Aiming to Increase Emodiversity and Decrease Depression Through an Emotion Knowledge Intervention

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Abstract

Being able to experience a diverse range of emotions has been found to be beneficial for mental health. Only being able to experience a small range of emotions can lead to maladaptive outcomes. Not much is known yet about possibilities for increasing emotional diversity. That is why, for this study, an intervention was designed which could potentially increase emodiversity. It was also tested whether, through this effect, depression could be decreased. One hundred and twenty participants were equally and randomly divided between an experimental condition and a control condition, in which they were informed about either emotions or countries, respectively. Of these participants, 62 were men and 58 were women. Participants' ages ranged from 18 to 74 years old. Emodiversity and depression levels were measured before and after the intervention. A 2x2 mixed ANOVA was conducted in order to test whether the intervention had indeed increased emodiversity levels and decreased depression levels. Against expectations, emodiversity levels had not significantly changed due to the intervention, nor had depression levels. An explorative analysis was conducted for positive and negative emodiversity separately, but again, no effects of the intervention were found. These findings suggest that emodiversity can most likely not be increased using an emotion knowledge intervention, and that this would not be an effective way of indirectly decreasing depression levels. More research should be done to explore whether other types of interventions could effectively increase emodiversity, so that maladaptive outcomes due to low emodiversity can be prevented or decreased.

Keywords: emodiversity, depression, emotional complexity, positive emodiversity, negative emodiversity, intervention

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In the Netherlands, approximately 1 out of 5 adults suffers from depression at least once in their lifetime (Castagna, 2022). Aside from the recognized affective symptoms of major depression, mainly sadness and hopelessness (American Psychiatric Association, 2013), the disorder was found to be associated with physical illnesses (Frerichs, 1982; Penninx et al., 2013) and other consequences such as poor school performance, substance abuse, and bingeing (Glied & Pine, 2002). On account of this, it is relevant that effective treatments are developed, while also finding ways to prevent the disorder and its symptoms and consequences.

In the past decades, researchers have extensively examined the relationship between depression and emotion. Common findings in these studies are a decrease in positive affect (e.g., Gruber et al., 2011) and a lower general reactivity to emotion-evoking stimuli in participants who have depression (e.g., Rottenberg, 2005; Wexler et al., 1994). The focus in earlier studies on emotion and depression has mainly been on negative and positive affect as stable constructs standing on their own. As explained by Berrios (2019), properties of the emotional experience such as appraisals show that affect is more complex and dynamic than just these single emotions. In order to make this limited view more complete, researchers have been looking into the connection between emotional *complexity* and depression (e.g., Kang & Shaver, 2004).

According to Kang and Shaver (2004), emotional complexity can be defined as having a broad range of well-differentiated emotional experiences. *Emodiversity* is an important part of emotional complexity (Schreuder et al., 2020). It refers to being able to experience a broad range of emotions (Quoidbach et al., 2014). To illustrate, if someone were to experience joy, contentment, and excitement all in one day, they would have a higher

emodiversity than someone who only feels ‘good’ in a more general way (Werner-Seidler et al., 2020).

Overall emodiversity scores can be determined by combining positive and negative emotion scores, while positive and negative emodiversity can also be analyzed separately (Quoidbach et al., 2014). A study by Quoidbach et al. (2014) showed that all forms of emodiversity, whether it be global, positive, or negative, were related to better mental and physical health. It was suggested that this could be because emotions provide information about our needs, making us able to act on them accordingly. Furthermore, Rivera et al. (2020) reviewed literature which had found that a lack of emodiversity is associated with inflammatory responses linked to depression. Thirdly, Benson and Ong (2020) found that positive emodiversity is a buffer in the relationship between stress and depression, especially in younger adults. These findings suggest that higher emodiversity may lower the risk for or reduce symptoms of depression.

However, the existing literature generally fails to view emodiversity as a concept that could potentially be improved. Not much is known yet about whether it is relatively fixed, or something that could be changed, whether that be consciously or unconsciously. If emodiversity can be trained and increased, it could potentially play a role in lowering the risk for depression, or it could be implemented in its treatment.

Taking into account the evidence regarding the importance of emodiversity for well-being, this study will examine whether emodiversity could be enhanced using an intervention in the form of information sessions, and whether this intervention designed to enhance emodiversity lowers depressive symptoms. The intervention group, as opposed to the control group, was informed about emotions using a daily information session for five consecutive days. The intervention entails a daily online information session that informs participants about emotions and the experiences they can bring about. Emodiversity scores are determined

pre- and post-intervention using the Modified Differential Emotions Scale (mDES). Depression scores are measured before and after the intervention using the Center for Epidemiologic Studies Depression scale (CES-D).

Firstly, it would be expected that the intervention group has a significantly higher level of emodiversity post-intervention compared to pre-intervention, and the control group does not (H1). This hypothesis was formed on the grounds that learning about the experiences of all sorts of emotions could make participants more aware of their own, potentially making them able to experience a wider range of emotions more consciously. The intervention was developed as an attempt to increase emodiversity in this way. Secondly, it would be expected that the intervention group scores lower on depression post-intervention compared to pre-intervention, and that the control group does not (H2). This hypothesis is based on the previously referred to literature, in which a higher emodiversity has repeatedly been linked to a better overall mental health and, specifically, lower depression scores. In the potential outcome that H1 is not confirmed, this second hypothesis will still be relevant, as it will show whether learning about emotions can help lower depression. If H2 is confirmed, meaning depression levels will indeed have decreased due to the intervention, it will be tested whether emodiversity served as a mediator in this effect. In combination with the first hypothesis this will answer the central research question, as it will become clear whether emodiversity can be increased with an intervention, hereby also lowering depression.

Method

Participants

Participants were recruited using Prolific, an online participant platform. If they completed all parts of the study, they were rewarded £15. An a priori power analysis was conducted using the software program G*Power (Faul et al., 2007). The power analysis (ANOVA: Repeated measures, within-between interaction) to determine medium effect size

(α = 0.05, with power 0.95) indicated that a total sample size of at least 54 was needed. In total, 120 English-speaking participants were recruited. Since the study was longitudinal as assessments were divided over a month, some dropout was expected, which is why more participants were recruited than the power analysis indicated. Participants were only included if they had completed at least a third of every assessment, which was the case for all participants, leaving N = 120. 62 were men and 58 were women. They were evenly distributed between conditions, so both conditions consisted of 31 men and 29 women. Participants' ages ranged from 18 to 74 years old (M = 35.67, SD = 13.43). 86.67% reported being White, 8.33% were Asian, 4.17% were Black, and 0.83% had a different ethnicity. 75.83% reported living in the United Kingdom, 10.83% lived in the United States, and 13.34% lived elsewhere. When it comes to the highest completed level of education, 33.33% reported having a Bachelor's degree, 30.83% had done some college but had no degree, 15.83% had a high school degree, and 20.01% had a different type of highest completed education. No notable differences in terms of demographics were found between conditions. This study was approved by the Social and Societal Ethics Committee of University of Leuven, KU Leuven, Belgium.

Materials

Emodiversity

Emodiversity was measured using the Modified Differential Emotions Scale (mDES) (Fredrickson et al., 2003). The questionnaire consists of 20 items, 10 on positive emotions and 10 on negative emotions. Three adjectives are used to describe an emotion, examples being "What is the most joyful, glad, or happy you felt?", and "What is the most proud, confident, or self-assured you felt?". Response options are on a five-point Likert scale, 0 meaning *never* and 4 meaning *most of the time*. For this study, emodiversity indices were computed using the formula from Shannon's entropy, as used by Quoidbach et al. (2014).

The entropy index shows the number of emotions as well as the relative amount of the emotions that are experienced (Quoidbach et al., 2014), capturing all that is relevant to this construct. For the index, a higher value means more emodiversity. The maximum score is 3, meaning all emotions are evenly experienced. A score of 0 would mean that the individual only experiences one type of emotion. This study focuses on global emodiversity, in which positive and negative emodiversity are taken together (Quoidbach et al., 2014). Empirical support was found for the validity and reliability of the mDES in a Greek sample (Galanakis et al., 2016). In order to confirm this reliability, Cronbach's alpha was computed for both assessments of the mDES used in this study. For the items concerning positive emotions, Cronbach's alphas on the first and second assessment were .88 and .89, respectively. For the items on negative emotions, they were .89 and .90, all indicating good reliability.

Depression

Depression was measured using the Center for Epidemiologic Studies Depression Scale (CES-D), developed by Radloff (1977). The questionnaire consists of 20 items measuring depressive symptoms experienced in the past week. Response options are on a 4-point Likert scale, ranging from 0 = *rarely or none of the time (less than 1 day)* to 3 = *most or all of the time (5-7 days)*. Example items include "I did not feel like eating; my appetite was poor" and "I felt hopeful about the future". The scores for the four positive items are reversed. The sum score of the CES-D was used for the analysis in this study. The possible range of sum scores is 0 to 60, with the higher scores being indicative of more depressive symptoms. A score of over 16 indicates that a depressive disorder may be present (Radloff, 1977). Empirical support for the validity and reliability of the CES-D was found (Roberts, 1980; Fountoulakis et al., 2001; Jiang et al., 2019). In order to confirm this reliability, Cronbach's alpha was computed. For both assessments, a Cronbach's alpha of .94 was found, indicating excellent reliability.

Emotion Knowledge Intervention

Participants were randomly assigned to either the experimental condition in which they were given information about emotions, or the control condition in which they were given information about the unrelated topic of countries and continents. The study lasted 8 days distributed over a month, and the intervention took place from day 2 to 6. On day 2 to 5, participants were informed about either emotions or countries and continents. The experimental condition was given information about 12 emotions based on Diener et al. (1995). Participants were given information in the form of text as well as visual stimuli for each emotion. Definitions of emotions and contexts in which they might arise were given. The visual stimuli were images of a person experiencing the emotion or of something that could elicit the emotion. The materials were retrieved from the Delft Institute of Positive Design database (2016, 2017). Participants in the control condition were given information about six countries and six continents. The information was presented in a way that was very similar to the information about emotions, with the same number of pictures and text, all retrieved from Wikipedia (n.d.). The text included information about capitals and inhabitants, while the photos included flags and landscapes. On day 6, all participants were informed about differences between either the countries or the emotions that they had been informed on, depending on their assigned condition. They then took a test to assess how much knowledge they had retained on their assigned topic.

Procedure

The study was conducted online using Qualtrics. Participation for 8 days distributed over a month was required. On day 1 (T1) all participants signed informed consent and the mDES and CES-D were assessed, among other questionnaires for a more extensive study. On days 2 to 5, participants in the experimental group were taught about emotions, while the control group was taught about countries and continents. The sequence of the emotions or

countries for these days was randomized. On day 6, each group's knowledge on the subject it had been informed on was assessed. On day 7 (T2), the mDES, CES-D, and other questionnaires were completed again. A month later, on day 8 of the study, the participants received the debriefing and all questionnaires were assessed again for a follow-up which will not be used for this study. The questionnaires on day 1 and 7 took approximately 30 minutes to complete. Reading the assigned information took about 15 minutes per day.

Statistical Analysis

In the experimental research design, the independent variables are the type of intervention and time, and the dependent variables are emodiversity and depression. Firstly, it was tested whether the type of intervention had an effect on emodiversity. If this was the case, an analysis would be done to see whether emodiversity was a mediator in the potential effect of the intervention on depression. After checking for missing data and outliers, which were not found, descriptive statistics were computed for each questionnaire. In order to then test the hypotheses, a 2(Time; within-factor)x2(Condition; between-factor) mixed ANOVA was conducted to compare post-intervention emodiversity levels (T2) with baseline levels (T1) for both conditions (H1), and to compare the difference in depression levels in the same way (H2). Adhering to ANOVA assumptions, there were no significant outliers, the dependent variables were approximately normally distributed as the sample size was sufficiently large (Kwak & Kim, 2017), the assumption of sphericity was met as there were only two within-subject levels, and the assumption for homogeneity was met. The software SPSS version 28.0 was used for data analysis.

Results

Descriptive Statistics

To begin with, the means and standard deviations were computed for both questionnaires, as shown in Table 1. Mean scores for emodiversity were lower post-

intervention (T2) compared to before the intervention (T1) for both conditions, as were mean depression scores.

Table 1

Means and Standard Deviations for Emodiversity and Depression

	Emotion		Country	
	M	*SD*	*M*	*SD*
Emodiversity T1	2.83	0.1	2.87	0.1
Emodiversity T2	2.79	0.2	2.86	0.1
Depression T1	18.08	12.9	19.58	12.8
Depression T2	16.88	12.6	19.03	12.4

Note. $N = 120$ ($n = 60$ for each condition).

Correlations between the variables were also computed, which can be found in Table 2. There was a high correlation between depression scores at T1 and T2, but only a low correlation between emodiversity scores at both timepoints. Correlations between depression and emodiversity scores were also low.

Table 2

Correlations between Emodiversity and Depression at T1 and T2 for both Conditions

	Emodiversity T1	Depression T1	Emodiversity T2	Depression T2
Emodiversity T1	-	.068	.381**	.081
Depression T1	.221	-	.051	.866**
Emodiversity T2	.326*	.370**	-	.059
Depression T2	.197	.897**	.264*	-

Note. Under the diagonal represent the correlations for the emotion condition, above the diagonal for the country condition.

*Correlation is significant at the 0.05 level (2-tailed).

**Correlation is significant at the 0.01 level (2-tailed).

Hypotheses Testing

Before testing the hypotheses, a one-way ANOVA was conducted to compare emodiversity and depression levels between conditions at T1. There was no significant effect of condition on either emodiversity ($F(1, 118) = 2.94$, $p = .089$, $\eta_p^2 = .024$) or depression ($F(1, 118 = .41$, $p = .524$, $\eta_p^2 = .003$), meaning that levels of emodiversity and depression were approximately the same between participants from both conditions before the intervention.

Hypothesis 1 – Intervention Effects on Emodiversity

The results of the 2x2 mixed ANOVA showed that there was no significant main effect of time on emodiversity, $F(1, 118) = 2.99$, $p = .086$, $\eta_p^2 = .025$, meaning emodiversity had not changed significantly after the intervention. There was, on the other hand, a significant main effect of the type of intervention on emodiversity, $F(1, 118) = 7.93$, $p = .006$, $\eta_p^2 = .063$, meaning that there was a significant difference in emodiversity between

conditions. Against expectations, emodiversity was significantly higher in the control condition. There was no significant interaction effect between time and condition for emodiversity, $F(1, 118) = 1.82$, $p = .180$, $\eta_p^2 = .015$, meaning that the emotion knowledge intervention did not lead to any significant changes in the experimental condition, thus H1 was not confirmed.

Hypothesis 2 – Intervention Effects on Depression

There was also no main effect of time on depression, $F(1, 118) = 2.41$, $p = .123$, $\eta_p^2 = .020$, meaning that there were no significant changes in depression levels between T1 and T2. To add to that, there was no significant main effect of type of intervention on depression, $F(1, 118) = .66$, $p = .418$, $\eta_p^2 = .006$, which means that there were no significant differences between conditions in terms of depression levels. There was also no significant interaction between time and condition for depression, $F(1, 118) = .33$, $p = .565$, $\eta_p^2 = .003$, meaning that the emotion knowledge intervention did not lead to any significant changes in the experimental condition in terms of depression scores. As H1 was not confirmed and depression levels had also not changed significantly as a result of the intervention, emodiversity could not have been a mediator in the previously hypothesized effect of the intervention on depression. Because of this, H2 was not confirmed, and the follow-up mediation analyses were not conducted.

Explorative Analysis - Positive and Negative Emodiversity

As mentioned previously, emodiversity scores are regularly computed and analyzed separately for positive and negative emotions. In previous studies, some effects have either only been found for positive emodiversity or for negative emodiversity. This could also be the case in this study. Therefore, a repeated measures mixed ANOVA was conducted for positive and negative emodiversity separately as an explorative analysis. Firstly, descriptive statistics were computed, which are shown in Table 3. Mean emodiversity scores were

approximately the same between timepoints for positive emodiversity in both conditions and for negative emodiversity in the control condition, but the mean for negative emodiversity was noticeably lower after the emotion knowledge intervention.

Table 3

Means and Standard Deviations for Positive and Negative Emodiversity

	Emotion		Country	
	M	*SD*	*M*	*SD*
Positive Emodiversity T1	2.24	0.1	2.23	0.1
Positive Emodiversity T2	2.23	0.1	2.23	0.1
Negative Emodiversity T1	2.10	0.2	2.15	0.2
Negative Emodiversity T2	1.98	0.4	2.14	0.3

Note. $N = 120$ ($n = 60$ for each condition).

No significant main effects for time were found on either positive emodiversity, $F(1, 118) = .027$, $p = .869$, $\eta_p^2 = .000$, or negative emodiversity, $F(1, 118) = 3.61$, $p = .060$, $\eta_p^2 = .030$, meaning that there were no significant changes after the intervention in either type of emodiversity. There were also no significant interaction effects between time and condition on either positive emodiversity, $F(1, 118) = .306$, $p = .581$, $\eta_p^2 = .003$, or negative emodiversity, $F(1, 118) = 3.36$, $p = .069$, $\eta_p^2 = .028$, meaning that the intervention did not lead to any significant changes in either type of emodiversity in the experimental condition. Even though no significant between-subjects effect of condition was found for positive emodiversity, $F(1, 118) = .091$, $p = .763$, $\eta_p^2 = .001$, there was a significant effect of condition on negative emodiversity, $F(1, 118) = 6.86$, $p = .010$, $\eta_p^2 = .055$. This shows that, unexpectedly, negative emodiversity levels were significantly higher in the control condition.

Discussion

Over the years, various studies have shown that being able to experience a broad range of emotions is associated with better mental well-being. A lack of this emodiversity is associated with lower well-being, meaning that it would be beneficial to find ways in which emodiversity could be increased. However, the existing literature does not address this potential. The current study attempted to increase emodiversity through an emotion knowledge intervention. It was hypothesized that the intervention would increase emodiversity levels, and that through this effect depression levels would be lowered. These hypotheses were not confirmed. As to H1, no significant change was found in emodiversity levels after the intervention, nor was there an interaction effect between time and type of intervention, meaning that the intervention did not have the hypothesized effect of increasing emodiversity. However, a significant main effect of medium effect size on emodiversity was found for the type of intervention. An explorative analysis on positive and negative emodiversity separately showed that this effect was present in negative emodiversity, which was higher in the control condition. This result is unexpected, as it was hypothesized that emodiversity would become significantly higher in the intervention group instead. In this intervention group, negative emodiversity levels had even almost significantly decreased after the intervention. There was, however, no significant interaction effect, meaning that the intervention did not have a significant effect on emodiversity levels. Thus, H1 was not confirmed. Concerning H2, no significant change in depression levels was found after the intervention, nor was there a significant interaction effect of time and type of intervention on depression. In other words, the intervention did not lead to a decrease in depression levels in either the experimental or the control condition, so H2 was also not confirmed.

These findings mean that the idea that emodiversity could be increased has not yet been confirmed. The results suggest that this type of intervention is most likely not effective.

It even appears to have led to a decrease in negative emodiversity, having the opposite of the desired effect, although this effect was not significant. To add to this, having the participants learn about emotions in this way was not effective with regards to depression, as depression levels were not lowered as a result of the intervention.

The findings are not in line with what was expected based on the existing literature. With Quoidbach et al.'s (2014) definition of emodiversity in mind, the intervention was designed based on the idea that learning about emotions would lead to individuals experiencing them more consciously. However, as discussed by Berrios (2019), emotions are complex processes with many underlying mechanisms, which could be why designing an intervention to increase emodiversity was not as straightforward as this current attempt. Even though the underlying mechanisms used to develop the intervention were logically based on existing literature, no actual evidence which shows that an intervention would be effective in this way exists. Apart from this straightforward explanation for why the intervention did not have the hypothesized effect, there could be other explanations. For example, Brown and Coyne (2017) showed that it could be questioned whether Shannon's entropy should be used as a measure of emodiversity, as it was originally used to quantify the distribution of species in a biological ecosystem. The measured variety of emotions with regards to emodiversity depends on the number of items in the measure that is used, while no such limit exists in a biodiversity context. To illustrate, in this study, the mDES was used to measure emodiversity. It measures how often participants experience 20 emotions. Another measure which is regularly used to measure positive and negative affect is the PANAS-X (Watson & Clark, 1994), which consists of 60 emotions. As explained by Brown and Coyne (2017), leaving out certain emotions in a questionnaire could affect emodiversity scores. In a biodiversity context, for which Shannon's entropy was developed, this limit does not exist. Certain animal species are not ignored when computing a biodiversity score simply because they are not

included in a measure. This is only one of the discrepancies between the different types of concepts to which the entropy is applied (Brown & Coyne, 2017). These theoretical and practical limitations could mean that, in this study, emodiversity was not measured in the most accurate way. This could be why no significant effects of the intervention on emodiversity were found.

Overall, the results of this study show that increasing emotion knowledge is most likely not an effective way of increasing the level of emodiversity, nor is it effective in lowering depression levels. This suggests that methods other than emotion knowledge should be used in a clinical context in order to increase emodiversity or lower depression. On top of this practical implication, there is also a theoretical implication. Earlier research has shown that emotional awareness can be enhanced through psychoeducation, skill instruction (e.g., about mindful emotion awareness), and group discussion, which led to reduced depression symptoms (Bernstein et al., 2021). This study expands on that by showing that merely learning about what a limited number of emotions are and when they may arise is not sufficient to achieve these effects. Actively practicing and applying emotion-related skills is most likely necessary to really affect emodiversity and depression levels.

Previous research combined with the current study can be used as guidelines for future research. Grossman et al. (2021) showed that daily diary-reflections on individuals' days increased emodiversity. This intervention potentially had an effect because, as opposed to merely being passively informed on emotions like in the current study, participants were actively focusing on their own emotional experiences. Daily diary-reflections could be used as an intervention to potentially increase emodiversity again in future research. It could then be analyzed whether depression symptoms and other psychopathology had decreased through this effect. If these hypotheses were to be confirmed, this could have practical implications, as daily-diary reflections could be used in the treatment of depression and, potentially, other

psychopathology. According to Wang et al. (2016), mindfulness can improve emotional complexity, but further research on the moderators and the neuropsychological mechanisms of emotional complexity is necessary. This suggests that the moderators and underlying mechanisms of emodiversity should be further examined, as emodiversity is an important part of emotional complexity. It has also been suggested that the mechanisms underlying positive and negative emodiversity could be different (e.g., Benson et al., 2017; Werner-Seidler et al., 2020), which means that different approaches could be necessary for both types of emodiversity. When attempting to increase emodiversity with an intervention in the future, firstly further exploring these underlying mechanisms of emodiversity would be beneficial. In this way, interventions could be designed based on a more solid body of evidence.

With regards to the current study, some limitations should be discussed. Firstly, the mDES questionnaire which was used to assess emodiversity only assesses a limited number of emotions. A more all-encompassing measure might have been more accurate, as people may experience emotions in their daily lives that are not included in the mDES. Secondly, as explained before, the use of Shannon's entropy in calculating emodiversity scores can be debated. This could add to the findings giving a somewhat distorted picture. Thirdly, the emotion knowledge intervention that was used only included a limited number of emotions. These emotions also differed from the emotions which were measured with the mDES in order to acquire emodiversity scores. Only four positive emotions were included in the intervention, while ten positive emotions were measured with the mDES. On top of that, the sample of the study was not representative, as the vast majority of participants reported to live in the United Kingdom. Previous research has shown that there are significant cultural differences in emotion (e.g., Lim, 2016). As found by Lim (2016), Western cultures promote and experience high arousal emotions such as 'excited' more, while Eastern cultures promote and experience low arousal emotions such as 'calm' more. The mDES mainly consists of

high arousal emotions, which means that different emodiversity scores could be found using this questionnaire in Eastern cultures. On that account, a more diverse sample should be used in order to be able to generalize results to a bigger population.

While these limitations were present in the study, there were also strong points worth mentioning. To begin with, the use of a control group made it possible to clearly see whether effects would be found due to the intervention specifically being about emotion. In addition, assessment both before and after the intervention made it possible to see whether the intervention or time had brought about any significant levels in emodiversity or depression levels. On top of that, the intervention lasted for a week instead of just a single day. This gave participants the time and opportunity to apply the information that they had learned to their own daily experiences before their emodiversity and depression levels were assessed again. Finally, as Cronbach's alphas were computed, good or even excellent reliability had been confirmed for the measures that were used.

To conclude, an emotion knowledge intervention informing individuals on what emotions are and when they can be experienced does not appear to effectively increase emodiversity or decrease depression. As low emodiversity was found to be associated with depression, and high emodiversity is associated with better mental and physical health, it would be beneficial for effective interventions to be developed in future research in order to be applied to a practical and clinical context.

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