

EMOTONGUE, a smartphone application designed to promote awareness and consequent emotional self-regulation measure emotions in natural contexts

EMOTONGUE, una aplicación para smartphones diseñada para fomentar la concienciación y la consecuente autorregulación emocional en contextos naturales

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Abstract

EMOTONGUE is an Android application designed to help people become more aware of their own emotions, facilitating emotional self-regulation processes in their daily lives. The app was evaluated in a study with 16 participants. They used the app five times a day for two weeks. The aim was to improve emotional management, emotional granularity and perception of emotional intensity. A mixed methods design was used, combining qualitative and quantitative approaches. Results indicated progressive improvements in self-awareness and emotional management, as well as in emotional granularity, by achieving app-based labelling of emotions in a more specific way. Differences in emotional expression were observed between native and second languages, as well as in the frequency of use of emotions related to arousal and/or pleasure due to cultural and/or gender nuances. Although the results suggest the efficacy of the app, a larger sample size is required to confirm them. This study highlights the importance of accessible tools in psychology and education to benefit more people.

Keywords

Application, Affective science, Emotional management, Smartphones, Natural context

Resumen

EMOTONGUE es una aplicación para Android diseñada para ayudar a las personas a ser más conscientes de sus propias emociones, facilitando procesos de autorregulación emocional en su vida diaria. La app fue evaluada en un estudio con 16 participantes. Estos utilizaron la app cinco veces al día durante dos semanas. Se buscaba mejorar el manejo emocional, la granularidad emocional y la percepción de la intensidad emocional. Se utilizó un diseño de métodos mixtos, combinando enfoques cualitativos y cuantitativos. Los resultados indicaron mejoras progresivas en la autoconciencia y el manejo emocional, así como en la granularidad emocional, al conseguir etiquetar, por medio de la app, las emociones de manera más específica. Se observaron diferencias en la expresión emocional entre los idiomas nativo y segundo, así como en la frecuencia de uso de emociones relacionadas con la activación y/o el placer debido a matices culturales y/o de género. Aunque los resultados sugieren la eficacia de la app, se requiere un tamaño de muestra más grande para confirmarlos. Este estudio resalta la importancia de herramientas accesibles en psicología y educación para beneficiar a más personas.

Palabras clave

Aplicación, Ciencias afectivas, Gestión emocional, Smartphones, Contexto natural

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1. Introduction

On a daily basis, we hold conversations about how we feel, using language as the most direct means of expressing our emotions, moods and feelings. Nevertheless, two questions that are often raised in research on emotions are (1) whether or not what we feel is truly what we express through language, and (2) how our cultural context and the emotional differences that come from it, influence our expression of what we feel (Jackson et al, 2019). When naming an emotion (placing an emotional label), can we be sure that both the sender and receiver of this information interpret the emotion in the same way?

For a long time, based on Darwin & Lorenz's discoveries (1965), various psychological theories attempted to demonstrate that emotions were universal (Ekman, 1992), innate and easily recognizable through facial expressions (Ekman & Friesen, 1983). However, recent studies have opposed to these theories, showing that there are no definitive connections between certain facial expressions and specific emotions one may experience (Russell, Bachorowski, & Fernández-Dols, 2003, Sánchez Aragón et al., 2011), and that a certain facial expression is not always accompanied by an emotion, nor is one expression always representative of the same emotion (Barrett, 2011; Barrett & Barberán, 2020; Le Mau et al, 2021). Following the pioneering work of William James (1884), the first individual to question the "classical view" of emotions and their separation into categories, different constructionist models have empirically demonstrated that our emotions aren't actually reactions to the world, but constructions of the world (Kober et al., 2008; Lindquist, Wager, Kober et al., 2012, Lindquist, 2013, Jackson et al, 2019).

According to different approaches of psychological constructionism, there are no pre-conceived categories of emotions. Emotions are not entities that exist on their own, but rather are psychological "compounds" that are created from a combination of the most basic psychological "ingredients" that aren't specific only to emotions (Lindquist, 2013).

There is evidence that the semantic categories that we usually use to refer to a certain emotion, such as anger, sadness, etc., are not biologically determined, but are actually constructs of the human mind. Several studies, in fact, analyzing self-reports have disputed the view of emotions as predetermined structural categories that are common to everyone, highlighting the fact that there exist other, more complex components to analyze when describing an emotional category (Barrett, 2006). In addition, these studies indicate that the aforementioned emotional categories are not universally linguistically representative of the emotional experience of a given individual (Barrett, 2006). Quoting Barrett (2006): "A person's understanding of emotion words does not strongly dictate the way that he or she uses those words to verbally represent experience" (p. 26).

According to psychological constructionism, instead of asking ourselves what emotions are like as structured entities, we should ask ourselves about emotional processes, how emotional episodes develop in the brain, which mechanisms underlying emotional episodes are species-specific, and, alternatively, which are specific to an individual (Barrett & Russell, 2015).

Furthermore, psychological constructionism disagrees with the innatist view of emotion as something beyond our control rather than something that we actively construct through brain mechanisms, social and cultural contexts, previous experiences, etc. It emphasizes that our brains continuously construct emotional experiences. When we experience a physiological sensation that is provoked by an event external to us (*exteroceptive sensations*) or manifests internally in the body (*affect*) in the form of an increased heart rate, the sensation of pleasure or disgust (*valence*), or activation/deactivation (*arousal*) (Lindquist, 2013). The brain, based on predictions made in the moment, which result from previous memories and socially and culturally learned conceptual knowledge, actively transforms this sensation into emotion. This is due to a conscious process in which the brain tries to make sense of uncertainty or ambiguity using a known emotional category and the context in which the sensation occurs (Lindquist, 2013).

Our knowledge of concepts, along with language, are tools that the brain uses to predict and interpret occurrences and transform them, in some situations, into emotion. However, the emotions that the brain constructs in each situation have distinct importance and cognitive loads each time. Therefore, they cannot be grouped into emotional categories in their classical sense. For a better understanding of this mechanism, we quote Barrett (2016) verbatim:

To consider how this works, try this thought experiment: in the past, you have experienced diverse instances of happiness, such as lying outdoors on a sunny day, finishing a strenuous workout, hugging a close friend, eating a piece of delectable chocolate, or winning a competition. Each instance is different from every other, and when the brain creates a concept of happiness to categorize and eventually make sense of the upcoming sensory events, it constructs a population of simulations. [...] So, the brain constructs an on-line concept of happiness, not in absolute terms, but with reference to a particular goal in the moment [...]. This implies that "happiness" has a specific meaning, but its specific meaning changes from one instance to the next. (p.12)

Language plays a key role in the construction of distinct emotional events, although this was not taken into account for a long time. In fact, the brain transforms abstract concepts into words and connects these words with vivid experiences in order to name them and relate them through language. Thanks to language, sensory information that the brain continuously receives from the body and the world is concretized into semantic labels that help people remember and name the things that happen to them (Lindquist, Mac-

Cormack & Shablack, 2015). In this way, people of the same culture can communicate with and understand each other through the creation of shared semantics.

From a very young age, language helps us differentiate between sensations of pleasure and disgust and discriminate between distinct emotional states, thanks to the capacity it gives us to put what we experience internally into words. Additionally, studies on alexithymia cited by Lindquist, et al., (2015), have demonstrated, for example, that children and adults suffering from it experience difficulty in expressing what they feel, as they lack conceptual knowledge of emotion and are only capable of reporting whether they feel good or bad. On the other hand, research finds that people accustomed to having a wide emotional vocabulary from a young age, or whose parents have spoken to them using various emotional labels since the first months of their lives, are more capable from childhood of interpreting and recognizing the facial expressions of others and, furthermore, of developing emotional regulatory strategies that are more effective and healthy than those who don't know how to differentiate them (Lindquist, MacCormack & Shablack, 2015). Likewise, different mental disorders such as anxiety have been linked to the inability to express what one feels, or in the case of depression, for example, to identify what one feels (Korkoliakou et al., 2014).

1.1. Self-reported studies on emotions

Various studies have been conducted on how people describe what they feel in self-reports completed in their daily lives during both short and relatively long periods of time (Barrett, 1998; Barrett, Gross, Christensen, & Benvenuto, 2001). These studies indicated that some people report what they feel using generic terms that refer to the more generalized feelings of pleasure or displeasure (valence), or activation and deactivation (arousal) (Barrett, 2006), while others describe what they experience internally in greater detail, differentiating between various emotional labels and between the different nuances of meaning within these labels (Barrett & Lindquist, 2008).

This difference in ability to verbally describe emotional experiences with a greater or lesser degree of detail, depending on the individual, is known as "emotional granularity" (Feldman Barrett, 2004; Barrett, Gross, Christensen, & Benvenuto, 2001; Tugade, Barrett, & Gross, 2007, Lindquist & Barrett, 2008). Individuals with high emotional granularity tend to be more accurate when verbally expressing their affective and emotional states, and thus have a greater ability to understand what is occurring, connect with it, and even apply appropriate strategies for emotional regulation. Conversely, individuals with low emotional granularity often confuse similar emotional states, use the same emotional label to verbally articulate distinct emotional episodes and are less accurate in understanding and describing what they are experiencing (Barrett & Lindquist, 2008).

Another aspect that plays an important role in the description of experiences with a greater or lesser emotional granularity in self-reports is what Barrett & Lindquist (2008) call working memory capacity (WMC). This capacity allows the individual, while completing the self-report, to hold an emotional experience in mind in linguistic, physiological and contextual terms and, at the same time, to describe it through emotional words and adjectives that allow it to be categorized. Individuals with high working memory capacity tend to be more accurate when completing self-reports while simultaneously having higher emotional granularity (Barrett & Lindquist, 2008). It has also been noted that some individuals, when reporting what they feel, focus more on hedonic aspects of their emotional experience, describing them in terms of pleasure or displeasure (*valence focus*), while other individuals pay more attention to states of bodily activation or deactivation (*arousal focus*) (Barrett, 2004).

Although some individuals may share more or emphasize states of activation while others focus on feelings of pleasure or displeasure in their descriptions of how they feel, the states of *valence* and *arousal*, which together constitute the *core effect*, are essential and structural components in what will become an emotional experience. That is to say, every individual feels and experiences, more or less consciously, levels of activation/deactivation or pleasure/displeasure, though some of these physical states are later converted into emotional categories (Russell & Barrett, 1999).

2. The current Study

Although there has been a proliferation of studies on emotions and their description in laboratory settings, our understanding of how people report their emotions in everyday contexts remains limited. Building on previous research that has attempted to track emotions in natural environments (Heij & Cheavens, 2014; Trampe, Quoidbach & Taquet, 2015; Frías et al., 2020; Simonazzi et al., 2020; Kinori et al., 2022), this study aims to investigate how individuals verbally express their emotions in real-time. We propose achieving this through the design and iterative implementation of a smartphone application within the broader framework of an emotion study.

Recent research has highlighted the effectiveness of digital technologies, particularly mobile applications, in improving emotion regulation (ER) skills and mental health outcomes among diverse populations (Jadhakhan et al., 2022). Studies by Leonard et al. (2018), Hides et al. (2019), Morris et al. (2010), and Anand et al. (2019) have demonstrated the potential of these applications to support ER and enhance emotional well-being. While existing applications have proven effective in promoting emotional management (Jadhakhan et al., 2022), this study introduces the EMOTONGUE application. Unlike other intervention types, EMOTONGUE The application purports to

foster users' autonomy, promoting awareness and self-regulation processes. Through the design and implementation of EMOTONGUE, this study aims to evaluate its impact on individuals' emotional management, since despite the wide range of mental health applications, few of them specifically promote emotion regulation (Eisenstadt et al, 2021). By fostering autonomy and promoting self-awareness, EMOTONGUE sought to provide a novel approach to emotion regulation support in natural contexts.

The application developed for this study aimed not only to assess the most commonly used emotional categories but also to analyze how participants describe their emotional experiences and investigate differences in expression among genders and languages. "EMOTONGUE," our smartphone software, is based on the Circumplex Model of Affect (Russell & Barrett, 1999), widely used in emotional studies (Di Blas, 2000; Tsai et al., 2006; Yik & Russell, 2003). This model maps emotional adjectives on axes representing valence and arousal, indicating their correlation and similarity. The application provides a range of emotions on a dynamic wheel, enhancing emotional granularity and helping users label and differentiate between similar states.

In fact, on certain days of the week, the application offers users a range of emotions to pick from a multi-colored and dynamic wheel, which in turn opens up to a broader range in which distinct categories and emotional adjectives that reflect states of emotional activation/deactivation and pleasure/disgust are presented to the user. The utilization of the application in this study aimed (among other objectives) to improve the emotional granularity of participants, helping them, through its structure and by way of the wheel designed from the *Circumplex Model*, to detect what they feel, give it a name, and be able to discriminate between similar emotional states, describing their emotional experiences with a greater level of detail.

We believed that achieving this first objective would, in turn, accomplish other more specific aims which are: 1) to evaluate the extent to which participants improved in the management of their emotions, 2) to check whether their emotional granularity improved due to the emotional wheels provided by the app, 3) to examine the influence of the software on participants' perception of the intensity of their emotions, 4) to verify whether there were differences in participants when expressing their emotions in their native language or in their second language, 5) and to check whether there were cultural or gender differences related to the type of emotions expressed by the participants.

In light of the previous explanation, we can thus summarize and make clearer the hypotheses of our study:

- Participants' emotional management will benefit from using the application created five times a day for two weeks in a natural context.
- Participants will more easily discriminate what they feel when they have the dynamic wheels provided by the app at their disposal than when they do not use them.
- Participants, through frequent use of the app, will be increasingly able to regulate the intensity with which they feel a certain emotion when answering the different questions in each notification.
- Significant differences will be found in the way participants will express their emotions in their mother tongue or in their second language.
- Cultural and/or sex differences will be found when analyzing the frequency of use of emotions related to states of arousal and/or pleasure.
- Relationships between language and use of *EMOTONGUE* Software without and with specific emotions
- Relationships between sex and language, arousal, valence

3. Method

This section describes information related to the empirical design of the study, which used a quasi-experimental design. The choice of a quasi-experimental design was appropriate due to the nature of the research question and the practical constraints involved in conducting the study.

Furthermore, the study employed a mixed methods approach, integrating both qualitative and quantitative methods. This approach was deemed suitable for capturing the complexity of the participants' emotional experiences and the effectiveness of the intervention provided by the *EMOTONGUE* application. Previous research has highlighted the benefits of using mixed methods in studies focusing on emotional experiences, as it allows for a more comprehensive understanding of the phenomena under investigation (Smith, 2018; Creswell & Creswell, 2017).

In particular, qualitative methods such as interviews can provide rich insights into participants' subjective experiences and perceptions, complementing the quantitative data. By combining these approaches, the study aimed to gain a deeper understanding of how participants interacted with the application and how it influenced their emotional awareness and regulation.

3.1. Participants

Initially, 30 individuals from Spain, North America, and Romania joined the study, but only 16 used the application for over 75% of the time. Data from the remaining participants were not included in the analysis. The sample consisted mostly of Spanish participants, with one bilingual Romanian resident. Participants' ages ranged from 20 to 35 years, with nine women and seven men. Three participants, two men, and one woman also participated in interviews a month after using the app.

The sample was randomly selected from a larger study on bilingualism and emotions. Before starting, participants signed informed consent forms guaranteeing confidentiality, voluntary participation, and the right to withdraw. The study was part of a doctoral thesis and met ethical requirements, approved by the program's Academic Committee.

Participants were informed about privacy protection and the research-only use of data in the consent form. Permission for data processing was required to use the application. Android smartphones were provided to participants who didn't own one. No compensation was provided for participation.

3.2. Instruments

EMOTONGUE

In recent years, there has been a notable surge in the exploration of emotions, with researchers dedicating efforts to develop and validate tools for assessing emotional intensity and meaning across diverse contexts (Manríquez-Betanzos & Montero-López, 2018; Rojas Ramírez & García-Méndez, 2017). This study emerges from the imperative to evaluate emotions in real-world settings, prompting the creation of a smartphone application. The application, tailored for Android devices with 4.0 or higher aversion of, serves as the primary tool for gathering data on participants' emotional states in natural environments. Developed entirely from scratch, the software utilizes Java for functionality and XML for its graphical interface, leveraging the open-source Android Studio by IntelliJ Platform.

Inspired by Larson and Csikszentmihalyi's (1983) experience sampling methodology, the aim was to capture participants' affective and emotional states as they naturally occurred throughout the day. This methodology, established since its inception (Csikszentmihalyi & Larson, 1987), systematically collects data on participants' daily lives using devices such as beepers or modern internet-connected tools, prompting participants to provide self-reports or complete questionnaires at random intervals.

Despite its rich history, smartphone applications have remained underutilized in emotion research for assessing participants' affective states and facilitating emotional regulation.

3.3. Procedure

“By utilizing a tool like EMOTONGUE, which is directly connected to a real-time database (Firebase) storing participants' responses, we expected to ensure the spontaneity of their reactions. This investigative tool offers convenience and practicality to participants, as it is readily accessible at their fingertips throughout the duration of its use.” In fact, over a period of two weeks, all they were required to do was respond to the notifications they were receiving on their smartphones, within a two-hour time limit, for each of the five notifications they received daily.

In order to use the app, the participants had to follow these steps:

1. Enter the *Play Store*.
2. Download the app for free.
3. Register by providing an email address and creating a password.
4. Verify the email address.
5. Accept the privacy policy, giving storage and recording permissions, as the app allows users to record their responses both in writing and through a voice recording, which is stored in the database both as an audio file and in the form of a literal transcription.
6. Use the application in their native language for a week and in their second language during the second week.

Currently, the application is designed in Spanish and English and can be downloaded from Spanish and English-speaking countries, along with Italy.

The App sends 5 notifications every day, each of which the participants can respond to within two hours. The notifications appear on the participant's smartphone at the following times: 8:30, 12:30, 16:30, 19:30, 22:30. The user must answer the three following questions in sequence for each notification: 1) *how do you feel?* 2) *why do you feel this way?* 3) *now that you've explained it, how do you feel?*

In addition to utilizing the app, in-depth interviews were conducted to gather supplementary qualitative data. The transcripts of these interviews were carefully analyzed for further insights. Below you can find the images from the app, regarding the moment one and three of each notifications, in Spanish.

Figures 1 and 2

Images of EMOTONGUE's first and third questions from Monday to Wednesday, in Spanish



The app presents questions with a 1 to 5 intensity scale. From Monday to Wednesday, text questions are used, while dynamic emotional wheels are provided from Thursday to Sunday. This approach aims to expand users' emotional vocabulary and deepen their connection. Dynamic wheels are used on specific days to evaluate emotional granularity. By comparing responses 1, 2, and 3 for each notification from Monday to Wednesday with those from Thursday to Sunday, it is possible to determine if the emotional vocabulary in responses 2 and 3 on Thursday to Sunday is broader than that in responses 2 and 3 from Monday to Wednesday.

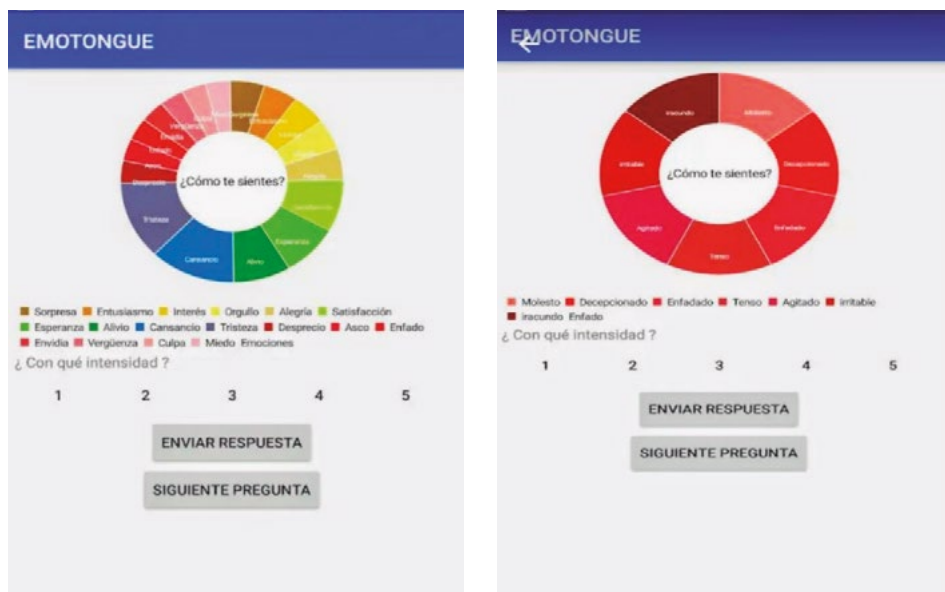
By comparing responses 1, 2, and 3 for each notification from Monday to Wednesday with those from Thursday to Sunday, it is possible to determine if the emotional vocabulary in responses 2 and 3 on Thursday to Sunday is broader than that in responses 2 and 3 from Monday to Wednesday.

User responses are recorded and stored in the database connected to the software.

Below, you can find the images of the app regarding the dynamic wheels.

Figures 3 and 4

The dynamic wheels that are presented from Thursday to Sunday



After using the application, three participants were asked to participate in individual interviews in order to conduct a case study that could provide additional information to interpret and complement the results obtained through the quantitative and qualitative analyses of the participants' responses. The aforementioned responses have been stored in the *Firebase* database and successively organized in individual files where the complete responses of each participant are collected and divided by days, notifications, responses to each notification, and response language.

4. Data analysis

The computer statistical program IBM SPSS was used for the quantitative analysis of the data, while the program NVIVO was used for the qualitative analysis of the data. McNemar's chi-square (χ^2) with Edward's correction was used in order to analyze the dependent groups data organized around the following categorical variables: language (Spanish / English), Use of the software's dynamic wheels (Yes / No), gender (men, women) and kind of emotions in terms of Valence (pleasure/ displeasure) and Arousal (high / low). Regarding

the variable time which considered three measurement moments and sex (man / woman), a Two-Way Repeated Measures ANOVA was used.

For qualitative results analysis, a thematic analysis approach was employed. Transcripts from in-depth interviews were reviewed and coded to identify emerging patterns and recurring themes regarding participants' emotional experiences. Comparisons were made between participant responses at different study intervals to gain a comprehensive understanding of EMOTONGUE's effects on emotional management. Qualitative findings were integrated with quantitative app data to provide a holistic view of the program's impact on emotional self-awareness and development.

5. Results

5.1. Quantitative Results

Table 1 shows the distribution of emotional experiences referred to the participants in terms of the variables Language and Use of the *EMOTONGUE* Software.

Table 1

Distribution of emotional experiences referred to the participants in terms of the variables Use of the EMOTONGUE Software and Language

Use of the EMOTONGUE Software and Language			
	No	Yes	Total
Spanish	281 (73.9)	168 (68)	449 (71.7)
English	99 (26,1)	79 (32)	178 (28.4)
Total	380 (100%)	247 (100%)	627 (100%)
Use of the EMOTONGUE Software (specific emotions) and Language			
	No	Yes	Total
Spanish	119 (73)	162 (67.2)	281 (69.6)
English	44 (27)	79 (32.8)	123 (30.4)
Total	163 (100%)	241 (100%)	404 (100%)

The table shows that, in general, there are more emotional experiences mentioned without using the dynamic wheels (380 uses, 60%) than when using them (247 uses, 40%). When participants use Spanish, there are more emotional references (71,7%) compared to when using English (28.4%), McNemar's $\chi^2 (1) = 17.32, p < 0.0001$.

Similar results are obtained between Spanish and English when using specific emotions instead of emotional references based on general evaluations (good, bad, better, worse). However, when we focus on specific emotions, there are more emotional experiences mentioned using the dynamic wheels (241, 60%) than when they are not used (163, 40%). McNemar's $\chi^2 (1) = 66.45, p < 0.0001$.

Table 2

Cross table Language and sex

	Sex and Language		
	Men	Women	Total
Spanish	19 (55.88)	100 (77.51)	119 (73.01)
English	15 (44.11)	29 (22.48)	44 (26.99)
Total	34 (100%)	129 (100%)	163 (100%)

As it is shown by table 2, when we compare the frequency of specific emotions in terms of Sex and Language, we find a statistically significant relationship. Women seem to make use of more emotions compared to men (129,79% and 34,21% respectively), and Spanish is again more used than English, when referring to emotions (73% and 27% respectively). McNemar's $\chi^2 (1) = 61.35, p < 0.0001$.

Furthermore, as you can see in the tables below, if we pay attention to how men and women differ in the way they refer to an emotional episode, we can notice that, depending on what kind of emotional label is used by them in terms of its valence (pleasure/displeasure) and arousal (high/low), we find the following results. Men and women agree in their proportion of use of high arousal emotions, but women stand out in low arousal emotions, both in Spanish (McNemar's $\chi^2 (1) = 1.36, p = 0.0,042$) and in English (McNemar's $\chi^2 (1) = 0.64, p = 0.000$).

Table 3

Cross Table Sex and arousal using Spanish or English

Sex and Arousal using Spanish			
	High arousal	Low arousal	Total
Men	18 (48.6)	28 (29.8)	46 (35.1)
Women	19 (51.4)	66 (70.2)	85 (64.9)
Total	37 (100%)	94 (100%)	131 (100%)

Sex and Arousal using English			
	High arousal	Low arousal	Total
Men	30 (85.7)	9 (29)	39 (59.01)
Women	5 (14.3)	22 (71)	27 (40.9)
Total	35 (100%)	31 (100%)	66 (100)

Sex and Valence using Spanish			
	Men	Women	Total
Displeasure	6 (11.32)	15 (12.93)	21 (69.56)
Pleasure	47 (88.67)	101 (87.06)	148 (30.44)
Total	53 (100%)	116 (100%)	169 (100%)

Sex and Valence using English			
	Men	Women	Total
Displeasure	1 (4.76)	3 (12)	4 (8.69)
Pleasure	20 (95.23)	22 (88)	42 (91.30)
Total	21 (100%)	25 (100%)	46 (100)

If we focus now on the variable valence, we find no statistical differences between sex and language when the language chosen is Spanish (McNemar's $\chi^2(1) = 0,87$, $p = 0.768$) or English ($\chi^2(1) = 0,753$, $p = 0.385$). Despite the participant's gender and the language used, most emotions mentioned had a valence of pleasure.

In order to evaluate the effect of the moment of using EMOTONGUE we performed a Repeated Measures ANOVA with a dependent variable as the number of emotions mentions in terms of Sex (Man/Woman).

Table 4

Descriptive statistics of the measurement time variable

sex	measurement	M	SD	95% Confidence Interval	
				Lower Bound	Upper Bound
Men	1	0.57	0.58	-0.59	1.73
	2	0.07	0.07	-0.08	0.22
	3	1.82	1.70	-1.60	5.24
Women	1	2.73	0.60	1.52	3.94
	2	0.19	0.08	0.04	0.35
	3	5.19	1.77	1.64	8.74

Table 5

Pairwise comparison (sex/measurement)

sex	(I) measurement	(J) measurement	m difference (I-J)	SE	p	95% Confidence Interval for Difference	
						Lower Bound	Upper Bound
Men	1	2	0.50	0.59	1.00	-0.96	1.96
		3	-1.25	1.88	1.00	-5.89	3.39
	2	1	-0.50	0.59	1.00	-1.96	0.96
		3	-1.75	1.69	0.916	-5.93	2.43
	3	1	1.25	1.88	1.00	-3.39	5.89
		2	1.75	1.69	0.916	-2.43	5.93
Women	1	2	2.54	0.61	<.001	1.03	4.05
		3	-2.46	1.95	0.636	-7.28	2.36
	2	1	-2.54	0.61	<.001	-4.05	-1.03
		3	-5.00	1.75	0.019	-9.34	-0.66
	3	1	2.46	1.95	0.636	-2.36	7.28
		2	5.00	1.75	0.019	0.66	9.34

Table 6

Pairwise comparison (time/sex)

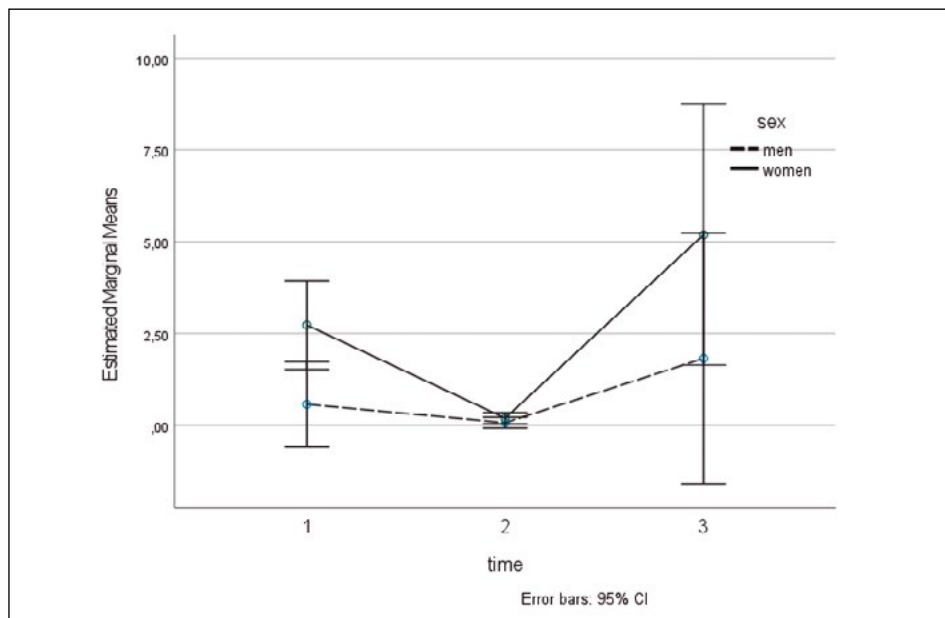
measurement	(I) sex	(J)sex	m difference (I-J)	SE	p	95% Confidence Interval for Difference	
						Lower Bound	Upper Bound
1	men	women	-2.16	0.84	0.0130	-3.84	-0.48
2	men	women	-0.12	0.11	0.2600	-0.33	0.09
3	men	women	-3.37	2.46	0.1760	-8.30	1.56

As Mauchly's test $W = 0.256$ indicated that the assumption of sphericity had been violated ($\chi^2(2) = 69.48, p < 0.001$, we used Huynh–Feldt (HF) correction of epsilon value ($\epsilon = 0.59$) that change the number of degrees of freedom t. According to this, we got a significant within-subject effect in the variable Time ($F_{HF}(1, 178) = 4.97, p = 0.025, \eta^2 = 0.086$), and not significant interaction Time * Sex ($F(1, 310) = 1.52, p = 0.224, \eta^2 = 0.015$)

As tables from 4 to 6 show there is a significant difference between men and women in the first measurement, and between first and second and second and third measurements in women's group. The effects can be seen on diagram 1.

Diagram 1

Three measurement moments in terms of sex



5.2. Qualitative Results

In this qualitative section, findings from individual participant files and in-depth interviews with three participants are reported. Analysis revealed:

Participants' emotional granularity improved with emotional wheels usage; without them, their emotional vocabulary was limited. Emotional intensities varied across responses, with improvement if unpleasant emotions were reported initially. Participants connected with their emotions, expressing them through the app, leading to increased emotional intensity for pleasant emotions.

Below, there are some comments which have been quoted from the third responses of some notifications. The same are taken as example of the aforementioned:

- "I am more conscious of what happens to me."
- "I feel even better now that I have expressed it."
- "Happier and grateful for being more conscious."
- "More conscious and maybe less tired, I just want to be calm."
- "Glad to share my emotions."
- "More conscious of how tired I am."
- "to recognize my emotions."
- "The app helps me recognize and accept my emotions."
- "I feel a little less sad and frustrated, now that I have expressed it."
- "Calmer because at least I've let it out. If I say it to my wife, she'll eat me alive, ahahah."
- "I'm better."
- "I'm slightly better."
- "Even better now that I have expressed it."
- "Happier and grateful for being more conscious."
- "Better, I have lost the desire to send him to hell."
- "A bit more conscious."
- "Even better."

Women had an easier time speaking coherently about interpersonal themes such as their close and familial relationships; they often attributed the cause of their emotional state in some way or another to their relationship with their partners or families in their second responses for various notifications. Men, on the other hand, mentioned matters relating to work and self-improvement in the majority of their second responses throughout the day. They spoke about their interpersonal relationships on a few occasions, often emphasizing moments of tension. Though men referred to issues related to love or family on some occasions, they did not linger on these ideas for a long time. Below (Table 7) there are some comments that have been quoted from the second response in relation to interpersonal themes.

Table 7

Responses by female and male participants

Female participants	Male participants
"I met a friend, and I enjoyed the afternoon."	"I have finished my internship."
"I left class late and am with my son after he spent two days at his dad's house."	"I could not complete the work I wanted to."
"I have an unexpected date."	"I've just finished my classes."
"Happy because I am with my partner."	"A lot of work... I have been working all day."
"I am in good company."	It's a complicated period with my job."
"My girlfriends visited me"	"I trained really hard"
"Evening with loved ones"	"I finished correcting and have already completed the assessment."
"I am with an old friend."	"I argued with a colleague."
"I am celebrating my cousin's birthday."	"I know that I work well even though there is friction with some colleagues."
"It was a long day. And I believe things with my ex-boyfriend will go well."	"I met my goals at work today."
"I'm very happy for being next to someone special."	"I'm curious to see how fast and how much I can study before the exam."
	"I'm nervous because I want to prove that I can make it perfect (even though I never managed to do so)"
	"I want to do great in the exam."

Concerning the use of Spanish or English, a clear difference was observed between participants' comments when speaking their second language and when using their mother tongue. Responses in their first language were more elaborate and detailed than their responses using their second language, which may be attributed to their second language skills or the fluency with which they speak their second language.

Furthermore, three individual interviews were conducted one month after app usage, involving three participants from the study: two males and one female. They willingly participated in the interviews, and the analysis of the same underscored that:

1. While using the application and in the period immediately after, all three participants realized that they did not know their emotional world as well as they had believed before carrying out the study:

“Thought I handled my emotions well, but I realized that there were emotions that I did not want to see or did not perceive before using the app. When I answered a notification, I would then stop to think: ‘I didn’t think I felt that way or that what had happened to me could have affected me so much.’”

“I didn’t know that so many emotions existed.”

“I liked forcing myself to use the application because after using it I would feel better and say to myself: ‘thank goodness I used it.’”

“Before the study, I didn’t have as large of an emotional vocabulary as I do now, and I didn’t usually connect with my emotions. I have realized that using the app has enabled me to connect more with what I feel.”

During their responses to the notifications, all three participants realized that the emotional intensity with which they felt an emotion was not as high as they had initially believed:

“As I answered the notifications, I realized that, maybe, if I felt an emotion X, I did not feel it as intensely as I thought I did before answer.”

“After answering that [an emotion] had an intensity of 5, I would say to myself: ‘I don’t even feel it that strongly.’”

“Remember feeling frustrated by certain things, but afterwards, you stop to think, and you notice that the matter was not that important and the intensity [of the feeling] goes down.”

2. The three participants realized that stopping to think about what they felt was something they weren’t accustomed to doing, but that they saw benefits from doing it through the app, and it helped their emotional management:

“Stopping to think about how I was feeling and why I was feeling it helped me process it and become more conscious of what I was feeling and the causes for it.”

“Perhaps thinking about and expressing what you feel in words helps you realize that there are things that you give a lot of importance to which aren’t actually very important, and others that do have importance which you hadn’t paid enough attention to, and this helps improve your emotional management.”

3. One of the three participants, who lives in Spain but isn’t Spanish, realized after using the app that when they felt emotions relating to anger, they felt and expressed them more in English than in Spanish. The two Spanish participants who were interviewed recognized that they would connect with their emotions less when they had to use their second language because they would pay more attention to syntactic and linguistic aspects:

“When I answered in English, I thought about grammar or how a word was said more than the emotion I felt, because I needed to concentrate on expressing what I actually wanted to say.”

4. The three participants reported to have benefited from the wheel, especially in moments in which their emotional intensity wasn't very high or when they didn't know what they were feeling:

“When I didn't have the wheel, I felt lost.”

“The wheel helped me recognize how I was feeling when I wasn't aware of it, when I didn't have a clear emotion or when the intensity of my emotion wasn't very high.”

“The wheel helped me in two ways: when I wasn't very conscious of what I was feeling, the wheel helped me realize it.”

5. The three participants noticed changes in their emotional intensity, depending on whether they were in the process of answering the notification questions or if they had just finished answering them:

“Lots of times I felt a little bit better.”

“I remember realizing that I noticed changes in my third responses, after explaining how I was feeling and why I was feeling that way. They weren't big changes in the [emotion's] intensity, but they were changes nonetheless, and I realized that there were even emotional changes while answering the questions, as I began to realize things.”

“On various occasions, after having answered the third question and feeling the same, I realized that I didn't actually feel the same when closing the app, but that either my mood changed or the intensity [of the feeling] had decreased.”

“Many times, I would respond out of habit, but then later I would realize that there really was something going on and it made me aware of what was happening to me after using the app.”

“I remember telling a colleague about feeling better after using the app on various occasions.”

6. Two of the three participants recognized that in some situations, unconsciously, they didn't respond to some notifications because they didn't want to connect with what they felt:

“I know that on many occasions I made the excuse of being too busy to answer the questions because, unconsciously, I was avoiding it because I didn't want to connect with certain emotions.”

“I sometimes used the excuse of being busy to avoid answering questions that I didn't feel like answering when I felt an unpleasant emotion with a high intensity.”

7. One of the two male participants recognized feeling shame or a certain pain in speaking about situations related to relationships, feelings of longing or melancholia:

“I remember thinking that I missed my partner on various occasions, but if I didn't express it [using the app] it's because I was embarrassed.”

“I was embarrassed to say ‘I feel very lonely here without my partner’[...] ... surely there is some underlying gender issue ...”

8. The three participants freely recommended the application to their circles of friends after using it:

“I have a person in mind who would do very well with the use of the app.”

“I know several people for whom the app would be good.”

6. Discussion

In recent years, there has been a significant increase in the use of apps and digital tools to promote people's wellbeing and mental health. The Covid-19 pandemic has further accelerated and encouraged interest in promoting these types of tools, due to the limitations and restrictions that have affected people's health (Kumar & Nayar, 2020; Li et al., 2020). Despite this, studies such as the one conducted by Eisenstand et al. (2021), where a systematic review of current applications promoting emotional wellbeing and mental health was undertaken, indicate that, among all the apps used for research purposes to date, there are still few explicitly promoting emotional management in the general population. Indeed, there are studies on apps designed to assist patients with borderline personality disorder during emotional crises (Frias et al., 2020), others aiding adolescents in managing anxiety (Iyer et al., 2021), and still others aimed at reducing stress in specific groups (Coelhoso et al., 2019; Huberty et al., 2019).

On the other hand, most studies using apps in the field of emotions adhere to the classical view of emotions (Eckman, 1992), which considers them universal and easily detectable in any human face, thus seeking ways to classify what the user feels from images or photos (Lee & Lee, 2021) or from the imitation of facial grimaces (Sato et al., 2021).

This is why an application like EMOTONGUE could potentially be a useful tool in affective science research, offering avenues for further exploration. In fact, it has not only been designed for the general population, thus able to assist any user in their emotional management, but also, through its structure that helps users become aware of the processes underlying emotional episodes, to notice how they themselves actively construct emotional experiences from language, the moment they feel an emotion, and the social and cultural context. It moves away from classical models of emotions that might hinder users

from understanding what they truly feel and how they feel it, reducing the range of possibilities to a limited number of emotions or facial expressions. The application in question has shown promising results in encouraging emotional granularity in participants, assisting users in expanding their emotional vocabulary and understanding more deeply what they were feeling and why they were feeling those feelings.

The use of the application facilitated more emotional distinctions (increased granularity) regardless of the language. This quantitative result is important given that, preliminary evidence suggests that individuals with a high level of granularity may have greater emotion regulation abilities (Barrett et al., 2001) and appear more resilient to stressful situations (Tugade et al., 2004) compared to those with a low level of granularity.

Additionally, people with high levels of emotional granularity seem to consume less alcohol (Kashdan & Ferszizidis, 2010), display less aggressive behavior in situations where anger predominates (Pond et al., 2012), and have a greater ability to avoid making moral judgments guided by emotional biases (Cameron et al., 2013). In contrast, individuals with low levels of granularity may experience borderline personality disorder (Suvak et al., 2011), major depression (Demiralp et al., 2012), or anorexia nervosa (Selby et al., 2014). Given these associations, applications like EMOTONGUE, and studies like the present one, warrant further investigation to explore their potential in measuring how people experience and express emotions in natural contexts and in facilitating an increase in their emotional granularity through user-friendly software.

The qualitative findings from this study suggest that, when expressing specific emotional episodes, participants tended to more easily discern their emotions when using the dynamic wheels compared to when they did not. The same participants reported having benefited from the dynamic wheels on different occasions to discern what they were feeling. They were able to better understand what they felt and recognize their emotions by employing the app. They also reported having become more aware of their emotions and better able to regulate the intensity of a particular emotion while answering the different questions of each notification. Taken together, these qualitative data and the quantitative data provided by the comparison of the three moments of measurement we could state that there has been an increase in the use of the app, which could have resulted in an improved emotional discrimination. This is particularly evident in females, with the greatest difference observed between the third and second measurement points. However, further longitudinal research is required to gain a more comprehensive understanding of the potential benefits of such tools.

Furthermore, both qualitative and quantitative data suggest that expressing emotions is easier and more detailed in one's native language compared to a second language. This

may have implications for the design and implementation of emotional management tools across diverse linguistic contexts.

Men often tend to report high arousal and pleasure in their emotional experiences, while women seem to express emotions associated with low arousal and pleasure. Lim (2016) conducted a study illustrating how Western cultures tend to value high arousal emotions and pleasure positively, whereas Eastern cultures tend to value emotions with low arousal more. In Western culture, individuals often seem to attempt to influence others, favoring high arousal emotions for this purpose. Conversely, Eastern culture seems to prioritize adapting and conforming to others, where low arousal emotions seem to function better for this aim. These findings suggest a clear cultural pattern.

Regarding women, they tend to use or mention low arousal emotions and pleasure more frequently. This may be attributed to persistent gender stereotypes, such as the belief that women have less agency and are more emotional than men (Hentschel et al., 2019). However, further investigation is needed to fully understand this aspect and measure arousal and valence for each emotional episode. As for valence, while there appears to be no clear difference between men and women, both sexes seem to prefer emotions involving positive valence. This could once again be linked to cultural factors, with Western individuals, particularly Northern Americans, showing a tendency to report and focus on positive emotions while minimizing negative ones (Kitayama et al., 2000).

In conclusion, while EMOTONGUE holds promise in enhancing emotional awareness and granularity, further research with larger and more diverse samples is needed to validate and expand upon these preliminary findings. Additionally, incorporating longitudinal studies and control groups would provide a more comprehensive understanding of the app's effectiveness and sustained benefits over time. Despite the limitations inherent in a small sample size and short study duration, this research lays the groundwork for future investigations into the role of digital tools in promoting emotional well-being and self-regulation skills.

7. Conclusions

Based on the findings, several insights emerge. First, EMOTONGUE appears to facilitate heightened emotional awareness and, consequently, improved self-management. Users become more attuned to their emotional states, enabling them to discern their feelings and utilize the tool as a means of emotional release. Expressing emotions prompts users to reflect on their emotional experiences, leading to potential reevaluation. The primary shift induced by the tool is a heightened attentiveness to emotional states, emphasizing the subjective construction and reconstruction of emotions.

However, it is important to note the limitations inherent in drawing firm conclusions from such a small sample size and a brief duration of study. The results suggest promising avenues for further exploration into measuring emotional events in natural contexts using innovative technological tools. Continued research in this domain is warranted to validate and expand upon these initial findings.

7.1. Study Limitations

A key limitation was the small participant pool, predominantly Spanish, limiting cultural diversity. To gain broader cross-cultural insights, future studies should include participants from diverse cultural backgrounds, including English speakers or others.

Moreover, this study represents an initial exploration, laying groundwork for future research. The limited sample size resulted from the application's demanding nature, requiring consistent engagement and deep emotional exploration. Recruiting participants willing to invest time for autonomous emotional exploration posed challenges in today's fast-paced society.

7.2. Future Directions

Further research is needed to explore the application's impact and effectiveness with a larger sample size to validate findings. This would enhance understanding of its effectiveness in promoting self-awareness and emotional exploration across diverse populations. Incorporating a control group in future studies would provide a more comprehensive evaluation, while longitudinal studies could offer insights into sustained benefits and long-term impact on emotional well-being and self-regulation skills.

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