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Impact of Ecological Momentary Interventions on Regulatory Strategies of Perceived Stress at Work: An Exploratory Study Based on the Application "MON SHERPA" Used 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 workdays. A sample of 15 workers, working at least 3 days a week and divided into one control group (n=5) and one experimental group (n=10), used an EMI application called "Mon Sherpa" for one week. 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 were conducted with participants of the experimental group (n=9) to identify their perception of the application. The statistical results indicated no effects of the EMIs. However, interviews indicated somatic, behavioral, and cognitive evolution 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 EMIs 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: information and communication technologies, ecological momentary intervention, worker well-being, perceived stress, ecological study

1. Introduction

Technologies are a source of hope for improving well-being and health at work (Del Rio et al., 2017). Among these, Ecological Momentary Interventions (EMIs), defined as a set of methods associated with clinical treatment in an ecological context (D'Alfonso, 2020), intervene notably in various psychological and psychiatric problems such as anxiety, depression, OCD (i.e., Obsessive-Compulsive Disorder), and post-traumatic stress (Van Ameringen et al., 2017; Linardon et al., 2019; Schueller et al., 2017). The EMIs, experiencing an expansive increase in the market (Van Ameringen et al., 2017; Myin et al., 2018), 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., Economides et al., 2019). Other studies have, on the contrary, shown a decline in the effects of the EMI over time (e.g., Baer et al., 1988; Rodgers et al., 2005; Vidrine et al., 2006) or their stagnation (e.g., Kenardy et al., 2003).

Furthermore, this recent theme was mostly investigated in the research of clinical psychology as a monitoring tool for the patient's progress (e.g., Donker et al., 2013; Torous et al., 2014). This limitation of EMI use to existing therapy leads to question a new standpoint concerning the EMI (e.g., Donker et al., 2013; Torous et al., 2014) and its potential contribution to the work context. As a matter of fact, we observe few research regarding the inclusion of applications promoting health, performance, and well-being at work (van den Heuvel et al., 2009; Robroek et al., 2010; Wierenga et al., 2013). Also, few studies explicitly address work-related stress, defined as a state occurring when an employee's perception of their own effort doesn't answer the actual reward obtained for their work (Siegrist, 1996). However, the presence of stress at work is a major issue, as the distress caused by the demands of work, burnout, and organizational pressures are significant nowadays (e.g., Bartlett et al., 2019). As a result, there is a real need to expand research on this subject, especially in other spheres such as work psychology.

This paper aims to characterize the effects of EMI on the stress regulation strategies developed by operators in a real work context.

The article is organized as follows: Section 2 presents the theoretical background underlying the dimension of EMIs. Section 3 clarifies the purpose and assumptions of the study. Section 4 details the research protocol based on a mixed methodology. Section 5 presents the main results of our study in relation to the hypotheses mentioned above. In section 6, a discussion puts our results in perspective in relation to the scientific literature. In conclusion, new research perspectives are proposed

2. Theoretical Background

2.1 Definition of EMIs

EMIs are characterized as part of the three possible uses of AI, next to digital phenotyping and language and chatbot analysis (D'Alfonso, 2020). These elements take place in the field of Psycho-informatics, defined as "an emerging discipline that uses tools and techniques from the computer and information sciences to improve the acquisition, organization, synthesis of human psychological data" (Yarkoni, 2012). More precisely, EMIs focus on a set of methods associated with clinical treatment in an ecological environment (D'Alfonso, 2020). Their mechanisms are based on large databases that can be collected passively by the phone's sensor (e.g., GPS) or actively by the completion of questionnaires by the user (Carter et al., 2007).

They can be used regarding different psychiatric and psychological problems such as anxiety, depression, OCD, and PTSD (Van Ameringen et al., 2017; Linardon et al., 2019; Schueller et al., 2017) as a tool of intervention. The term "EMIs" was first mentioned by Patrick et al. (2005) in a study on communication mechanisms for patients suffering from cancer. The goal was originally to deliver personalized interventions to patients. Therefore, EMIs take place in a complex construction defined by the relationship between the users and the intervention (Carter et al., 2007).

2.2 EMIs' Reference Model

As an ecological intervention, EMIs are based on Brofenbrenner's classic ecological framework (1979). This theory highlights the impact of the environment on human behavior. Brofenbrenner offered a list of determining factors contributing to the modeling of behavior. The main factors are identified as follows: the direct social environment, known as the microsystem (e.g., relationships, roles); the mesosystem, containing the indirect effect of the social environment on human development (e.g., peer group activities); the exosystem linked to the external social environment (e.g., organizational culture); and lastly, the macrosystems, underlying the effect of consistent elements between each of the systems (i.e., micro-, meso-, and exo-systems), such as the socioeconomic status. All those components interact to influence the behavior of the subject. This complexity explains the difficulties in developing targeted behaviors without taking into account the immediate environment and its effect on behaviors. EMIs allow personal advice to respond to those needs by including the environment in their digital counseling

2.3 Forms of EMIs

EMIs can be used in therapeutic follow-up or in everyday life because of their adaptability. This explains their extensive growth in the market field, with EMIs becoming more numerous, with many forms and applications. Their rapid development is also explained by the curiosity surrounding the system (Van Ameringen et al., 2017; Myin et al., 2018). They can offer different interventions, from simple clinical recommendations (e.g., relaxation exercises in stressful periods) to more formal and structured interventions (e.g., motivational messages during a craving phase for smoking cessation). They can also be used as a complement to therapeutic interventions or alone (Carter et al., 2007). EMIs usually allow different levels of complexity, depending on their features. The three main levels range from simple intervention to interactive and then integrative levels with a learning system over time (Schueller et al., 2017). At this stage, EMIs make use of machine learning, allowing recommendations to become more and more precise for the user as time goes by. This process follows the construction of interactive models as well as the construction of cognitive patterns. Therefore, their functioning becomes closer to that of Just-in-Time Adaptive Interventions (JITAIs), a system offering custom interventions at the right time and for a unique user (Nahum-Shani et al., 2018).

2.4 Devices for EMIs

EMIs can be used from a computer or a smartphone. Indeed, computers offer several systems allowing EMIs to function, such as a personal digital assistant (PDA), a small electronic device running applications on a digital screen. However, smartphones seem advisable for EMIs use because of their ability to send and receive written and vocal messages, pictures, and videos. Their small size presents an asset for mobility and ease of use in an individual's daily life (Heron & Smyth, 2010). Some studies have shown good acceptance from participants for EMIs transmitted by those devices (Newman et al., 1999; King et al., 2008). Volunteers find it easy to remind themselves to use the device (Newman et al., 1999; King et al., 2008). However, as with other applications, EMIs can depend on the user's familiarity with the

interface (Rodgers et al., 2005).

2.5 Measurements of the Effects of EMIs

Due to the different interventions offered by EMIs, previous studies have had to adapt their measurement tools to the subject of the intervention. Indeed, no official measurements are recommended to evaluate the impact of EMIs. As an ecological intervention, such tools have to adapt to specific situations. For example, the Depression Anxiety and Stress Scale (DASS-21; Lovibond et al., 1995), the Perceived Stress Scale (PSS; Cohen et al., 1983), and the 20-item Positive and Negative Affect Schedule (PANAS; Watson et al., 1988) were used to measure the impact of EMI on distress and affective disorders (Nguyen-Feng et al., 2019). We can also mention the 20-item State-Trait Anxiety Inventory-Trait Version to measure trait anxiety (Spielberger et al., 1983) and the 14-item Hamilton Anxiety Rating Scale to rate the severity of each overarching anxiety symptom cluster (Hamilton, 1959). The Penn State Worry Questionnaire, a 16-item self-report measure of the frequency and intensity of worry, was also used to measure the impact of EMI on anxiety (Newman et al., 2014; Meyer et al., 1990). Finally, as a tool for measuring perceived stress, the Psychological Stress Measurement 9 (PSM-9) is a questionnaire derived from the PSM 25 and the PSM 49, all created by Lemyre and Tessier (1988). The PSM-9 allows the quick measurement of three dimensions: behavioral strategies, cognitive-affective strategies, and somatic reactions. Each part refers to certain items of the questionnaire. Measuring scores of item 8 allows measurement of behavioral strategies, adding up scores of items 1, 2, 4, 5, 7, and 9 refers to measurement of cognitive-affective strategies, and scoring items 3 and 6 refers to measurement of somatic reactions (cf: Table 1).

2.6 Stress Model

Based on Siegrist's stress model (1986), Lemyre, Tessier, and Fillon (1990) proposed a biopsychosocial stress model relating to three main factors: cognitive-affective, behaviors, and somatic. This model associates individual processes, referring to coping strategies and perception, with environmental parameters (e.g., events and life context), leading to an integrative overview of factual parameters and psychological phenomena (cf: Figure 1). The authors offer a new position in stress definition, between a state of mental tension (Lemyre and Tessier, 1988) and the expression of stress biomarkers (e.g., cortisol levels and stress-related psychological responses) (Lupien et al., 2002; Theorell, 2007). This model identifies three main dimensions of stress components: affective cognitive, somatic, and behavioral. Stress is perceived as a fluctuant but normal phenomenon related to periods and life events, and it can differ from extremely low levels to overwhelming high states. Stress is seen as energizing or debilitating depending on individuals and situations (Lemyre and Tessier, 2003). Moreover, psychological stress can be defined as a continual state of psychological tension related to individual experience (Lemyre, 1987). However, the authors differentiate the events causing stress from stressors as two separate phenomena. Stressors are related to chronic situations or life events, demonstrating the impact of the environment as a contributing factor or a provoking agent of the stress feeling (Orpana et al., 2004; Orpana et al., 2007). This definition brings the vision of stress as a core construct resulting from the adaptation of the subject to life demands and the prediction of health (Lemyre and Lalande-Markon, 2009).

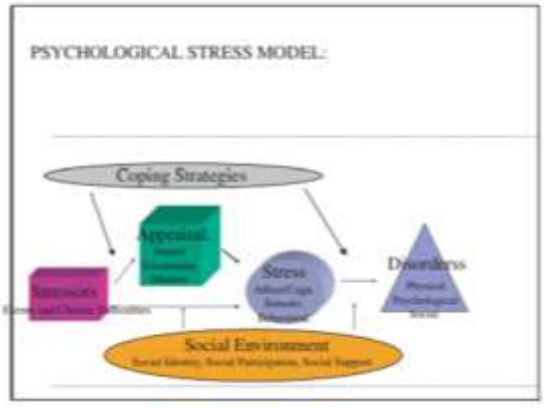

Figure 1. The psychological stress model (Lemyre and Lalande-Markon, 2009)

A long-term exposure to stress can then enhance stress disorders, leading to mental or physical illness. On a biological level, high stress intensity or long-term exposure to stress can be related to neuro-endo-immune mediators that weaken individuals' defense mechanisms. The stress model refers to a direct relation with health and is also perceived as a by-product of several factors, including healthcare, social, environmental, biological, and behavioral (Lemyre and Orpana, 2002). Its systemic approach allows the integration of stress as an integrative variable that takes part in the human ecology of health, as related to Brofenbrenner's classic ecological framework (1979) (cf: Figure 2).

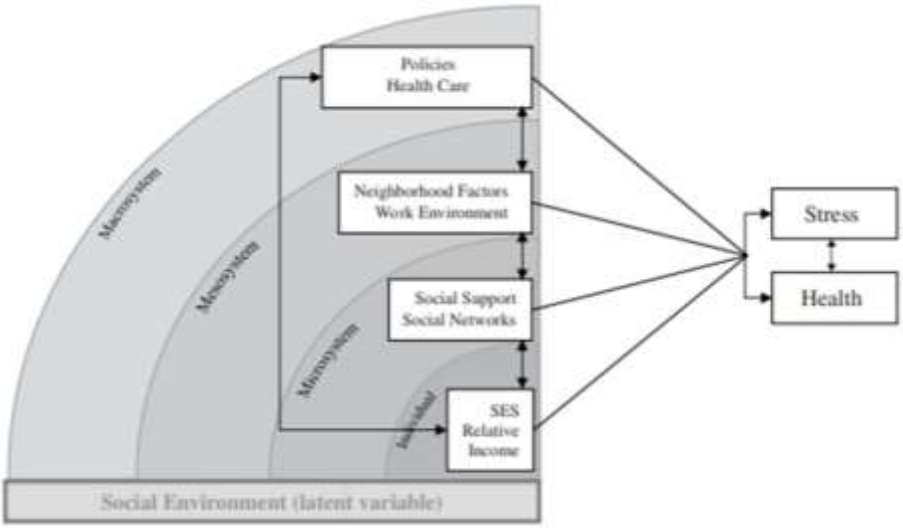

Figure 2. The ecological model of stress and health, adapted from S. Gibson, in Lemyre and Laland-Markon (2009)

The use of this model follows a consideration of social, biological, and psychosocial factors within a holistic approach to the individual in an environment. Health Psychology examines the influence of psychological factors on health or illness issues, such as social support, perceived stress, personality, and economic status (e.g., Taylor, 2008). This biopsychosocial model seems particularly relevant in a situation of diagnosis and intervention, serving as an initial assessment of an individual's health.

3. Aims and Hypotheses

Our objective was guided by the limitation of research regarding the use of EMIs (e.g., Donker et al., 2013; Torous et al., 2014) and the scarcity of studies exploring the inclusion of applications promoting health, performance, and well-being at work (van den Heuvel et al., 2009; Robroek et al., 2010; Wierenga et al., 2013). The aim of the present study was to examine the effects of EMI on the stress regulation strategies implemented by operators in a real work context. Three hypotheses were formulated:

1) Considering the three dimensions of perceived stress as proposed by Lemyre and Tessier (1988), stress should be measured through behavioral strategies. Thus, we hypothesized that EMIs would lead to changes in behavioral strategies, enabling individuals to better control perceived stress at work.
2) Another measure of perceived stress is the modification of cognitive and emotional strategies (Lemyre & Tessier, 1988), which can indicate the influence of EMIs on stress levels. As a second hypothesis, we supposed that EMIs would lead to the development of new cognitive and emotional strategies that regulate an individual's perceived stress at work.
3) Lastly, the somatization of perceived stress should also be observed (Lemyre & Tessier, 1988). Accordingly, we hypothesized that EMIs would be able to reduce somatization related to perceived stress in a work context.

4. Methods

4.1 Participants

Fifteen participants (14 women, 1 man) who volunteered to take part in this study were assigned to one of two conditions: the "no use of the EMI" condition and the "use of the EMI" condition. To recruit participants, we conducted online presentations of the study on social platforms and company networks. The study criteria were also provided: participants had to work at least three days a week, be fluent in French, be available for one full week, and have a personal smartphone to download the application. Initially, 30 volunteers were found, but only 15 completed the entire study. As the participants' level of technological proficiency might influence their use of the EMI (Stieger & Lewetz, 2018), they were asked if they were comfortable using smartphones during the initial contact. Those who faced difficulties were assigned to the control group, where they did not use the application. Two groups were formed: 10 participants in the "use of the EMI" condition (experimental group) and 5 participants in the "no use of the EMI" condition (control group). The participants included 9 employees, 5 managers, and 1 student employee, aged 21-60 (M = 44, SD = 11.5). The control group consisted of 4 women and 1 man, aged between 33 and 60 (M = 44.3, SD = 11.6). The experimental group consisted of 10 women aged between 21 and 60 (M = 44, SD = 12.1).

4.2 Material and Methods

4.2.1 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 in 2021. The application provides personalized follow-up and exercises tailored to individual needs, and it offers a space for patients to communicate and receive support between their appointments via a chatbot (Fig. 1).

Figure 3. “Mon Sherpa” (selected screens from the application)

4.2.2 Tasks

Participants were asked to complete a single activity per workday from a range of choices offered by the EMI over a one-week period. The choice of location and time of use was left to the participants, following the EMI protocol. The use of EMI needed to be coordinated with the users' needs (D'Alfonso, 2020), so they were allowed to choose the time of the intervention. The length of the experiment was designed according to ecological constraints. As the experiment took place in April, the planning was adjusted based on the participants' holiday schedules, resulting in a one-week duration. This short period aligned with the aim of our study, providing an initial assessment of the effects of the EMI at work.

To facilitate the use of the application and the understanding of the research protocol, two documents were provided to the participants. The first document summarized the aim of the study and the process to be followed during the week, while the second document presented a user's guide for "Mon Sherpa," providing step-by-step assistance in navigating the application.

4.2.3 Questionnaires and Interviews

Participants were asked to answer two questionnaires: one before, only on the first day, and the second questionnaire on three occasions - once before (day 1) and twice after performing the task (i.e., using "Mon 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, was the PSM-9 (Psychological Stress Measure), used to measure perceived stress at different times during the study (Lemyre & Tessier, 2003). This questionnaire was chosen as a quick evaluation of perceived stress, which can be completed during a working day, allowing participants to spend less time on 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 and 6), six cognitive-affective items (items 1, 2, 4, 5, 7, and 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 (Lemyre & Tessier, 2003).

Table 1. PSM-9 questionnaire

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

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

Semi-structured interviews were conducted with 9 volunteer participants from the experimental group to gather feedback on the use of the application (Table 2). The interview guide consisted of six sections: utility, usability, regulation, satisfaction, opinion of the experiment, and other feedback. These themes were chosen to incorporate the impact of technology into the process of stress regulation, aiming to understand the reasons for using the system (utility), the interaction between the user and the interface (usability), and the subjective aspect of user experience (satisfaction) (Brangier & Barcenilla, 2003). Regulation was also investigated to explore the behavioral changes that occurred during the period of app usage (Mercier & Lefer Sauvage, 2017). Despite integrating ergonomic dimensions, the study aimed to understand the participants' motivation during the experiment, as it could have influenced the results (Shahzadi et al., 2014).

Table 2. Guide for the semi-structured interview

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 ?

5. Results

For the analysis of PSM-9 scores, we ran a test of normality (i.e., Shapiro Wilk test). The data were analyzed using a Student's t test 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 thematic content analysis.

5.1 The Effects of EMIs on Behavioral States and Strategies for Regulating Perceived Stress at Work

5.1.1 Control Group vs. Experimental Group

According to the analyses of the PSM-9 results, 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 8 "*I have difficulty controlling my reactions, emotions, moods or gestures*" : $t(4) = 0.250$, $p = .407$ on day 1 (Table 3). No significant difference is then observed on days 3 and 5.

Table 3. Student's test on Days 1,3 and 5 from PSM-9 results

	Independent Samples T-Test (D1)				Independent Samples T-Test (D3)			Independent Samples T-Test (D5)		
		Statistic	**df**	**p**	**Statistic**	**df**	**p**	**Statistic**	**df**	**p**
Item 1	Student's t	1.957	13.0	0.036	-0.376	13.0	0.643	0.6774	13.0	0.255
Item 2	Student's t	-0.608	13.0	0.723	2.047	13.0	0.031	1.1918	13.0	0.127
Item 3	Student's t	1.242	13.0	0.118	0.248	13.0	0.404	1.6695	13.0	0.059
Item 4	Student's t	0.343	13.0	0.369	-1.089	13.0	0.852	0.6001	13.0	0.279
Item 5	Student's t	1.336	13.0	0.102	0.898	13.0	0.193	1.4491	13.0	0.086
Item 6	Student's t	1.152	13.0	0.135	-0.488	13.0	0.683	0.3616	13.0	0.362
Item 7	Student's t	0.321	13.0	0.377	-0.419	13.0	0.659	0.3430	13.0	0.369
Item 8	Student's t	0.259	13.0	0.400	-1.210	13.0	0.876	-1.0574	13.0	0.845
Item 9	Student's t	0.494	13.0	0.315	-0.924	13.0	0.814	0.0820	13.0	0.468

5.1.2 Evolution of Behavioral Strategies

Analysis of PSM-9 scores suggests that EMI does not significantly influence the deployed behavioral strategies: $\chi^2 (2) = 2.09$, $p = .352$ (Table 4). Participants who used the application for five days did not perceive any changes in their current daily behaviors.

Table 4. Detailed analyses of scores from the PSM-9

Detailed analyses of scores from the PSM-9														
Behavioral strategies			Cognitive and emotional strategies						Somatizations					
Friedman			Within Subjects Effects						Within Subjects Effects					
χ^2	**df**	**p**		**Sum of Squares**	**df**	**Mean Square**	**F**	**p**		**Sum of Squares**	**df**	**Mean Square**	**F**	**p**
2.09	2	0.352	Cognition	64.8	2	32.4	2.57	0.102	Somatization	0.0606	2	0.0303	0.00489	0.995
			Residual	252.5	20	12.6			Residual	123.9394	20	6.1970		

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 with the characteristics of the workspace, with employees reporting 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).*

5.2 The Effects of EMIs on Cognitive-Affective Strategies for Regulating Perceived Stress at Work

5.2.1 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 item 1 "I am relaxed" on day 1: $t(13) = 1.957$, $p = 0.036$ (Table 3). This suggests that participants in the experimental group reported feeling more relaxed compared to the control group on the first day of the study.

Furthermore, the results indicate that item 2 "I feel overwhelmed, I feel like I'm running out of time" yielded significantly higher scores for the experimental group (M = 4.82; SD = 1.4) compared to the control group (M = 3.25; SD = 0.957) on day 3: $t(13) = -2.047$, $p = .031$. This indicates that participants in the experimental group reported feeling more overwhelmed and time-constrained compared to the control group on the third day of the study.

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

Regarding the evolution of cognitive-affective strategies, the PSM-9 scores suggest that EMI did not lead to the adoption of new cognitive schemas or changes in affective state: $F(2,20) = 2.57$, $p = .102$ (Table 4). This indicates that 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" to seek emotional support "without judgments." The virtual companion was perceived as a friendly entity conducive to interactions without social norms, especially those expected in the context of work. As one participant expressed, "*It's a relief if you talk to someone who won't judge you*" (Participant 8). However, these conversations were still perceived as limited, as another participant mentioned, "*After that, it's still a computer interface*" (Participant 5). The comfort derived from the application was more related to the caring nature of the words and the design of the mascot. As one participant noted, "*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 allowed users to externalize their emotions and develop a sense of distance from intrusive thoughts that contributed to the deterioration of their affective state. One participant mentioned, "*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). The management of cognitive affects was addressed by almost all participants, with the exercises providing a sense of "appeasement." However, this sense of relief was perceived as temporary, as another participant mentioned, "*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 momen*t" (Participant 2).

5.3 The Effects of IMEs on Somatization Associated With Perceived Work-Related Stress

5.3.1 Control Group vs. Experimental Group

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

5.3.2 Evolution of Somatizations

The scores obtained from the PSM-9 indicate that EMI has no significant effect on somatic regulation: $F(2,20) = 0.005$, $p = .995$ (Table 4). This suggests that the application does not significantly influence the construction and expression of employees' somatic responses over the course of a week.

However, the comments made by the employees provided a nuanced perspective and added context to the statistical analyses. Out of the nine participants, seven mentioned experiencing somatic regulation as a result of practicing the exercises offered by "Mon Sherpa." These effects were observed in various aspects, including improvements in sleep quality. One participant stated, "*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 2 a.m. and fall asleep at 5 a.m. But now, I fall asleep at 11 p.m. and wake up at 6 a.m. or 7 a.m.*" (Participant 1). Additionally, the exercises were reported to contribute to a reduction in agitation.

6. Discussion

Regarding our first hypothesis, which suggests that EMIs lead to changes in behavioral strategies for controlling perceived stress at work, the statistical analysis did not show a significant impact of the EMI on behavioral strategies. However, the thematic analysis of the semi-structured interviews revealed effective modifications in behavioral strategies reported by the participants. They mentioned improvements in motivation to act and better regulation of working hours. This discrepancy between the statistical results and the thematic analysis partially validates the hypothesis. This finding is consistent with previous studies, such as Waters et al. (2014).

Moving to our second hypothesis, which proposes that EMIs lead to the development of new cognitive and emotional strategies for regulating perceived stress at work, it was also only partially validated due to differences between the statistical results (as described in Section 4.2.2) and the semi-structured interviews. The EMIs, particularly the breathing and meditation exercises offered by "Mon Sherpa," were reported to contribute to a sense of well-being by addressing anxiety, stress levels, and the management of intrusive thoughts, as mentioned by participants during the interviews. However, the simplified interactions with the app in a care context could lead to a potential risk of social disconnection, as individuals may rely on the application for support instead of facing conflicts in their work environment (Sigerson et al., 2017). The effects, however, were not strong enough to produce a significant impact on work-related stress levels measured by the PSM-9.

Moving to our third hypothesis, which suggests that EMIs can reduce the somatization of perceived stress in the work context, it was also only partially validated due to contradictory results between the two methods. The interviews suggested an effect of EMIs on improving sleep quality, which confirms previous studies demonstrating the effectiveness of EMIs on sleep through the adoption of various behavioral strategies, such as getting up immediately after waking up (Rayward et al., 2020). However, these effects were not confirmed by the PSM-9, especially in the statistical analysis of the impact of EMIs on somatization (as described in Section 4.3.2).

Overall, our study suggests an immediate but not long-lasting effect of EMIs on work-related stress. According to the results, the use of EMIs may lead to a temporary change in individuals' behavior or cognition. However, they are more likely to return to their initial state of stress and anxiety after completing the guidance provided by the EMI, as indicated by one participant's statement. The partially validated hypotheses and the limitations in the sample size prevent us from making reliable conclusions based solely on the quantitative results. It is important to note that while EMIs can provide social support, especially when it is lacking from one's social circle, they cannot solve the underlying sources of work-related stress. Secondary prevention should not replace primary prevention and should be seen as a complement.

However, due to the small sample size, these results cannot be generalized and may differ in other samples depending on the organizational context of employees' industries. As mentioned earlier, results can vary depending on the type of work environment (e.g., open space, individual workspace) and the availability of workers throughout the day. Furthermore, the short duration of the experiment did not allow for the analysis of medium- or long-term effects. Participants did not have enough time to develop new habits, which could have influenced their use of the application and the resulting outcomes. Additionally, this study focused only on a few measures of perceived stress, while other manifestations may be involved. These limitations pose threats to the internal and external reliability and validity of the experiment. Since no other measuring tools were used to accommodate participants' daily availability, a comprehensive understanding of the effects of EMIs could not be achieved. Internal reliability might also be compromised by the chosen methodology, as participants self-recorded their responses using an online questionnaire. The possibility of social desirability bias could also influence the study's findings.

Further investigations are recommended with more comprehensive measurements, longer timeframes, and larger sample sizes. It would also be beneficial to examine variations in the impacts of EMIs across different work organizations.

7. Conclusion

This paper aimed 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 no significant results were found indicating the effects of EMIs, the semi-structured interviews revealed very short-term behavioral, cognitive-affective, and somatic changes immediately after engaging in the exercises proposed by 'Mon Sherpa'. This exploratory study has three main limitations: a small sample size, a short duration of the experiment, and a focus on perceived stress. Therefore, it would be interesting to include measures related to observable manifestations of perceived stress and involve a larger number of participants from various professional contexts in a long-term study.

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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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