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Making sense of COVID-19: a longitudinal investigation of the initial stages of developing illness representations

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ABSTRACT

Objectives: To describe and explain peoples' developing threat appraisal and representations of the novel illness COVID-19 over the first months of the pandemic. The Common-Sense Model of illness perceptions provided the theoretical framework.

Design: A cross-sectional study with 511 respondents and a follow-up study 4 months later on 422 respondents completing an online survey measuring demographic factors, media consumption, self-assessed health, experience with the disease, health anxiety, COVID-19 threat, worries and cognitive and emotional illness representations.

Results: Health anxiety, media consumption, female gender, lower self-assessed health, knowing a deceased COVID-19 patient and being infected explained variance in threat appraisal. Worries represented 2 factors: psychosocial and existential. Threat appraisal and worries explained variance in illness representations. Representations of the disease worsened and started stabilizing over time. Emotional representations were exceptionally stable and explainable by threat appraisals.

Conclusions: These studies revealed the initial stages of developing representations of a new disease in the context of the COVID-19 pandemic. Gaining insights into those representations is key to understanding, predicting and modifying behavioral and mental responses to the pandemic.

On March 11, 2020, the World Health Organization (WHO) declared COVID-19 a pandemic. With no vaccine or medication to cope with the novel disease, behavior was the only weapon to fight it (Arden & Chilcot, 2020). Given that voluntary behavior results from foreseeable psychological processes, the purpose of this study was to gain insights into people's feelings and thoughts about COVID-19 that are expected to explain psychological and behavioral consequences.

Within the framework of the Common Sense Model (CSM) of self-regulation (Leventhal et al., 1992), individuals' representations (perceptions and beliefs) of illnesses are important mediating links between health threats and responses to them. Five

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core dimensions of illness representations are delineated: identity of the threat (its symptoms and label); cause (e.g. infection, genetic); time line (duration and development); consequences (somatic and psychosocial); and controllability (prevention and cure). The initial response to a health threat is an automatic elicitation of cognitive and emotional illness representations, followed by planning and execution of coping responses and evaluation of coping outcomes that completes the self-regulation process. Variations in representations are expected to evoke different responses to the same condition. This theory has been used extensively and successfully in numerous studies of healthy and patient groups around the world (Dempster et al., 2015a; Hagger et al., 2017).

The CSM distinguishes between prototypes (memory structures developed over years) and representations. The latter are the mental models activated at specific times and are presumed to be dynamic and changing (Leventhal et al., 2016). Prototypes are of critical importance for the formation of illness representations because they provide standards for comparisons with experience (Leventhal, 2019). Relevant cues (e.g. symptoms, health-related news items) perceived as creating a problem for the individual—a health threat—activate the prototypes on which specific representations can develop. But what if a health threat is novel, like the COVID-19 pandemic?[1] What if the news about the pandemic is terribly threatening, but the person has no related prototype in memory to match it (the 2002 SARS epidemic did not spread in Israel)? How are illness representations formed under such conditions? The first aim of the study was to find responses to these questions. As a starting point to answering these questions, health threat appraisals were examined for their components and structure, the cues eliciting them, and their effects on cognitive and emotional representations of COVID-19.

Health threats are defined mainly by perceived risk (likelihood of contracting the disease) and perceived disease severity (Leppin & Aro, 2009), and both explain health worries (Shiloh et al., 2013). Threat appraisal may vary considerably among people facing the same situation. Thus, the next aim of the study was to discover factors that can explain variance in threat appraisals. One such factor is mass media consumption. Extensive mass media coverage of a disease outbreak and overflow of information may result in increased threat appraisals (Falagas & Kiriaze, 2006). Another potential source of variance in threat appraisals is self-assessed health (Leventhal et al., 2011). It was expected that people who perceive their health as generally good will appraise the COVID-19 threat as lower than people who assess their health as poor. Personality factors and emotional states were also presumed to affect threat appraisals (Leventhal et al., 1992, 1999), with individuals high in health anxiety expressing higher threat appraisals (Asmundson & Taylor, 2020). Finally, we expected that personal experience with COVID-19 would increase threat appraisals.

COVID-19, however, was more than just a health threat. It was clear from the beginning of the pandemic that people's concerns and worries extended far beyond fears of being infected, as the mandated closing of businesses and work places caused vast unemployment and financial worries. Another measure taken to contain the disease, self-isolation, was a cause for worry. Being quarantined during a pandemic can have negative psychological effects, including confusion, anger, frustration, and

even post-traumatic stress symptoms (Brooks et al., 2020). The high levels of uncertainty is also a source of threat and worry (Taha et al., 2014), as are interpersonal conflicts and worries about vulnerable relatives. Taken together, we decided to extend the scope of threat appraisals elicited by COVID-19 to domains of worry other than the narrow definition of a health threat. In view of the fact that representations of COVID-19 were expected to evolve over time, two studies were performed: Study 1 from April 21 to 24 2020, when a first peak of new infections in Israel occurred, and 4 months later on August 10 to19, during a second wave of the pandemic in the country.

Study 1

The main aim of the study was to describe and explain peoples' threat appraisals and representations of the COVID-19 disease. In view of the above theoretical considerations and literature summary, the present study explored a tentative model for explaining the formation of the COVID-19 representations (Figure 1). The model suggests that background factors, i.e. health anxiety, media consumption, self-assessed health and personal experience with the disease affect health threat appraisals (severity and risk perceptions) and other worry domains (personal, social, financial), which, in turn, relate to emotional and cognitive representations of COVID-19.

Methods

Participants

In order to achieve 0.8 power in detecting small mediating effect sizes, the necessary sample size is N = 462 (Fritz & MacKinnon, 2007)[2]. Participants were 511 individuals recruited to the study by a survey company ensuring the sample was representative of the Israeli population: 48% male; mean age 40.61 years (SD = 15.09, range 18–70); mean number of school years 15 (SD = 4.54); 57% married or in a steady relationship. Of the initial dataset of 537 participants, 15 were eliminated for having the same exact IP address as another (randomly chosen) participant, and 11 for unreasonably short completion time (less than 441.42 seconds) defined as 3 times the Semi-Quarterlies Range lower than the Mean time. Work status at the time of the study (after the initial introduction of COVID-19 mitigation policies) consisted of: 22% on unpaid leave,

Figure 1. A process model describing the development of COVID-19 representations.

21% employed as usual, 19% working from home, 8% on paid leave, 8% unemployed prior to the pandemic, 7% retired, 2% laid off during the pandemic, and the remaining 12% reported other statuses such as maternity leave, student, part-time work and disability leave.

Health-related background: 2.5% reported having been infected with COVID-19 but not hospitalized; 6.5% reported being quarantined after possible exposure to the virus or for self-protection; 23% reported knowing a COVID-19 patient and 4% knew someone who had died of the disease; 18% reported having a chronic illness of some kind (e.g. asthma, heart disease, diabetes, hypertension, renal disease and hepatitis).[3] On a 7-point scale ranging from 1 = very bad to 7 = excellent, the mean score of self-assessed health was 5.59 (*SD* = 0.98).

Instruments

An online questionnaire was used to collect the data.

Background data. Demographic information regarding age, gender, education level, marital and work statuses were reported at the beginning of the questionnaire, followed by medical background questions including a self-assessed health scale (1 = very bad to 7 = excellent) and a report on chronic health conditions. Personal experience with COVID-19 was assessed by questions on being infected oneself, knowing someone who got infected and/or died of COVID-19, and being quarantined due to the pandemic.

Consumption of media. In response to the question: 'How much information about COVID-19 do you consume (through newspapers, TV, etc.)?', responses were reported on a 7-point scale (1 = not at all to 7 = extensive).

COVID-19 threat appraisal. The COVID-19 threat was assessed by 3 items often used for measuring disease threat (de Zwart et al., 2009): personal chances of being infected by COVID-19, chances of being infected compared to people of the same sex and age, and appraisal of the severity of the condition. All questions used 7-point scales. The vulnerability score was computed by averaging the 2 items about chances of being infected (Cronbach's α = .75). Higher scores denote higher threat appraisal.

COVID-19 worries. Worries representing health and other life domains (Topper et al., 2014) potentially affected by the pandemic were generated by the authors. Twelve worries were listed: financial concerns, self-health worries, worry about health of relatives, death anxiety, fear of uncertainty, harm to partner/romantic relationship, harm to family relationships (e.g. parents, children), loneliness, disruption of education/career plans, mental health worries, disturbance to leisure activities and fear of social crime/violence. Worries were rated on 7-point scales ranging from 1 = no worry at all to 7 = extreme worry. Respondents could add unlisted worries, and the few who used this option mostly repeated worries that were listed or added idiosyncratic worries such as war, gaining weight, political concerns[4].

COVID-19 cognitive and emotional representations. Cognitive representations of COVID-19 were measured by 6 single-item 7-point scales from the Brief Illness Perception Questionnaire (B-IPQ) (Broadbent et al., 2006). The original instrument

was designed for patients and phrased to capture perceptions of an illness that respondents have. It was adapted to the current study by instructing respondents to check the number (1–7) that best corresponds to their views of COVID-19[5]. The items measured: consequences (illness' effect on a patient's life), identity (how much does a patient experience symptoms of the illness), timeline (how long does the illness last), personal control (patient's control over the illness), treatment control (treatment can help the patient's illness), and illness comprehensibility (how well do you feel you understand this illness). A seventh item measuring the perceived pre-ventability of the disease was added since prevention was the only target of behav-ioral efforts at that time. Three items of the B-IPQ were not used: 'concern' and 'emotionality' were replaced by an extended measure of emotional representations (see below), and 'causes', an open question that is often eliminated in studies (Broadbent et al., 2015), seemed pointless in view of the enormous publicity about the coronavirus.

Emotional representations of COVID-19 were measured by 8 items of the State-Trait Anxiety Inventory (Spielberger, 1984). Respondents were asked to report on 7-point scales ranging from 1 = not at all to 7 = extremely how much thinking about COVID-19 makes them feel: fearful, upset, worried, anxious, tense, distressed, having bad mood and uncomfortable. An 'emotional representations' score, representing negative emo-tions elicited by COVID-19, was computed by averaging across the items (Cronbach's $\alpha = 0.94$).

Trait health anxiety. Measured by the Health Anxiety Questionnaire (HAQ), a measure based on a cognitive behavioral analysis of health anxiety (Lucock & Morley, 1996). Respondents were asked to think about their habitual emotional states, unrelated to the current pandemic, and respond to 21 items (e.g. 'Do you ever find it difficult to keep worries about your health out of your mind?') on 7-point scales (ranging from 1 = never to 7 = most of the time). The total score was computed by averaging across all items (Cronbach's α reliability = 0.92).

Procedure

The study was approved by the institutional review board. The questionnaire was distributed online, using the Qualtrics platform. The introductory page explained that the study is being conducted for a university, deals with health issues related to the COVID-19 pandemic, and that participation is anonymous. After checking for eligibility (age over 18 years), participants expressed their consent by their willingness to enroll in the survey. They were reimbursed for their participation (~$2) by the survey com-pany. Data collection was conducted on April 21–24, 2020, during a peak of new infections in Israel. After reporting background demographic and medical data, par-ticipants filled out the threat and worry questionnaires, the COVID-19 representations and the trait health anxiety measures. The survey included other measures (e.g. behavioral reports and use of emotional coping strategies) that were not part of this study and will be published separately.

Statistical analyses. After examining the distributions of items measuring the threat and worry constructs, reliability analyses (Cronbach's α) and factor analysis (of worries) were used to examine their internal composition. Next, bi-variate

Table 1. Means and standard deviations (*SD*s) and rotated factor loadings[a] of worries (*n* = 511).

Worry	Mean (0–7)	SD	Loading on 'Psycho-social worry' factor	Loading on 'Existential worry' factor	Level[b]
Loneliness	3.60	1.91	**.82**	.11	4
Partner/romantic relationship	2.74	1.84	**.73**	.11	6
Mental health	3.22	1.92	**.72**	.34	5
Family relationships	3.19	1.97	**.71**	.23	5
Leisure activities	4.14	1.83	**.62**	.24	3
Education/career	3.18	1.91	**.61**	.24	5
Social crime/violence	3.20	1.81	**.57**	.41	5
Health of relatives	5.32	1.68	.10	**.81**	1
Self-health	4.05	1.79	.18	**.79**	3
Uncertainty	4.38	1.87	.31	**.74**	2
Death anxiety	3.23	1.89	.32	**.67**	5
Financial concerns	4.45	1.81	.16	**.61**	2

[a]Bold fonts indicate scale belonging.
[b]By post-hoc analysis (Scheffe's test) following repeated-measures ANOVA.

correlations were computed between the background variables and threat and worry scores, and regression analyses (Enter method) were performed to discover predictors of threat and worry. Similarly, distributions of illness representations and their bi-variate correlations with threat and worry were examined, followed by regression analyses to explain variance in illness representations by threat and worry scores.

Results

COVID-19 worries and threat appraisals

Repeated-measures ANOVA indicated significant differences among means of worry domains ($F(12,504) = 132.24$, $p < .000$, $\eta_p^2 = 0.21$), with worry about relatives' health highest, and worries about partner/romantic relationships lowest (Table 1). In view of the exploratory nature of studying COVID-19 worries and our wish to maximize inter-pretability, we used Principal Component Analysis (PCA) with Varimax rotation. The analysis revealed 2 distinct factors of worries. As indicated by item loadings, factor 1 was termed 'psycho-social worries' (highest components were loneliness and partner/romantic relationship), and factor 2 was 'existential worries' (highest components were relatives' and own health). All item loadings were >.56. Accordingly, 2 reliable worry scores were computed by averaging the relevant items: 'Psycho-social worries' (7 items, Cronbach's $\alpha = 0.85$) and 'Existential worries' (5 items, Cronbach's $\alpha = 0.82$). Existential worries ($M = 4.29$, $SD = 1.38$) were significantly higher ($t(35) = -16.00$, $p < .000$) than psychosocial worries ($M = 3.40$, $SD = 1.35$), and the Pearson correlation between the 2 worry scales was 0.58. Regression analysis to predict psychosocial worries by background factors yielded a model explaining 32% of the variance by health anxiety ($\beta = 0.48$) and age ($\beta = -0.16$). Regression analysis to predict existential worries by background factors yielded a model explaining 37% of the variance by health anxiety ($\beta = 0.41$), age ($\beta = -0.19$), female gender ($\beta = 0.22$), media consumption ($\beta = 0.19$), self-assessed health ($\beta = -0.09$) and having been quarantined due to COVID-19 symptoms ($\beta = -0.09$). Those coefficients were significant ($p < .01$).

Perceived illness severity was rated significantly higher than perceived vulnerability ($t(497) = 19.91$, $p < .000$; $M = 4.96$, $SD = 1.60$ and $M = 3.33$, $SD = 1.19$, respectively). The correlation between the scales was 0.17 ($p < .000$). The comparative risk item (chances of being infected compared to people of the same sex and age) was significantly lower ($M = 3.30$, $SD = 1.34$) than the mid-scale − 4 ($t(497) = -11.70$, $p < .000$, $d = 0.52$). Regression analysis to predict severity perceptions by background factors yielded a model explaining 19% of the variance by: media consumption ($\beta = 0.21$), female gender ($\beta = 0.20$), health anxiety ($\beta = 0.18$), age ($\beta = 0.12$), having chronic conditions ($\beta = 0.10$), and knowing someone who had died of COVID-19 ($\beta = 0.09$). Regression analysis to predict vulnerability perceptions by background factors yielded a model explaining 17% of the variance by health anxiety ($\beta = 0.31$) and self-assessed health ($\beta = -.15$). Pearson correlations between threat appraisals and worries were: for perceived severity 0.21 and 0.36 ($p < .001$) with psychosocial and existential worries, respectively; and for perceived vulnerability 0.21 and 0.32 ($p < .001$) with psychosocial and existential worries, respectively.

COVID-19 cognitive and emotional representations

The profile of COVID-19 representations as delineated by cognitive and emotional scale means is presented in Table 2. Repeated-measures ANOVA indicated significant differences among the representations ($F(7,504) = 170.79$, $p < .000$, $\eta_p^2 = 0.70$), with consequences (effects on patient's life) highest and patient's control over the disease lowest. Table 2 also presents results of regression analyses for predicting each of the illness representations by vulnerability and severity appraisals and both worries scores. As can be seen, emotional representations were best explained by all the predictors (53% of the variance), followed by consequences of the disease (27%, only by severity appraisals). Other representations were less explained by the investigated predictors.

Table 2. Means and standard deviations (SDs) of COVID-19 representations and their prediction by threat appraisals (severity and vulnerability) and worries (existential and psychosocial) ($n = 511$).

Level[a]	Representation scale	Mean	SD	% Explained by threat appraisals and worries	Significant predictors (β)
1	Consequences	5.60	1.39	27%	Severity (0.48)
2	Identity	4.71	1.31	18%	Severity (0.40)
3	Comprehensibility	4.34	1.53	3%	Severity (0.14); Vulnerability (0.10)
3	Prevention	4.28	1.56	2%	Vulnerability (−.10)
3	Treatment control	4.19	1.59	2%	Psychosocial worries (0.14)
4	Timeline	3.80	1.13	15%	Severity (0.28); vulnerability (0.15)
4	Emotional representations	3.60	1.54	54%	Existential worries (0.46); Psychosocial worries (0.26); vulnerability (0.12); Severity (0.10)
5	Patient control	2.77	1.49	1%	–

[a]By post-hoc analysis (Scheffe's test).

Discussion

As predicted, higher threat appraisal was explained mainly by health anxiety, media consumption, lower self-assessed health, and personal experience with the disease. Female gender was also found to predict higher threat appraisal, in line with findings that women report higher levels of perceived vulnerability to dangerous events (Cohen-Louck, 2019; Kung & Chen, 2012), which has been attributed to their lower self-efficacy, tendency to use less effective coping strategies, and propensity to report their fears more openly (Solomon et al., 2005). These results identify sub-groups in the population that are at increased risk of developing excessive distress and in need of support during a pandemic.

The highest component of the COVID-19 pandemic threat was its perceived severity, while risk (vulnerability) perceptions were relatively low. These findings are compatible with the literature derived from the psychometric paradigm of risk perceptions (Fischhoff et al., 1978). The most important determinant of a 'risk image' is the dread risk dimension, defined by involuntariness, uncontrollability, fatal consequences, and catastrophic results (Slovic, 2000). It seems that the severity component has captured the dread risk construct.

The finding that concern about the health of relatives was highest among the worries corresponds with reports from an ongoing study in Germany indicating that the motivation to protect vulnerable others explains willingness to restrict one's behavior (Betsch, 2020). It is also possible that given the nature of COVID-19 and the age distribution of participants in Study 1, many of them may have perceived their aged relatives to be at greater risk than themselves. An unexpected observation was that younger age was associated with higher levels of worries. This agrees with findings showing age-related reduction in worry and intolerance of uncertainty (Basevitz et al., 2008). We speculate that, compared to older adults, younger adults facing the outbreak of the COVID-19 were more worried because they were less tolerant of the uncertainty in the situation, in addition to having a stronger feeling that the pandemic will interfere with pursuing their life goals.

The discovery of a clear factor structure separating 'existential worries' from 'psycho-social worries' is noteworthy. The 'psycho-social' factor included expected components such as loneliness, relationships, mental health, and education/career worries. The 'existential' factor, on the other hand, encompassed financial concerns and uncertainty in addition to the expected death fears and health concerns. Financial worries can cause serious psychological distress (Weissman et al., 2020), and uncertainty is known to be an aversive experience underlying a range of psychological disorders (Barlow, 2000). According to Carleton (p. 39) 'Fear of the unknown may be, or possibly is, the fundamental fear, representing an Archimedean lever for human psychology' (Carleton, 2016). It is noteworthy that the outbreak of COVID-19 triggered such a fundamental worry.

Study 2

Threat appraisals and COVID-19 representations disclosed in Study 1 (T1) were expected to change with time and experience. All relevant factors were constantly changing, beginning with the natural development of the pandemic. The results of T1, which

was conducted at an early stage of the outbreak, were considered baseline bench-marks for a repeat investigation 4 months later. Study 2 was conducted to discover whether and how the representations of the new disease changed, and to explain them vis-a-vis their equivalents at baseline and the mediating threat appraisals (at both times), as delineated in our research model (Figure 1). It was expected that cognitive representations of the disease will change over time, and become more explainable by threat appraisals and worries. In addition, the cross-sectional design of Study 1 limited arriving at directional conclusions regarding the predicted influences of threat appraisals on illness representations. Study 2, being a longitudinal extension, was intended in part to clarify the direction of influences between the two groups of variables.

Methods

All participants in T1 were contacted by the survey company on August 10th, 2020, during the second wave of the pandemic in the country (Figure 2), and asked to participate again in the study about COVID-19. Recruitment for T2 ended on August 19th (a reminder was sent on August 15th).

Participants

A total of 422 individuals agreed to participate, 83% of the original sample. Fifty-one percent of the sample were male; mean age 41.99 years ($SD=15.08$); mean number of school years 14.75 ($SD=4.87$); 58% were married or in a steady relationship. Work status at the time of Study 2: 20% on unpaid leave, 23% employed as usual, 19% worked from home, 10% on paid leave, 8% unemployed prior to the pandemic, 8% retired, 2% laid off during the pandemic, and the remaining 10% reported other statuses. Health-related background: 3% reported having been infected with COVID-19; 6% reported being quarantined after possible exposure to the virus or for self-protection; 23% reported knowing a COVID-19 patient and 4% knew someone who had died of the disease; 18% reported having a chronic illness of some kind. On a 7-point scale, the mean self-assessed health was 5.58 ($SD=0.98$).
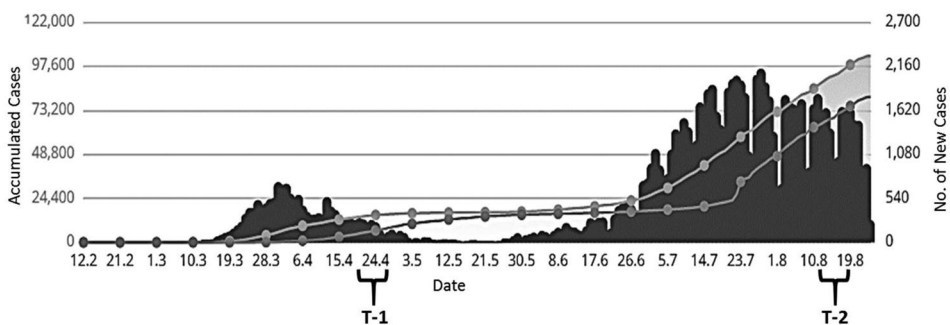

Figure 2. Two waves of data collection by distribution of new and accumulated cases of COVID-19 in Israel.

Table 3. Means and *SD*s of T1 (Study 1) and T2 (Study 2) threat appraisals and illness representations and Pearson correlations between them (*n* = 422).

	T1		T2			T1–T2 correlation
	M	*SD*	*M*	*SD*	t	
Threat appraisals:						
Vulnerability	3.30	1.20	3.68	1.16	−6.34**	.49**
Severity	4.96	1.57	4.98	1.48	−.30	.53**
Existential worries	4.20	1.38	4.38	1.39	−3.12*	.64**
Psychosocial worries	3.27	1.37	3.50	1.36	−4.26**	.66**
Illness representations:						
Emotional Representations	3.52	1.60	3.45	1.65	1.14	.64**
Consequences	5.52	1.37	5.77	1.22	−3.82**	.46**
Prevention	4.29	1.53	4.35	1.49	−.71	.30**
Timeline	3.83	1.12	4.20	1.17	−5.60**	.31**
Patient control	2.80	1.49	2.83	1.53	−.29	.36**
Treatment control	4.19	1.54	4.29	1.54	−1.13	.24**
Identity	4.70	1.30	4.95	1.22	−3.78**	.40**
Comprehensibility	4.25	1.56	3.74	1.63	6.36**	.46**

*p < .01.
**p < .001.

Instruments and procedures

The procedures and online questionnaire were the same as in T1, including the measures of background data, COVID-19 threat appraisals and worries, and COVID-19 cognitive and emotional representations (see Study 1 Methods above).

Results

The profile of COVID-19 representations at T2 is presented in Table 3. Consistent with findings of T1, repeated-measures ANOVA indicated significant differences among the representations ($F(7,415) = 186.03$, $p < .000$, $\eta_p^2 = 0.76$), with consequences highest and patient control lowest.

T1–T2 comparisons

Comparisons between the baseline and longitudinal data (Table 3) indicate that threat appraisals increased over time (except for severity), vulnerability to the disease was appraised as higher, and existential and psychosocial worries increased. Emotional representations of COVID-19 did not change between the two studies, but some of the cognitive representations changed: consequences, timeline and identity representations increased, while comprehensibility decreased. That is, compared to four months earlier, respondents evaluated COVID-19 as affecting patients' lives more seriously, causing more symptoms, lasting longer, and being less comprehensible. All the correlations between the corresponding T1 and T2 scores were significant and the stability of worries and emotional representations was especially remarkable ($r > 0.60$).

Explaining variance in T2 representations

In order to explain variance in T2 COVID-19 representations by threat appraisals and worries, regression analyses were computed for each representation separately.

Table 4. Regression model summaries for predicting T2 COVID-19 representations ($n = 422$)

T2 representation	R^2 change by steps			Significant predictors (β)	Total explained variance in T1
	Step 1	Step 2	Step 3		
Consequences	.21***	.24**	.33***	T2 Severity (.32***)	27%
				T1 Consequences (.30***)	
				T2 Existential worry (.13*)	
Identity	.16***	.20**	.27***	T1 Identity (.32***)	18%
				T2 Severity (.29***)	
				T1 Vulnerability (−.13*)	
Patient control	.13***	.17**	.22***	T1 Patient control (.34***)	1%
				T2 Severity (−.26***)	
Treatment control	.06***	.07	.08	T1 Treatment control (.24***)	2%
				T1 Vulnerability (−12*)	
Timeline	.09***	.11	.21***	T2 Severity (.34***)	15%
				T1 Timeline (.25***)	
Comprehensibility	.21***	.22	.23	T1 Comprehensibility (.47***)	3%
Prevention	.09***	.11	.12	T1 Prevention (.30***)	2%
Emotional representations	.41***	.44***	.60***	T1 Emotional representations (.45***)	54%
				T2 Psychosocial worry (.30***)	
				T2 Existential worry (.26***)	
				T1 Vulnerability (−.15***)	
				T1 Psychosocial worry (−.12*)	
				T2 Severity (.12**)	

Step 1: The equivalent representation at T1; Step 2: T1 threat and worry appraisals; Step 3: T2 threat and worry appraisals.
*$p < .05$; **$p < .01$; ***$p < .001$.

Predictors were entered in 3 consecutive steps: step 1 consisted of the equivalent T1 (baseline) representation; step 2 added the 4 baseline threat appraisals (severity, vulnerability, existential and psychosocial worries); and step 3 included the same threat appraisals measured at T2. Table 4 presents the model summaries for each of the representations, the amount of explained variance added by each step of the analysis (R^2 change), and the predictors with significant standardized coefficients (β) in the final model.

In T2, like in T1, emotional representations were far better explained by the predictive model (60% of the variance) than were cognitive representations. A few of the cognitive representations (consequences, identity, patient control and timeline) were moderately predicted (33%-21% explained variance). Treatment control, prevention and comprehensibility were least predicted by the model. Yet, compared to the total explained variances in T1, all the representations were better explained at T2, even those that were hardly predicted. For example, the prediction of the prevention representation increased from 2% to 12%. As expected, baseline levels were significant predictors of all T2 representations. Interestingly, T2 threat appraisals, especially severity appraisals, added to explained variance of most T2 representations (except prevention and comprehensibility) beyond the contributions of the same appraisals at T1.

Finally, in order to test whether T1 illness representations predicted T2 threat appraisals (the direction opposite to our research model), we conducted another series of regression analyses in which each T2 threat appraisal (severity, vulnerability, existential and psychosocial worries) was predicted by its equivalent (baseline) measure on step 1, and by all T1 illness representations on step 2. The contributions of illness representations to predicting variance in T2 threat appraisals (R^2 change in

Step 2 of the regression models) were: 2% for perceived illness severity, 4% for perceived vulnerability, 8% for psycho-social worries, and 5% for existential worries. These results (Median 4.5%) are significantly lower (z=6.6; $p < .0001$) than those obtained for predicting illness representations by threat appraisals (Median 20%; Table 4, Step 2). This supports our theoretical model, positing that threat appraisals predict illness representations.

Discussion

As predicted by the CSM, illness perceptions were found to be dynamic and changing (Leventhal et al., 2016). Clearly, representations of COVID-19 worsened over the 4-month period between the 2 measurement points: vulnerability to the disease was assessed as higher, existential and psychosocial worries increased, and the consequences, timeline and identity representations of the disease were augmented. At the same time, comprehensibility levels decreased, which may have resulted from the unmet expectation that after 4 months medical research would have solved the mystery of the disease and found a solution (Heinig et al., 2016). These findings indicate that within the timeframe of the studies, people's representations of COVID-19 indicated a trend of increasing sensitization to the threat of the disease.

Despite changes in representations' means, their relative configuration remained very similar to T1, with consequences highest and patient control lowest. Signs of stability were also evidenced by the significant correlations between T1 and T2 representations. This was especially remarkable for worries and emotional representations. Emotional representations were not only more stable than cognitive representations, they were also more explainable by the model's mediating factors: threat appraisals and worries. These findings could stem from the facilitating effect of high reliability (test-retest) on the validity of emotional representations. However, they also correspond with the extensive literature showing that affective factors are quicker and easier to develop in complex, uncertain, and dangerous circumstances (Slovic et al., 2004). In the case of COVID-19, worries and emotional representations were formed early and remained stable for a few months. Finally, the findings support our research model (Figure 1) by showing that over time, threat appraisals and worries predicted illness representations, rather than the opposite (illness representations predicting threat appraisals).

General discussion

In situations of extreme uncertainty like the COVID-19 outbreak, our brains struggle to organize confusing information into a coherent interpretation (Chater, 2020). The present research is a preliminary step toward understanding people's sense-making efforts. The unprecedented pandemic of a novel disease for which no prototype existed provided a unique opportunity to examine the very initial phases of the self-regulation process prior to the elicitation of illness representations.

The present studies achieved their main objectives: to describe and explain peoples' threat appraisals and representations of the COVID-19 disease, and to follow their development over a few months. According to the initial findings (Study 1), threat appraisal—comprised of risk and severity perceptions—and worries (existential and psychosocial) were associated with some background factors and illness representations. The main background factors associated with threat appraisals were dispositional health anxiety, female gender, increased media consumption, lower self-assessed health, and personal experience with the disease. Follow-up of appraisals and representations after 4 months (Study 2) showed that perceptions of the disease had worsened. Cross-time correlations indicated that illness representations started stabilizing; and emotional representations, compared to cognitive representations, were exceptionally stable and explainable by threat appraisals.

The current findings show that health threats, delineated in the CSM as the main cues for activating illness representations (Leventhal et al., 1992, 2011, 2016), explained mainly emotional representations, and to a lesser degree some of the cognitive dimensions: consequences, identity, patient control and timeline. This may create a vicious cycle, because situations of uncertainty evoke feelings of fear, and leave individuals little choice but to rely on their emotional experiences (Leppin & Aro, 2009), which develop faster, and are adapted for coping with complex and dangerous circumstances (Slovic et al., 2004). It seems that threat appraisals, at least in the first few months of exposure to the threat, were less relevant for the elicitation of treatment control, prevention and comprehensibility representations. The development of these representations is probably more related to 'objective' information about the disease, which was still lacking at the time of our studies. The amount and sources of media consumption may be essential for understanding the development and stabilization of COVID-19 cognitive representations (Vai et al., 2020). This topic requires further investigations.

According to the profile of COVID-19 representations discovered in both studies, consequences (effects on a patient's life) were rated highest and patient's control was rated lowest. This pattern represents a high level of learned helplessness (Seligman, 1972), an attributional style in which the person believes that bad events are global, stable and beyond control. Unfortunately, learned helplessness is associated with passive and inadequate coping with illness (Nowicka-Sauer et al., 2017). The combined worsening of illness representations and lowered comprehensibility of the disease may represent increasing levels of learned helplessness that may impact negatively on adaptive coping behaviors.

Finally, as the process of sense-making continues, the feelings and beliefs about COVID-19 are expected to develop into a 'pandemic prototype' that may influence responses to future pandemics. These 'memory' structures or prototypes defined by the common sense model are assumed to be essential expectancies that guide heuristic decisions about illness (Leventhal, 2019). Findings show that high-prototype symptom sets facilitate the processing of symptom information, increase correct identifications of target diseases, and speed responses to them (Bishop & Converse, 1986).

Limitations of the study

The brief measure of illness perceptions, with its limited level of reliability, can be improved in future studies by using the full Illness Perceptions Questionnaire (Moss-Morris et al., 2002). The attrition rate of 17% in the longitudinal study may also be considered a limitation, although recent investigations concluded that loss to follow-up rarely affects estimates of association in longitudinal studies (Saiepour et al., 2019; Steinhausen et al., 2020). Also, using only 2 measurement points for examining changes in illness perceptions may not be enough for detecting potential fluctuations in illness perceptions. In addition, all the emotional representations examined in this study were negative (mainly anxiety), although crisis situations may also elicit positive emotions (e.g. gratitude, interest, and love) found after the September 11 tragedy (Fredrickson et al., 2003). Further investigation of positive emotional representations in the context of COVID-19 is desired. Finally, the current results require replication in other populations in light of the evidence of cross-cultural differences in responses to pandemic risks (de Zwart et al., 2007).

Conclusions

In addition to the theoretical contributions about the early stages of the development of representations for a new disease, the study may also have practical implications. As evidence of the mental health toll of COVID-19 accumulates (Gallagher et al., 2020; McElroy et al., 2020), emotional representations, the most stable and valid factor found in our studies, may be an especially useful predictor of individuals in need of psychological support. This is in line with consistent findings in meta-analyses that emotional representations were the factor most related to emotional outcomes over a range of illnesses (Dempster et al., 2015b; Hagger et al., 2017; Hoerger et al., 2020). Understanding COVID-19's cognitive representations may also become paramount for explaining and predicting consequent health behaviors that, as of now, are the only available measures to fight this devastating pandemic (Lin et al., 2020; Zajenkowski et al., 2020).

Notes

1. The first patient was identified in Israel on February 27, 2020.
2. Fritz and MacKinnon (2007) present empirical power tables generated empirically from simulations of data sets, taking bootstrap samples, and then testing for significance a total of 1,000 times for each sample size. Power was then equal to the number of times out of 1,000 that the resampling confidence intervals detect the mediated effect.
3. The categories of health-related background were not mutually exclusive. A person could fall into one or more categories.
4. Unrelated to the pandemic, the political situation in Israel has been unstable in the past year.
5. The Brief IPQ is a 10-point scale. It was adapted to 7-point scales to align with for other measures in this study.

Disclosure statement

No potential conflict of interest was reported by the authors.

Data availability statement

The data that support the findings of this study are available from the corresponding author, [S.S.], upon reasonable request.

References

Arden, M. A., & Chilcot, J. (2020). Health psychology and the coronavirus (COVID-19) global pandemic: A call for research. *British Journal of Health Psychology*, 25(2), 231–232. https://doi.org/10.1111/bjhp.12414

Asmundson, G. J. G., & Taylor, S. (2020). How health anxiety influences responses to viral outbreaks like COVID-19: What all decision-makers, health authorities, and health care professionals need to know. *Journal of Anxiety Disorders*, 71, 102211. https://doi.org/10.1016/j.janxdis.2020.102211

Barlow, D. H. (2000). Unraveling the mysteries of anxiety and its disorders from the perspective of emotion theory. *American Psychologist*, 55(11), 1247–1263. https://doi.org/10.1037/0003-066X.55.11.1247

Basevitz, P., Pushkar, D., Chaikelson, J., Conway, M., & Dalton, C. (2008). Age-related differences in worry and related processes. *The International Journal of Aging and Human Development*, 66(4), 283–305. https://doi.org/10.2190/AG.66.4.b

Betsch, C. (2020). How behavioural science data helps mitigate the COVID-19 crisis. *Nature Human Behaviour*, 4(5), 438.

Bishop, G. D., & Converse, S. A. (1986). Illness representations: A prototype approach. *Health Psychology*, 5(2), 95–114. https://doi.org/10.1037//0278-6133.5.2.95

Broadbent, E., Petrie, K. J., Main, J., & Weinman, J. (2006). The brief illness perception questionnaire. *Journal of Psychosomatic Research*, 60(6), 631–637. https://doi.org/10.1016/j.jpsychores.2005.10.020

Broadbent, E., Wilkes, C., Koschwanez, H., Weinman, J., Norton, S., & Petrie, K. J. (2015). A systematic review and meta-analysis of the Brief Illness Perception Questionnaire. Psychology & *Health*, 30(11), 1361–1385. https://doi.org/10.1080/08870446.2015.1070851

Brooks, S. K., Webster, R. K., Smith, L. E., Woodland, L., Wessely, S., Greenberg, N., & Rubin, G. J. (2020). The psychological impact of quarantine and how to reduce it: Rapid review of the evidence. The *Lancet*, 395(10227), 912–920. https://doi.org/10.1016/S0140-6736(20)30460-8

Carleton, R. N. (2016). Into the unknown: A review and synthesis of contemporary models involving uncertainty. *Journal of Anxiety Disorders*, 39, 30–43. https://doi.org/10.1016/j.janxdis.2016.02.007

Chater, N. (2020). Facing up to the uncertainties of COVID-19. *Nature Human Behaviour*, 4(5), 439.

Cohen-Louck, K. (2019). Perception of the threat of terrorism. *Journal of Interpersonal Violence*, 34(5), 887–911. https://doi.org/10.1177/0886260516646091

de Zwart, O., Veldhuijzen, I. K., Elam, G., Aro, A. R., Abraham, T., Bishop, G. D., Richardus, J. H., & Brug, J. (2007). Avian influenza risk perception. *Emerging Infectious Diseases*, 13(2), 290–293. https://doi.org/10.3201/eid1302.060303

de Zwart, O., Veldhuijzen, I. K., Elam, G., Aro, A. R., Abraham, T., Bishop, G. D., Voeten, H. A. C. M., Richardus, J. H., & Brug, J. (2009). Perceived threat, risk perception, and efficacy beliefs related to SARS and other (emerging) infectious diseases: Results of an international survey. *International Journal of Behavioral Medicine*, 16(1), 30–40. https://doi.org/10.1007/s12529-008-9008-2

Dempster, M., Howell, D., & McCorry, N. K. (2015). Illness perceptions and coping in physical health conditions: A meta-analysis. *Journal of Psychosomatic Research*, 79(6), 506–513. https://doi.org/10.1016/j.jpsychores.2015.10.006

Falagas, M. E., & Kiriaze, I. J. (2006). Reaction to the threat of influenza pandemic: The mass media and the public. *Critical Care*, 10(2), 408. [Mismatch] 10.1186/cc4910

Fischhoff, B., Slovic, P., Lichtenstein, S., Read, S., & Combs, B. (1978). How safe is safe enough - psychometric study of attitudes towards technological risks and benefits. *Policy Sciences*, 9(2), 127–152. https://doi.org/10.1007/BF00143739

Fredrickson, B. L., Tugade, M. M., Waugh, C. E., & Larkin, G. R. (2003). What good are positive emotions in crises? A prospective study of resilience and emotions following the terrorist attacks on the United States on September 11th, 2001. Journal *of Personality & Social Psychology*, *84*(2), 365–376. https://doi.org/10.1037//0022-3514.84.2.365

Fritz, M. S., & MacKinnon, D. P. (2007). Required sample size to detect the mediated effect. *Psychological Science*, *18*(3), 233–239. https://doi.org/10.1111/j.1467-9280.2007.01882.x

Gallagher, M. W., Zvolensky, M. J., Long, L. J., Rogers, A. H., & Garey, L. (2020). The impact of covid-19 experiences and associated stress on anxiety, depression, and functional impairment in american adults. *Cognitive Therapy and Research*, *44*(6), 1–9. https://doi.org/10.1007/s10608-020-10143-y

Hagger, M. S., Koch, S., Chatzisarantis, N. L. D., & Orbell, S. (2017). The common sense model of self-regulation: Meta-analysis and test of a process model. *Psychological Bulletin*, *143*(11), 1117–1154. https://doi.org/10.1037/bul0000118

Heinig, S. J., Dev, A., & Bonham, A. C. (2016). The U.S. public's investment in medical research: An evolving social contract. The *American Journal of the Medical Sciences*, *351*(1), 69–76. https://doi.org/10.1016/j.amjms.2015.10.016

Hoerger, M., Alonzi, S., Perry, L. M., Voss, H. M., Easwar, S., & Gerhart, J. I. (2020). Impact of the COVID-19 pandemic on mental health: Real-time surveillance using Google Trends. *Psychological Trauma*, *12*(6), 567–568. https://doi.org/10.1037/tra0000872

Kung, Y. W., & Chen, S. H. (2012). Perception of earthquake risk in Taiwan: Effects of gender and past earthquake experience. *Risk Analysis*, *32*(9), 1535–1546. https://doi.org/10.1111/j.1539-6924.2011.01760.x

Leppin, A., & Aro, A. R. (2009). Risk perceptions related to SARS and avian influenza: Theoretical foundations of current empirical research. *International Journal of Behavioral Medicine*, *16*(1), 7–29. https://doi.org/10.1007/s12529-008-9002-8

Leventhal, H. (2019). Next Steps for examining the common-sense of health behaviour. *Health Psychology Review*, *13*(4), 487–489. https://doi.org/10.1080/17437199.2019.1642791

Leventhal, H., Diefenbach, M., & Leventhal, E. A. (1992). Illness cognition - using common-sense to understand treatment adherence and affect cognition interactions. *Cognitive Therapy and Research*, *16*(2), 143–163. https://doi.org/10.1007/BF01173486

Leventhal, H., Idler, E. L., & Leventhal, E. A. (1999). The impact of chronic illness on the self system. *Self, Social Identity, and Physical Health*, *2*, 185–208.

Leventhal, H., Leventhal, E. A., & Breland, J. Y. (2011). Cognitive science speaks to the "common-sense" of chronic illness management. *Annals of Behavioral Medicine*, *41*(2), 152–163. https://doi.org/10.1007/s12160-010-9246-9

Leventhal, H., Phillips, L. A., & Burns, E. (2016). The common-sense model of self-regulation (CSM): A dynamic framework for understanding illness self-management. *Journal of Behavioral Medicine*, *39*(6), 935–946. https://doi.org/10.1007/s10865-016-9782-2

Lin, C. Y., Imani, V., Majd, N. R., Ghasemi, Z., Griffiths, M. D., Hamilton, K., Hagger, M. S., & Pakpour, A. H. (2020). Using an integrated social cognition model to predict COVID-19 preventive behaviours. *British Journal of Health Psychology*, *25*(4), 981–1005. https://doi.org/10.1111/bjhp.12465

Lucock, M. P., & Morley, S. (1996). The health anxiety questionnaire. *British Journal of Health Psychology*, *1*(2), 137–150. https://doi.org/10.1111/j.2044-8287.1996.tb00498.x

McElroy, E., Patalay, P., Moltrecht, B., Shevlin, M., Shum, A., Creswell, C., & Waite, P. (2020). Demographic and health factors associated with pandemic anxiety in the context of COVID-19. *British Journal of Health Psychology*, *25*(4), 934–944. https://doi.org/10.1111/bjhp.12470

Moss-Morris, R., Weinman, J., Petrie, K. J., Horne, R., Cameron, L. D., & Buick, D. (2002). The revised illness perception questionnaire (IPQ-R). *Psychology & Health*, *17*(1), 1–16. https://doi.org/10.1080/08870440290001494

Nowicka-Sauer, K., Hajduk, A., Kujawska-Danecka, H., Banaszkiewicz, D., Czuszyńska, Z., Smoleńska, Ż., & Siebert, J. (2017). Learned helplessness and its associations with illness perception,

depression and anxiety among patients with systemic lupus erythematosus. *Family Medicine & Primary Care Review*, *3* (3), 243–246. https://doi.org/10.5114/fmpcr.2017.69285

Saiepour, N., Najman, J. M., Ware, R., Baker, P., Clavarino, A. M., & Williams, G. M. (2019). Does attrition affect estimates of association: A longitudinal study. Journal *of Psychiatric Research*, *110*, 127–142. https://doi.org/10.1016/j.jpsychires.2018.12.022

Seligman, M. E. (1972). Learned helplessness. *Annual Review of Medicine*, *23*(1), 407. https://doi.org/10.1146/annurev.me.23.020172.002203

Shiloh, S., Wade, C. H., Roberts, J. S., Alford, S. H., & Biesecker, B. B. (2013). Associations between risk perceptions and worry about common diseases: A between- and within-subjects examination. *Psychology & Health*, *28*(4), 434–449. https://doi.org/10.1080/08870446.2012.737464

Slovic, P. (2000). *The perception of risk*. Earthscan Publications.

Slovic, P., Finucane, M. L., Peters, E., & MacGregor, D. G. (2004). Risk as analysis and risk as feelings: Some thoughts about affect, reason, risk, and rationality. *Risk Analysis.*, *24*(2), 311–322. https://doi.org/10.1111/j.0272-4332.2004.00433.x

Solomon, Z., Gelkopf, M., & Bleich, A. (2005). Is terror gender-blind? Gender differences in reaction to terror events. *Social Psychiatry and Psychiatric Epidemiology*, *40*(12), 947–954. https://doi.org/10.1007/s00127-005-0973-3

Spielberger, C. D. (1984). *State-trait anxiety inventory: A comprehensive bibliography*. Consulting Psychologists Press.

Steinhausen, H. C., Spitz, A., Aebi, M., Metzke, C. W., & Walitza, S. (2020). Selective attrition does not affect cross-sectional estimates of associations with emotional and behavioral problems in a longitudinal study with onset in adolescence. *Psychiatry Research*, *284*, 112685. https://doi.org/10.1016/j.psychres.2019.112685

Taha, S., Matheson, K., Cronin, T., & Anisman, H. (2014). Intolerance of uncertainty, appraisals, coping, and anxiety: The case of the 2009 H1N1 pandemic. *British Journal of Health Psychology*, *19*(3), 592–605. https://doi.org/10.1111/bjhp.12058

Topper, M., Emmelkamp, P. M., Watkins, E., & Ehring, T. (2014). Development and assessment of brief versions of the Penn State Worry Questionnaire and the Ruminative Response Scale. *British Journal of Clinical Psychology*, *53*(4), 402–421. https://doi.org/10.1111/bjc.12052

Vai, B., Cazzetta, S., Ghiglino, D., Parenti, L., Saibene, G., Toti, M., Verga, C., Wykowska, A., & Benedetti, F. (2020). Risk perception and media in shaping protective behaviors: Insights from the early phase of COVID-19 Italian outbreak. Frontiers *in Psychology.*, *11*, 563426. https://doi.org/10.3389/fpsyg.2020.563426

Weissman, J., Russell, D., & Mann, J. J. (2020). Sociodemographic characteristics, financial worries and serious psychological distress in US adults. *Community Mental Health Journal*, *56*(4), 606–613. https://doi.org/10.1007/s10597-019-00519-0

Zajenkowski, M., Jonason, P. K., Leniarska, M., & Kozakiewicz, Z. (2020). Who complies with the restrictions to reduce the spread of COVID-19?: Personality and perceptions of the COVID-19 situation. Personality *and Individual Differences*, *166*, 110199. https://doi.org/10.1016/j.paid.2020.110199