OSF: https://osf.io/dngyk/.

See the document titled "ESM-RUM_Formr_Instructions.docx".