ann. behav. med. (2016) 50:935–945
DOI 10.1007/s12160-016-9820-x

ORIGINAL ARTICLE

The "ick" Factor Matters: Disgust Prospectively Predicts Avoidance in Chemotherapy Patients

Lisa M. Reynolds, PhD[1] · Ian P. Bissett, MBChB, FRACS, MD[2] · David Porter, MBChB, FRACP, MD[3] · Nathan S. Consedine, PhD[1]

Published online: 13 July 2016

Abstract
Background Chemotherapy can be physically and psychologically demanding. Avoidance and withdrawal are common among patients coping with these demands.
Purpose This report compares established emotional predictors of avoidance during chemotherapy (embarrassment; distress) with an emotion (disgust) that has been unstudied in this context.
Methods This report outlines secondary analyses of an RCT where 68 cancer patients undergoing chemotherapy were randomized to mindfulness or relaxation interventions. Self-reported baseline disgust (DS-R), embarrassment (SES-SF), and distress (Distress Thermometer) were used to prospectively predict multiple classes of avoidance post-intervention and at 3 months follow-up. Measures assessed social avoidance, cognitive and emotional avoidance (IES Avoidance), as well as information seeking and treatment adherence (General Adherence Scale).
Results Repeated-measures ANOVAs evaluated possible longitudinal changes in disgust and forward entry regression models contrasted the ability of the affective variables to predict avoidance. Although disgust did not change over time or vary between groups, greater disgust predicted greater social, cognitive, and emotional avoidance, as well as greater information seeking. Social avoidance was predicted by trait embarrassment and distress predicted non-adherence.
Conclusions This report represents the first investigation of disgust's ability to prospectively predict avoidance in people undergoing chemotherapy. Compared to embarrassment and distress, disgust was a more consistent predictor across avoidance domains and its predictive ability was evident across a longer period of time. Findings highlight disgust's role as an indicator of likely avoidance in this health context. Early identification of cancer patients at risk of deleterious avoidance may enable timely interventions and has important clinical implications (ACTRN12613000238774).

Keywords Disgust · Emotion · Avoidance · Chemotherapy · Cancer · Health

Introduction

Significant physical and psychological challenges confront the chemotherapy patient. Alongside the emotional challenge of a cancer diagnosis, treatment is typically characterized by the burden of numerous appointments and hospital commitments, the actual or anticipated fear of debilitating physical symptoms, and marked changes to lifestyle, social and role functioning [1–3]. Whereas some patients confront these challenges directly, others do not. Withdrawal, avoidance, and delay are common; people delay seeking help for symptoms [4], avoid talking to others about their cancer [5], fail to make decisions about treatment within recommended timelines [6], and do not adhere to treatment [7].

Although avoidance may be of little consequence in some contexts, avoidance during acute cancer treatment can be

✉ Lisa M. Reynolds
l.reynolds@auckland.ac.nz

[1] Department of Psychological Medicine, The University of Auckland, Private bag 92019, Victoria Street West, Auckland 1142 New Zealand

[2] Department of Surgery, The University of Auckland, Private bag 92019, Victoria Street West, Auckland 1142, New Zealand

[3] Auckland Regional Cancer and Blood Service, Auckland, New Zealand

serious. Delays predict health complications and reduced survival [8, 9] and non-adherence to recommended treatments is linked to impaired psychological functioning [10]. The current report describes a prospective investigation into an established predictor of avoidance (disgust) that while seemingly relevant in the cancer treatment context has historically been overlooked.

While there are undoubtedly multi-faceted contributors to avoidance in cancer settings, it is the functional, economic, or socio-cultural predictors that have gained the widest attention [11, 12]. It has only been recently that less "rational" predictors of avoidance (i.e., emotions) have been considered across the cancer care trajectory. Two emotions in particular have received attention: fear and embarrassment. Greater embarrassment, for example, predicts avoidance of medical examinations [13, 14] and fear of pain or a cancer diagnosis can deter people from screening [15–17]. Until recently, however, disgust has been overlooked. Given that disgust is arguably the only emotion specifically evolved with a health-promoting purpose [18], this omission is surprising.

Evolutionary theorists posit that the primary purpose of disgust is to promote avoidance of actual or potential threats to health [19, 20]. When a stimulus is appraised as a potential contaminant, a coordinated cluster of behavioral, physiological, cognitive, and expressive changes occur [21]. Physical sensations (e.g., stomach churning, nostrils narrow, salivation increases), aversive thoughts (e.g., about the nastiness of the stimuli), and motivational tendencies (e.g., desire to withdraw from or avoid situations altogether) combine to minimize exposures. Importantly, many of the established elicitors of disgust (blood, feces, vomit, reminders of death, etc. [22]) are evident in physical health contexts such as chemotherapy. Initial experimental work in the area suggests its causal significance, with greater disgust predicting increased illness threat perceptions [23], greater attention to cleanliness [24], behavioral avoidance of "disgusting" stimuli like a filled bedpan or stoma bag [25, 26], and anticipated avoidance of help-seeking where medical contact would involve exposure to disgust elicitors [27]. However, this work has predominantly been conducted with young, essentially healthy, volunteers in laboratory contexts, with few studies investigating disgust among patients or in cancer settings.

A recent review of disgust and cancer identified only a handful of studies [28], with most focused on screening [29, 30]. Fewer studies exist in cancer *treatment* settings. Notable exceptions include a pair of cross-sectional studies showing that some chemotherapy patients report disgust towards blood and/or receiving injections [31, 32] and a single qualitative study showing that treatment side effects (hair loss) can elicit disgust [33]. To date, no research has examined whether disgust might predict avoidance during cancer treatment and interpretations are necessarily limited by the cross-sectional nature of the designs.

In the context of cancer treatment, it is also noteworthy that the tendency to feel disgusted varies across persons and contexts [34]. Greater disgust sensitivity predicts poorer adjustment to illness and reduced quality of life in patient populations [35, 36]. In addition, sensitivity is heightened when vulnerability to pathogens increases [37] such as in the first trimester of pregnancy [38], when conception risk is high [39], or during demanding medical regimens [40]. That disgust sensitivity might fluctuate in tandem with immune vulnerability is pertinent to contexts where health is compromised as it may serve to exaggerate avoidant tendencies or the impact of disgust [27]. Given that chemotherapy typically suppresses immunity and leaves cancer patients vulnerable to infection [41], it may be that disgust has particular relevance in this context. Again however, there is little work to provide insight into whether sensitivity to disgust or other emotional responses are particularly relevant during chemotherapy treatment.

The Current Report

Chemotherapy can be a challenging treatment for cancer patients [1–3], and avoidance is common [28]. Given that chemotherapy contains many established elicitors of disgust and the fact that disgust causes avoidance [27], we hypothesized that disgust might also predict avoidance during chemotherapy. Thus, the aim of the current report was to investigate whether disgust sensitivity predicted social, emotional, cognitive, and behavioral avoidance (non-adherence) during cancer treatment. Because multiple, avoidance-promoting emotions (i.e., distress, embarrassment, and disgust) can occur in cancer treatment, a secondary aim was to contrast the ability of distinct emotional responses to prospectively predict different classes of avoidance.

Method

Study Design and Participants

The current report presents a secondary analysis of a randomized controlled trial among cancer patients undergoing chemotherapy. These data, and detail about the procedure, are presented elsewhere [42]. In brief, patients with a cancer diagnosis scheduled to initiate chemotherapy completed trait measures of emotion before being randomized to one of two conditions: a brief mindfulness-based program (bMBT) or an active control (relaxation). Exclusions were as follows: non-English speaking patients, those aged less than 18 years, previous chemotherapy, or concurrent enrolment in another clinical trial. The study was given ethical approval by the New Zealand Northern B Health and Disability Ethics Committee, the protocol was approved by the Auckland District Health

Board (ADHB) Research Review Committee, and was prospectively registered with the Australian New Zealand Clinical Trials Registry (ACTRN1261300238774).

Procedure

Eligible patients were identified from the ADHB chemotherapy waitlist between March and August 2013. Interested participants were given written information about the study and a consent form. Depending on preference, a baseline questionnaire assessing dispositional emotion was completed electronically or in written form. Participants were randomized to group in blocks of eight, using an Excel-generated randomization sequence. In both conditions, participants attended three 90 min sessions on consecutive weeks at the premises of the Cancer Society, Auckland. Participants were given a $10 petrol voucher for each session to cover travel costs, and, when transport was unavailable, volunteer drivers/taxis were provided. Data were collected March 2013–January 2014.

Measures

Assessment occurred at three time points: immediately prior (baseline) and post-intervention, and at follow-up, 3 months later (see Fig. 1).

Demographics and Medical Status

The baseline questionnaire assessed demographics such as age, sex, marital status, and ethnicity (see Table 1). Chart reviews were conducted to verify diagnosis and determine the presence of (non)metastatic disease.

Physical and Psychological Symptomology

At all three time points, participants completed the Memorial Symptom Assessment Scale—Short Form (MSAS-SF) assessing the presence of 28 physical symptoms and four psychological symptoms in cancer patients [43]. Participants indicate the presence/absence of symptoms during the past 7 days. Items were summed to provide a total score, with higher scores indicating greater symptomology.

Baseline Affective Measures (Time 1)

Distress

The Distress Thermometer (DT) is a widely used, one-item measure that briefly and simply assesses distress in cancer patients [44]. Using a 0 to 10 scale, participants rate distress across the past week. Higher scores indicate higher distress.

Embarrassment

A modified version of the Susceptibility to Embarrassment Scale assessed the tendency to become embarrassed (SES; [45]). Given concerns about the practicalities of a 25-item measure, it was shortened to the 10 items loading of .70 or greater in an early study of physical health in older adults. Items including "I feel inadequate when I am talking to someone I just met" and "I get tense just thinking about making a presentation by myself." In the current report, internal consistency for the modified SES was strong (Time 1, $\alpha = .95$).

Disgust

The tendency to experience disgust was assessed using the Disgust Sensitivity-Revised scale (DS-R) [46]. The DS-R is a 27-item measure on which participants use a 0 to 4 scale to rate how disgusting they find a variety of experiences and the extent of agreement with a list of possible behavioral responses to established elicitors. The DS-R has been used in numerous studies [25, 47], has good internal consistency, demonstrated construct validity, and predicts avoidance behavior in experimental settings [46]. The total mean score provides an overall score, with higher scores indicating greater sensitivity. In this study, reliability for the DS-R at Time 1 was .78.

Outcome Measures (Time 2 and Time 3)

In line with the exploratory nature of this report, several types of avoidance and withdrawal that commonly occur during the cancer trajectory were assessed.

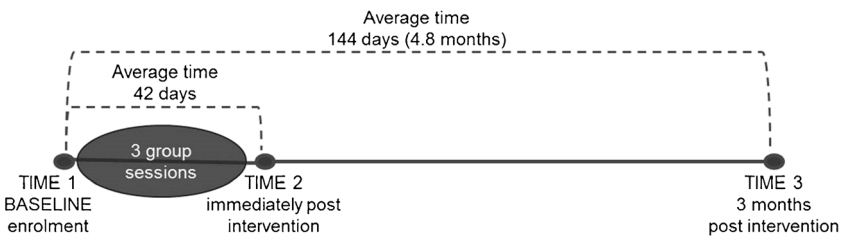

Fig. 1 Assessments conducted at three time points

Table 1 Demographic characteristics for participants

Measure	$N = 68$
Age: mean (SD)	55.97 (12.78)
Gender:	
Male	19 (27.9 %)
Female	49 (72.1 %)
Marital status:	
Single	13 (19.1 %)
Married/cohabiting	42 (61.8 %)
Separated/divorced/widowed	13 (19.1 %)
Ethnicity:	
NZ European	49 (72.1 %)
NZ Maori	7 (10.3 %)
NZ Maori/European	2 (2.9 %)
Pacific	4 (5.9 %)
Asian	5 (7.4 %)
Other	1 (1.5 %)
Diagnoses:	
Breast	27 (39.7 %)
Lung	7 (10.3 %)
Colorectal/anal	15 (22.1 %)
Gynecological	7 (10.3 %)
Upper gastrointestinal	2 (2.9 %)
Head/neck	2 (2.9 %)
Bladder	2 (2.9 %)
Prostate	2 (2.9 %)
Other	4 (5.9 %)
Time since diagnosis, weeks (SD)	11.57 (11.91)
Chemotherapy:	
Adjuvant	39 (57.4 %)
Neo-adjuvant	12 (17.6 %)
Metastatic	17 (25.0 %)

Social Avoidance

Socially avoidant thoughts and feelings were assessed with a specifically developed seven-item scale listing reasons that people with cancer might avoid other people. Participants were asked "Since I was diagnosed with cancer, I have avoided other people because…" and asked to rate from 0 to 4 how true a number of statements were for them, including "I was embarrassed by the way I look" and "I didn't want to talk about unpleasant aspects of my cancer and treatment." Principal components analysis suggested a single component that had good reliability (Time 2, $\alpha = .94$; Time 3, $\alpha = .93$).

Cognitive and Emotional Avoidance

The Impact of Events Scale—Revised (IES-R) is a 22-item measure assessing thoughts, feelings, and behavior after traumatic events [48]. It has three subscales including cognitive/emotional avoidance, intrusion, and hyper-arousal. The IES-R has been adapted to assess the impact of a cancer diagnosis (Impact of Events Scale-Cancer; IES-C) and been shown to be valid and reliable in cancer patients [49]. The avoidance sub-scale includes items such as "I tried not to talk about cancer" and "I stayed away from reminders of cancer" and has good reliability (Time 2, $\alpha = .90$; Time 3, $\alpha = .90$).

Non-adherence to Treatment

Self-reported non-adherence to chemotherapy was assessed using the five-item General Adherence (GA) Scale as originally used in the Medical Outcomes Study [50]. While it has previously been reliable in cancer patients (Cronbach alphas ranging from .66 to .89; [50]), internal reliability was suboptimal in our sample (Time 2, $\alpha = .55$; Time 2, $\alpha = .51$). Removal of the reverse-coded items improved scale reliability (Time 2, $\alpha = .67$; Time 3, $\alpha = .78$). The modified version of the GA Scale thus included three items: "I had a hard time doing what the doctor suggested I do," "I was unable to do what was necessary to follow my doctor's treatment plans," and "I had thoughts about quitting my treatment" with six responses ranging from "none of the time" (coded 0) to "all of the time" (coded 5). Items are summed to give a total treatment adherence score, with higher scores indicating greater difficulties with adherence.

Information Seeking

To assess the absence of avoidance, participants were asked to specify how many times in the past 4 weeks they had contacted (a) their personal doctor, (b) the hospital, and/or (c) a cancer help-line for *additional* information about their cancer or treatment. Data were summed to give a total number of contacts. As might be expected, these data were skewed and a binary variable was created with those that made no additional contacts coded 0, and those that made one or more contacts coded 1.

Analytic Strategy

Commensurate with research foci, analyses proceed in two general phases. First, in line with our exploration of whether avoidance-promoting affect changed over time, Intent to Treat (ITT) analyses began by assessing whether disgust sensitivity, dispositional embarrassment, and distress, changed over time and whether there were main effects associated with intervention group or time and/or whether these variables interacted. A series of 3 Time (baseline vs. post-intervention vs. 3 month follow-up) × 2 Condition (bMBT vs. relaxation) repeated-measures ANOVAs on DS-R, SES, and distress thermometer scores were conducted. Second, we evaluated whether

affective variables (distress, embarrassment, disgust) at baseline prospectively predicted avoidance immediately after the group intervention or at follow-up. For continuous variables (social avoidance, cognitive and emotional avoidance, and treatment adherence), step-wise multiple regression models were run, and a logistic variant was used for the information seeking variable. In each of these models, possible confounds including intervention group, sex, presence of metastatic disease, and number of symptoms were entered at step 1. At step 2, potential affective predictors of avoidance—baseline distress, embarrassment, and disgust—were allowed to enter the model via forward entry. We thus assessed (1) which, if any, affective predictors were preferentially entered into the models and (2) the extent to which adding these variables improved the model's ability to predict outcomes.

Results

Did Affect Change Over Time?

To assess whether our measures of affect changed over time, a series of time (baseline vs. post-intervention vs. 3 months later) × 2 condition (bMBT vs. relaxation) repeated-measures ANOVAs on disgust sensitivity (DS-R scores), dispositional embarrassment (SES scores), and distress (distress thermometer scores) were conducted. There was no change in disgust sensitivity over time (Wilks' $\Lambda = .98$, $F(2, 65) = .74$, $p = .481$, $\eta_p^2 = .02$), nor was there an interaction between time and condition (Wilks' $\Lambda = 1.00$, $F(2,65) = .16$, $p = .854$, $\eta_p^2 = .01$). In contrast, dispositional embarrassment declined over time (Wilks' $\Lambda = .88$, $F(2,65) = 4.56$, $p = .014$, $\eta_p^2 = .12$), although, like disgust, there was no interaction between time and condition (Wilks' $\Lambda = .98$, $F(2,65) = .54$, $p = .586$, $\eta_p^2 = .02$). Similarly, distress marginally declined over time (Wilks' $\Lambda = .92$, $F(2,65) = 2.77$, $p = .070$, $\eta_p^2 = .08$), although again, there was no interaction between time and condition (Wilks' $\Lambda = .99$, $F(2,65) = .31$, $p = .735$, $\eta_p^2 = .01$).

Affective Predictors of Avoidance

Social Avoidance

The model assessing the predictors of social avoidance post-intervention was significant at the first step when possible covariates were entered (group, sex, presence of metastatic disease, and number of symptoms), $R^2 = .22$, $F(4,67) = 4.34$, $p = .004$, and remained significant at both a second step when disgust sensitivity was brought into the model, $R^2 = .39$, $F(5,67) = 8.03$, $p = .000$, and a third step when dispositional embarrassability entered, $R^2 = .50$, $F(6,67) = 10.05$, $p = .000$. The final model showed that greater social avoidance was predicted by a greater number of symptoms, $\beta = .22$, $t(67) = 2.24$, $p = .028$, by being male, $\beta = -.23$, $t(67) = -2.09$, $p = .041$, and, as expected, by greater disgust sensitivity $\beta = .40$, $t(67) = 3.77$, $p = .000$, and greater embarrassment $\beta = .40$, $t(67) = 3.55$, $p = .001$. Distress was not utilized by the model at any step.

Next, the prospective predictors of social avoidance at the 3-month follow-up were evaluated. At step 1, the initial model was significant $R^2 = .21$, $F(4,67) = 4.16$, $p = .005$, and significance was maintained at step 2 when disgust was brought into the model, $R^2 = .41$, $F(5,67) = 8.49$, $p = .000$, and, again, at a third step when embarrassment was entered, $R^2 = .45$, $F(6,67) = 8.17$, $p = .000$. In the final model, greater social avoidance at the 3-month follow-up was predicted by greater symptoms, $\beta = .29$, $t(67) = 2.87$, $p = .006$, greater baseline disgust sensitivity, $\beta = .43$, $t(67) = 4.05$, $p = .000$, and greater baseline embarrassment, $\beta = .22$, $t(67) = 2.08$, $p = .042$ (see Table 2).

Cognitive and Emotional Avoidance

The model investigating IES-C avoidance post-intervention was not significant at step 1, $R^2 = .31$, $F(4,67) = 1.72$, $p = .156$, but became significant in step 2 when disgust was entered, $R^2 = .37$, $F(5,67) = 7.31$, $p = .000$, and remained significant at a third step when distress was entered, $R^2 = .42$, $F(6,67) = 7.48$, $p = .000$. Embarrassment was not brought into the model at any step. In the final model, none of the covariates were independent predictors but greater disgust sensitivity $\beta = .49$, $t(67) = 4.22$, $p = .000$, and greater distress $\beta = .29$, $t(67) = 2.37$, $p = .021$, both predicted greater avoidance; disgust was, again, the stronger predictor.

The 3-month model assessing cognitive and emotional avoidance was significant at step 1, $R^2 = .25$, $F(4,67) = 3.53$, $p = .001$, and remained significant in step 2 when disgust was brought into the model, $R^2 = .42$, $F(5,67) = 9.04$, $p = .000$. Neither embarrassment nor distress was entered. In the final step, greater cognitive and emotional avoidance was predicted by greater symptoms, $\beta = .37$, $t(67) = 3.66$, $p = .001$, and greater disgust sensitivity $\beta = .46$, $t(67) = 4.34$, $p = .000$.

Non-adherence to Treatment

Next, predictors of GA scores at the two time points were assessed. The model assessing predictors of non-adherence post-intervention was significant at step 1, $R^2 = .15$, $F(4,67) = 2.73$, $p = .037$, and at step 2, when distress was entered, $R^2 = .25$, $F(5,67) = 4.06$, $p = .003$. Neither disgust nor embarrassment was entered. Unlike the avoidance metrics, only greater distress predicted greater non-adherence to treatment $\beta = .37$, $t(67) = 2.85$, $p = .006$.

The model assessing predictors of adherence at the 3-month follow-up was marginal at step 1, $R^2 = .13$, $F(4,67) = 2.30$, $p = .069$, but significant at step 2 when distress

Table 2 Step-wise multiple regression: final (steps 2 and 3) models showing predictors of social avoidance, cognitive and emotional avoidance, and treatment adherence immediately post-intervention and 3 months later

Variable (β)		Social avoidance		Cognitive and emotional avoidance		Self-reported non-adherence to treatment	
		Post-intervention	3-months follow-up	Post-intervention	3-months follow-up	Post-intervention	3-months follow-up
Group[a]		.12	−.00	.14	.00	.04	−.05
Sex[a]		−.23*	−.17	−.20+	−.08	−.16	−.13
Metastatic disease[b]		−.09	−.09	−.05	.06	−.23+	−.21
Number of symptoms		.22*	.29**	.02	.37**	.17	.17
Distress		x	x	.29*	x	.37**	.45**
Embarrassment		.40**	.22*	x	x	x	x
Disgust sensitivity		.40**	.43**	.49**	.46**	x	x
Step 1 model:	R^2	.22	.21	.10	.25	.15	.13
	F	4.34**	4.16**	1.72	5.13**	2.73*	2.30+
Step 2 model:	R^2 (ΔR^2)	.39 (.18)	.41 (.20)	.37 (.27)	.65 (.18)	.25 (.10)	.30 (.07)
	F ($F\Delta$)	8.03** (18.10)**	8.49** (20.64**)	7.31** (26.83**)	9.04** (18.87**)	4.06** (8.13**)	5.27**(15.11**)
Step 3 model:	R^2 (ΔR^2)	.50 (.10)	.45 (.04)	.42 (.05)	–	–	–
	F ($F\Delta$)	10.05** (12.61**)	8.17** (4.32*)	7.48** (5.62*)	–	–	–

x = not utilized in model

$^{+}p < .10$; $^{*}p < .05$; $^{**}p < .01$

[a] Binary data coded 0/1 such that 0 = control and male

[b] Categorical data coded 0 = non-metastatic, 1 = adjuvant, 2 = metastatic

was brought into the model, $R^2 = .30$, $F(5,67) = 5.27$, $p = .000$. Neither embarrassment nor disgust was brought into the model. In the final model, again, greater reported difficulties with adherence was only predicted by greater distress, $\beta = .45$, $t(67) = 3.89$, $p = .000$.

Information Seeking

Given the distribution of the information seeking variable (low/high), logistic regressions were run to assess predictors at each time point. The model predicting the presence/absence of information seeking immediately post-intervention was significant at the first step χ^2 (4, 68) = 12.22, $p = .016$, and explained 22.5 % of the variance (Nagelkerke R^2). Women were marginally more likely than men to seek information, Wald = 3.12, $df = 1$, $\eta_p^2 = 3.64$, $p = .078$, but no affective variables were entered.

These analyses were repeated by testing the predictors of information seeking at 3 months. The step 1 model was significant, χ^2 (4, 68) = 12.07, $p = .017$, and explained 22.0 % variance (Nagelkerke R^2). At step 2, with disgust entered, χ^2 (5, 68) = 17.12, $p = .004$, 30.1 % variance was explained, with 70.1 correctly classified cases. Neither embarrassment nor distress was entered. In the final model, lower odds of seeking additional information was predicted by greater symptoms, Wald = 3.92, $df = 1$, $\eta_p^2 = 1.07$, $p = .048$, and greater disgust sensitivity, Wald = 4.67, $df = 1$, $\eta_p^2 = 2.48$, $p = .031$ (see Table 3).

Discussion

The physical and psychological challenges associated with chemotherapy have been extensively studied. So too have the avoidant strategies that cancer patients often employ to manage these challenges; evading others, missing appointments, and steering clear of cancer reminders are all common hallmarks of the cancer trajectory. What has been less studied is how an emotion known to promote avoidance, such as disgust, might be relevant. The current study is the first to explore this possibility, and analyses permit several observations. First, while disgust did not change over time in cancer patients as they underwent chemotherapy (and did not vary between intervention groups), baseline dispositional disgust was a robust prospective predictor of multiple forms of avoidance. Greater baseline disgust sensitivity predicted greater self-reported social avoidance, cognitive and emotional avoidance and, perhaps conversely, also predicted greater information seeking. Second, this report also provides some indication that distinct affects may be germane to different forms of avoidance. As might be expected, embarrassment predicted social avoidance but *did not* predict avoidance in other (non-social) domains. Likewise, distress showed a discriminant

Table 3 Step-wise logistic regression: final models showing predictors of information seeking immediately post-intervention and 3 months later

Variable	*B*	Wald	Odds ratio (η_p^2)	95 % CI for odds ratio	
				Lower	Higher
Post-intervention:					
Group[a]	−.91	2.58	.40	.13	1.22
Sex[a]	1.29	3.12	3.64+	.87	15.25
Metastatic disease[b]	−.29	.61	.75	.37	1.54
Number of symptoms	.05	1.76	1.05	.98	1.12
Distress	x	x	x	x	x
Embarrassment	x	x	x	x	x
Disgust sensitivity	x	x	x	x	x
3 months later:					
Group[a]	1.04	2.95	2.82	.86	9.21
Sex[a]	.97	.73	2.65	.64	10.99
Metastatic disease[b]	−.06	.02	.95	.46	1.93
Number of symptoms	.07	3.92	1.07*	1.00	1.14
Distress	x	x	x	x	x
Embarrassment	x	x	x	x	x
Disgust sensitivity	.91	4.67	2.48*	1.09	5.63

x not utilized in model

$^{+}p < .10$; $^{*}p < .05$; $^{**}p < .01$

[a] Binary data coded 0/1 such that 0 = control and male;

[b] Categorical data coded 0 = non-metastatic, 1 = adjuvant, 2 = metastatic

pattern of relationships, predicting more difficulties with treatment adherence and short-term cognitive/emotional avoidance but not with other outcomes. Below, we consider how our findings extend the current literature, discuss clinical implications, and conclude by noting study limitations and directions for future research.

We believe that evolutionary theory offers some insight to our findings. In this view, disgust evolved as a protective mechanism to ward against potential health threats [19, 20]. Given the increased vulnerability to infection in people with compromised immune function—as is typical during chemotherapy [41]—we expected that disgust sensitivity might fluctuate in chemotherapy patients over the course of treatment. However, our results showed no changes across the three measurement points. This finding appears in contrast with studies showing disgust sensitivity to be greatest when infection risk is high [51] and during periods of reduced immunity such as the first trimester of pregnancy [38]. Unlike the current work, prior studies have utilized between-group methodologies and, to our knowledge, no other studies have investigated how (or whether) disgust might change over time *within* a sample as infection risk fluctuates.

Despite our null results, however, it remains possible that disgust sensitivity may fluctuate in tandem with immune system functioning in cancer or other patient samples. There are two reasons why this possibility may not have been supported in the current report. First, these findings represent a secondary analysis of data from a broader trial that was not specifically designed to assess fluctuations in either immunity or disgust. It is possible that fluctuations in disgust and immunity are relatively nuanced and that the study design was inadequately powered to detect this relationship. Future studies would need to gather data at the specific points in the chemotherapy cycle when immunity is known to vary [41] and, potentially, use a more sensitive and less trait-like measure of disgust. Second, it may be that *habituation* to disgust elicitors is occurring concurrently and thus countering small fluctuations in immune status. Repeated exposure to elicitors can lead to reductions in disgust sensitivity [52, 53] and habituation may occur across chemotherapy. In any case, given the issues associated with appetite and weight loss among chemotherapy patients, possible links between immunity and disgust sensitivity during chemotherapy warrant future research.

More expected, and in line with disgust's evolved function to minimize exposure to potential health risks, was our finding that disgust prospectively predicted avoidance in social, cognitive, and emotional domains. In a general sense, the compromised immunity of cancer patients coupled with the health risks posed by others may mean that restricting social interactions is adaptive, an interpretation that is consistent with suggestions that disgust comprises part of a "behavioral immune system" [37, 54]. Groups living in geographic regions with historically high rates of infectious disease are less extraverted [55] and recent experimental work suggests that disgust

causes social avoidance [56]. Although it was not directly tested here, strangers are known to evoke stronger avoidance of disgusting material [57], presumably because people have a lower immunity to deal with pathogens of less familiar persons [57].

However, greater disgust also predicted avoidance of both cognitions ("I tried not to think about cancer") and emotions ("I avoided letting myself getting upset about cancer"). While avoidance of this type may not directly ward against threats to health, it may be that through a process of "preadaptation" [58], the disgust system promotes the avoidance of stimuli that are "risky" in other senses. Much like the adapted variant "socio-moral disgust" which promotes the avoidance of individuals who violate social or moral codes [59], disgust may be fostering avoidance of *psychologically* risky stimuli, such as reminders of cancer. The current work extends such studies by showing links between disgust and avoidance across various domains in a clinical sample.

Perhaps surprisingly then, analyses also revealed that both greater disgust and number of physical symptoms predicted *increased* information seeking. These findings are consistent with suggestions that to understand avoidance, we must first understand the *source* of emotions [16]. Perhaps cancer patients, disgusted by their symptoms, seek additional information as a means of managing symptoms. Studies have found that emotions predict both a higher and a lower frequency of cancer screening depending on whether persons are afraid of cancer or the screening process itself [14, 15]. Similarly, people who are embarrassed by the idea of undressing in front of their doctor may be less likely to seek medical help [13], whereas embarrassment caused by socially observable symptoms such as urinary incontinence, poor dentition, or obesity are more likely to do so [14]. Like embarrassment, disgust occurs in response to specific elicitors. Thus, where patients are confronted with "disgusting" symptoms, information seeking, health care utilization, and treatment adherence might be greater. Our data showed that information seeking was greater in more disgust sensitive persons, although adherence to treatment was not predicted by disgust. The majority of participants reported no difficulties with adherence and it may be that larger, less self-selected samples are needed to detect variation in this important outcome. Investigating the health-promoting and health-deterring impact of disgust generated by a person's symptoms compared to that generated by medical screening, interventions or treatment would be a worthy focus for future research.

Perhaps more importantly, compared to the established affective predictors of avoidance, embarrassment, and distress [14, 60], disgust was not only a stronger predictor across the breadth of avoidance domains assessed here, but its predictive ability was evident over a longer period of time. Given the evolved purpose of embarrassment lies in preserving social relationships [61], our finding that embarrassment predicted social, but not other classes, of avoidance, fits with this function and adds discriminant validity to our work. In comparison, disgust not only predicted social avoidance, but was also a stronger predictor than embarrassment in prospectively predicting avoidance at follow-up (3 months). Although this may be a measurement issue, it is also possible that people habituate to embarrassment more quickly than they do disgust. Similarly, while both baseline distress and disgust predicted cognitive/emotional avoidance immediately following the intervention, only disgust continued to predict at 3 months. If, as these findings suggest, disgust's avoidance-promoting effects are less prone to amelioration over time, then early identification and pro-active intervention with disgust sensitive persons may prove useful. Certainly, these findings point to the potential merit of including a person's sensitivity to disgust in the health professional's clinical radar.

Clinical Implications

These data suggest a new consideration in the early identification of chemotherapy patients at risk of maladaptive coping. Increased use of screening tools such as the Distress Thermometer [62] has undoubtedly improved the ability of health professionals to identify at-risk persons and intervene early. However, although ultra-short distress measures have practicality in their favor, they are also limited by both brevity and generality. Arguably, they do not have the sensitivity to predict maladaptive avoidance over time. In acute cancer treatment contexts, avoidance can lead to health complications, reduced survival [8, 9], and impaired psychological well-being [10]. During chemotherapy, which can be both lengthy and demanding, maintaining supportive relationships can bolster a person's ability to withstand psychological and physical challenges [63–65]. Thus, the early identification of people who are more likely to cope avoidantly has important implications for the clinician, potentially enabling intervention before a patient has withdrawn from others or their treatment. Screening for disgust sensitivity may prove a useful addition in this regard.

It is important, however, to remember that while disgust-generated avoidance may often be problematic for chemotherapy patients, there are other times at which it might prove useful. For example, given disgust's function in protecting us from health risks, temporary elevations in social avoidance may be prudent during times of compromised immunity. As such, short-term withdrawal from friends and family [37, 66] may facilitate the avoidance of potential contamination risks. More speculatively, short-term social avoidance might protect key relationships where social partners are not equipped with the resources to cope with the challenge. "Support" is not always perceived as helpful [67], implying that maintaining distance during times of vulnerability could be adaptive [68], particularly where social contact involves exposing others to

potentially confronting reminders of cancer [69]. Thus, while remembering that the disgust mechanism may be oversensitive to possible threats [27], clinicians working with chemotherapy patients should nonetheless also be alert to the possibility that, at times, disgust sensitivity might play a beneficial role in psychological or physical adaptation.

Notwithstanding that disgust-generated avoidance might sometimes be adaptive in people who have cancer, key questions regarding what strategies might usefully either reduce disgust or circumvent disgust's association with avoidance remain. There is little work to guide us in this respect. The tolerance of unpleasant emotion that is promoted in mindfulness training [70] is one possibility, yet findings from the current RCT and indications elsewhere suggest lower utility than might be expected [71]. Another possibility, drawn from intervention work with bowel patients, suggests that supplementing mindfulness training with exposure-based therapy leads to improvements in disgust-related symptoms [72]. Further investigation is required to determine whether mindfulness in conjunction with another therapy, or an alternative approach altogether, might be more helpful in reducing deleterious disgust-generated avoidance.

Limitations and Concluding Remarks

Although emerging research in other clinical settings has investigated links between disgust sensitivity and subsequent quality of life [36], only a handful of studies have investigated disgust in cancer contexts [28]. In contributing to this fledgling area, the current report has shown that disgust sensitivity in chemotherapy patients predicts avoidance across multiple domains, thus highlighting a new direction for research into the person variables predicting avoidant coping. Although this work represents the first investigation of this kind—in a treatment context where avoidance can have serious implications—there are several limitations. First, this work involved secondary analyses of data from a broader RCT. As such, the self-reported avoidance metrics were relatively crude measures of the kinds of avoidance that might make a real difference in this context. Future investigations would be much improved by the inclusion of additional and/or objective measures of avoidance such as food aversions and appointment attendance or other indicators of healthcare utilization. Second, there were no changes in disgust sensitivity over time, despite an expectation that disgust might vary during this period. As noted, the timing of measurements in the current design was limited in its ability to investigate this possibility and studies assessing disgust with either more sensitive, less trait-like instrumentation and/or timing assessments to coincide with known periods of side effects and toxicity are an obvious next step.

Notwithstanding the above limitations, research in this clinical sample is notoriously difficult to conduct given the numerous physical and psychological demands. Perhaps the most important contribution of this work lies in demonstrating that the emotion of disgust is worthy of consideration for the cancer clinician's radar and to encourage future research in the area. Disgust evolved to promote avoidance of health threats, and although avoidance in cancer treatment could be variously both advantageous and deleterious, understanding disgust in this context may help clinicians harness the emotion where it is helpful and intervene where it is not. The exact nature of such interventions requires further investigation.

Compliance with Ethical Standards

Authors' Statement of Conflict of Interest and Adherence to Ethical Standards Authors Reynolds, Bissett, Porter, and Consedine declare that they have no conflict of interest. All procedures, including the informed consent process, were conducted in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000.

Funding This research was supported by a grant from the Oakley Mental Health Research Foundation.

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