Article

Impact of Ecological Momentary Interventions on regulatory strategies of perceived stress at work: example with the application "MY SHERPA" in an ecological context.

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Abstract: Based on ICT, specifically smartphones and their mobile apps, this exploratory study questions the impact of EMIs on employees' perceived stress during work days. A sample of 15 workers, working at least 3 days a week - divided into one control groups (n=5) and one experimental group (n=10) - have used an EMI application "Mon Sherpa" for one-week length. Participants responded to two questionnaires at the beginning of the study: a sociodemographic questionnaire and the PSM-9 (Psychological Stress Measure). They completed the PSM-9 once again in the middle and at the end of the experiment, to compare the score's evolution depending on the formed groups. Additionally, semi-structured interviews have been conducted with participants of the experimental group (n=9) to identify their application's perception. Statistics results indicate no effects of the EMIs. However, interviews indicated somatic, behavioral, and cognitive evolutions throughout the experiment in the field of stress, anxiety, and invasive thoughts. These conflicting results might be explained by an immediate but not lasting effect of EMI's on work-related stress. It may also be partly explained by some limitations of the study. More cross-disciplinary and larger research is required.

Keywords: ICT, EMI, worker well-being, perceived stress, ecological study.

1. Introduction

Technologies are a source of hope for improving well-being and health at work [1]. Among these, the Ecological Momentary Interventions (EMIs), defined as a set of methods associated with clinical treatment in an ecological context [2], intervene notably on various psychological and psychiatric problems such as anxiety, depression, OCD (i.e. Obsessive Compulsive Disorder) and post-traumatic stress [3, 4, 5]. The EMIs, experiencing an expansive increase in the market [3, 6], can take many forms, ranging from simple clinical recommendations (e.g., relaxation techniques in stressful periods), to more formal and structured interventions (e.g., recall and motivational messages during the withdrawal phase of smoking).

Studies investigating the effects of the use of EMIs are not consistent. Some studies suggest benefits to individuals related to reduced anxiety after treatment with EMIs (e.g. [7]). Other studies have, on the contrary, shown a decline in the effects of the EMI over time (e.g. [8, 9, 10]), or their stagnation (e.g. [11]). Moreover, few studies explicitly address work-related stress, defined as a state occurring when an employe's perception of his own effort doesn't feat to the actual reward obtained for his work [12]. This theory perceiving stress as a result of effort and reward imbalance.

The objective of this article is to characterize the effects of an EMI on the stress regulation strategies implemented by operators in a real work context. To do this, three assumptions are formulated:

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- The EMIs lead to changes in behavioral strategies, allowing the individual to control perceived stress at work.
- The EMIs induce to the construction of new cognitive and emotional strategies that regulate the individual's perceived stress at work.
- The EMIs are able to restrict the somatization of perceived stress in a work context.

The article is organized as follows. Section 2 details the research protocol based on a mixed methodology. Section 3 presents the main results of our study in response to the assumptions mentioned above. In section 4, a discussion puts our results in perspective in relation to the scientific literature. In conclusion, new research perspectives are proposed.

2. Methods

2.1. Participants

Fifteen participants (14 women, 1 man) who had volunteered to take part in this study were assigned to one of the two conditions (no use of the EMI vs. use of the EMI). Two groups were constituted: 10 in “use of the EMI” condition (i.e., experimental group) and 5 in “no use of the EMI” condition (i.e., control group). Participants were 9 employees, 5 managers and 1 student, aged 21-60 (M = 44, SD = 11.5).

2.2. Material and Methods

2.2.1. EMI “Mon Sherpa” on the phone

The application used in this study was « Mon Sherpa » developed by the company Qare. This application was awarded at the Psychiatry Congress "l'Encéphale" (2021) and downloaded more than 100,000 times over the year 2021. The application provides follow-up and exercises adapted to each need and offers a listening and follow-up space to patients between their appointments *via* a chatbot (Fig. 1).

Figure 1. “Mon Sherpa”.

2.2.2. Tasks

Participants were asked to complete a single activity per workday, from among several choices of activities offered by the EMI over a one-week period. The choice of location and time of use was free.

In order to facilitate the handling of the application and the understanding of the research protocol, two documents were given to the participants: the first one summarizes the aim of the study and the process to be carried out during the week, and the second one presents a "Mon Sherpa" user's guide in order to assist the users step by step in the handling of the application.

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2.2.3. Questionnaires and interviews

Participants were asked to answer two questionnaires: one before and only the first day, and the second questionnaire on three occasions, once before (day 1) and twice after performing the task (i.e. using "My Sherpa"), on day 3 and day 5 of the study. These questionnaires were administered online via a link sent to each participant.

The questionnaire filled in before the task contained 5 questions: four demographic items (age, gender, professional status, occupation) and the number of days worked per week.

The second questionnaire, administered three times, the PSM-9 (Psychological Stress Measure) was used to measure the perceived stress at different times during the study [13].

This questionnaire was chosen as a quick evaluation of perceived stress which can be used during a working day, allowing participants to spend less time into what can be perceived as a long and repetitive task over the week.

The French version used contained 9 items rated on 8-point Likert-like scales scored from 1 to 8 (Table 1): two somatic items (items 3 et 6), six cognitive-affective items (items 1, 2, 4, 5, 7 et 9) and one behavioral item (item 8). This PSM shows the same psychometric qualities of validity (.95), internal consistency (between .35 and .85) and reliability (.89) as the PSM-49 and the PSM-25, long and intermediate forms of the questionnaire [13].

Table 1. PSM-9 questionnaire.

Tableau 1. La Mesure du stress psychologique MSP-9

Cochez le chiffre qui indique le mieux le degré auquel chaque affirmation s'est appliquée à vous récemment, c'est-à-dire dans les 4 à 5 derniers jours.

	PAS DU TOUT	PAS VRAIMENT	TRÈS PEU	UN PEU	QUELQUE PEU	PAS MAL	BEAUCOUP	ÉNORMÉMENT
	1	2	3	4	5	6	7	8
Je suis détendu(e)								
Je me sens débordé(e); j'ai l'impression de manquer de temps								
J'ai des douleurs physiques: maux de dos, maux de tête, mal à la nuque, maux de ventre								
Je me sens préoccupé(e), tourmenté(e) ou anxieux (anxieuse)								
Je ne sais plus où j'en suis, je n'ai pas les idées claires, je manque d'attention et de concentration								
Je me sens plein(e) d'énergie, en forme								
Je sens peser un grand poids sur mes épaules								
Je contrôle mal mes réactions, mes émotions, mes humeurs, mes gestes								
Je suis stressé(e).								

Lemyre et Tessier, 1988, 2002.

Mark the number that best indicates the degree to which each statement applies to you recently, that is in the last 4-5 Days

	Not at all ®	Not really ©	Very little ™	A bit ∑	Somewhat (	Quite a bit |	Very Much)	Extremely [
1. I feel calm	®	©	™	∑	(	|	)	[
2. I feel rushed; I do not seem to have enough time.	®	©	™	∑	(	|	)	[
3. I suffer from physical aches and pains: sore back, headaches, tensed neck, stomach aches.	®	©	™	∑	(	|	)	[
4. I feel preoccupied, tormented or worried.	®	©	™	∑	(	|	)	[
5. I feel confused; my thoughts are muddled; I lack concentration and I cannot focus my attention.	®	©	™	∑	(	|	)	[
6. I feel full of energy and keen.	®	©	™	∑	(	|	)	[
7. I feel a great weight on my shoulders.	®	©	™	∑	(	|	)	[
8. I have difficulty controlling my reactions, emotions, moods or gestures.	®	©	™	∑	(	|	)	[
9. I feel stressed.	®	©	™	∑	(	|	)	[

© Lemyre et Tessier, 1988, 2002

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Semi-structured interviews were conducted with 9 volunteer participants (among the 10 participants of the experimental group) in order to gather feedback on the use of the application (Table 2). The guide for the semi-structured interview was divided into 6 sections, referring to utility, usability, regulation, satisfaction, opinion of the experiment and other feedback. These themes were chosen in order to incorporate the impact of a technology into the process of stress regulation, meaning to understand the reason of use of the system (utility), the interaction between the user and the interface (usability), and the subjective aspect of usability (satisfaction) [14]. Regulation was also investigated as the result of relationship between the user and the system, allowing to understand some behavioral modification during the period of use [15]. Despite the integration of ergonomics dimensions, the study was in need to understand the motivation of the subject during the experiment, as it could have led to a change of the results [16].

Table 2. Guide for the semi-structured interview.

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Thèmes	Questions de relance
Pouvez-vous vous présenter ? (Nom, âge, profession, expériences, durée d'ancienneté)	
Utilité	- L'application vous a-t-elle été utile ? Pourquoi ? - Comment vous a t-elle aidé ou non à mieux gérer votre stress ? - L'application vous a-t-elle aidé dans d'autres domaines de votre quotidien ?
Utilisabilité	- Comment avez-vous trouvé l'application en termes de prise en main ? Pourquoi ? - Vous a t'il fallut du temps pour vous familiariser avec l'application ? Combien ? - Dans quel contexte avez-vous utilisé l'application ? Au travail ? A votre domicile ? Autre part ? - Pour quelles raisons avez-vous choisi ces contextes ? - Pensez-vous que cette application soit utilisable dans n'importe quel environnement ?
Régulations mises en place	- Avez-vous appris de nouvelles techniques pour réguler votre stress ? Lesquelles ? - Pensez-vous les réutiliser par la suite ? - A quels occasions ces techniques pourraient-elles vous servir ? - Avez-vous ressenti une différence dans vos comportements au travail durant cette semaine d'utilisation ? Au quotidien ?
Satisfaction	- Qu'avez-vous pensé de l'application ? - Pensez-vous la réutiliser plus tard ? Pourquoi ? - Y'a-t-il des éléments que vous souhaiteriez améliorer au sein de l'application ? Si oui lesquels ? - Y'a-t-il des éléments qui vous ont plus au sein de l'application ? Si oui lesquels ?
Retours sur l'expérience	- Qu'avez-vous pensé de l'expérience ? - Comment vous a-t-elle parue en termes de difficultés ? - Pouvez-vous m'en donner des points positifs et/ou négatifs ? - Qu'avez-vous pensé de sa durée ? - Et le temps de passation par jours ? - Qu'avez-vous pensé des questionnaires ? Et de leur mode d'administration ?
Autres commentaires	- Avez-vous d'autres retours à me faire ? Des points qui n'auraient pas été abordés ?

Themes	Questions
Could you present yourself ? (Name, age, occupation, experiences, years of experience)	
Utility	- Was the application useful to you ? Why ? - How does she help you or not to manage your stress ? - Did it help you in other fields of your daily life ?
Usability	- How do you find the application's first handling ? Why ? - Had you needed some time to get used to it ? How much? - In which situation had you used the application ? At work ? At your home ? Anywhere else ? - For which reasons had you choose those situations ? - Do you think this application would be usable in every situation ?
Regulations used	- Had you learned some new techniques to compose with your stress ? Which ones ? - Do you think of reusing them later ? - For which occasion those techniques may be useful to you ? - Have you felt a difference in your daily behaviors at work during this week ? And in your everyday life ?
Satisfaction	- What have you felt about the application ? - Do you think about using it in the future ? Why ? - Are there some elements you would like to upgrade inside the application ? If yes which ones ? - Are there some elements that please you inside ? f yes which ones ?
Opinions about the experiment	- What is your feeling about the experiment ? - How does it looks to you, in terms of difficulty ? - Could you give me some positive and negative points ? - What do you think about the lengths ? - And for the lengths of each exercise ? - What about the questionary ? And the form of the application ?
Other feedbacks	- Have you other feedback to me ? Some points that haven't been explained ?

3. Results

For the analysis of PSM-9 scores, we ran a test of normality (i.e., Shapiro Wilk test). The data was analyzed using the nonparametric Mann-Whitney U test when the Shapiro

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Wilk test indicated a significant result ($p < 0.05$), while a Student's t test was used when the Shapiro Wilk test indicated a non-significant difference ($p > 0.05$). A repeated measures ANOVA was also used to compare the evolution of the PSM-9 scores obtained over the different days of the study. An inter-item comparison was also performed to observe the evolution of each of the three themes covered in the PSM-9 questionnaire.

Verbal data, extracted from the interviews, were subjected to a thematic content analysis.

3.1. The effects of EMIs on behavioral states and strategies for regulating perceived stress at work

3.1.1. Control group vs. experimental group

There is no significant difference between the control group (M= 3.25 ; SD= 1.17) and the experimental group (M= 3.55 ; SD= 2.02) for item 37 "*I have difficulty controlling my reactions, emotions, moods or gestures*" : $t(4) = 0.250$, $p = .407$ on day 1.

No significant difference is then observed on days 3 and 5.

3.1.2. Evolution of behavioral strategies

Analysis of PSM-9 scores suggests that EMI does not significantly influence the behavioral strategies deployed: $\chi^2 (2) = 2.09$, $p = .352$. Participants who used the application over the five days would not have perceived any changes in their current daily behaviors.

On the contrary, analysis of the interviews suggests that participants developed new behavioral strategies to regulate perceived stress, anxiety or intrusive thoughts. These are mostly expressed in the search for action support through the application. Indeed, all the participants interviewed declared that they use the application to reinforce and increase their motivation to act « *At least we have a tool with activities that are proposed, that's useful because the activities even if you can do it without an application, doing it alone at home, it's less obvious. So, to have a little help, something that guides us, that's what it is in fact, it's to have a guide* » (Participant 2).

Nevertheless, the participants specified that this use must be occasional in response to particular needs « *On days when I'm really feeling overwhelmed, maybe the day I need to get away and even on weekends if I have a worry, I can use it* » (Participant 8).

Moreover, these behavioral strategies are related to the design of the application that encourages its use (e.g., functions): « *Sometimes during the day we get a message: Sherpa ask you if you slept well, or that kind of thing, so it reminds you ah yes I have to go see* » (Participant 1).

These strategies appear to be constrained by the environmental and temporal constraints often associated to the characteristics of the workspace, with employees reporting a fear of being bothered by "interruptions", "noise" or the discomfort of performing exercises in front of colleagues « *So at work it's more difficult because we don't really have a place to isolate ourselves so we're on a open space if I stop and start breathing in a strange way they'll wonder* » (Participant 7). The lack of time at work was also mentioned by seven participants, with most preferring to use the application outside of work hours. Nevertheless, one person mentioned new regulation behaviors at work through the implementation of breaks used in particular for the application of "Mon Sherpa" « *When I'm at work I have a hard time taking breaks, and I don't really think about it, and the fact that the phone is ringing and I have a notification and I see the little guy can give me a break so it's good* » (Participant 5).

3.2. The effects of EMIs on cognitive-affective strategies for regulating perceived stress at work

3.2.1. Control group vs. experimental group

There is a significant difference between the control group (M= 2.75 ; SD= 0.5) and the experimental group (M= 4.73 ; SD= 1.95) for the item 30 " *I am relaxed* ": $t(13) = 1.957$, $p = 0.036$, for day 1.

Additionally, the results indicate that item 31 "*I feel overwhelmed, I feel like I'm running out of time*" provided significantly higher scores for the experimental group (M = 4.82; SD

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= 1.4) compared to the control group (M = 3.25 ; SD = 0.957): $t(13) = -2.047$, $p = .031$, for the day 3.

No significant differences were observed between the control and experimental groups on day 5.

3.2.2. Evolution of the cognitive-affective strategies

The PSM-9 scores show that EMI does not lead to the adoption of new cognitive schemas or changes in affective state: $F(2,20) = 2.57$, $p = .102$. The participants did not perceive major differences in their cognitive patterns and affective states as they used the EMI.

In the interviews, eight participants mentioned the desire to talk to " Mon Sherpa " in order to seek emotional support "*without judgments*", the virtual companion being perceived as a "*friend*" favorable to interactions without social norms, especially those expected in the context of work: "*It's a relief if you talk to someone who won't judge you*" (Participant 8). Yet, these conversations would still be perceived as limited: "*After that, it's still a computer interface*" (Participant 5). The comfort would rather be linked to the caring of the words and the design of the application: "*I think that it was created to be kind and to listen and this is felt in the design of the mascot*" (Participant 4).

The application would allow the user to externalize his affects and to develop a distancing from the invasive thoughts at the origin of the deterioration of their affective state " *To feel better, we must also take the time to know ourselves and simply stop the activities of the day to do so* " (Participant 2). Moreover, the management of cognitive affects is addressed by almost all the participants, the last participant not insisting on the "*appeasement*" provided by the exercises. This would nevertheless remain temporary " *But it is just in the immediate after we resume the rhythm if I had been in a tense situation, I would have gone back to the tense situation but it would have allowed me to stop at the moment* " (Participant 2).

3.3. The effects of IMEs on somatization associated with perceived work-related stress

3.3.1. Control group vs. experimental group

No significant difference was observed between the two groups for days 1, 3 and 5.

3.3.2. Evolution of somatizations

The scores obtained from the PSM-9 show that EMI has no effect on somatic regulations: $F(2,20) = 0.005$, $p = .995$. The application would not allow, over a week, to act on the construction as well as the expression of the employees' affects.

The comments made by the employees also nuanced the statistical analyses. Indeed, seven out of nine participants mentioned at least once the presence of somatic regulation induced by the practice of the exercises proposed by "Mon Sherpa". These effects would not only concern the improvement of the quality of sleep "*I sleep better, I manage to sleep I wake up less, yes I find that I wake up less. I manage to sleep for 6 hours in a row whereas before I used to wake up at 2am and fall asleep at 5am but now I fall asleep at 11pm and wake up at 6am or 7am*" (Participant 1), but also the reduction of agitation.

4. Discussion

Our first hypothesis, namely that the EMIs lead to changes in behavioral strategies allowing the individual to control perceived stress at work, was only partially validated. This result is consistent with the findings of previous studies (e.g., [17]).

The simplified interactions of the app in a care context could, for example, prompt the employee to transfer his/her need for social support to the AI, effectively creating a dependent relationship with the system [18]. EMIs could, in this sense, represent a risk of social disconnection since the individual could take refuge in the application rather than face the conflicts of the field.

Our second hypothesis, namely that the EMIs lead to the construction of new cognitive and emotional strategies to regulate the individual's perceived stress at work, was also only partially validated. The EMIs, and in particular the exercises of breathing

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and meditation proposed by " Mon Sherpa ", would allow to build a sense of well-being by acting not only on the levels of anxiety and stress, but also on the distancing of invading thoughts. The effects were nevertheless no strong enough for producing an effect on the level of work-related stress, as measured by the PSM-9.

Our third hypothesis, namely that the EMIs are able to restrict the somatization of perceived stress in the work context, was still only partially validated. The interviews suggest an effect of EMIs on improving sleep quality, confirming various studies that have already demonstrated the effectiveness of EMIs on sleep thanks to the adoption of various behavioral strategies such as getting up immediately after waking up [19]. But these effects were not confirmed by the PSM-9.

In facts, our study suggests an immediate but no-lasting effect of EMI's on work-related stress. According to the results, the EMI's use would favorize a brief change into the subject behavior or cognition. Despite the use of the EMI, individuals would be more likely to return to their initial state of stress and anxiety, after the completion of the advice given by the EMI (e.g. "*if I had been in a tense situation, I would have gone back to the tense situation but it would have allowed me to stop at the moment")*. This could be the explanation of the partially validated hypotheses, as well as the size of the sample, preventing affirmation about the quantitative results. If EMI's can provide social support, especially when it can not be fulfilled by the entourage, it is unable to solve the very source of work-related stress. Secondary prevention does not replace primary prevention and should only be seen as a complement.

5. Conclusions

The purpose of this paper was to investigate the effects of EMIs on behavioral, cognitive-affective, and somatic strategies for perceived work-related stress. Perceived stress scores measured by the PSM-9 were compared with participants' verbalizations. Although there were no significant results showing any effects of EMIs, the semi-structured interviews indicated very short-term behavioral, cognitive-affective and somatic changes immediately after the realization of the exercises proposed by "Mon Sherpa". This exploratory study has two major limitations: the first is the small sample size, and the second is the focus of the study on perceived stress. Therefore, it would be interesting to integrate measures related to observable manifestations of perceived stress and to involve a large number of participants from various professional contexts.

Supplementary Materials: The following supporting information can be downloaded at: www.mdpi.com/xxx/s1, Figure 1: Mon Sherpa; Table 1: PSM-9 questionnaire; Table 2: Guide for the semi-structured interview.

Author Contributions: Emilie Perreau contributed to the conceptualization, methodology, formal analysis, writing—original draft preparation and writing—review and editing. Sarah Belouahchi participated in the validation and writing—review and editing. Davy Castel participated in the validation and writing—review and editing. Emilie Loup-Escande contributed to the supervision, writing—original draft preparation and writing—review and editing. All authors read and approved the published version of the manuscript.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and its subsequent amendments. Before the experiment, the participants signed a web-based consent form. The participants did not receive any financial compensation for their participation, and they agreed to participate in the study. The anonymity, confidentiality, and secure storage of the data were guaranteed to the participants and respected. Ethical review and approval were waived for this study due to the use of a standardized and scientifically validated questionnaire and an interview that does not involve personal data.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

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