



How can we Best Use Technology to Teach Children to Regulate Emotions? Efficacy of the Cognitive Reappraisal Strategy Based on Robot Versus Cartoons Versus Written Statements in Regulating Test Anxiety

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Accepted: 21 December 2021 / Published online: 5 February 2022

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Abstract

Test anxiety has a high prevalence in children and is associated with lower academic performance. The main purpose of the current paper was to investigate the efficacy of using technology based tools, in the form of a robotic agent and cartoons, for teaching school aged children functional cognitive reappraisal emotion-regulation strategies for managing test anxiety. Sixty-nine elementary school aged children participated in the current study. Test anxiety was induced and then the children were allocated to the roboRETMAN, the PsyPills (written reappraisal statements), and the wait-list conditions. In the second stage, children in the wait-list received the RETmagic cartoons. Children reported on their anxiety, positive emotions, rational and irrational beliefs. Results show a higher efficacy for the roboRETMAN compared to wait-list in helping children manage their test anxiety, improving their positive emotions and reducing irrational cognitions. This study brings important contributions to the field, given that there is no research done so far investigating most effective means for delivering emotion-regulation strategies in children.

Keywords Exam anxiety · REBT based robotherapy · Child emotion-regulation

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Introduction

Test anxiety is associated with lower academic performance in children (see von der Embse et al., 2018) and has a prevalence of 25 to 40% in school children. It is considered (Putwain et al., 2009) that among the relevant regulating mechanisms for anxiety in children, an important role is played by their negative cognitive distortions. Thus, we expect that teaching children how to use effective emotion-regulation strategies, such as cognitive reappraisal, should translate in benefits for their negative moods, such as test anxiety.

While the efficacy of the cognitive reappraisal was intensively investigated in regulating anxiety in adults, much less is known about how it works in regulating anxiety in youth. This gap is due to the difficulties in finding the adequate means for delivering such strategies in children.

Moreover, functional cognitive reappraisal is an ecological form of cognitive reappraisal (see Cramer & Buckland, 2010; Szasz et al., 2011), derived from the Rational-Emotive and Cognitive-Behavior Therapy (RE&CBT; Ellis, 1962), being based on changing irrational beliefs into rational beliefs. Indeed, large scale meta-analyses showed the role of irrational beliefs in psychopathology (e.g., including anxiety) (Visla et al., 2016) and the protective role of rational beliefs (Oltean et al., 2018). Beyond classical RE&CBT sessions, functional reappraisal was also found effective in the emotional regulation framework, when delivered in the form of written rational statements, called “psychological pills”, both using paper (Cristea et al., 2012) or an automatic app (PsyPills app; David & David, 2019).

Overview of the Current Study

The main purpose of the current paper was to investigate the efficacy of teaching school aged children functional reappraisal for managing test anxiety. Another innovative component is the use of a technology-based functional reappraisal. Indeed, technology is a constant presence in our societies and a point of attraction for children. Therefore, using it as a mean to implement psychological interventions could potentially have a strong practical impact.

We expected that technology based tools will be more effective in training functional reappraisal skills in children and thus the groups using roboRETMAN and Cartoons report lower anxiety and irrational beliefs, while reporting more positive emotions and rational beliefs.

Method

Participants

Sample consisted of 69 children aged 9 to 10 years old ($M_{age} = 10.10$, $SD = 3.38$; 35 girls and 34 boys) from a school in a small city. They participated in this study while at school and their parents signed an informed consent for participating.

Measures

We measured anxiety and positive emotions in the test situation using the Profile of Affective Distress (Opris & Macavei, 2007), and rational and irrational thinking using the Exam-Rational and Irrational Beliefs Scale (Montgomery et al., 2007).

Profile of Affective Distress (PAD; Opris & Macavei, 2007)

PAD is a measure of psychological distress and positive affect that consists of 39 items. Each item corresponds to an adjective describing an emotion is rated by respondents regarding how she/he has felt during the last 2 weeks, on a five-point Likert scale. We adapted the instruction and asked participants how they are feeling right now. The scale has a total distress score, with the positive emotions subscale reversed. PAD can be scored using four subscales, of which in this study we used the anxiety subscale and the positive emotions subscale. The PAD has good internal consistency (α Cronbach = 0.94; Opris & Macavei, 2007).

Exam- Beliefs Scale (E-RIBS; Montgomery et al., 2007)

E-RIBS is an eight item measure for assessing irrational and rational beliefs that have been specifically associated with the exam situations. The scale has four items phrased irrationally and four stated rationally and can be scored in two subscales or a total score of irrational beliefs by reversing the rational items and summing the items. The measure has adequate internal consistency (0.74; Montgomery et al., 2007).

Procedure

Test anxiety was induced, by announcing a very difficult test based on which the ranking of the students' performance would be made public in the school. After that, baseline assessment was conducted for anxiety and emotions. Then participants were randomly distributed in the roboRETMAN condition (24 children—the robot reading radio frequency cards with emotions and playing the psychological pills to the children; see Appendix for the played statements), the PsyPills condition (19 children—the children received the functional reappraisal

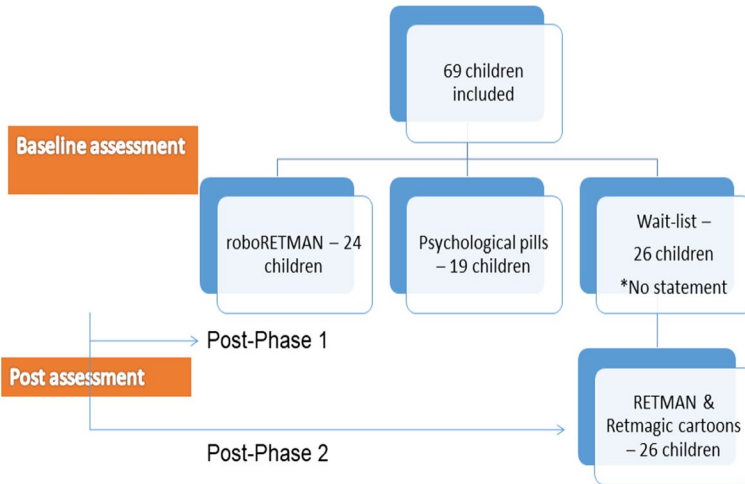


Fig. 1 Phases of the study

strategies, named also Psychological Pills, written on a card; see Appendix for the written statements), or a wait-list (WL; 26 children—no strategy given) and then the first post-assessment was conducted. The experimenter (first author) delivered all the interventions in the classrooms. In a third phase, children in the WL were given an episode from the RETMAN and RETmagic cartoons for managing anxiety and their mood was assessed again (see Fig. 1).

RETMAN is a superhero character developed within the RE&CBT framework (Marrieffield & Marrieffield, 1979), which has its own therapeutic stories (David, 2010; see www.retman.ro), and more recently was extended towards technology based tools, such as therapeutic cartoons (RETMAN and RETmagic) and to function as a robot (roboRETMAN).

Robotherapy or robot based/enhanced therapy refer to technological tools that respond to user's input in an intelligent, human-like manner and which can have different degrees of autonomy (see David et al., 2014). Robot-based means of delivering therapy (especially cognitive-behavioral therapy) and socially assistive robots are considered as having important applications and few tools have been developed and tested in the treatment of autism spectrum disorders in children (see Rabbitt et al., 2014). However, the applications of such tools for teaching children emotion-regulation skills is lacking. The roboRETMAN is a simple robotic agent (mechatronic devices; see Fig. 2) that was developed by first author in collaboration with a team from Vrije University Bruxelles and uses sensors able to read radio-frequency identification card labeled with a dysfunctional feeling. Depending on the specific emotion, roboRETMAN plays a reappraisal statement based on RE&CBT (see the PsyPills in the Appendix) that can help by the child to regulate his/her mood.

The RETMAN and RETmagic therapeutic cartoons have been developed to teach children the principles of RE&CBT for managing specific emotions, such as anxiety, depressive mood, anger and guilt (see Fig. 3). Each episode is focused on a situation

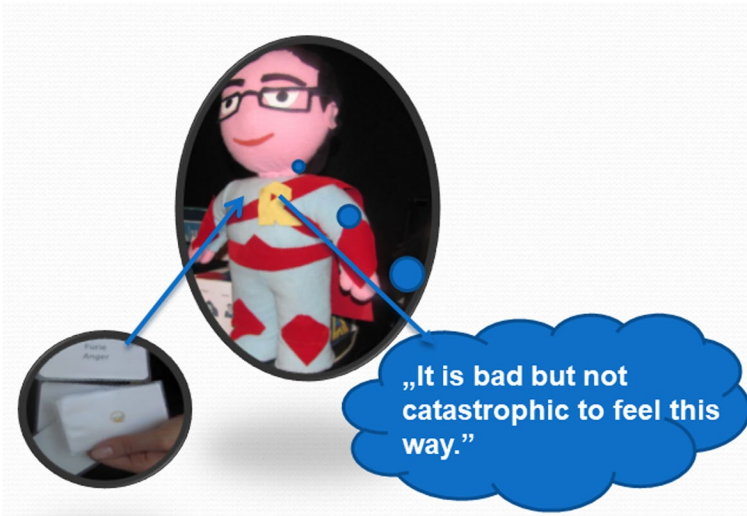


Fig. 2 The roboRETMAN tool for coaching emotion-regulation in children



Fig. 3 Episode from the RETMAN and Retmagic therapeutic cartoons

when the main character feels a specific negative emotion, understands how the thoughts are involved in producing it and then the RETMAN character appears and teaches the child the secrets of RETmagic, represented by functional reappraisals. In this study, we used the episode dedicated to helping children manage anxiety, having the length of 12 min.

Data Analysis

In order to analyze the results, we used a mixed within-between ANOVA, having the time of measurement (pre-test vs. post-test) as the within-subjects factor, and the

experimental groups (roboRETMAN vs. PsyPills vs. WL) as the between-subjects factor. In a second phase, we analyzed comparatively the changes in each group, from pre to post-test in the outcomes, and thus we performed Paired-samples *t* test. We computed the *Cohen's d* index as an indicator of the effect size.

Results

Descriptive Statistics

Manipulation Check

We checked the degree to which anxiety was induced after implementing the induction procedure compared to the instrument norms. The mean level of anxiety reported by the children was higher than mean level of anxiety reported in the PAD norms (Opris & Macavei, 2007). In order to check how much the children were able to use the instructions, we used the question "How much did you internalize that way of thinking?" as a single item with a range from 0 to 10, where 0 meant "Not at all" and 10 meant "Very much". We found differences between the three groups $F(2,66) = 4.12$, $p = 0.020$, with children in the roboRetman condition, $MD = -0.89$, $p = 0.039$ and Cartoons condition, $MD = -0.80$, $p = 0.045$ reporting higher levels of internalizing the cognitive reappraisal strategies offered compared to the PsyPills condition (Table 1).

Table 1 Descriptive statistics for the outcomes

Group	Anxiety pre	Anxiety post	Positive emotions pre	Positive emotions post	Irrational beliefs pre	Irrational beliefs post	Rational beliefs pre	Rational beliefs post
roboRetman								
M	11.75	7.16	46.33	53.62	10.86	8.16	9.82	12.79
SD	6.70	2.27	11.13	14.06	3.93	2.47	3.02	3.74
PsyPills								
M	12.78	9.15	35.36	46.00	10.00	10.47	10.57	11.15
SD	6.14	4.20	12.21	12.45	3.00	3.20	2.77	2.94
Cartoons								
M	10.73	6.73	48.23	48.96	10.23	8.57	11.07	11.80
SD	5.19	1.28	7.64	11.58	2.58	2.31	1.95	2.59
WL								
M	10.73	11.34	48.23	42.42	10.23	11.00	11.07	11.23
SD	5.19	4.65	7.64	11.70	2.58	3.80	1.95	2.97
Total								
M	11.40	8.58	45.17	47.75	10.34	9.51	10.67	11.76
SD	5.76	3.80	10.72	12.95	3.01	3.20	2.44	3.10

Inferential Analyses

ANOVA Repeated Measures analyses showed in terms of *anxiety* reported by children a significant within-subjects main effect of Time $F(1,66)=23.41, p=0.001$, a significant Time x Group effect $F(2,66)=4.007, p=0.023$, and a significant between-subjects main effect of the Group $F(1,66)=3.32, p=0.042$ (see Fig. 4). Post-hoc Tuckey HSD tests showed significant mean difference between the roboRETMAN group and WL ($MD=-2.82, p=0.041, d=1.14$). We conducted paired *t* test analyses in order to measure changes from pre to post-test in each of the groups. We found significant changes in all active groups, roboRETMAN, $t(1,23)=3.34, p=0.003, d=0.91$; PsyPills, $t(1,18)=3.58, p=0.002, d=0.69$; Cartoons- $t(1,25)=4.22, p<0.001, d=1.07$; except for the WL ($p>0.05$).

For the *positive emotions* subscale, we found a significant within-subjects main effect of Time $F(1,66)=21.60, p<0.001$, a significant Time x Group effect $F(2,66)=19.73, p<0.001$, and a significant between-subjects main effect of the Group $F(1,66)=4.19, p=0.019$. Post-hoc Tuckey HSD tests showed a significant mean difference between the roboRETMAN group and WL ($MD=-9.27, p=0.024, d=0.88$). Paired *t* tests showed significant changes in positive emotions

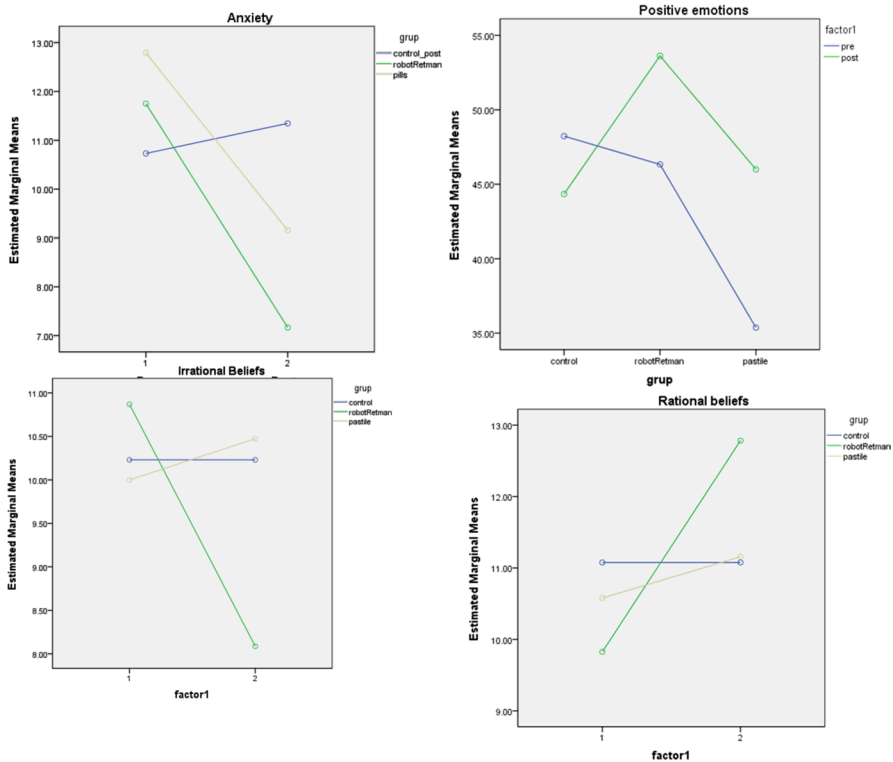


Fig. 4 Graph on means of the sample on measured outcomes

from pre to post only for the roboRETMAN group $t(1,23) = -4.54, p < 0.001, d = 0.57$.

In terms of *irrational beliefs* reported by children, we found a significant within-subjects main effect of Time $F(1,66) = 7.38, p < 0.008$, a significant Time \times Group interaction effect $F(2,66) = 12.85, p < 0.001$, and a significant between-subjects main effect of the Group $F(1,66) = 3.57, p = 0.036$. Post-hoc Tuckey HSD tests showed a significant mean difference between the roboRETMAN group and WL ($MD = 2.06, p = 0.026, d = 0.88$), and the roboRETMAN group and PsyPills group ($MD = 2.30, p = 0.016, d = 0.79$). Paired t tests showed significant improvements only in the roboRETman group $t(1,23) = 3.91, p = 0.001, d = 0.82$ and Cartoons group- $t(1,25) = 3.02, p < 0.006, d = 0.67$.

For the *rational beliefs* subscale, results showed a significant within-subjects main effect of Time $F(1,66) = 12.74, p = 0.001$, a significant Time \times Group interaction effect $F(2,66) = 7.95, p = 0.001$, and a not-significant between-subjects main effect of the Group $F(1,66) = 0.16, p = 0.84$. Paired t tests showed significant improvements only in the roboRetman group $t(1,23) = -3.59, p = 0.002, d = 0.91$.

Conclusions

In the present study, we investigated the efficacy of three different tools to train functional cognitive reappraisal strategies for test anxiety in elementary school children. We expected that technology based tools would be more effective in helping children use functional reappraisal to change their beliefs and manage their test anxiety. In line with our expectations, we found a higher efficacy for the roboRETMAN compared to wait-list in helping children manage their test anxiety. Moreover, although all means for using cognitive reappraisal strategies were used effectively and children reported significantly lower test anxiety in all active groups, technology based tools registered high level magnitude changes in anxiety, while written pills had only medium size magnitude changes.

Our results show that children report higher levels of positive emotions after the use of cognitive reappraisal strategies only in the roboRETMAN group compared to wait-list. Medium level magnitude of change in terms of positive emotions is registered only for children in the roboRETMAN group after the use of the strategies. In terms of cognitive change outcomes, roboRETMAN was more effective in producing changes in irrational beliefs for children compared to no strategy offered (wait-list) or reading the reappraisal strategies (PsyPills). Both roboRETMAN and Cartoons were highly effective in reducing the level of irrational beliefs after their use, as expected. Although, we did not find significant differences between the groups in terms of children's' changes in rational beliefs, we found improvements only in the roboRETMAN group after its use.

Our study has a number of limitations. The design we used did not allow us to compare the efficacy of cartoons in teaching cognitive reappraisal compared to the other groups. Future studies need to use a larger sample size and improved design to investigate comparative efficacy between different types of technology based tools. This study brings important contributions to the field, given that

there is no research done so far investigating most effective means for delivering emotion-regulation strategies in children.

Our results suggest that children best benefit from the cognitive reappraisal statements given by a robotic agent—in our case roboRETMAN—in order to effectively facilitate beliefs change and reduce anxiety in test situations. Moreover, roboRETMAN brings more positive affect which might be due to the play preference of children. Future research should investigate the additive effects of using multiple means (study in preparation), the efficacy of using these means in regulating different emotions, their efficacy in different settings (e.g., at home), and for other age ranges. Also, future studies should investigate the efficacy of reappraisal delivered by the means of technology based tools to other types of negative emotions, like anger or depressed mood.

Appendix

Psychological Pills (PsyPills) Used for Anxiety

I can see that you feel fear. In order to overcome fear is better to think this way:

- “It is unpleasant but I can handle even worse situation than what I am facing now.”
- “It is very unpleasant but it is not awful not to be in control in this situation the way that I would want to.”
- “It is bad but not catastrophic to feel this way.”
- “It is bad but not catastrophic to have this kind of thoughts.”

Funding This work was supported by two grants awarded to Oana A. David from the Romanian National Authority for Scientific Research, CNCS—UEFISCDI [Grant Number PN-II-PT-PCCA-2013-4-1937 and PN-III-P2-2.1-PED-2019-3837].

Declarations

Conflict of interest The author declares that they have no conflict of interest.

Research Involving Human Participants and/or Animals Yes.

Informed Consent Children participated in this study while at school and their parents signed an informed consent for participating. Study was approved by the IRB Committee of the university.

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