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ORIGINAL ARTICLE

Measuring feelings about choices and risks: The Berlin Emotional Responses to Risk Instrument (BERRI)

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Abstract

We introduce a brief instrument specifically validated for measuring positive and negative feelings about risks—the Berlin Emotional Responses to Risk Instrument (BERRI). Based on seven studies involving diverse adults from three countries (n = 2120), the BERRI was found to robustly estimate *anticipatory affective reactions* derived from subjective evaluations of positive (i.e., assured, hopeful, and relieved) and negative emotions (i.e., anxious, afraid, and worried). The brief BERRI outperformed a 14-item assessment, uniquely tracking costs/benefits associated with cancer screening among men and women (Studies 1 and 2). Predictive validity was further documented in paradigmatic risky choice studies wherein options varied over probabilities and severities across six contexts (health, social, financial, technological, ethical, and environmental; Study 3). Studies 4–6, conducted during the Ebola epidemic and COVID-19 pandemic, indicated BERRI responses were sensitive to subtle effects caused by emotion-related framing manipulations presented in different cultures and languages (the United States, Spain, and Poland). Study 7 indicated BERRI responses remained stable for 2 weeks. Although the BERRI can provide an estimate of overall affect, choices were generally better explained by the unique influences of positive and negative affect. Overall, results suggest the novel, brief instrument can be an efficient tool for high-stakes research on decision making and risk communication.

KEYWORDS
affect, cognitive biases, decision making, emotions, risk communication, risk literacy, risk perception, risky choice, risky prospects

1 | INTRODUCTION

Today, the role of subjective affect in decision making has been thoroughly empirically established (Ferrer et al., 2016; Kusev et al., 2017; Lerner et al., 2015; Naqvi et al., 2006; Västfjäll & Slovic, 2013; Weiss et al., 2015; Zaleskiewicz & Traczyk, 2020). To illustrate, consider research on the *affect heuristic*, which indicates that people often make decisions by consulting their general feelings about the *goodness* and *badness* associated with decision options (Finucane et al.,

2000; Slovic et al., 2007). This influence of affect on decision making has been shown among diverse people facing many types of decisions, and appears broadly robust when assessed with various methods (Skagerlund et al., 2020). The role of affect has also been more formally integrated with leading theories of risky choice (e.g., Prospect Theory; Kahneman & Tversky, 1979), wherein research has mapped the relations between affective reactions and parameters of prospect theory (e.g., the value function and the probability weighting function; Petrova et al., 2014, 2019; Prietzel, 2020). Research further suggests that people's ability to precisely calibrate their affective reactions may be an essential component of skilled decision making and risk literacy, more generally (i.e., the ability to independently evaluate and understand risk; see Skilled Decision Theory (Cokely et al., 2018; Garcia-Retamero & Cokely, 2017)).[1]

Yet despite these and many other advances, to date there are no validated instruments specifically designed to provide a brief assessment of people's anticipatory positive and negative feelings about risks. Can a brief instrument focusing on only a few specific emotional responses robustly predict a wide range of risky choices and behaviors of diverse adults?

1.1 | Anticipatory affective reactions and risky choice

Given the potential benefits and risks, how would you feel about receiving a novel vaccine? When presented with a risky prospect like this, people's reports of their positive and negative feelings felt at the moment of decision making often predict their choices and behaviors (Ferrer et al., 2016; Kusev et al., 2017; Lerner et al., 2015; Naqvi et al., 2006; Västfjäll & Slovic, 2013; Weiss et al., 2015; Zaleskiewicz & Traczyk, 2020). According to the Risk-as-Feelings model (Loewenstein & Lerner, 2003; Loewenstein et al., 2001), it is useful to recognize a fundamental distinction between *anticipatory* versus *anticipated* affective reactions (Loewenstein & Lerner, 2003). *Anticipatory* affective reactions are said to refer to the affective states that decisionmakers experience *at the time of the decision* (e.g., hope), whereas *anticipated affective reactions* refer to emotions that they *forecast they will feel* when they experience the possible consequences of that decision (e.g., regret).[2]

Anticipatory affective reactions can be measured in terms of more general affective responses based on valence (i.e., positive or negative) or in terms of specific emotions (Finucane et al., 2000; Peters, 2006; Slovic et al., 2007). Whereas specific emotions may be associated with distinct appraisal tendencies that in turn may affect behavior in different ways (e.g., fear and anger can have opposite effects on risk perceptions, see Angie et al., 2011; Lerner et al., 2015), they can also contribute to a general, overall positive or negative affective response (Finucane et al., 2000; Slovic et al., 2007). Theoretically, emotions that are of the same valence and are characterized by similar appraisal tendencies may often be reflected in more general positive and negative affective responses (Finucane et al., 2000; Peters, 2006; Slovic et al., 2007).

Overall, a large and growing body of research has documented widespread and robust relations between anticipatory affective responses and diverse choices and risk evaluations (Ferrer et al., 2016; Kusev et al., 2017; Loewenstein et al., 2001; Naqvi et al., 2006; Schlösser et al., 2013; Västfjäll & Slovic, 2013).[3] Theoretically, affective reactions can influence choices via both direct (without altering perceptions) and indirect effects on risky decision making and behavior (e.g., by influencing perceptions and evaluations) (Lerner et al., 2015; Loewenstein et al., 2001). A full summary of the available evidence is beyond the scope of this article, however, it may be useful to note that anticipatory affective reactions can serve multiple decision-relevant functions: They can serve as information; they can help focus our attention; they can motivate us; and they can help us to evaluate and compare options (Clore et al., 2014; Peters, 2006; Peters et al., 2006).

Beyond the growing interest in anticipatory affect in risky choice investigations and theory, research has also focused on the role that affect plays in people's response to risk communications more generally (Keller et al., 2006; Peters, 2011; Rakow et al., 2015). For example, when considering risks depicted by realistic scenarios, people often spontaneously visualize the potential consequences of their decisions. This visualization can elicit positive and negative affective reactions that then directly shape people's memory representations of the risks, which in turn can influence their willingness to take these risks (Traczyk et al., 2015). Examples of processes such as these are consistent with many other risk communication studies revealing the influential role that affectively charged memory representations of risk often have on downstream choices and life outcomes (for a related review, see Garcia-Retamero & Cokely, 2017). Indeed, the influence of affect may be so influential to risk communication research and intervention design that some scholars have noted "just informing people about risks without affect induction is not easy, perhaps even impossible" (Visschers et al., 2012, p. 267). Taken altogether, the empirical, theoretical, and practical foundations suggest a growing need for more integrated,

[1] It is also worth mentioning that the seminal work conducted by Lopes (1987) is widely regarded as some of the earliest research on affect in risky decision making. This work specifically focused on the influence of security motivations (i.e., to mitigate fear) as compared potential motivations (i.e., feeling hope), demonstrating that these two factors helped explain differences between risk-averse and risk-seeking individuals.

[2] The emotion-imbued choice model (Lerner et al., 2015) proposes that emotions felt at the moment of decision making are a function of the characteristics of the decision options, the characteristics of the decision maker, and incidental influences (e.g., general mood). These immediately experienced emotions influence the decision maker's conscious and unconscious evaluation of the situation and affect judgment and choices.

[3] To further illustrate, consider another recent model applied to decision making under risk and uncertainty that emphasizes the fundamental role of anticipatory affective reactions—i.e., The Fuzzy Trace Theory (Reyna, 2008; Rivers et al., 2008). This model differentiates between precise verbatim representations of the information (e.g., recollection of facts in a risk communication) and more intuitive (fuzzy) gist representations that incorporate emotional reactions including valence, arousal, feeling states, and discrete emotions. Notably, Fuzzy Trace Theory suggest that these affective reactions can determine whether gist or verbatim representations are further processed, which in turn shapes the extent to which decision makers may be vulnerable to biases and information neglect.

reliable, and efficient assessment of anticipatory affective reactions to risk.

1.2 | Developing the Berlin Emotional Responses to Risk Instrument

As noted, we can find no other published instrument in the literature that has been specifically validated for the assessment of *general anticipatory positive and negative affective reactions to decision-relevant information about costs, benefits, and risks*. Perhaps the most influential related instrument is the Positive and Negative Affect Schedule (PANAS) (Thompson, 2007; Watson et al., 1988). The PANAS is relatively brief (5–10 min) and has been successfully adapted for a very wide range of applications in psychology and beyond. Another popular instrument is the self-assessment manikin (SAM), which is a nonverbal pictorial assessment that measures the estimated pleasure, arousal, and dominance associated with a person's subjective affective reaction (Bradley & Lang, 1994). While both instruments are highly useful and influential, neither of these specifically focuses on the decision-relevant emotions or sources of anticipatory affect that have been the focus of major theories of decision making under risk (Loewenstein et al., 2001; Lopes, 1987). In other words, there are specific decision-relevant emotions (e.g., hope, fear, anxiety, and worry) that are thought to be essential elements linking anticipatory affective reactions with risky choices and that could form the basis of an instrument specifically designed to measure affect in the context of risky decision making and risk communication. For instance, risk researchers often do not use the PANAS or the SAM to assess affect but instead collect data using specific individual emotion items (alone or combined in a short scale) when investigating relations between affect and risky decision making.

Given the current gap among available affect-related measurement instruments, rather than develop an extensive and complex assessment, we reasoned that a more efficient next step would be to develop a brief, robust, and easy-to-use research instrument following the tradition of other risk-oriented instruments, such as the Berlin Numeracy Test (Cokely et al., 2012). Accordingly, we conducted a series of seven studies testing, refining, and documenting essential aspects of psychometric performance (American Educational Research Association, 2018; Messick, 1995) and applicability across diverse participants, multiple languages, and a wide range of decision contexts (e.g., health, emerging pandemics, financial, social, and environmental).

2 | EMPIRICAL STUDIES

Following trends in modern risk literacy and risk communication research, a primary objective of our initial set of studies was to distill a brief instrument from a broader initial pool of relevant items. This initial pool was composed of 14 items that were selected from previous risk communication studies investigating the effectiveness of diverse communication tools and strategies (e.g., message framing, visual aids) (Garcia-Retamero & Cokely, 2011, 2012, 2014; Rothman et al., 1999). This initial pool was also selected to because it contained specific emotion items (e.g., hopeful, afraid, and worried) that we identified as often used in the literature as stand-alone items or combined in short scales.

We first tested the underlying structure, internal consistency, and predictive validity of this initial item pool, which included seven positive and seven negative items. Based on results and theory, we then reduced the long item pool to a shorter, more efficient set of six items (three positive and three negative, namely, the *Berlin Emotional Responses to Risk Instrument*—i.e., *BERRI*). For this initial evaluation, we reasoned it was important to choose a task that was generally representative of the type of tasks in which the new instrument could be applied (e.g., cases when participants receive risk communication materials that contain information about a risk that is relevant to them, such as cancer). As an initial test of predictive validity, we then investigated the extent to which BERRI responses predicted relevant criteria such as cancer screening perceptions and behavioral intentions among distinct and diverse adult groups (i.e., men and women).

2.1 | Study 1

Study 1 was based on a secondary analysis of an experimental risk communication study about prostate cancer screening conducted in 256 men residing in the United States, between 18 and 70 years of age ($M = 36$, $SD = 13$) (more detailed sociodemographic characteristics are available in Appendix A). The full study details and results unrelated to the evaluation of the BERRI are available elsewhere (Petrova et al., 2015).

In this study, participants received information about the benefits and harms of prostate cancer screening adapted from the Website of the US Centers for Disease Control and Prevention. Prostate cancer is the second most common cancer in men and is one of the leading causes of death in the United States (Centers for Disease Control and Prevention (CDC), 2021). Thus, it represents an important threat to health and information about its early detection is likely to be emotion-evoking, making this context suitable for the evaluation of the BERRI.

The information presented showed that screening did not reduce mortality from prostate cancer (i.e., it provided little benefit) but could cause substantial harms such as overdiagnosis and unnecessary treatment (Esserman et al., 2013). On scales from 1 (not at all) to 7 (extremely), participants responded to the initial pool of items by indicating how *assured, calm, cheerful, happy, hopeful, relaxed, relieved, anxious, afraid, discouraged, disturbed, sad, troubled*, and *worried* they felt after reading the information. The order of the adjectives was randomized. In addition, participants

TABLE 1 Study 1: Component loadings from a principal component analysis (PCA) on the initial pool of 14 items with Promax rotation with Kaiser normalization

	Component	
	1	2
Assured	0.04	**0.81**
Calm	−0.18	**0.66**
Cheerful	0.04	**0.84**
Happy	−0.07	**0.85**
Hopeful	0.10	**0.81**
Relaxed	−0.21	**0.74**
Relieved	0.23	**0.80**
Anxious	**0.84**	0.08
Afraid	**0.88**	0.06
Discouraged	**0.79**	−0.10
Disturbed	**0.82**	−0.05
Sad	**0.79**	0.03
Troubled	**0.88**	−0.08
Worried	**0.81**	0.07

Bold values indicate the higher component loading of each item for each of the two factors.

were asked to rate their perceived risk of cancer (two items, Cronbach's $\alpha = 0.79$), the perceived benefit from screening (three items, Cronbach's $\alpha = 0.95$), their intention to participate in screening (one item), and their intention to look for more information about screening (one item) using seven-point Likert scales, where a higher score indicated higher perceived risk, benefit, and intentions, respectively. These were our criterion items.

To summarize the observed data and reduce the number of items from the initial pool, we conducted principal components analysis (PCA) using Promax rotation, allowing for a correlation between the generated components. The Kaiser-Meyer-Olkin (KMO) and Bartlett's test were used to evaluate the adequacy of the data. Internal consistency was evaluated using the Cronbach's α coefficient. Our *a priori* criterion regarding the predictive validity of the BERRI in comparison to the initial pool of items was that correlations with relevant criteria should not be reduced by more than 0.10.

2.1.1. Results

The KMO (0.90) and the Bartlett's test of sphericity, $\chi^2(91) = 2198$, $p < 0.001$, indicated that the data were adequate for a PCA. The PCA resulted in two components, explaining 67% of the variance, with eigenvalues of 5.6 and 3.8, respectively. The correlation between the two components was $r = -0.19$. Table 1 shows the component loadings, which clearly indicated the first component to be negative and the second positive emotional reactions.

All items had high factor loadings, so in order to reduce the number of items we used a mixture of theoretical and practical criteria. We selected items that were applicable to theories of the role of general affective reactions in risky decision making (e.g., hopeful, afraid, and anxious) (Loewenstein et al., 2001; Lopes, 1987),[4] that were frequently used by researchers in risk communication studies identified in our review of the literature (e.g., afraid, worried, anxious, and hopeful)[5]; and that were likely to be directly produced in response to risk and benefit information (e.g., assured, relieved, and worried), as opposed to affective states that could be more general (e.g., sad, cheerful, and calm). We considered this last criterion because such affective reactions may be especially influential and diagnostic when assessing the effects of risk communications.[6] The final selection of items is shown in Figure 1.

To create the scale scores, we averaged the scores across the negative adjectives as a measure of negative affect (BERRI-neg) and across the positive adjectives as a measure of positive affect (BERRI-pos). The Cronbach's α values and correlations with the criterion variables based on the initial item pool and the BERRI are shown in Table 2. The BERRI positive and negative components showed excellent internal consistency and were not correlated with each other (Table 2).

Generally, the correlations (or lack thereof) among the initial item pool version with the criteria were maintained when using the shorter BERRI, and the two components also correlated with key criteria. Specifically, the negative component correlated with perceived risk and the intention to look for more information (i.e., participants who felt stronger negative emotions perceived more risk from cancer and wanted more information), whereas the positive component correlated with perceived benefit and intentions to undergo screening (i.e., participants who felt stronger positive emotions perceived more benefit and wanted to undergo screening).

In summary, this initial evaluation showed that: (1) the BERRI responses were well-characterized by two underlying components based on affective valence (positive and negative); (2) the BERRI responses meet accepted thresholds for internal consistency; and (3) the BERRI provided considerable predictive validity over a set of relevant criteria including perceptions and behavioral intentions. Next, we tested the extent to which these properties generalized to another sample of diverse adults.

[4] According to the risk-as-feelings hypothesis (Loewenstein et al., 2001), responses to risky situations result in part from direct emotional influences, including feelings such as worry, fear, or anxiety. Another seminal work on the affective psychology of risk was that of Lopes (1987), who used security motivation (i.e., to mitigate fear) versus potential motivation (i.e., feeling hope) to explain differences between risk-averse and risk-seeking individuals (see also Petrova et al., 2014).

[5] To give a few examples of studies that used these items in different contexts: Allen Catellier and Yang, 2012; Oh et al., 2021; Petrova et al., 2014; Timmermans et al., 2008; van Gelder et al., 2009. For instance, Allen Catellier and Yang (2012) used the three selected negative affect items (anxious, afraid, and worried) combined into a scale to measure negative affect. Overall, feelings of anxiety and worry have been frequently assessed in the risk perception literature (Siegrist & Arvai, 2020).

[6] To illustrate, when one receives information about possible risk mitigation or risk increase, feeling assured, relieved, or worried may directly result from the information received and may be more relevant for subsequent decisions than feeling sad or cheerful, which are more general affective states.

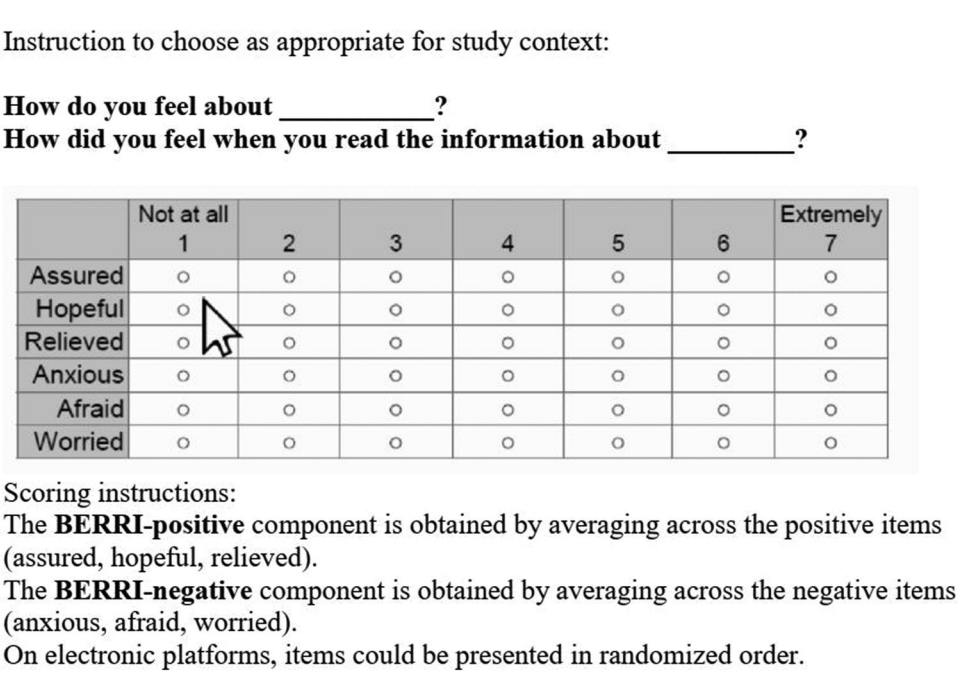

FIGURE 1 The Berlin Emotional Responses to Risk Instrument (BERRI): Administration and scoring instructions

TABLE 2 Study 1: Pearson correlations between the initial items pool, the BERRI, and the criteria

	(1) Negative IP	(2) Positive IP	(3) BERRI-neg	(4) BERRI-pos	Perceived risk	Perceived benefit	Intention to participate	Intention to look for more information
Cronbach's α	0.92	0.89	0.85	0.81	0.79	0.95	–	–
(1)		−0.21*	0.93*	−0.06	0.21*	−0.13*	−0.11	0.22*
(2)			−0.13*	0.89*	−0.03	0.25*	0.18*	−0.03
(3)				0.02	0.26*	−0.05	−0.07	0.21*
(4)					0.05	0.31*	0.22*	0.04

Note: IP, initial pool of items.
*$p \leq 0.05$.

2.2 | Study 2

The objective of Study 2 was to provide an out-of-sample cross-validation test of the underlying structure of the BERRI via confirmatory factor analysis (CFA), and to test its internal consistency and predictive validity against the initial pool of items in a new sample of diverse participants. This study was a secondary analysis of an experimental risk communication study about breast cancer screening conducted in 355 women residing in the United States, between 18 and 85 years of age ($M = 38$, $SD = 14$) (see also Appendix A). The full study details and results unrelated to the BERRI are available elsewhere (Petrova et al., 2015).

This study was analogous to Study 1: Participants received information about the benefits and harms of breast cancer screening adapted from the website of the US Centers for Disease Control and Prevention. Breast cancer is the second most common cancer in women and one of the leading causes of death in the United States (CDC, 2021) and previous studies have shown that affective reactions are important drivers of screening behavior (Consedine et al., 2004). The information presented showed that screening achieved a modest reduction in mortality from breast cancer (moderate benefit) but could also cause substantial harms such as overdiagnosis and unnecessary treatment (Esserman et al., 2013). Participants answered the same questions as in Study 1, only pertaining to breast cancer.

2.2.1 | Results

We compared four CFA models: with one versus two latent factors for both the initial item pool and the six BERRI items selected in Study 1. The CFA analysis showed that the two-factor model for the BERRI scale had the best fit (see Table S1 for detailed results). Moreover, in the case of the

TABLE 3 Study 2: Pearson correlations between the initial items pool, the BERRI, and the criterion variables

	(1) Negative IP	(2) Positive IP	(3) BERRI-neg	(4) BERRI-pos	Perceived risk	Perceived benefit	Intention to participate	Intention to look for more information
Cronbach's α	0.93	0.88	0.88	0.82	0.82	0.93	–	–
(1)		−0.25*	0.93*	−0.07	0.28*	−0.02	0.08	0.19*
(2)			−0.23*	0.88*	−0.11*	0.19*	0.08	0.05
(3)				−0.03	0.34*	0.09	0.14*	0.24*
(4)					0.00	0.23*	0.13*	0.12*

Note: IP, initial pool of items.
*$p \leq 0.05$.

two-factor structure all factor loadings were above 0.7 (BERRI-neg: $\lambda_{anxious} = 0.81$; $\lambda_{afraid} = 0.86$; $\lambda_{worried} = 0.89$; BERRI-pos: $\lambda_{assured} = 0.77$; $\lambda_{hopeful} = 0.84$; $\lambda_{relieved} = 0.73$).

Table 3 shows the correlations between the initial item pool, the BERRI, and the criteria. Again, the patterns of correlations with the validity criteria were similar across the initial pool of items and the BERRI, with the BERRI even detecting (stronger) correlations with intentions that were not detected with the initial version. Similar to Study 1, there was no significant correlation between the BERRI-pos and the BERRI-neg components (Table 3). Again, participants who reported stronger negative emotions perceived more risk from cancer, whereas participants who reported stronger positive emotions perceived more benefit from screening. Consistent with the nature of the information provided (both benefits and harms from screening were possible), both positive and negative emotions were related to intentions.

Overall, the results from Study 2 converge with those from Study 1 suggesting that the BERRI may generally exhibit satisfactory psychometric properties and robust predictive validity in some relevant, high-stakes health contexts. Next, we tested the instrument's convergent and divergent validity, and psychometric sensitivity, by investigating paradigmatic risky prospect evaluation tasks from a range of contexts beyond and including the health domain.

2.3 | Study 3

There were four primary aims of Study 3, as follows: (1) to test the sensitivity of the BERRI to variations in two key parameters that determine risky decisions, namely, probability and outcome severity (Kahneman & Tversky, 1979, 1984); (2) to assess the usefulness and generalizability of the BERRI across diverse risk contexts outside the health domain; (3) to document convergent and divergent validity of the BERRI with other constructs (i.e., risk taking, personality, and statistical numeracy); and (4) to provide an additional test of predictive validity against commonly used paradigmatic criteria (i.e., willingness to engage in a risky behavior and willingness to pay to avoid the risk).

Study 3 was designed with the sole purpose to evaluate the BERRI. The participants were 515 adults (257 males, 257 females, 1 other), residing in the United States, between 18 and 79 years of age ($M = 36$, $SD = 13$), recruited via a paid web-panel service (see also Appendix A).

2.3.1 | Design

This study employed a 3 × 3 × 6 mixed design. Outcome severity (with three levels: mild, moderate, and high) and probability (with three levels: low, medium, and high) were within-subject factors. Risk context (with six levels: technological, health, social, financial, ethical, and environmental) was a between-subjects factor.

Six risk scenarios were developed and pretested in a pilot study described in Appendix B. Each scenario pertained to one of six risk type categories: technological, health, social, financial, ethical, and environmental, and included a brief description of a risk-relevant situation and its possible future outcome. Participants were presented with the possibility of a gain (e.g., make a financial investment with high return), which was associated with a risk for a negative outcome. The potential negative outcome presented (e.g., stock values declining in value over time) varied in terms of severity (i.e., mild, moderate, or high) and probability of occurrence (i.e., low: 5%, medium: 50%, and high: 95%), leading to a total of 54 different risk scenarios. Participants were randomly assigned to one of the six risk contexts and then received nine scenarios with varying severity and probability (see Appendix C).

2.3.2 | Measures

After each scenario, the BERRI and the following criterion items were administered:

Willingness to take the risk (WTT)
Participants were asked how willing they would be to engage in the risky behavior in question (e.g., make the financial investment) on a scale from 1 (Not at all willing) to 7 (Extremely willing).

Willingness to pay to reduce one's risk (WTP)
Participants were given a brief description of an alternative option to a given risky behavior (e.g., getting a broker's advice about better options) and asked how much they would be willing to pay for this alternative by indicating an amount in US dollars.

To establish convergent and divergent validity, after the scenarios the following scales were administered:

Domain-specific risk-taking scale (DOSPERT)
This 30-item scale measures general risk-taking propensity in five different domains: ethical, financial, health/safety, recreational, and social (Blais & Weber, 2006). Participants were instructed to rate the likelihood that they would engage in domain-specific risky activities on a seven-point rating scale from 1 (Extremely unlikely) to 7 (Extremely likely). Overall and domain-specific risk-taking scores were calculated per the scale's instructions. Because emotions are important drivers of risk perception, evaluation, and risk-taking behavior (Cokely et al., 2018; Kusev et al., 2017; Slovic et al., 2004; Slovic & Peters, 2006), we expected that responses on the BERRI would be correlated with the DOSPERT.

Ten-item personality inventory (TIPI)
This brief 10-item measure of the Big Five personality dimensions was used to assess extraversion, agreeableness, conscientiousness, emotional stability, and openness to experience (Gosling et al., 2003). Participants indicated the extent to which they agreed or disagreed with the statement, "I see myself as," followed by a pair of traits (e.g., anxious/easily upset, calm/emotionally stable) on a seven-point rating scale from 1 (Disagree strongly) to 7 (Agree strongly). Scores on each of the five dimensions were calculated by averaging the participant's ratings on the corresponding items for each dimension.

We had no specific expectations about relationships between these general personality traits and participants' emotional responses to specific risk scenarios.

Statistical numeracy and risk literacy
The Berlin numeracy + Schwarz test (BNT-S) was administered, which is a test of practical probabilistic math skills that measures people's general ability to independently evaluate and understand risk (i.e., risk literacy) based on three items developed by Schwartz et al. (1997) and four items from the Berlin Numeracy Test (Cokely et al., 2012, 2014). Following Cokely et al. (2014), we used the sum of the participants' scores on both tests as our estimate of participants' statistical numeracy. Previous research has shown that statistical numeracy is one of the strongest predictors of general decision-making skill and risk literacy (Cokely et al., 2012, 2018), wherein people with higher statistical numeracy tend to show affective responses that are more sensitive and normatively calibrated to variations in probability and outcome severity (Petrova et al., 2014, 2019). We thus expected the BERRI to reflect this heightened sensitivity.

2.3.3 | Analysis

We first conducted a CFA similar to the one in Study 2, using the items averaged across the nine severity*probability scenarios for each participant. We then conducted repeated measures ANOVA with outcome severity and probability as within-subject factors and context as a between-subjects factor. This analysis was conducted on the BERRI-pos and BERRI-neg component scores. Finally, we calculated Pearson correlations between BERRI scores and WTT, WTP (log-transformed due to skewness), the DOSPERT scale domains, personality scores, and numeracy.

2.3.4 | Results

Factor structure and internal consistency
The CFA showed an excellent fit for the two-factor model (see Table S1). The internal consistency of both components was excellent, with Cronbach's α's ranging from 0.91 to 0.94 for BERRI-pos and 0.86 to 0.93 within each severity-probability variation (see Table S2).

Sensitivity of the BERRI
Both BERRI-pos and BERRI-neg were highly sensitive to variations in outcome severity and probability (see Figures 2, S1, and S2, and Table S3). About 20% of the variance in BERRI scores was explained by outcome severity (partial η^2 of 0.18 and 0.20 for BERRI-neg and BERRI-pos, respectively) and about 40% by probability (partial η^2 of 0.36 and 0.43 for BERRI-neg and BERRI-pos, respectively). There was some expected variability between contexts (see Figures S1 and S2). In particular, there were significant interactions of outcome severity and probability with scenario context (all p's < 0.05[7]). However, the explained variance was modest in comparison, with partial η^2 between 0.02 and 0.03.

Predictive validity
Scores on the BERRI were significantly related to how willing participants were to avoid the risks described in the different scenarios (WTT) and how much they were willing to pay to avoid those risks (WTP). In this study, the BERRI-neg component showed weak correlations, whereas the BERRI-pos component was a strong positive predictor of these criterion variables (Pearson r's > 0.70, Table S4). Overall, participants who reported stronger positive affect were more willing to take the risk and would pay more to reduce it.

Convergent/divergent validity
For the subsequent analyses, we used the total means for the BERRI scores (averaged for each participant across the nine severity*probability scenarios). The BERRI-pos and BERRI-

[7] On BERRI-neg: interaction of scenario context with severity $p = 0.047$ and with probability $p = 0.004$. On BERRI-pos: interaction of scenario context with severity $p < 0.0001$ and with probability $p = 0.001$.

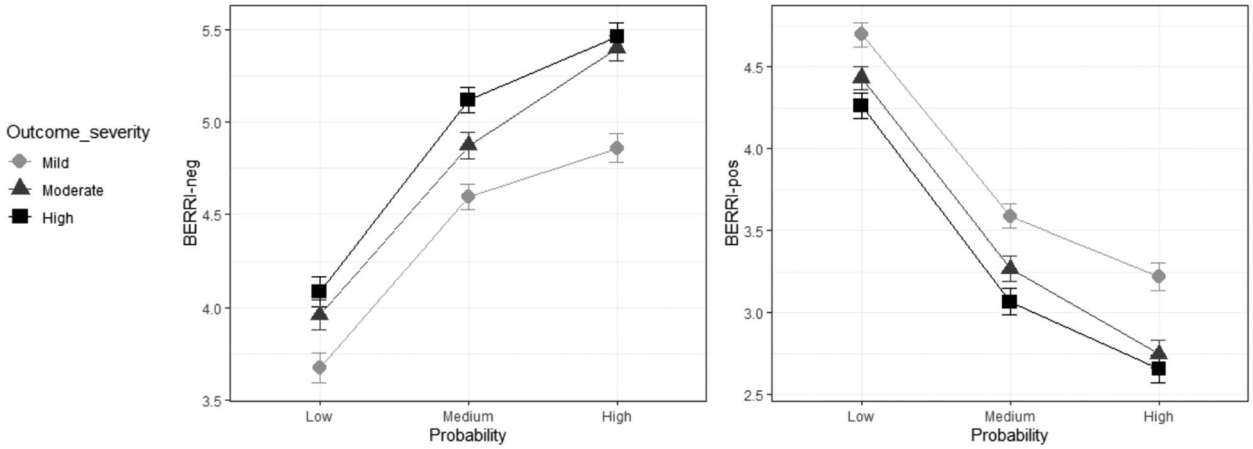

FIGURE 2 Study 3: Mean BERRI scores (BERRI-neg, and BERRI-pos) according to outcome severity and probability averaged across all scenarios

Note: Error bars are ±1 within-subject standard error of the mean.

TABLE 4 Study 3: Pearson correlations between BERRI scores and the DOSPERT scale overall and for the scenarios where the context matches one of the DOSPERT scale's subdomains

			DOSPERT domain				
Study scenario context	**Score**	**DOSPERT**	**Ethical**	**Financial**	**Health/safety**	**Recreational**	**Social**
Overall $N = 515$	BERRI-neg	0.19*	0.15*	0.16*	0.14*	0.15*	0.21*
	BERRI-pos	0.65*	0.66*	0.62*	0.60*	0.57*	0.18*
Ethical $N = 93$	BERRI-neg		0−.20				
	BERRI-pos		0.76*				
Financial $N = 88$	BERRI-neg			0.21*			
	BERRI-pos			0.63*			
Health $N = 85$	BERRI-neg				0.07		
	BERRI-pos				0.56*		
Social $N = 87$	BERRI-neg						0.21
	BERRI-pos						0.40*

*$p < 0.05$.

neg were again uncorrelated ($r = 0.02$, $p = 0.593$). We also calculated the variance of the BERRI scores across the nine severity*probability scenarios, as a measure of participants' emotional responsiveness to the manipulation of severity and probability (i.e., more responsiveness, higher variance of BERRI responses).

DOSPERT. The BERRI-pos component was more strongly related to risk-taking propensity than BERRI-neg in all domains (see Table 4), with the exception of the social domain. The pattern of correlations was similar when we considered only BERRI responses to the scenarios that have a matching DOSPERT domain. In addition, participants who scored higher on the DOSPERT also showed lower variance in both positive ($r = –0.46$, $p < 0.001$) and negative ($r = –0.39$, $p < 0.001$) affective reactions. A closer examination of the data showed that participants who were frequent risk takers (high DOSPERT scores) consistently reported higher positive emotions regardless of the probability or outcome severity. In contrast, those who were not risk takers (low DOSPERT scores) reported negative emotions that varied much more strongly according with the probability and outcome severity. Overall, frequent risk takers were characterized by a pattern of high positive affect coupled with lower emotional responsiveness to key characteristics of the decision situation (see Table S5).

TIPI. Only the BERRI-pos component was significantly related to the Big Five. Notably more extraverted participants reported stronger positive emotions on the BERRI, whereas more conscientious participants reported weaker positive emotions (Table S6).

Statistical numeracy. Higher numeracy was consistently associated with higher variance in BERRI responses (BERRI-neg $r = 0.30$ and BERRI-pos $r = 0.31$, both $p < 0.001$). A closer examination of the data showed that participants with lower numeracy reported generally higher positive and negative emotions regardless of probability or outcome

severity. In contrast, participants with higher numeracy reported emotional reactions more in line with the probability and severity of the outcomes presented (e.g., low positive emotions when the probability and outcome severity were high, but high positive emotions when the probability and outcome severity were low). Overall, participants with high numeracy displayed a pattern of responses consistent with higher emotional responsiveness and normative calibration across key characteristics of the decision situation (Table S7).

Take altogether, Study 3 demonstrated sensitivity and predictive validity of the BERRI across many different risk contexts and showed evidence for convergent and divergent validity as compared to other related constructs. Results suggest that the BERRI may generally be a robust predictor of diverse paradigmatic criteria frequently used in decision-making studies (e.g., correlations generally in the range $r = 0.30–0.70$) and is highly sensitive to variations in key properties of the decision environment such as the severity of decision outcomes and the probability of their occurrence (i.e., detecting partial η^2 effect sizes between 0.20 and 0.40). Finally, the BERRI also tracked how subjective emotional responses corresponded with individual differences in risk-taking propensities and statistical numeracy skills across varied decision situations. Accordingly, we next sought to replicate and extend these findings by testing the sensitivity of the BERRI to the causal influence of subtle affect-related manipulations in how relevant risk information is presented in the context of actual emerging high-stakes pandemic risks.

2.4 | Study 4

Between 2014 and 2016, there was a devastating outbreak of the Ebola Virus Disease in West Africa-the largest Ebola epidemic in history (Bell, 2016). The infection did not spread more widely around the world in part because Ebola is relatively hard to contract. While Ebola infection carries a high risk of death (i.e., about 50%), it is only spread through direct contact with infected bodily fluids (i.e., it is not spread by food, air, or water) (Bell, 2016). Despite Ebola posing little danger to US citizens at that time, extensive media coverage and speculation centered on dread risk fears about an Ebola epidemic in the United States (i.e., strong fears that result from low probability, high consequence events) (Basch et al., 2014; Gigerenzer, 2004).

Study 4 was a secondary analysis of a risk communication experiment conducted in October 2014, 3 weeks after the first case of Ebola was confirmed in the United States, the full details of which are reported elsewhere (Petrova, 2016). The goals of this study were to test to what extent the BERRI was sensitive to subtle affect-related manipulations in how emerging risks are presented and to what extent it was related to important criterion variables such as behavioral intentions and policy endorsement in the context of emerging pandemics.

Participants were 505 adults (171 males, 337 females) between 18 and 79 years of age ($M = 38$, $SD = 13$), residing in the United States, recruited for participation via a paid web-panel service (see also Appendix A). They received basic information about the Ebola virus, including its transmission, the risk of getting infected and the risk of dying once infected as reported by the World Health Organization (WHO) at the time.

2.4.1 | Design

Two subtle affect-related between-subject experimental manipulations were employed including how the disease and the probability of contracting it were labeled. All participants received the same information about the Ebola virus. However, half of the participants received the information about the disease with its popular and dreaded name "Ebola hemorrhagic fever," while the other half received information about "viral hemorrhagic fever." In addition, when referring to the probability of infection or dying, half of the participants saw the word "risk" while the other half saw the more neutral, less emotionally-laden word "likelihood." Hence, the experiment employed a 2 (outcome label: Ebola hemorrhagic fever, Viral hemorrhagic fever) by 2 design (probability label: risk, likelihood). We tested whether the more negatively emotionally-laden labels (i.e., "Ebola" and "risk") resulted in stronger negative and weaker positive emotional reactions on the BERRI.

2.4.2 | Measures

Dependent measures included the BERRI and the following criterion items:

Perceived danger. Participants indicated the extent to which they believed the virus was (1) deadly and (2) dangerous on scales from 1 (not at all) to 7 (extremely) (Cronbach's $\alpha = 0.73$).

Behavioral intentions. These were assessed with 19 items on scales from 1 (no change) to 5 (extremely likely to avoid) (Cronbach's $\alpha = 0.94$). Participants indicated how likely they were to avoid any of 13 behaviors (e.g., going to work, using public transportation, sending their children to school, going to their annual doctor's appointment, playing team sports, dancing with strangers, dining out, etc.). In addition, on scales ranging from 1 (strongly disagree) to 7 (strongly agree) participants indicated their agreement with actions aiming at prevention or protection from the virus (three items, e.g., the government should introduce stricter border control to keep Ebola/the viral fever from spreading.). We also measured general intentions to adopt risk-reducing behavior (three items, e.g., I intend to take action to protect myself from Ebola/the viral fever). Larger scores indicated behavioral intentions that were more avoidance-oriented and on average would be more likely to be associated with counterproductive personal, social, economic, and health outcomes, in line with the CDC's decision at the time not to take any special measures against Ebola transmission in the United States.

TABLE 5 Study 4: Pearson correlations between BERRI scores and criterion variables

	Cronbach's α	Perceived danger	Behavioral intentions	Policy endorsement
BERRI-neg	0.92	0.37*	0.56*	0.40*
BERRI-pos	0.76	−0.20*	−0.19*	−0.12*

* $p < 0.05$.

Policy recommendations. These were measured with four scenarios presenting different public policy options (Cronbach's $\alpha = 0.89$). Participants were asked to imagine that the US government or the World Health Organization (WHO) was considering redirecting funds currently used to combat other diseases toward Ebola/the viral fever prevention and treatment, including: (1) funds for cardiovascular disease prevention, (2) funds for development of HIV/AIDS vaccine, (3) funds for covering the treatment of 10,000 individuals infected with malaria, and (4) funds for covering the treatment of 10,000 individuals infected with tuberculosis. All four cases assessed the degree to which one recommended that policies be changed in favor of prevention or treatment of individuals with Ebola/the viral fever. Participants indicated their support for these policies on scales from 1 (strongly against) to 7 (strongly in favor). A larger score indicated stronger endorsement of these policies. We chose these diseases because the risk of dying from each disease was much higher than the risk of dying from Ebola in the United States at that time. We also chose the number of affected individuals to be larger than the number of registered Ebola cases in the world at that time. Given the assumption that on average better policies should protect and save more lives, we assumed that better recommendation decisions were those that did not redirect funds to combat Ebola/the viral fever.

2.4.3 | Analysis

We conducted a CFA on the BERRI items following the methods of our previous studies. We then calculated Pearson correlations with the criteria and tested the effect of the manipulations on the BERRI components using independent samples *t*-tests.

2.4.4 | Results

Factor structure and internal consistency
The CFA showed again excellent fit of the two-factor model (Table S1) and the two component scores had good internal consistency (Table 5). In this study BERRI-neg and BERRI-pos were negatively correlated ($r = –0.31$, $p < 0.001$).

Predictive validity
There were significant, medium-sized correlations between the BERRI and the criteria, with the BERRI-neg component showing higher predictive validity in this context (Table 5). Participants who reported stronger negative and weaker positive emotions after reading the information about Ebola reported more perceived danger, were more willing to engage in likely unnecessary avoidance behaviors at the time (e.g., canceling medical visits, keeping children home from school), and supported policy proposals likely to cost lives (e.g., redirecting funds from cardiovascular care to Ebola treatment in the United Statea).

Sensitivity to affective manipulations
Labeling the disease as "Ebola" versus "viral fever" did not influence BERRI-pos scores ($p = 0.824$). It did however influence BERRI-neg, such that participants in the Ebola condition reported stronger negative emotions ($M = 3.82$, $SD = 1.77$ vs. $M = 3.40$, $SD = 1.82$, $t(506) = 2.60$, $p = 0.009$, Cohen's $d = 0.24$). Labeling the probability as "risk" versus "likelihood" had no significant effects ($p = 0.557$ for BERRI-neg and $p = 0.115$ for BERRI-pos).

Overall, this study provided a first demonstration that the BERRI, albeit only its negative component, can detect changes in affect resulting from a subtle negative affective manipulation (i.e., using the name of a dreaded disease). It also showed that the scale was significantly related to more risk literate behavioral responses in the context of the emerging pandemic (correlations between $r = 0.40$ and 0.50 for BERRI-neg). In the next study, our goal was to test the sensitivity of the BERRI to a positive affective manipulation and to validate it for applications in another language and culture.

2.5 | Study 5

Study 5 was also conducted in the context of an emerging pandemic, this time in a European context. However, in the current study, the pandemic posed a very direct and substantial risk to the participants in the study, as evidenced by the multiple and often extreme measures taken by European governments at the time.

In particular, the new coronavirus disease (COVID-19), that started at the end of 2019, began to spread around the globe (Wang et al., 2020). On March 11, 2020, the WHO declared it as a global pandemic. This new emerging risk affected the everyday life of Europeans dramatically. With little warning, people were required to change their lives and social habits, and adopt various preventive measures such as keeping social distance or frequently washing hands thoroughly.

Study 5 was a secondary analysis of an experimental risk communication study conducted in March 2020, 3 weeks after the first case of severe acute respiratory syndrome

TABLE 6 Studies 5 and 6: Polish and Spanish versions of the BERRI

	Instructions to adapt as appropriate for study context	Items	Answer scales
Polish	Jak czułeś/aś się myśląc o_____? Jak się czułeś/aś czytając informację o _____?	bezpieczny/a będący/a dobrejmyśli odczuwający/a ulgęzaniepokojony/a wystraszony/a zmartwiony/a	Wcale Bardzo
Spanish	¿Cómo te sientes sobre _____? ¿Cómo te has sentido cuando has leído la información sobre _____?	Seguro/a Esperanzado/a Aliviado/a Ansioso/a Asustado/a Preocupado/a	Nada en absoluto Extremadamente

coronavirus 2 (SARS-CoV-2) infection was confirmed in Poland. The full study details and results unrelated to the evaluation of the BERRI are available elsewhere (Sobkow et al., 2020).

The aim of this study was to validate the instrument in Polish and test the generalizability of its factor structure, internal consistency, predictive validity, and sensitivity to a positive affect-related experimental manipulation. Participants were 253 university students from the SWPS University of Social Sciences and Humanities in Poland (M_{age} = 29, SD_{age} = 9, 221 females) who completed an online questionnaire (see also Appendix A).

2.5.1 | Design

Participants were randomly assigned to one of five experimental conditions. However, only one included an affect-related manipulation and was hence considered relevant for the evaluation of the BERRI, together with the control condition for comparison (no manipulation of any kind). The affect-related manipulation was based on mental imagery: Participants were asked to imagine positive consequences of the COVID-19 pandemic situation.

2.5.2 | Measures

BERRI. The scale was translated into Polish (and then back-translated into English to check for consistency) by three native speakers (see Table 6). Participants responded using a nine-point scale from 1 (not at all) to 9 (extremely).

The following criterion items were measured:

Risk perception of COVID-19. Participants answered five questions related to the perception of personal risk associated with the COVID-19 outbreak (e.g., "How do you estimate the chances that the virus will negatively influence you or your family's health?") using five-point scales (Cronbach's $\alpha = 0.81$).

Sources of worry about the COVID-19 pandemic. Participants were asked to indicate to what extent they were worried about various issues related to the COVID-19 pandemic: health (e.g., "being hospitalized," Cronbach's $\alpha = 0.89$), restrictions (e.g., "being unable to travel," Cronbach's $\alpha = 0.76$) and finance (e.g., "being unable to work," Cronbach's $\alpha = 0.72$) using a seven-point scale (1—not at all, 7—very much).

TABLE 7 Study 5: Pearson correlations between BERRI scores and criterion variables

Variable	BERRI-pos	BERRI-neg
Worry health	−0.44*	0.60*
Worry restrictions	−0.11	0.17*
Worry finance	−0.19*	0.19*
Risk perception	−0.45*	0.60*
Behavioral intentions	−0.22*	0.30*

*$p < 0.05$.

Intentions toward COVID-19 preventive behaviors. Participants were asked to indicate to what extent they would be willing to take various preventive measures such as "avoid going to bars or restaurants," or "frequently wash hands thoroughly (with soap for at least 30 s)," using a seven-point scale (1—not at all willing to do it, 7—very willing to do it) (Cronbach's $\alpha = 0.91$).

2.5.3 | Results

Factor structure and internal consistency

The CFA results showed that the two-factor solution had excellent fit to the data and was better than the one-factor solution (see Table S1). In case of the two-factor structure, all of the factor loadings were above 0.4 (BERRI-neg: $\lambda_{anxious} = 0.90$; $\lambda_{afraid} = 0.85$; $\lambda_{worried} = 0.84$; BERRI-pos: $\lambda_{assured} = 0.87$; $\lambda_{hopeful} = 0.62$; $\lambda_{relieved} = 0.48$). BERRI-neg had higher internal consistency (Cronbach's $\alpha = 0.90$) than BERRI-pos (Cronbach's $\alpha = 0.68$). Moreover, similar to Study 4, the two subscales were strongly negatively correlated $r = -0.50$, $p < 0.001$.

Predictive validity

The BERRI was correlated with all criteria (see Table 7). People who reported more positive and fewer negative emotional reactions perceived the risk related to COVID-19 as lower, experienced lower worry (about their health, restrictions, and

finance), and also reported that they were less likely to adopt COVID-19 preventive behaviors (e.g., behavioral intentions).

Susceptibility to the mental imagery manipulation

We found that the positive mental imagery manipulation affected only the positive BERRI component, $t(100) = -2.14$; $p = 0.034$; Cohen's $d = -0.43$. Participants who imagined positive consequences of COVID-19 experienced more positive emotions, $M = 3.91$, $SD = 1.46$, $n = 49$, than those in the control condition $M = 3.28$, $SD = 1.50$, $n = 53$. There was no effect on BERRI-neg ($t(100) = 1.04$; $p = 0.301$).

To summarize, the Polish version of the BERRI has similar psychometric properties as its original English form. Moreover, it was significantly related to criterion variables in a pandemic context (correlations generally between $r = 0.20$ and 0.60) and the positive BERRI component was sensitive to a subtle positive affect manipulation based on mental imagery. In the next study, we aimed to validate a Spanish version of the BERRI.

2.6 | Study 6

Study 6 was specifically designed to validate the BERRI in Spanish (see Table 6) and to test the generalizability of its factor structure, internal consistency, and convergent and predictive validity. Participants were 102 psychology students from the University of Granada in Spain ($M_{age} = 22$, $SD_{age} = 3$, 81 females), who completed an online questionnaire. The detailed results of this study are reported in Appendix D. Overall, it demonstrated that the Spanish version of the BERRI had robust, comparable psychometric properties to the original English version. To come full circle with our psychometric investigation and assessment of the BERRI, our final investigation of the instrument aimed to establish the relative temporal stability of the BERRI responses over an extended period.

2.7 | Study 7

To examine the temporal stability of responses, in Study 7 we examined test–retest reliability in a sample of young adults who completed the BERRI twice (i.e., 2 weeks apart). In particular, 131 psychology students ($M_{age} = 27$, $SD_{age} = 8$, 106 females) from the SWPS University of Social Sciences and Humanities in Poland participated in the two stages of this online study.

In the first session (S1), participants were presented with the three scenarios from Study 6 (the health, financial, and social; moderate severity and medium probability versions) displayed in counterbalanced order. Each scenario was rated using the BERRI. The second session (S2) took place after a 2-week interval. In this session, participants were asked to complete exactly the same task as in S1.

2.7.1 | Results

The BERRI had very good internal consistency (α ranging from 0.69 to 0.89) at both test and retest. Correlations between the BERRI scores in the two sessions (indicating test–retest reliability) were moderate (r ranging from 0.40 to 0.59, see Table S8). This suggests that the BERRI may generally be relatively stable over time, although it is not necessarily or exceptionally stable, as should be expected from a measure that is sensitive to subtle affective manipulations and general affective states. Nevertheless, we did not find differences in mean BERRI scores across two sessions (all p's > 0.05), suggesting BERRI estimates can be temporally stable and reliable for some judgments.

3 | GENERAL DISCUSSION

In a series of seven studies we distilled, tested, and documented evidence of validity for a brief instrument specifically designed to estimate positive and negative anticipatory affective reactions, based on subjective responses to three positive emotions (i.e., assured, hopeful, and relieved) and three negative emotions (i.e., anxious, afraid, and worried). Overall, results revealed a pattern suggesting that the BERRI may generally provide a robust, reliable, and valid index of key aspects of anticipatory affect in the context of risky choice, decision making, and risk communication. Findings suggest the BERRI tends to exhibit a very consistent factor structure, generally meets thresholds for internal consistency[8] and longitudinal stability (i.e., stable test–retest reliability when tested weeks apart), and also satisfies a wide array of theoretically and practically relevant tests of predictive validity in studies involving diverse adults from three distinct cultures, presented in three different languages.

The subjective judgments measured by the instrument were distilled from a broader range of affective responses that have been the subject of many previous inquiries (e.g., content validity) as stand-alone items or in combination. For instance, we are aware of at least one previous study that combined the three negative items that form the BERRI negative component to measure negative affect in the context of risk information seeking (Allen Catellier & Yang, 2012). In contrast to existing validated instruments that measure affect more generally and have diverse and broad applications (e.g., PANAS, SAM), the BERRI was designed to be applicable specifically to diverse, naturalistic, and high-stakes risk communication contexts. As such, results suggest it may be well-suited to assess relevant affective responses in response to the communication of decision-relevant (numerical and/or verbal) information about risks and/or benefits of available decision options (e.g., treatment options, new emerging hazards, and proposed risk mitigation measures). Furthermore,

[8] It is worth noting that, generally, the internal consistency of the BERRI-pos component was slightly lower than the BERRI-neg component. Despite this difference, both components showed unique predictive power.

we found that the instrument was applicable to, and consistent with, widely used and highly influential theories of decision making under risk (e.g., Prospect Theory). In particular, the BERRI was found to be sensitive to changes in decision contexts, such as the severity of potential decision outcomes and the probability of their occurrence. The BERRI also tracked subtle affective shifts caused by manipulations in how the information was presented—effects that should be of particular interest to researchers who evaluate high-stakes risk communications (e.g., formats, frames, and decision aids). Results further revealed that the BERRI generally provided robust predictive validity across paradigmatic and naturalistic decision tasks and diverse outcome variables (e.g., moderate to strong correlations with risk and benefit perceptions; behavioral intentions; willingness to pay for products, and policy endorsements). Beyond the evidence presented here on the psychometric quality of the BERRI instrument, the current findings also suggest several noteworthy theoretical and practical implications, and some potential best practice guidelines.

3.1 | Negative affect, positive affect, and global affect intensity

There is a long-standing theoretical debate about whether positive and negative affect are generally independent or bipolar opposites of each other (Russell & Carroll, 1999). While there seems to be no consensus about the specific functional dynamics of positive versus negative affect in the context of risky choice (Kusev et al., 2017), there is considerable agreement that the influence of affect on risky decision making tends to be highly context-specific. As such, researchers have generally been encouraged to examine the unique predictive power of both positive and negative affect separately (Green & Salovey, 1999; Tellegen et al., 1999). Consistent with that convention, in the current studies we observed clear independence of positive and negative affect in nearly every decision context that was investigated. Notably, a negatively valenced manipulation in Study 4 causally affected only the negative BERRI component, whereas a positively valenced manipulation in Study 5 causally affected only the positive BERRI component. This finding suggests that dissociations of positive and negative affect as measured by the BERRI components may typically be uniquely, and causally, related to differences in specific decision task constraints (e.g., the type of information presented).

To the extent the current results generalize, our findings suggest that the BERRI's ability to independently assess both positive and negative affective responses offers many novel opportunities for investigations of the relations between affect and risk (e.g., how positive vs. negative affective reactions independently shape risk perceptions or risk acceptance or how they are differentially influenced by a focus on potential harms vs. gains). Because the BERRI assesses both positive and negative affective responses, there are opportunities for investigations to go beyond previous research on the affect heuristic that has emphasized the use of unstandardized unipolar measurement scales ranging from negative to positive (Siegrist & Arvai, 2020). Likewise, the BERRI may extend and complement the SAM, which also uses unipolar scales for measuring valence, arousal, and dominance (Bradley & Lang, 1994). The PANAS, in contrast, already provides separate assessments of positive and negative affect (Watson et al., 1988). However, it is longer than the BERRI, even in its short versions (Mackinnon et al., 1999; Thompson, 2007). Moreover, the PANAS emphasizes general affect rather than being specifically focused on the emotional and affective responses that are most relevant to risks and risk communications.[9] In these and other ways, considering positive and negative affect independently could help refine and complement extant research, advancing theoretical investigations of the conditions under which positive versus negative affect independently shape risk perceptions, as well as further clarifying how different characteristics of particular hazards and different decision maker characteristics shape risk perceptions and risky choices (Siegrist & Arvai, 2020).

Theoretically, the relative predictive power of the positive versus negative component of the BERRI is likely to be determined by the specific decision circumstances (e.g., degree of potential risk or benefit in the decision at hand; Lerner et al., 2015) or by the correspondence between the valence of the affective component and the decision outcome of interest (e.g., positive emotions predicting perceived benefit and negative emotions predicting perceived risk; Rothman et al., 1999). For example, depending on the information provided (e.g., presenting only costs), evaluations of a risky prospect could theoretically result in parallel effects on positive and negative affect (e.g., increasing negative affect and reducing positive affect, producing a negative correlation between the two BERRI components). Indeed, we observed such a parallel influence on affect in our investigations of emerging pandemic risks in Studies 4 and 5. Notably, however, these findings came from studies wherein there was no information about potential benefits presented, and in both cases negative affect was found to be more strongly related to the criteria. In contrast, in all the other studies reported here, information about potential benefits and risks was provided, and across those results both positive and negative BERRI components tended to function as robust independent predictors.

Despite consistently finding that positive and negative affect tended to have unique, independent effects on decisions, theoretically it could be interesting to combine the negative and positive BERRI components into a global estimate (e.g., total affect intensity = sum of (1) negative and (2) reversed positive BERRI components). The distinct predictive validity of the two affective components, and the lack of consistent correlations between them, suggest this type of analysis should not be reported without presenting additional information (i.e., researchers should present both

[9] Only one item from the BERRI (afraid) is included in the PANAS, considering several of its versions (Mackinnon et al., 1999; Thompson, 2007; Watson & Clark, 1999; Watson et al., 1988), see Appendix E.

positive and negative BERRI results separately, along with any global estimates). In fact, an averaged global score can often mask important relationships of the separate components (Schneider & Schwarz, 2017). Determining how, when, and why the total intensity of affect may be relevant remains an open and interesting question. Nevertheless, we believe that a standard (best practice) approach to analyses with the BERRI requires that researchers consistently present results of positive and negative affect separately, even when a combined BERRI total affect intensity score is presented and analyzed.

3.2 | Risk communications, affective reactions, and individual differences

Risk communications often include complex numerical information (e.g., a decision aid helping patients to choose between different treatments and presenting the probabilities of benefits and side effects of each available option (Bonner et al., 2021)). Accordingly, a large proportion of the risk communication literature focuses on research and methods for improving decision making through enhancing message effectiveness (Balog-Way et al., 2020; Garcia-Retamero & Cokely, 2014; Rakow et al., 2015) such as promoting more transparent decision aids that enable informed, value-consistent decision making among diverse decision makers (Cokely et al., 2018; Garcia-Retamero & Cokely, 2017; Peters, 2011; Petrova et al., 2015). Given this broad emphasis and the robust relations of affect and decision making documented in the current research, it seems obvious that affect can and likely should be routinely assessed when evaluating many (if not most) high-stakes risk communications. The current results further suggest that integrated approaches to evaluation of risk literacy and risk communications should more generally involve combined differential and experimental studies on the role of affect (e.g., mapping the interplay of individual differences and group-level interventions on choices and outcomes).

To further illustrate our perspective, we find that the current results and available literature converge, suggesting that both group differences and individual differences are often robustly related to affective reactions and subsequent risky choices and behaviors. As such, given the availability of valid and reliable measures such as the BERRI, there appears to be good reason to think that researchers conducting evidence-based evaluations of risk communications may run a considerable risk if they neglect to measure the role of affect in combination with other known influential factors (Cokely et al., 2018; Garcia-Retamero & Cokely, 2017; Peters, 2011; Visschers et al., 2012). To further illustrate with a related example, Study 3 demonstrated that the BERRI tracked variability in how people who differed in their risk-taking propensity responded emotionally to specific decision situations. This study also revealed that statistical numeracy was linked with affective reactions to costs, risks, and benefits. Specifically, the BERRI tracked differences in how people with high and low numeracy emotionally responded to different scenarios, which in turn translated into differences in downstream variables (e.g., intentions, choices, and behaviors). These results and others suggest that key individual differences in emotional sensitivity to risk severity (how bad the consequences would be if this happens) and probability (how likely it is that it happens) may generally help explain major differences in decision quality and life outcome variables.

More generally, it is well-established that people with more developed statistical numeracy skills tend to be more risk literate, and thus are much more likely to make normatively superior decisions about risk in general (e.g., they seek medical attention quicker when having a heart attack Cokely et al., 2018; Garcia-Retamero et al., 2019; Petrova et al., 2016). While there are many mechanisms that help explain these relations, the current results highlight one conventionally surprising mechanism: Numerate people (i.e., people better at math) tend to have a higher emotional sensitivity to risk (Petrova et al., 2014, 2019) such that their emotional responses may be more in tune with actual risks (e.g., better calibrated affective reactions), reflecting a more representative understanding of the risks, stakes, and potential personal consequences of their choices (Cokely et al., 2018). Moreover, in the current study both low and high probabilities were associated with relatively equal (and strong) emotional reactions in people with low numeracy, yet among people with higher numeracy the reported emotional reactions tended to be aligned with the objective probabilities (i.e., affect calibration). While these relations between affect and risk literacy (as measured by statistical numeracy) have been demonstrated previously (Petrova et al., 2014), it seems noteworthy that until now there was no brief, validated instrument available to directly measure and compare these effects across studies (e.g., no standard instrument). To the extent the current results generalize, we think they suggest many exciting opportunities to use the BERRI to increase synthesis and integration of research while also breaking new empirical ground on many frontiers (Allan, 2021; Cokely et al., 2018).

3.3 | Conclusions and limitations

Rather than develop a complex, extensive instrument assessing the comprehensive range of affective reactions and specific emotions, we developed and validated a brief (e.g., 1 min), easy-to-administer tool for measuring anticipatory affective reactions. We believe the development of the BERRI presents a valuable advance given the growing needs and opportunities for assessments of factors that influence high-stakes risky decision making and risk communications. Going forward, however, we want to reiterate that the BERRI is designed to be a measure of general anticipatory negative and positive affective reactions, and as such it may be less useful when the influence of discrete anticipatory emotions such as anger or disgust are of primary interest (Angie et al., 2011; Ferrer et al., 2016; Lerner & Keltner, 2001). That is, the BERRI does not capture *all* types of affective reactions

such as anticipated regret or pleasure, which are also known to influence risky choice (Mellers & McGraw, 2001; Richard et al., 1996).

It is worth noting that the majority of our studies validating the BERRI were based on demographically diverse samples drawn from web panels, whereas others were conducted in university students (i.e., predominantly female and highly educated samples). The BERRI has also been tested as a self-administered instrument and as such it appears that a minimum level of literacy is required for reliable interpretation and use (i.e., being able to read and use a numeric Likert-type scale). For populations that do not possess such abilities, other more visually or perceptually grounded instruments such as the SAM may be more suitable (Bradley & Lang, 1994). It also seems worth noting that for the translation of the BERRI from English to Polish and Spanish we relied on the proficiency of native speakers who were experts in risky decision making and risk communication. As such, we did not perform more extensive cognitive testing (e.g., to ensure similar interpretation of the items in different languages), which is something that may be appropriate for future adaptations of the BERRI to other languages, should researchers decide it is necessary.

These and other limits notwithstanding, we feel confident the BERRI is a timely step toward more precise and integrated investigations of risky decision making. Taken altogether, results suggest that in about 1 minute the BERRI can reliably and robustly measure how people feel about a wide range of risks, enabling efficient assessment of factors that may help clarify and protect against decision vulnerability.

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Studies 1, 2, 4, and 5 were not conducted for the sole purpose of validating the scale. Hence, they contain experimental manipulations and additional measures that, for the sake of brevity, are not described in detail in the current manuscript. Full details are available in the original reports of the studies cited in each respective section and available on OSF: doi:https://doi.org/10.17605/OSF.IO/F4P38. Study 3 was the master thesis of Kelly Wall in the Masters of "Psychology of Social Interventions" at the University of Granada, Spain, we thank her for her valuable contributions to this study. The Berlin Emotional Responses to Risk Instrument (BERRI) is part of the international www.RiskLiteracy.org project (Science for Informed Decision Making). Dafina Petrova is supported by a Juan de la Cierva Fellowship from the Ministry of Science and the National Research Agency of Spain (MCIN/AEI, JC2019-039691-I, https://doi.org/10.13039/501100011033).

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ETHICAL APPROVAL

Studies 1, 2, and 6 were approved by the Ethics Committee of the University of Granada (Spain). Study 3 was approved by the University of Oklahoma-Norman Campus Institutional Review board (USA). Study 4 was approved by the Michigan Technological University Review Board (USA). Studies 5 and 7 were approved by the Psychology Department Ethical Committee of the SWPS University of Social Sciences and Humanities (Poland). All participants provided informed consent before each of the studies.

DATA AVAILABILITY STATEMENT

Data set and materials for all studies are available on the Open Science Framework (OSF): doi:https://doi.org/10.17605/OSF.IO/F4P38. These include code to use the BERRI in the Qualtrics survey software (www.qualtrics.com) and code to compute the components of the BERRI, calculate descriptive statistics, correlations, and Cronbach's reliability coefficients in the software R (https://www.r-project.org).

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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APPENDIX A: AVAILABLE SOCIODEMOGRAPHIC INFORMATION ABOUT THE STUDY SAMPLES

Study 1. Participants were 256 men, mean age = 36, median = 32, min = 18, max = 70

		N	Percent
Race/ethnicity	White/Caucasian	206	80.5
	African American	19	7.4
	Hispanic	19	7.4
	Asian	9	3.5
	Pacific Islander	1	0.4
	Other	2	0.8
Occupation	Management, professional, or related	56	21.9
	Science or education	24	9.4
	Service	27	10.5
	Sales or office	28	10.9
	Farming, fishing, or forestry	3	1.2
	Construction or maintenance	11	4.3
	Production or transportation	12	4.7
	Government	13	5.1
	Retired	12	4.7
	Unemployed	41	16.0
	Other	29	11.3
Education level	Less than high school	1	0.4
	High school/GED	30	11.7
	Some college	70	27.3
	2-year college degree	32	12.5
	4-year college degree	89	34.8
	Master's degree	25	9.8
	Doctoral degree	5	2.0
	Professional degree (JD, MD)	4	1.6
	Total	256	100.0

Study 2. Participants were 355 women, mean age = 38, median = 34, min = 18, max = 85

		N	Percent
Race/ethnicity	White/Caucasian	286	80.6
	African American	32	9.0
	Hispanic	16	4.5
	Asian	16	4.5
	Pacific Islander	1	0.3
	Other	4	1.1
Occupation	Management, professional, or related	70	19.7
	Science or education	36	10.1
	Service	22	6.2
	Sales or office	49	13.8
	Farming, fishing, or forestry	2	0.6
	Construction or maintenance	2	0.6
	Production or transportation	1	0.3
	Government	12	3.4
	Retired	29	8.2
	Unemployed	60	16.9
	Other	72	20.3
Education	Less than high school	8	2.3
	High school / GED	39	11.0
	Some college	109	30.7
	2-year college degree	36	10.1
	4-year college degree	116	32.7
	Master's degree	41	11.5
	Doctoral degree	2	0.6
	Professional degree (JD, MD)	4	1.1
	Total	355	100.0

Study 3. Participants were 515 adults, mean age = 36, median = 31, min = 18, max = 79

		N	Percent
Sex	Male	257	49.9
	Female	257	49.9
	Other	1	0.2
Race/ethnicity	American Indian or Alaska Native	5	1.0
	Asian	33	6.4
	Black or African American	71	13.8
	Caucasian or White	363	70.5
	Hispanic or Latinx	33	6.4
	Middle Eastern	3	0.6
	Other	7	1.4
Education	Some high school or less	4	0.8
	High school or equivalent	39	7.6
	Some college	89	17.3
	2-year college degree	58	11.3
	4-year college degree	211	41.0
	Master's degree or higher	114	22.1
	Total	515	100.0

Study 4. Participants were 506 adults, mean age = 38, median = 34, min = 18, max = 79

		N	Percent
Sex	Male	171	33.7
	Female	337	66.3
Education	No school degree	8	1.6
	High-school diploma	54	10.6
	Some college	136	26.8
	Associate degree	47	9.3
	Bachelor of Science/Arts	184	36.2
	Master of Science/Arts	61	12.0
	Doctorate/Advanced Professional Degree (PhD/MD/JD)	18	3.5
	Total	508	100.0

Study 5. Participants were 253 students at the SWPS University of Social Sciences and Humanities (Poland); 221 (87%) were females and 32 (13%) males. Mean age was 29.2 years (*SD* = 9.3), Median = 26; 65 (26%) participants had children; 61 (24%) participants lived with older or chronically ill persons; and 162 (64%) participants were employed.

Study 6. Participants were 102 university students from the University of Granada in Spain; 81 (79%) were females and 21 (21%) males. Mean age was 22 years (*SD* = 2.5).

Study 7. Participants were 131 psychology students from the SWPS University of Social Sciences and Humanities in Poland; 106 (81%) were females and 25 (19%) were males. Mean age was 27, *SD* = 8.

APPENDIX B: PILOT STUDY PRECEDING STUDY 3

In this pilot study, we designed risk scenarios with varying outcome severity levels, with the purpose to check whether participants' perceived severity of the scenarios varied according to the designed outcome severity level.

Method

Participants. Fifty participants were recruited via an online post on Facebook that advertised the need for volunteers to complete an anonymous, online survey. Three participants were excluded from the study due to a self-reported lack of English fluency, resulting in a total of 47 participants (15 males, 30 females, 2 other) between 20 and 77 years of age (*M* = 29.62, *SD* = 9.39). Participants represented 13 different nationalities with American (45%) and Bulgarian (11%) nationalities making up the majority. Participants did not receive compensation for their participation but were thanked for their contribution.

Design. The pilot study was a 6 × 3 within-subjects design with two independent variables, risk context (six levels: technological, environmental, health, social, ethical, and financial) and outcome severity (three levels: mild, moderate, and high), as the within-subjects factors. The dependent variable was participants' perceived severity, measured by their severity ratings of the outcomes of the risk scenarios.

Materials. The participants completed an online survey consisting of 18 different risk scenarios that varied in risk context (i.e., technological, environmental, health, social, ethical, and financial) and outcome severity (i.e., mild, moderate, and high). All scenarios were designed for the purposes of this study and are available in Appendix C. The order in which the six risk contexts and their three severity levels were presented was randomized. Participants were asked to rate the severity of the outcome of each risk scenario on a Likert scale from 1 (not at all severe) to 7 (extremely severe). The end of the survey included four demographic questions.

Procedure. The study was advertised as a "Risk Perception" survey. Participants clicked on the link provided on the Facebook post advertising the online survey and were redirected to the Qualtrics platform to begin the survey. They read a brief introduction and the informed consent prior to participating. All participants 18 years of age or older were eligible. The entire survey took approximately five minutes to complete on average.

Results

A repeated measures analysis of variance with a Greenhouse–Geisser correction was conducted with risk context and outcome severity as independent variables and perceived severity as a dependent variable to determine if the manipulated outcome severity had an effect on perceived severity. Table B1 demonstrates that there was a significant main effect of risk severity on participants' perceived severity ratings for all six contexts. *Post hoc* tests using the Bonferroni correction revealed that participants rated the outcomes of the high-risk scenarios significantly higher in severity than the outcomes of moderate-risk scenarios (see Table B2). In addition, both high-risk and moderate-risk scenario outcomes were rated significantly higher in severity than the mild-risk scenario outcomes. These results were consistent across all risk type scenarios.

Discussion

This pilot study served as a manipulation check for the mild, moderate, and high outcome severity scenarios that were created for use in the main study. Results revealed that participants' perceived severity differed significantly between scenarios with mild, moderate, and high-risk severity outcomes across all scenario categories (i.e., technological, health, social, financial, environmental, and ethical). These results indicate that the severity manipulations in all scenarios have the intended effects and are thus suitable for use in our main experiment.

This study was part of the master thesis of Miss Kelly Wall in the Master's "Psychology of Social Interventions" at the University of Granada.

TABLE B1 Repeated measures ANOVA summary for perceived severity across risk context scenarios in the pilot study

Risk context	Source	Sum of squares	*df*	Meansquare	*F*	Partial Eta squared
Technological	Risk severity	203.59	1.47	138.75	130.53*	0.74
	Error	71.75	67.50	1.06		
Health	Risk severity	144.06	1.74	82.62	85.02*	0.65
	Error	77.94	80.21	0.97		
Social	Risk severity	91.76	1.49	61.61	52.60*	0.53
	Error	80.24	68.51	1.17		
Financial	Risk severity	130.44	1.68	77.56	65.06*	0.59
	Error	92.23	77.36	1.19		
Ethical	Risk severity	171.67	1.75	98.03	60.59*	0.57
	Error	130.33	80.56	1.62		
Environmental	Risk severity	38.99	1.42	27.53	47.61*	0.51
	Error	37.67	65.14	0.58		

Note. The Greenhouse–Geisser correction has been applied. *$p < 0.001$.

TABLE B2 Bonferroni comparisons for perceived severity across risk type scenarios ($N = 47$) in Experiment 1 (pilot study)

				95% CI	
Risk context	**Comparisons**	**Mean difference**	**Std. error**	**Lower bound**	**Upper bound**
Technological	Mild vs. Moderate	−2.36*	0.21	−2.88	−1.84
	High vs. Moderate	0.34*	0.12	0.06	0.63
	High vs. Mild	2.70*	0.21	2.19	3.21
Health	Mild vs. Moderate	−1.40*	0.15	−1.78	−1.03
	High vs. Moderate	1.06*	0.20	0.57	1.56
	High vs. Mild	2.47*	0.22	1.94	3.00
Social	Mild vs. Moderate	−1.21*	0.15	−1.58	−0.84
	High vs. Moderate	0.75*	0.18	0.31	1.18
	High vs. Mild	1.96*	0.24	1.36	2.56
Financial	Mild vs. Moderate	−1.40*	0.20	−1.89	−0.92
	High vs. Moderate	0.94*	0.17	0.51	1.36
	High vs. Mild	2.34*	0.25	1.73	2.95
Ethical	Mild vs. Moderate	−0.72*	0.24	−1.32	−0.13
	High vs. Moderate	1.89*	0.21	1.39	2.40
	High vs. Mild	2.62*	0.29	1.91	3.32
Environmental	Mild vs. Moderate	−0.79*	0.12	−1.08	−0.50
	High vs. Moderate	0.49*	0.10	0.24	0.74
	High vs. Mild	1.28*	0.17	0.86	1.70

Note. Std. = Standard; CI = Confidence Interval.
*$p < 0.05$.

APPENDIX C: SCENARIOS USED IN STUDY 3

Techno-cyber

You have just purchased a new laptop for personal use and are considering downloading a free virus protection software. However, you are worried about the quality of this software and the potential risks if it does not work properly. There has been a new virus going around and some of your friends got it and had computer problems. You decide to call the IT specialist at your local electronic store for advice on this software and he tells you that it is quite good overall. However, it could still leave you vulnerable to the new virus *mild severity: by letting it infect a couple of computer files but without serious consequences/ moderate severity: by letting it infect a couple of computer files and causing permanent data loss*

of these files/ high severity: by letting it infect a couple of computer files, causing permanent data loss of these files and also wiping some of your hard drive irreversibly. He tells you that the risk of this happening is *low risk: quite low, about 5%, medium risk: medium, about 50%, high risk: high, about 95%*.

How would you feel about downloading the free virus protection software? BERRI

Criterion 1 > How willing would you be to download the free virus protection software? Likert scale

Criterion 2 > There is an alternative virus protection software that offers a similar service but does not leave you vulnerable to the new virus. However, you must purchase this software. How much would you be willing to pay per month for this alternative virus protection software? Indicate Amount in USD

Environmental

You recently purchased a household cleaning product and have just looked at the warning label. You are considering using the product as directed but are worried about the effects of its chemical ingredients on the environment. You decide to call the US Environmental Protection Agency's customer service hotline to get more information. The representative tells you that the chemicals in the cleaning product you are using could pollute the environment by *mild severity: decreasing the food supply for fish in streams and lakes/ moderate severity*: d*ecreasing the food supply for fish in streams and lakes and harming their reproduction/ high severity: decreasing the food supply for fish in streams and lakes, harming their reproduction, and killing them*. He says that the risk of this happening is *low risk: quite low, about 5%, medium risk: medium, about 50%, high risk: high, about 95%*.

How would you feel about using the household cleaning product? BERRI

Criterion 1 > How willing would you be to use the household cleaning product? Likert scale

Criterion 2 > There are alternative cleaning products that are ecofriendly and do not have negative effects on the environment. However, they are more expensive than the one you purchased. How much would you be willing to pay for one of these alternative cleaning products? Indicate Amount in USD

Health

You have been having some really unpleasant allergies recently. Because of these allergies you haven't been able to breathe and sleep properly, so they have really affected your quality of life. You went to the doctor and he prescribed you a medicine that is effective at reducing the allergy symptoms. You are considering buying the medicine and before you do, you consult its leaflet online. It says that as a side effect the medicine could cause *mild severity: some mild stomach problems/ moderate severity: some quite unpleasant and persistent stomach problems /high severity: some quite unpleasant and persistent stomach problems that could even keep you at bed rest*. It says the risk of such side effect is *low risk: quite low, about 5%, medium risk: medium, about 50%, high risk: high, about 95%*.

How would you feel about taking this medicine? BERRI

Criterion 1 > How willing would you be to take this medicine? Likert scale

Criterion 2 > There is an alternative medicine that could help you and does not expose you to the risk of such a side effect. However, it is not covered by your insurance. How much would you be willing to pay for this alternative medicine? Indicate Amount in USD

Social

You just received a unique job offer for a position in your preferred field of work at a promising startup. You are considering taking the offer, but because the company is a startup, you are concerned about job security and the risk of being laid off. You decide to seek advice from a friend who is familiar with the new company and is a successful business owner. He tells you that the company looks very promising indeed but nevertheless, if you take the job, you run the risk of *mild severity: a small reduction in working hours that can slightly decrease your pay/ moderate severity: a reduction to a part-time position that will decrease your pay substantially/ high severity: unemployment at a moment's notice*. He tells you that the risk of such a situation is *low risk: quite low, about 5%, medium risk: medium, about 50%, high risk: high, about 95%*.

How would you feel about taking the job offer? BERRI

Criterion 1 > How willing would you be to take the job offer? Likert scale

Criterion 2 > Your friend suggests that you put a portion of your paycheck away in an emergency fund to decrease your worries about job security. How much money per month would you be willing to put away in this emergency fund to reduce your worries? Indicate Amount in USD

Financial

You have saved up some money and you are considering investing some of it in one specific company. You decide to consult a broker about it. The broker tells you that this company seems like an excellent investment and there is a chance of very high return; however, like with any investment, there could be some risks. In particular, with this company there could be a risk of *mild severity: stock values remaining stagnant for the next 5 years / moderate severity: stock values declining in value over the next 5 years/ high severity: the company going bankrupt during the next 5 years and losing your investment*. He tells you that the risk of this happening is *low risk: quite low, about 5%, medium risk: medium, about 50%, high risk: high, about 95%*.

How would you feel about purchasing shares of stock in this company? BERRI

Criterion 1 > How willing would you be to purchase shares of stock in this company? Likert scale

Criterion 2 > The broker informs you that there are alternative companies for you to invest in with potentially similar gains but less risk. However, you must pay the broker a fee for

this advice. How much would you be willing to pay to know about the alternative companies? Indicate Amount in USD

Ethical

You have been given a company card for job-related expenses on a business trip and you are considering using the card for some personal expenses such as buying magazines to read on your flight or buying toiletries you forgot to pack. However, you are concerned about the possible risks of making these unapproved purchases. You ask a friend who is a human resources manager about the potential risks involved and he tells you that you run the risk of being caught by the accounting assistant and *mild severity: asked to reimburse the company for the spending/ moderate severity: given a week of suspension without pay / high severity: getting fired from your job*. He tells you that the risk of this situation is *low risk: quite low, about 5%, medium risk: medium, about 50%, high risk: high, about 95%*.

How would you feel about using the company card for some personal expenses? BERRI

Criterion 1 > How willing would you be to use the company card for some personal expenses? Likert scale

Criterion 2 > Your friend tells you that the local workers' union is fighting to make these types of personal expenses be considered as job-related. If they succeed, these types of expenses will no longer be considered as unapproved purchases. You are considering supporting the union to avoid the risk of making unapproved purchases. How much would you be willing to pay per month for union membership? Indicate Amount in USD

APPENDIX D: DETAILED RESULTS OF STUDY 6

Study 6 was specifically designed to validate the BERRI in Spanish and to test the generalizability of its factor structure, internal consistency, and convergent and predictive validity. Participants were 102 psychology students from the University of Granada in Spain ($M_{age} = 22$, $SD_{age} = 3$, 81 females), who completed an online questionnaire.

We used the health, social, and financial scenarios from Study 3 (moderate severity and medium probability versions). Participants read the three scenarios in that order and answered the BERRI (translated by two native speakers, see Table 6). For each scenario, participants answered four criterion items, including the willingness to take the risk (WTT) and willingness to pay (WTP) questions used in Study 3. They also answered one question about perceived benefits ("To what extent do you think [description of the risky decision in each scenario] could be beneficial for you?") and one about perceived harms ("To what extent do you think [description of the risky decision in each scenario] could be harmful to you?"), on seven-point Likert scales from 1 (Not at all) to 7 (Extremely). At the end of the study participants also indicated the amount of emotional distress they had felt in the past week using the Distress Thermometer from 1 (no distress at all) to 10 (extreme distress) (Vaíllo et al., 2015). We expected the Distress Thermometer, as a general measure of affective state, to be significantly related to the BERRI scores.

Results

Factor structure and internal consistency. The confirmatory factor analysis (CFA) results showed that the two-factor solution had good fit to the data and was better than the one-factor solution (see Table S1). In case of the two-factor structure, all of the factor loadings were above 0.6 (BERRI-neg: $\lambda_{anxious} = 0.84$; $\lambda_{afraid} = 0.86$; $\lambda_{worried} = 0.85$; BERRI-poz: $\lambda_{assured} = 0.67$; $\lambda_{hopeful} = 0.92$; $\lambda_{relieved} = 0.89$). The Spanish version had excellent internal consistency (see Table D1).

Predictive validity. In this study, the BERRI-pos and BERRI-neg were not significantly correlated ($p > 0.05$). Generally, both BERRI-pos and BERRI-neg were significantly related to the criteria, such that participants who reported stronger negative and weaker positive emotions perceived less benefit and more harm and were less willing to take the risk (see Table D1).

Convergent validity. The distress thermometer was only related to BERRI responses in the social scenario (about a new job offer). Participants who reported higher emotional distress in the past week reported stronger negative and weaker positive emotions in response to this scenario (albeit the correlation with BERRI-pos was not significant) (Table D1).

Overall, Study 6 demonstrated that the Spanish version of the BERRI had robust, comparable psychometric properties to the original English version.

Note. WTT, willingness to take the risk; WTP, willingness to pay, log-transformed due to skewness.

* $p < 0.05$.

TABLE D1 Study 6: Cronbach's α of the BERRI components and Pearson correlations between BERRI scores and criterion variables

Scenario context	BERRI component	Cronbach's α	Perceived benefit	Perceived harm	WTT	WTP	Distress thermometer
Health	BERRI-neg	0.85	−0.41*	0.59*	−0.52*	0.29*	−0.03
	BERRI-pos	0.89	0.51*	−0.43*	0.50*	−0.10	0.02
Social	BERRI-neg	0.86	−0.59*	0.55*	−0.52*	−0.15	0.23*
	BERRI-pos	0.85	0.39*	−0.26*	0.38*	0.18	−0.19
Financial	BERRI-neg	0.88	0.03	0.15	0.03	0.40*	0.04
	BERRI-pos	0.72	0.47*	−0.29*	0.52*	−0.01	−0.16

References: Vaíllo, Y. A., Garrido, M. J. G., López, P. M., & Arroyo, O. M. (2015). Precisión diagnóstica del termómetro de distrés en neoplasias hematológicas. *Psicooncología, 12*(2), 237–247.

APPENDIX E: COMPARISON OF ITEMS IN THE BERRI AND DIFFERENT PANAS VERSIONS

Items with (*) are included in the BERRI

Items with (+) were included in the initial item pool but not in the BERRI

PANAS first version (Watson et al., 1988)

PA: Interested, Excited, Strong, Enthusiastic, Proud, Alert, Inspired, Determined, Attentive, Active

NA: Distressed, Upset, Guilty, Scared, Hostile, Irritable, Ashamed, Nervous, Jittery, Afraid (*)

PANAS-short forms

The subscales for the short form-Mackinnon et al., 1999 are: PA (inspired, alert, excited, enthusiastic, determined); NA (afraid (*), upset, nervous, scared, distressed).

The subscales for the short form-Thompson, 2007 are: PA (inspired, alert, attentive, active, determined,); NA (afraid (*), upset, nervous, ashamed, hostile).

PANAS-X expanded form (Watson & Clark, 1999)

General Dimension Scales

Negative Affect (10): afraid (*), scared, nervous, jittery, irritable, hostile, guilty, ashamed, upset, distressed

Positive Affect (10): active, alert, attentive, determined, enthusiastic, excited, inspired, interested, proud, strong

Basic Negative Emotion Scales

Fear (6) afraid (*), scared, frightened, nervous, jittery, shaky

Hostility (6) angry, hostile, irritable, scornful, disgusted, loathing

Guilt (6) guilty, ashamed, blameworthy, angry at self, disgusted with self, dissatisfied with self

Sadness (5) sad (+), blue, downhearted, alone, lonely

Basic Positive Emotion Scales

Joviality (8) happy (+), joyful, delighted, cheerful (+), excited, enthusiastic, lively, energetic

Self-Assurance (6) proud, strong, confident, bold, daring, fearless

Attentiveness (4) alert, attentive, concentrating, determined

Other Affective States

Shyness (4) shy, bashful, sheepish, timid

Fatigue (4) sleepy, tired, sluggish, drowsy

Serenity (3) calm (+), relaxed, at ease

Surprise (3) amazed, surprised, astonished

BERRI

Positive (i.e., assured, hopeful, relieved) and Negative (i.e., anxious, afraid, worried)

Initial pool for the BERRI

assured, calm, cheerful, happy, hopeful, relaxed, relieved, anxious, afraid, discouraged, disturbed, sad, troubled, and worried