Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Research paper

Health anxiety is associated with fearful imagery of contracting COVID-19: An experimental study

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ABSTRACT

Background: Aversive mental images of contracting or having a severe disease are assumed to contribute to the development and maintenance of health anxiety (HA) via the elicitation of fear, arousal and defensive mobilization. The current COVID-19 pandemic is known to trigger fears of contracting COVID-19.
Methods: In this study, we used an experimental approach to investigate whether COVID-19-related mental images lead to a fearful response and whether this is associated with levels of HA. 139 participants vividly imagined neutral, standard fear and COVID-19 related narrative scenes.
Results: Standard fear and COVID-19 scripts prompted higher anxiety, arousal, displeasure and avoidance tendencies as compared to neutral scripts. HA was associated with higher anxiety, arousal, displeasure, imagery vividness and stronger avoidance tendencies during imagery of COVID-19 scenes. No associations were found for anxiety sensitivity, trait anxiety as well as depressive and anxiety symptoms. Moreover, there was no association of HA with emotional responses during imagery of standard fear scenes.
Limitations: Fear responses were assessed via verbal reports. Future studies should also assess behavioral and physiological correlates of fear.
Conclusions: The present results indicate that individuals with high levels of HA are prone to fearful mental imagery of contracting COVID-19 which might be crucial factor contributing to the exacerbation and chronicity of excessive HA in times of a pandemic.

1. Introduction

Almost everyone experiences some health related anxiety or worries once in a while (Asmundson and Fergus, 2019; Asmundson and Taylor, 2020b). However, health anxiety may become burdensome or even psychopathologically relevant, i.e., manifest itself in excessive worry and anxiety about one's health or having or getting a severe disease (Asmundson et al., 2010; Asmundson and Fergus, 2019). Persons with high levels of HA typically misinterpret body symptoms as signs of potentially life-threatening diseases and show body checking or reassurance behavior (Warwick and Salkovskis, 1990; Asmundson et al., 2010). Moreover, it has been demonstrated that distressing intrusive imagery of contracting or having a severe disease are prevalent in individuals with high HA (Muse et al., 2010). In a line with etiological models of HA (Warwick and Salkovskis, 1990) and evidence from studies in posttraumatic stress disorder or anxiety disorder patients (Wells et al., 1995; Hackmann and Holmes, 2004; Hirsch et al., 2006; Hirsch and Holmes, 2007; Holmes and Mathews, 2010), it has been proposed that intrusive images regarding getting or having a severe disease contribute to the development and maintenance of persistent HA, possibly via the elicitation of fear, arousal and avoidance or safety behavior (Warwick and Salkovskis, 1990; Hirsch and Holmes, 2007; Muse et al., 2010). Despite its high relevance for the etiology of HA and its benefits as a potential target in the treatment or prevention of HA, the emotional responses to mental images, especially in persons high in HA, have not yet been assessed systematically.

Since the coronavirus disease (COVID-19) is spreading around the globe, individuals are faced with a realistic potential threat of contracting a disease that may take a severe course in some persons affected. This threat is constantly communicated by the media, and indicated by safety measures, that are currently in place (e.g., instructions for handwashing, wearing masks and physical distancing). Across countries worldwide the COVID-19 pandemic has led to an increase in levels of HA (Asmundson and Taylor, 2020b; Jungmann and Witthöft, 2020). High

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levels of HA, in turn, have been reported to be associated with pronounced fear and worry regarding contracting COVID-19 (Jungmann and Witthöft, 2020; Mertens et al., 2020; Sauer et al., 2020). Moreover, it may be assumed that the pandemic situation might trigger aversive and fearful mental images and concerns regarding contracting COVID-19 especially in those individuals that are high in HA (Wells and Hackmann, 1993; Muse et al., 2010). In the context of the current pandemic, i.e., a situation in which individuals are under threat of contracting a potentially life-threatening disease, the study of responses to COVID-19-related mental images and its modulation by HA allows to advance our understanding of psychopathologically relevant processes (i.e., fearful mental imagery of contracting a life-threatening disease) in individuals with high HA.

To evaluate the correlates of high HA in the current pandemic situation, we assessed HA and fear of contracting COVID-19 and elicited mental images of COVID-19-related situations in a controlled experimental design to characterize emotional responses to these images. We assumed that images of COVID-19-related situations would trigger fear, arousal and defensive mobilization. In the present study, imagery responses were systematically compared to standard fear situations which are known to elicit defensive mobilization (Lang et al., 1980; Cuthbert et al., 2003; McTeague et al., 2010). In accordance with well-established script-driven mental imagery tasks (Lang et al., 1980; Cook et al., 1988; Cuthbert et al., 2003; McTeague et al., 2009; Gruszka et al., 2018), neutral scripts were included as a non-aversive control condition. We assessed verbal indicators of defensive activation during imagery including hedonic valence as well as arousal, experienced anxiety, and the tendency to avoid imagery. To test for the specificity of the potential associations with HA, we also included psychological factors (i.e., anxiety sensitivity, trait anxiety, depressive and anxiety symptoms) that has previously been discussed to be related to increased fear of COVID-19 and fearful imagery in general (Asmundson and Taylor, 2020a; Jungmann and Witthöft, 2020; Mertens et al., 2020; Sauer et al., 2020). Based on previous studies (Jungmann and Witthöft, 2020; Mertens et al., 2020; Sauer et al., 2020), we suggested that HA would be significantly associated with increased fear of contracting COVID-19 above and beyond other psychological factors mentioned above. We assumed that participants would report higher anxiety, aversion, arousal and a stronger avoidance tendency during imagery of both aversive narrative scripts - the standard fear and COVID-19 scripts – as compared to the imagery of the neutral scripts. Moreover, we expected that higher HA (as compared to low HA) would be associated with higher anxiety, aversion, arousal and a stronger avoidance tendency during imagery of COVID-19-related narrative scenes. In line with studies in individuals with pathological anxiety demonstrating higher defensive reactivity to disorder-specific threat but not to standard threat material (McTeague et al., 2009, 2010; Lang et al., 2014), we expected that there would be no association between HA and fearful responses to imagery of threat that has no specific relevance for individuals with high HA (e.g., being attacked by a snake).

2. Methods

2.1. Participants

Due to the lack of previous studies investigating the effect of HA on emotional responses during aversive imagery, we decided that our analyses should be sufficiently powered to detect a small to medium effect. A sample size of 133 subjects was calculated to detect a small to medium effect (f^2=0.10) and to achieve a power of 95% for a single regression coefficient in a multiple linear regression model (number of predictors = 8). We expected that 20–30% of the participants would not adhere to the task, i.e., participants would be interrupted, disturbed or distracted during the experiment. Therefore, we aimed to investigate between 166 and 190 participants. In the present study, one hundred and eighty participants completed the online experiment that was conducted between the 19th May and 06th June 2020. 41 participants (23%) were excluded from the present analyses as they reported that they were interrupted, disturbed or distracted during the experiment. Overall, 139 participants (70.5% women) were included in the present analyses. Participants were aged 18 to 69 (M = 25.27, SD=8.84). Participants were recruited via convenience sampling methods (social media, personal contacts, emails, etc.). All participants gave their informed consent. The study was approved by the Ethics Committee of the Department of Psychology at the University of Marburg.

2.2. Questionnaires

Anxiety Sensitivity Index-3 (ASI-3). The ASI-3 (Taylor et al., 2007) is an 18-item measure that assesses the tendency to fear anxiety-related sensations (AS; McNally, 2002) on a 5-point Likert scale ranging from 0 (very little) to 4 (very much). In previous studies, the ASI-3 has demonstrated good reliability and validity (e.g., internal consistency α = 0.92; Taylor et al., 2007; Kemper et al., 2009, 2012). The current study also demonstrated an excellent internal consistency for the ASI-3 (i.e., α = 0.91).

State-Trait Anxiety Inventory - short form (STAI-5). The trait portion of the short form of the STAI (Laux et al., 1981; Spielberger et al., 1983) measures the general proneness to experience anxiety and perceive situations as threatening with 5 items on a 4-point Likert scale (Zsido et al., 2020). In the current study, the trait version of the STAI-5 was used. In a previous study, the STAI-5 has demonstrated good reliability and validity (e.g., internal consistency α = 0.86; Zsido et al., 2020). The current study also demonstrated good internal consistency for the trait version of the STAI-5 (i.e., α = 0.86).

Generalized Anxiety Disorder – 2 (GAD-2). The GAD-2 (Spitzer et al., 2006; Kroenke et al., 2007) is a 2-item measure that assess generalized anxiety symptoms during the last two weeks on a 4-point Likert scale ranging from 0 (not at all) to 3 (nearly every day). The GAD-2 demonstrated a high sensitivity for diagnosing anxiety disorders. The current study demonstrated an acceptable internal consistency for the GAD-2 (i.e., α = 0.73).

Patient Health Questionnaire – 2 (PHQ-2). The PHQ-2 (Kroenke et al., 2001; Löwe et al., 2005) is a 2-item measure that assess depressive symptomatology during the last two weeks on a 4-point Likert scale ranging from 0 (not at all) to 3 (nearly every day). The PHQ-2 demonstrated a high sensitivity for diagnosing depressive disorders. The current study demonstrated good internal consistency for the PHQ-2 (i.e., α = 0.80).

Modified version of the Short health anxiety inventory (mSHAI). Trait HA was measured using the German modified version of the short health anxiety inventory (SHAI; Bailer and Witthöft, 2006; Bailer et al., 2013). The mSHAI is a 14-item measure assessing HA over the past 6 months on a 5-point scale ranging from 0 (strongly disagree) to 4 (strongly agree). In previous studies, the mSHAI demonstrated excellent reliability and validity (e.g., internal consistency α = 0.94; Bailer et al., 2013). The current study demonstrated an excellent internal consistency for the mSHAI (i.e., α = 0.94).

Fear of contracting COVID-19. Participants were asked to rate their fear of contacting COVID-19 on a visual analog scale ranging from 0 (no anxiety) to 100 (very strong anxiety).

2.3. Experimental stimuli

The online experiment including ratings, timing and presentation of stimuli was realized using an online survey platform (soscisurvey.de).

Imagery scripts. Nine narrative imagery scripts were used. Scenes included three neutral (e.g., loading the dishwasher), standard fear (e.g., attack by a snake or a stranger) and COVID-19-related (e.g., experiencing COVID-19-like symptoms) events. In accordance with previous studies, we used three scripts per category (Cuthbert et al., 2003; Gruszka et al., 2018; Lang et al., 2018). Scripts comprised between 29

and 39 words. All scripts were developed according to recommendations of Lang (1979). Thus, all scripts were written in first person present tense and included sensory and context information as well as behavioral and somato-visceral responses. All scripts are provided in Table 1.

Visual Stimuli. A blue circle signaled participants to vividly imagine the scenes.

Ratings. Participants were asked to rate the vividness of imagery (1= not vivid at all, 9= very vivid) as well as their experienced anxiety (1= no anxiety, 9=very strong anxiety), displeasure (1 = pleasant, 9 = unpleasant), emotional arousal (1 = relaxed, 9 = aroused) and the wish to avoid imagery (1 = no wish to avoid, 9 = strong wish to avoid imagery) during the imagery phase on a 9-point rating scale.

2.4. Procedure

In accordance with well-established mental imagery procedures (Lang et al., 1980; Cuthbert et al., 2003; Gruszka et al., 2018; Lang et al., 2018), participants were instructed to read the scripts and, then, during presentation of the blue circle, to vividly imagine the scenes, as if actively engaged in the scene. Script texts were presented on screen for 12 s and directly followed by the 12 s imagery phase. After imagery, participants were asked to rate their vividness of imagery as well as their experienced displeasure, emotional arousal, anxiety and wish to avoid imagery during the imagery phase. Scripts were presented in a pseudo-randomized order with the restriction that no more than two scripts of the same content category were presented consecutively. Before the experiment started, one trial including reading of a neutral script as well as an imagery and rating phase was presented to practice imagery and rating procedures. After the experiment, participants were asked to complete the questionnaires mentioned above.

2.5. Data analyses

Statistical analyses were conducted with SPSS 26 (SPSS for windows, IBM). In line with previous studies (Lang et al., 1980; Cuthbert et al., 2003; Gruszka et al., 2018), all ratings were averaged per category. First, differences in emotional responses during imagery between script categories were analyzed using an analysis of variance (ANOVA) with the within-subject factor category (neutral vs. standard fear vs. COVID-19). Second, zero-order correlations between predictors and emotional responses during imagery were computed. Third, trait anxiety, anxiety sensitivity, depressive and generalized anxiety as well as trait HA were used as multiple predictors for fear of contracting COVID-19 as well as emotional responses during imagery of COVID-19 and standard fear scenes. Multiple regression models were adjusted for age, sex and emotional response during neutral imagery. All predictors and outcomes were standardized. The alpha level was set at 0.05.

Table 1
Neutral, standard fear and COVID-19-related scripts.

Neutral scene
1. I run the comb through my damp hair, check the fit of my clothes. "Everything fits." The water runs down the drain. I turn off the tap and go.
2. I take the groceries out of the car. I pick up the shopping bag, press it against my chest tightly, and lean over to close the trunk. What am I going to eat today?
3. I put a plate into the full dishwasher. “Now I can turn it on”. I put the dishwasher tablet in the dishwasher. There’s a soft beep as I switch it on.
Standard fear scene
1. I suddenly wake up in my sleeping bag. It’s pitch-black outside and I feel a snake glide up my legs. I scream, trying to get out of the sleeping bag. Will it bite me?
2. I am alone in a deserted area when suddenly a man with a knife approaches me and smirks menacingly. I run faster. My heart is pounding in my chest. What is he going to do to me?
3. I hear the screeching of brakes. I look up and see my girlfriend has been hit by a car. Her leg is crushed, a vein is torn, blood pumps onto the street. I can’t think clearly, how am I supposed to help her?
COVID-19-related scene
1. I wake up and have to cough. My throat feels dry. I immediately search the internet for the symptoms of Covid-19. I must have been infected. Do I have to go to the hospital? Will I die?
2. I feel out of breath, I have a sore throat. Have I contracted Corona? My whole body is tense. I immediately check my temperature. Will I get seriously ill?
3. Suddenly I have to sneeze, my nose is running. I get scared, I am tense. Where did I get infected with Corona? Could I have infected someone else? I pick up the phone and call my doctor.

3. Results

3.1. Differences in emotional responses during imagery of neutral, standard fear and COVID-19 scripts

As depicted in Table 2, participants reported greater aversion, emotional arousal, anxiety and a stronger avoidance tendency during imagery of standard fear and COVID-19 scenes as compared to imagery of neutral scenes (all ps < 0.05). The imagery of neutral scenes was rated as more vivid than the imagery of standard fear and COVID-19 scenes. Ratings of displeasure, emotional arousal, anxiety, avoidance tendencies and imagery vividness were significantly higher for imagery of standard fear as compared to COVID-19 scripts (all ps < 0.05, see Table 2).

3.2. Zero-order correlations between predictors and outcomes

As depicted in Table 3, trait anxiety, anxiety sensitivity and trait HA were positively correlated with fear of contracting COVID-19, while there was no association of depressive and generalized anxiety symptoms with fear of contracting COVID-19.

Trait HA was positively correlated with higher displeasure, anxiety, urge to avoid imagery and vividness of imagery as well as more emotional arousal during imagery of COVID-19 scripts (all ps < 0.01). Anxiety sensitivity was positively related to more aversion and vividness of imagery as well as higher urge to avoid imagery (all ps < 0.05), but was not correlated with emotional arousal or anxiety during imagery of COVID-19 scripts. Trait anxiety was only related to higher avoidance tendencies and vividness ratings to imagery of COVID-19 scripts (see Table 3). Depressive and generalized anxiety symptoms were not related to any emotional responses during imagery of COVID-19 scripts (see Table 3, all ps > 0.05). During imagery of standard fear scenes, higher depressive and generalized anxiety symptoms were associated with lower emotional arousal, but not with displeasure, anxiety, the tendency to avoid imagery and imagery vividness (see Table 3). There was no association of trait anxiety, anxiety sensitivity and trait HA with emotional responses during imagery of standard fear scenes (all ps $>$ 0.05).

3.3. Multiple regressions on fear of contracting COVID-19 and emotional responses during imagery

In a multiple regression model, only trait HA was significantly related to higher fear of contracting COVID-19, $\beta = 0.439$, SE $= 0.100$, $p < 0.001$, while generalized anxiety, $\beta = -0.009$, SE $= 0.149$, $p = 0.949$, depressive symptoms, $\beta = -0.066$, SE $= 0.127$, $p = 0.602$, anxiety sensitivity, $\beta = -0.120$, SE $= 0.113$, $p = 0.289$, and trait anxiety, $\beta = 0.111$, SE $= 0.129$, $p = 0.391$, were not associated with fear of contracting COVID-19. Moreover, in a multiple regression model, higher trait HA was significantly associated with higher aversion, emotional arousal, anxiety, tendency to avoid imagery and imagery vividness during imagery of COVID-19 scenes (all ps < 0.05), while the remaining predictors were not related with emotional responses during imagery of COVID-19 scripts (see Table 4, all ps > 0.05). Importantly, during imagery of standard fear scenes, there was no association of trait anxiety, anxiety sensitivity, depressive symptoms, generalized anxiety symptoms and trait HA with emotional responses (see Table 4, all ps > 0.05; except for the association between anxiety sensitivity and rated anxiety during imagery of standard fear scenes, $\beta = 0.258$, SE $= 0.116$, $p = 0.027$).

Table 2
Means and standard deviations of reported valence, arousal, anxiety, avoidance tendencies and vividness during imagery.

	Neutral		Standard fear		COVID-19		Category
Valence [1–9]	2.74	(1.21)	7.64[a]	(1.35)	6.23[a,b]	(1.31)	$F(2, 276) = 613.13$, $p < 0.001$
Arousal [1–9]	2.50	(1.20)	7.42[a]	(1.39)	5.53[a,b]	(1.56)	$F(2, 276) = 506.29$, $p < 0.001$
Anxiety [1–9]	1.39	(0.87)	6.52[a]	(1.96)	4.30[a,b]	(1.19)	$F(2, 276) = 450.20$, $p < 0.001$
Avoidance [1–9]	1.58	(0.99)	6.95[a]	(2.14)	5.00[a,b]	(2.21)	$F(2, 276) = 428.12$, $p < 0.001$
Vividness [1–9]	7.47	(1.34)	6.73[a]	(1.56)	5.61[a,b]	(1.83)	$F(2, 276) = 90.70$, $p < 0.001$

Verbal anchors: Valence: 1 = pleasant, 9 = unpleasant; Arousal: 1 = relaxed, 9 = aroused; Anxiety: 1 = no anxiety, 9 = severe anxiety, Avoidance: 1 = no wish to avoid, 9 = strong wish to avoid imagery, Vividness: 1= not at all vivid, 9= very vivid imagery.
[a] Bonferroni corrected post-hoc comparison to neutral scripts significant at $p < 0.05$.
[b] Bonferroni corrected post-hoc comparison between standard fear and COVID-19 scripts significant at $p < 0.05$.

Table 3
Zero-order correlations of predictors with fear of contracting COVID-19 and emotional responses during imagery of COVDI-19 and standard fear scripts.

	Fear of contracting COVID-19	Imagery of COVID-19 scenes					Imagery of standard fear scenes				
		Valence	Arousal	Anxiety	Avoidance	Vividness	Valence	Arousal	Anxiety	Avoidance	Vividness
Trait Anxiety (STAI-5)	.203*	.159	.150	.149	.213*	.180*	−0.026	−0.063	−0.060	.079	.029
Anxiety Sensitivity (ASI-3)	.173*	.176*	.155	.119	.171*	.233**	.069	.033	.081	.166	.139
Depressive Symptoms (PHQ-2)	.078	.034	.027	.001	−0.001	−0.064	−0.116	−0.181*	−0.149	−0.108	−0.094
Generalized anxiety symptoms (GAD-2)	.148	.056	.037	.030	.072	.032	−0.095	−0.180*	−0.140	−0.039	−0.011
Trait health anxiety (mSHAI)	.405***	.254**	.206**	.318***	.312***	.394***	.039	−043.	.055	..154	.103

***$p<0.001$, **$p<0.01$, *$p<0.05$.

Table 4
Associations of anxiety sensitivity, trait anxiety, depressive and generalized symptoms and health anxiety with emotional responses during imagery.

	Imagery of COVID-19 scripts									
	Valence		Arousal		Anxiety		Avoidance		Vividness	
predictors	*β*	SE	*β*	SE	*β*	SE	*β*	SE	*β*	SE
Anxiety Sensitivity	.074	.119	.051	.119	-.074	.114	-.023	.115	.040	.101
Trait anxiety	.081	.136	.105	.135	.150	.132	.186	.132	.175	.114
Depressive symptoms	.003	.134	.013	.132	-.036	.129	-.134	.129	-.205	.112
Generalized anxiety symptoms	-.158	.157	-.223	.156	-.197	.151	-.104	.152	-.130	.132
Health anxiety	.225*	.107	.233*	.106	.339**	.104	.281**	.105	.366***	.089
	Imagery of standard fear scripts									
	Valence		Arousal		Anxiety		Avoidance		Vividness	
predictors	*β*	SE	*β*	SE	β	SE	*β*	SE	*β*	SE
Anxiety Sensitivity	.185	.121	.224	.118	.258*	.116	.218	.119	.153	.103
Trait anxiety	-.065	.139	-.008	.134	-.160	.133	.037	.137	-.049	.117
Depressive symptoms	-.062	.137	-.075	.132	-.047	.130	-.178	.134	-.190	.115
Generalized anxiety symptoms	-.114	.160	-.204	.156	-.181	.153	-.109	.157	.062	.135
Health anxiety	.036	.109	-.046	.106	.053	.105	.097	.109	.012	.091

β: standardized beta coefficient; multiple regressions were adjusted for age, gender and respective emotional response to imagery of neutral scripts; ***$p<.001$, **$p<.01$, *$p<.05$

4. Discussion

In the present study, an established script-driven mental imagery task was used to investigate fear responses to imagery of COVID-19 related narrative scenes. The study aimed at examining whether HA is specifically associated with fearful imagery of contracting COVID-19. In the present study, standard fear and COVID-19 specific scenes prompted fearful mental imagery in all participants. However, the anxious response during imagery of COVID-19 related scenes was modulated by HA in that higher HA was associated with a more pronounced fearful emotional response during mental imagery of COVID-19 scripts. Most importantly, the association with fearful mental imagery of COVID-19 scripts was only observed for HA but not for anxiety sensitivity, trait anxiety or depressive and anxiety symptoms. Moreover, there was no association of HA with fear responses to imagery of standard fear scripts, suggesting a specific sensitivity to fearfully respond to stimuli or context information regarding a potential infection with COVID-19 (i.e., COVID-19-like body symptoms) in persons with high levels of HA.

As expected, during mental imagery of COVID-19 scenes, participants reported higher displeasure, anxiety, arousal and avoidance tendencies as compared to imagery of neutral scenes, suggesting that mental imagery of cues indicating a potential COVID-19 infection (e.g., COVID-19-like symptoms) may activate a COVID-19 related fear network. A similar fear response has repeatedly been observed during imagery of aversive and clinically relevant stimuli (e.g., feared animals, social threat situations) in healthy and clinical populations (Cook et al., 1988; Cuthbert et al., 2003; McTeague et al., 2009, 2010, 2011; McTeague et al., 2012; Burkhardt et al., 2019). Higher subjective ratings of displeasure, arousal and fear during aversive mental imagery are typically accompanied by increased physiological arousal and a pronounced potentiation of the startle eyeblink reflex indicating the activation of defensive brain circuits (Lang et al., 1980; Cuthbert et al.,

2003; Lang and McTeague, 2009; McTeague et al., 2009, 2010). It is suggested that this fear response results from increased associative strength within an elaborated fear network related to the imagined aversive stimulus (e.g., a feared animal) (Lang, 1979; Lang and McTeague, 2009). Thus, the present finding might suggest that imagery of specific cue and context information indicating a potential COVID-19 infection (i.e., COVID-19-like symptoms) might activate an elaborated COVID-19-related fear memory network, concomitant with defensive activation.

Most importantly, the current findings might indicate that this COVID-19-specific fear memory network is more elaborated in individuals with high HA. Accordingly, this might explain the increased arousal, aversion, fear and avoidance tendency during imagery of contracting COVID-19 in individuals high in HA. Interestingly, it has previously been demonstrated that the fear response pattern during aversive imagery parallel fear responses observed during anticipation or perception of threat (Lang et al., 1983). According to the bio-informational theory of emotional imagery (Lang, 1977, 1979), it is suggested that imagery of threat or indicators of threat (cues and contexts indicating threat) activate an associative fear network that overlap with the fear network activated when actually encountering the threat in real life (Lang, 1979; Ji et al., 2016). Neuroimaging studies revealed that both imagining and anticipating a clinically-relevant threat (e.g., feared body symptoms) elicit a stronger activation of the brain's defensive circuit in persons who show elevated fear of body symptoms (Holtz et al., 2012; Burkhardt et al., 2019). In line with these findings, the results of the present findings might indicate that, in individuals with increased levels of HA, cues associated with threat of COVID-19 (i.e., COVID-19-like symptoms) prompt increased activation of the brain's fear network, concomitant with maladaptive anxious behavior (e.g., stockpiling of disinfectants, excessive contact with health services or unnecessary social withdrawal). Most importantly, HA was a better predictor for fear responses to imagery of contracting COVID-19 than trait anxiety, anxiety sensitivity, or depressive and anxiety symptoms. Moreover, the present result suggest that HA is associated with an increased sensitivity to disorder-specific threat, i.e., threat of contracting a life-threatening disease, but not to threat in general. Consequently, the present findings support the view that HA might be a specific disposition to fearfully respond to threat of COVID-19.

Moreover, the findings of the study might suggest that fearful imagery of contracting a life-threatening disease is a correlate of increased HA. Previous studies demonstrated that recurrent and distressing mental images of getting or having life-threatening diseases are relatively prevalent in individuals with high HA (Wells and Hackmann, 1993; Muse et al., 2010). Similar disorder-specific intrusive images also emerge in PTSD or anxiety disorder patients that typically engage in maladaptive behaviors such as avoidance, suppression, distraction, reassurance or safety behavior to terminate or attenuate these aversive images (Borkovec et al., 2004; Clark and Wells, 1995; Ehlers and Clark, 2000; Hirsch and Holmes, 2007; Hirsch and Mathews, 2012). Interestingly, in the present study, high HA was associated with a stronger tendency to avoid COVID-19 related mental images, indicating that persons with high HA are prone to engage in maladaptive behaviors to avoid COVID-19-related imagery. According to etiological models of HA, these maladaptive behaviors are assumed to maintain pathological worries, mental images and fear, thus contributing to the proliferation and chronicity of pathological HA (Warwick and Salkovskis, 1990; Hirsch and Holmes, 2007; Muse et al., 2010; Asmundson and Fergus, 2019). Thus, fearful imagery of contracting COVID-19 might be a relevant factor contributing to the development and maintenance of HA in time of the corona pandemic.

5. Limitations

Several limitations of the present findings need to be commented on. The present experiment was conducted online to allow the study of fear processing related to threat of COVID-19 under pandemic conditions. Therefore, in the present study, we only used verbal indicators of defensive motivational activation. However, for a comprehensive characterization of fear processing during mental imagery of COVID-19 related narrative scenes, future studies ought to assess behavioral and physiological (somatic reflex and arousal responses) correlates of fear. Future studies should also consider prior experiences related to COVID-19 or a potential exposure to COVID-19 to elucidate a potential modulatory effect on fearful imagery. Moreover, the sample is predominantly composed of young, female participants limiting the generalization of the result. Therefore, the present findings should be replicated in larger and more diverse samples in terms of age and gender.

6. Conclusion

In the present study, it was demonstrated that higher HA is associated with increased fear, arousal, aversion and stronger avoidance tendencies to COVID-19-related mental images. The present result suggests that individuals with high HA are prone to anxiously respond to cues and contexts indicating a potential COVID-19 infection (e.g., COVID-19-like symptoms). Importantly, in the context of the COVID-19 pandemic, this anxious response elicited by threat of COVID-19 might be accompanied by maladaptive behavior such as stockpiling of disinfectants, excessive contact with health services or unnecessary social withdrawal. Moreover, fearful imagery of contracting a life-threatening disease might be a crucial factor contributing to the proliferation or chronicity of pathological HA. Script-driven mental imagery might be a useful tool to characterize defensive reactivity in persons with varying levels of HA to elucidate the role of fearful imagery in HA. Future studies might use a longitudinal design to delineate the exact role of fearful imagery on the development and maintenance of HA. Moreover, mental imagery of feared situations, cues or events has been successfully implemented in the treatment of PTSD and various anxiety disorders (Holmes et al., 2007; Wild et al., 2008; Hoyer et al., 2009; Neudeck and Wittchen, 2012). Thus, targeting aversive images via imagery exposure or imagery re-scripting might help to optimize and improve treatments of HA.

Declaration of Competing Interest

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