Evaluating psychological preparedness for the threat and impacts of climate change disasters and its change after intervention: an integrated modelling approach

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Abstract

The aims of the present study are 1) to collect data on psychological preparedness and its psychological predictors in the sample in Novorossiysk, a city located on the Black Sea shore in Southern Russia where climate change disasters such as storm wind, flooding and earthquake now occur very often; 2) to use collected data for identification of parameters of nonlinear model of psychological preparedness (PREP model) and its validation; 3) to propose psychological rhythmic movement therapy (RMT) intervention for increasing psychological preparedness; 4) to apply PREP model as an effective assessment tool for evaluating pre-post intervention levels of psychological preparedness. A total of 52 subjects were selected at random and assessed with the appropriate questionnaires. The collected data were used for PREP model's parameters identification and its validation. After that two groups were formed: 1 (with low and medium, N=12) and 2 (with high, N=40) levels of psychological preparedness. Subjects of group 1 were proposed to participate in rhythmic movement therapy intervention. PREP model was used as the assessment tool of the RMT effectiveness. The results demonstrated significant improvement in psychological preparedness and several other personal variables in subjects of the RMT group.
Keywords: psychological preparedness, integrated model, psychological predictors, method of response functions.

1 Introduction

Climate change disasters represent sudden, extreme, environmental phenomena, including such events as hurricanes, tornados, floods, etc. that occur with little or no warning and impact a large number of people with such consequences as traumatic stress or even death and/or illness (e.g. [1]). In the disaster context, *preparedness* is an essential component of all disaster management models and frameworks, but typically focuses exclusively on what *household preparations* and *actions* one should take to protect oneself and family and to prevent or mitigate damage and human and financial costs and loss. *Psychological preparedness* differs from household or physical preparedness in that what is referred to is an intra-individual and psychological state of awareness, anticipation, and readiness - an internal, primed, capacity to anticipate and manage one's psychological response in an emergency situation [2–4]. Individual and community psychological preparedness in the natural disaster context has proven to be one of the most effective resilience-conferring strategies available in the context of natural disasters [5]. The construct of individual "resilience" typically refers to inner strengths and coping resources for necessary adaptation to situational demands (e.g. [6]). "Resilience" has become the principal theme in the APA's web-based help line and brochures providing advice and guidance in the context of disasters and terrorism [7].

However, pre-impact psychological assessment and intervention has been an area of surprising omission in multidisciplinary writings about human response to natural disaster. This is not to say that an extensive literature on human response to natural and man-made hazards does not exist, but much of this discourse relates to either post impact stress and coping issues or organizational preparedness and response [8]. Many studies consider the factors that relate to the recovery of an individuals or community affected by emergency. In particular, principles of recovery, the process of recovery, the reactions of people affected by emergencies, and the means by which recovery needs might be addressed are considered [9]. Attempts to adequately conceptualise, measure, and address psychological coping and adaptation strategies and responses to climate change disasters at an individual and psychological level have to date been largely unsatisfactory [10]. However, understanding psychological factors related to preparedness are central to the efforts to reduce the negative effects of disasters.

Results of many studies suggest that personality is fundamental to the understanding of resilience and preparedness for disaster. A number of models of psychological preparedness exist based predominantly on proactive and resource-based theories of stress and coping, such as the "Conservation of Resources Model" [3], the "Warning and Response Model" [11], the "Proactive Coping Model" [12], the "Person Relative to Event Model" [13].

A great deal of prior research on disaster preparedness has been undertaken, with a number of key influences of preparedness identified (see [14] for a review). Despite the amount of research that has taken place, there are still gaps

in our knowledge about the socio-psychological processes related to preparing [15].

There has been a strong consensus among clinical and counselling psychologists and other mental health professionals that adequate information and preparation for recurrent natural disasters can empower individuals and assist in the prevention of physical and psychological devastation and distress [16]. However, there have been very few published research findings relating to psychological intervention outcome studies particularly focused on natural disaster public education or psychological preparedness.

For example, the Australian Psychological Society has developed a number of disaster preparedness brochures and tip sheets which use a stress inoculation approach to assist individuals to *prepare them* as well as their households for disasters [8, 17, 18]. A number of self-help approaches to resilience-building have been developed, drawing mainly on the theory and practice of cognitive-behavioural therapy [19]. The American Psychological Association (APA) has been very active in developing resources relating to coping with disasters [7]. However, the results of one study supported the fact that chronically anxious or previously traumatised individuals might need more assistance than that which a brief self-instruction guide on managing emotions might be able to provide [8].

Thus, one of the most important tasks in the context of disaster management is the elaboration of the model of intra-individual psychological preparedness which would appear to predict risk perceptions and understandings, effective coping responses and resilience, overt behavioural adjustment and change [10].

The second important task is the development of pre-impact psychological intervention with the aim to increase psychological preparedness through increasing individual resilience.

2   Integrated model of psychological preparedness

In our previous study we constructed the nonlinear integrated model of individual *psychological preparedness* (PREP model) based on the method of response functions (MRF) and prior knowledge of several personality variables: dispositional optimism, self-esteem, self-efficacy, and trait anxiety [20]. The theory of the MRF and its applications has been described in several articles and monograph [21].

The aims of the present study are 1) to collect data on psychological preparedness and its psychological predictors in the sample in Novorossiysk, city located on the Black Sea shore in Southern Russia where climate change disasters such as storm wind, flooding and earthquake occur now very often; 2) to use collected data for identification of parameters of the model of psychological preparedness (PREP) and its validation; 3) to propose psychological intervention for increasing psychological preparedness; 4) to apply PREP model as an effective assessment tool for evaluating pre-post intervention levels of psychological preparedness.

To be able to provide the identification of parameters of PREP model and its validation we were collecting data on psychological preparedness and its

psychological predictors in the sample in Novorossiysk city located on the Black Sea shore in Southern Russia where climate change disasters such as storm wind, flooding and earthquake occur now very often.

2.1 Participants

A total of 52 subjects were selected at random. Demographic items included age and gender, which were assessed with single questions. The sample consisted of 28 males (54% mean age 35.7±12.1) and 24 females (46%, mean age 34.7±11.1). The nature of the study was explained to prospective participants in an initial meeting, and written informed consent was obtained. The Ethics Committee of the Research Center for Interdisciplinary Environmental Cooperation Russian Academy of Sciences (INENCO RAS) Saint-Petersburg, Russia approved this study.

2.2 Measures

Subjects were assessed with the measures presented below. Russian-validated translations of all measures were used.

Life Orientation Test (LOT) [22]. LOT was developed to assess individual differences in generalized optimism versus pessimism. Scores range from 0 to 32, with higher scores indicating higher optimism. The internal consistency of the Russian translation of the scale (Cronbach's alpha) was equal 0.84.

Self-esteem Scale (SES) [23]. SES is a 10-item self-report measure of global self-esteem. It consists of 10 statements related to overall feelings of self-worth or self-acceptance. Scores range from 10 to 40, with higher scores indicating higher self-esteem. The internal consistency of the Russian translation of the scale (Cronbach's alpha) was equal 0.87.

General Self-Efficacy Scale (GSE) [24]. GSE is a 10-item psychometric scale that is designed to assess optimistic self-beliefs to cope with a variety of difficult demands in life. Scores range from 10 to 40, with higher scores indicating higher self-efficacy. Cronbach's alpha in the Russian sample was equal 0.80.

Anxiety Scale (AS) of Texas Christian University Self-Rating Forms (TCU/SRF) [25] is a 7-item psychometric scale which provides a quick assessment of anxiety. Scores range from 7 to 28, with higher scores indicating higher anxiety. The internal consistency of the Russian translation of the scale (Cranach's alpha) was equal 0.90.

Disaster preparedness is evaluated with the 14-item preparedness scale based on 18-item Psychological Preparedness to Disaster Threat Scale (PPDTS) [26]. Sample instructions and items include, "I am familiar with the severe storm or cyclone preparedness materials available to me", "I know which household preparedness measures are needed to stay safe in a very severe storm or cyclone situation", "In a severe storm or cyclone situation I would be able to cope with my anxiety and fear". Respondents are asked to indicate the extent of preparedness with regard to each item in the scale by checking either 'yes' (score = 3), 'unsure' (score = 2), or 'no' (score = 1). The internal consistency of the

Russian translation of the scale was assessed with Cronbach's alpha that was equal 0.88. The value of the test-retest correlation was 0.84.

2.3 Evaluation of parameters and validation of the model

PREP model's parameters have been evaluated using the output of the measures mentioned above. As model (1) is nonlinear in parameters, the problem of parameter estimation can be solved only by numerical methods. The parameters are determined by minimising the sum of squared differences between estimated data and survey measurements. Also, we enter the coded values because the "natural" measurements of personality variables under study had different ranges that might cause difficulties for the parameter's estimation procedure. All raw scales are linearly converted to a scale from 0 to 10, with a higher score indicating higher levels of personality variables. The goodness of PREP model fit (i.e. average value of residual errors in estimation of model's parameters) is equal to 4.66% (range from 0.46 to 7.67%). While the standard error of measurement in the given sample is equal 5.24% thus the goodness of PREP model fitting seems satisfactory.

Then the model of psychological preparedness (PREP) is looking as follows:

$$PREP_{mod} = PREP_{max} \cdot F_{st}$$

$$F_{st} = f_1(OPT) \cdot f_2(EST) \cdot f_3(SEF) \cdot f_4(ANX)$$

$$f_1(OPT) = 0.6 \cdot \left(OPT^{1.69} \cdot \exp(-2.88 \cdot (\frac{OPT}{14.7 - OPT})^{0.34}) \right) \quad (1)$$

$$f_2(EST) = 1.37 \cdot \left(\frac{1.29}{1.78 + \exp(1.35 - 1.54 \cdot EST)} \right)$$

$$f_3(SEF) = 0.13 \cdot \left(\frac{1.0}{0.12 + \exp(0.13 - 7.5 \cdot SEF)} \right)$$

$$f_4(ANX) = 1.0 - 0.25 \cdot (1.0 - \exp(-0.79 \cdot ANX))^{6.43},$$

where $PREP_{mod}$, $PREP_{max}$ are the actual values of psychological preparedness measure resulted from the modified Psychological Preparedness to Disaster Threat Scale (PPDTS) and maximum possible score, OPT are the scores of dispositional optimism scale, EST are the scores of self-esteem scale, SEF are the scores of self-efficacy scale, ANX are the scores of anxiety scale, F_{st}, f_j are the generalised and partial response functions respectively, the estimated value of $PREP_{max}$ is equal 10.0.

The views of partial response functions obtained as a result of model parameters' identification (Figure 1) are corresponding with underlying psychological theories.

The unimodal function was selected to describe the impact of dispositional optimism on psychological preparedness for disaster because of recent results that in an uncertain or rapidly changing situation very high level of optimism can lead to poorly informed decisions as well as to lower level of psychological preparedness [27, 28].

The partial response functions of self-esteem and self-efficacy are increasing with the increasing of self-esteem and self-efficacy levels. Our results corroborate with many other previous results [2, 13, 23, 29, 30]. Higher levels of self-esteem and self-efficacy have been found to be associated with active-behavioural coping methods.
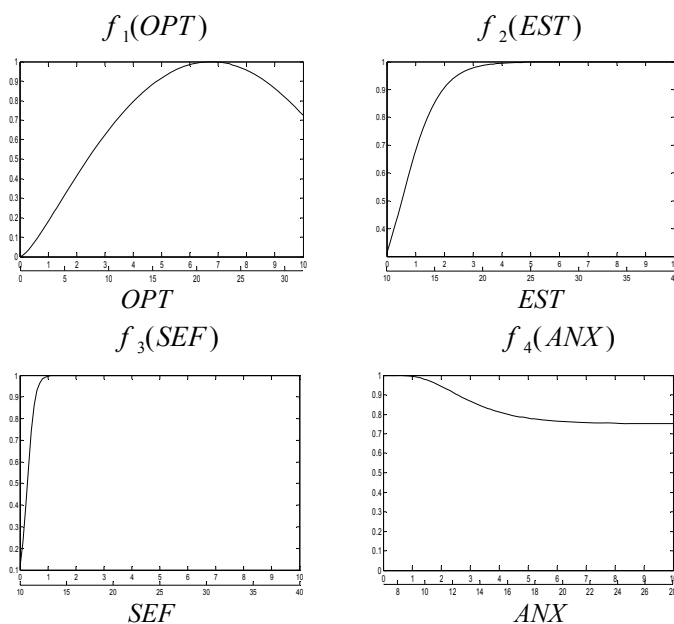

Figure 1:   Partial response functions of PREP model. *OPT* are the scores of the dispositional optimism scale, *EST* are the scores of the self-esteem scale, *SEF* are the scores of the self-efficacy scale, *ANX* are the scores of the anxiety scale, f_j are the partial response functions, where $j = 1,...4$.

The partial response function of anxiety is decreasing with the increasing of the scores. These results are not surprising as, on one hand, it is known that the high anxiety is positively associated with a series of negative psychological traits that one could label as general neuroticism, and, on the other hand, the low anxiety is most strongly related to active coping and dominance [31, 32].

Validation of the PREP model has been provided using the in data not included in estimation procedure. The average error of validation is 5.48% (range from 2.15 to 10.0%) between model and data that seems satisfactory.

3   Rhythmic movement therapy for increasing psychological preparedness

After the PREP model's parameters identification and its validation, the whole group of participants was divided into two more groups in accordance their level of preparedness. A cutoff score of 33 was used to divide particpants into groups with low and medium levels (PREP ≤ 33) (group 1) and high level (group 2) of psychological preparedness. Group 1 includes 12 particpants, all females, mean age 30.2±8.9. Group 2 includes 40 participants, mean age 36.8±11.9 years, 28 (70%) males and 12 (30%) females. One-way ANOVA with the psychological preparedness as a factor was used to analyse the differences of two groups regarding all variables under study. The ANOVAs demonstrated that subjects of both groups did not show any significant differences in age (F =3.13, p = 0.08), but were significantly different not only in psychological preparedness ($p<0.001$), but in dispositional optimism ($p<0.001$), self-esteem ($p<0.001$), self-efficacy ($p<0.001$) and anxiety ($p<0.001$).

After that the rhythmic movement therapy (RMT) programme was proposed to the subjects of the first group for increasing their level of psychological preparedness.

RMT is a model of psychological intervention that is philosophically and theoretically rooted in Body-oriented psychotherapy (BOP), dance-movement therapy (DMT) and rhythmic gymnastics (aerobics). The therapeutic work in RMT can be summarized in two main principles: (1) using the diagnostic system of core personal problems corresponding with various characters and body types; and (2) using rhythmic movement as a medium of change [33]. RMT diagnostic system is based on the ideas of attachment theory that character strategies are starting very early in life when people generalize their experience into prototypes and rules (mental models, core beliefs) that are primarily the result of a child's natural responses to his or her environment over time [34]. Described as internal working models that are encoded and stored as implicit procedural memories, these cognitive/affective representations help organize affect and social experience and shape not only current but future behavioural patterns [35].

Also, recent findings from neuroscience reveal that the brain remains open to new experiences from the environment during the lifespan. This process is called "brain plasticity" that involves not only the creation of new synaptic connections among neurons but also the growth of new neurons [36]. Neuroplasticity is a prerequisite for any enduring change in behaviour, cognition, and emotion, which is the focus of psychotherapy.

The basic mechanisms of RMT are the rhythmic movement itself and kinaesthetic trance. Kinaesthetic trance is an altered state of consciousness (ASC) induced by rhythmic movement [37]. Trance state allows the access to the content of subject's implicit memory storage. The "hardwired" beliefs, generalizations and reactions maybe "reprogrammed" by direct accessing the subconscious through ASC [38].

The RMT program was delivered by psychologists who were trained in RMT during a 1-year course. The RMT intervention consists of 32 twice-a-week

structured sessions of 45–50 min per week in a group setting. Each RMT session consists of three types of exercises: diagnostic, resource, and test. The movement part closes with verbal feed-back and exchange of the movement experience by participants in a circle in order to promote as well as to integrate new interactive experiences, which lasts about 10–15 minutes.

All patients of RMT group completed their treatment programs in accord with pre-planned schedules of twice-a-week 32 sessions and were repeatedly tested after 16 weeks of treatments with the same measures as at the beginning.

3.1 Analysis

The main assessment method in evaluating the outcome of RMT for increasing psychological preparedness was the application of PREP model in the RMT intervention group.

3.2 Results

Computer experiments with PREP model and pre scores of psychological variables of participants of RMT groups were provided with the aim to reveal how satisfactory PREP model predicted the initial level of psychological preparedness.

Table 1: Initial and final scores of psychological variables, experimental and modelled preparedness scores in RMT group.

N	Age	OPT pre	OPT post	EST pre	EST post	SEF pre	SEF post	ANX pre	ANX post	PREP pre (exp)	PREP pre (mod)	PREP post (exp)	PREP post (mod)
1	30	12	22	18	22	24	24	20	14	27	28	36	38
2	33	13	23	19	21	26	26	18	16	31	31	38	36
3	28	12	24	15	15	18	20	20	11	28	28	37	37
4	45	14	24	18	21	20	22	15	13	32	33	37	38
5	16	11	25	18	18	19	21	14	13	31	30	35	37
6	29	10	26	21	19	21	23	15	15	30	29	33	34
7	30	11	24	19	19	25	26	16	14	29	30	38	37
8	28	12	22	17	17	17	19	17	11	29	30	39	39
9	33	15	26	16	20	27	27	18	17	31	32	36	35
10	29	12	27	20	20	20	21	15	15	32	31	36	34
11	45	12	22	19	19	19	23	15	15	31	31	36	37
12	16	12	22	17	17	22	23	14	14	33	31	35	36

Note: OPT – dispositional optimism; EST – self-esteem; SEF – self-efficacy; ANX-anxiety; PREP (exp) and PREP (mod) are experimental and modelled values of psychological preparedness for disasters.

Computer experiments with PREP model and post scores of psychological variables of participants of RMT groups were provided with the aim to demonstrate whether intervention-related changes in several psychological variables were mechanisms underlying psychological preparedness increase in subjects participating in RMT programme. There were no drop-outs of participants during the study. Changes in psychological variables and psychological preparedness before and after the RMT intervention are presented in Table 1. Also, Table 1 contains the simulated results of the pre-post levels of psychological preparedness.

The average error (i.e., average value of residual errors) of PREP model simulation of psychological preparedness before RMT intervention is equal to 0.8% (range from 0% to 6.1%) between model output and experimental data. The average error of PREP model simulation of psychological preparedness after RMT intervention is equal to 1.2% (range from 0% to 5.7%) between model output and experimental data. While the goodness of PREP model fit (i.e. average value of residual errors in estimation of model's parameters) is equal to 4.66% (range from 0.46 to 7.67%) the goodness of PREP pre-post simulations seem satisfactory.

4 Discussion

In the present study we continue the construction of the nonlinear integrated model of individual psychological preparedness (PREP), based on the method of response functions (MRF), data and prior knowledge or information on several personality variables: trait anxiety, self-efficacy, dispositional optimism and self-esteem. Another objective of the study was to evaluate the outcome of rhythmic movement therapy (RMT) for increasing psychological preparedness using PREP model as an assessment tool.

The nonlinear modelling procedure described here is useful for several reasons. First, it provides information about the nonlinear relationships between prognostic factors and psychological preparedness that is not revealed by the use of standard statistic and linear modelling techniques. Second, the PREP model allows predicts whether intervention-related changes in several psychological variables are mechanisms underlying psychological preparedness increase in subjects participating in RMT intervention programme. Third, PREP model allows to conduct a dose-response study, rather than an "all or none" (intervention vs. control) comparison commonly used in clinical trials.

Substantial changes in psychological preparedness and underlying psychological state were observed among the participants as a result of RMT intervention in the present study. In particular, dispositional optimism, self-efficacy and self-esteem improved, and anxiety decreased.

RMT provides techniques for increasing affect awareness and emotional regulation through the exploration of rhythmic movement inducing kinaesthetic trance. Based on the recent neurological findings on memory the main goal of RMT is to recover, in the course of the intervention, those primary emotional schema that belong to infantile amnesia and cannot be remembered. As a more

conscious interrelationship between the mind and the body is developed, the body naturally becomes the resource for emotional self-regulation and integration [39].

Although preliminary and in need of further study, the results from our study suggest that, while psychotherapy interventions in the context of disaster preparedness may be challenging, RMT may be readily accepted in such programs.

5   Limitations of the study and future research directions

Our study is subject to certain limitations. First, although the age of participants in our sample was ranging from 16 up to 60 years, our sample was significantly homogeneous concerning all psychological predictors as well as psychological preparedness. All means in the sample are high except for anxiety which is low: dispositional optimism mean score is equal 22.4 ± 5.72 (high); self-esteem – 29.7 ± 6.59 (high); self-efficacy – 28.0 ± 6.26 (high); anxiety – 13.1 ± 3.09 (low); psychological preparedness – 35.7 ± 3.62 (high).   Thus, sufficient variation in experimental data was strictly limited.

Second, the RMT group consisted only of females. These limitations are added to the fact that study sample is small. These facts are limiting the interpretations of the results and generalization of study findings.

It is also important to take into consideration the possible omission of important psychological predictors, and changing relationships among prognostic factors when new predictors are added.

Future research needs in a larger and more heterogeneous sample. Also, future study needs to include new prognostic factors, based on theoretical models or ad hoc findings.

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