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Evangelos C. Karademas, Georgios D. Sideridis and Konstantinos Kafetsios

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Health-related Information Processing and Recent Health Problems

Evidence from a Modified Stroop Task

EVANGELOS C. KARADEMAS, GEORGIOS D.
SIDERIDIS, & KONSTANTINOS KAFETSIOS
University of Crete, Greece

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ADDRESS. Correspondence should be directed to:
EVANGELOS C. KARADEMAS, Department of Psychology, University of
Crete, 74100, Gallos, Rethymnon, Greece. [Tel. + 30 28310 77532;
Fax + 30 28310 77578; email: karademas@psy.soc.voc.gr]



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Abstract

Our purpose was to assess the relationship between health status and health-related information processing. We expected that persons who report a recent health problem would show greater bias towards relevant stimuli. Participants comprised two groups: the experimental with 25 students who recently had to interrupt usual activities because of their health, and a comparison group of 25 healthy students matched for demographics, health habits and current health. Using an emotional Stroop task, the experimental group demonstrated enhanced interference effects for illness and health-related versus general threat and neutral words. Satisfaction with life impacted the processing of health and illness-related stimuli.

Keywords

- *health cognitions*
- *health information processing*
- *health problems*
- *Stroop task*

HEALTH status affects multiple domains of personal experience and functioning, and it is also reciprocally affected by them (Martin & Leventhal, 2004; Stewart, Ross, & Hartley, 2004). There is increased awareness of the various factors associated with health status that can direct a person's current or future behaviours and reactions (e.g. Johnson & King, 1995; Leventhal, Hansell, Diefenbach, Leventhal, & Glass, 1996; Shorter, 1995). Among these factors, subjective representations of illness symptoms and the relevant information and cognitive schemata constitute an important determinant of health-related emotions and behaviour (Cioffi, 1991; Leventhal et al., 1997). For example, the ways individuals perceive and process information about their health status is similar to the processing of any other threatening or stressful stimuli, whereas pre-existing cognitive schemata exert influence on the cognitive analysis and integration of health-related information (Martin & Leventhal, 2004). It is well documented that chronic pain patients show greater recall for sensory-pain-related words when the reference is the self than other persons. An underlying activated pain schema is a possible candidate for that effect (Wells, Pincus, & McWilliams, 2003). There is also evidence that memory biases are present when a person is faced with information about health threats (e.g. MacLeod, 1991; Sherman, Nelson, & Steele, 2000).

Beck, Emery and Greenberg (1985) and Bower (1981) suggested that distress is characterized by impaired information processing; specifically that distress-related stimuli are associated with attentional biases (i.e. more attention devoted to distress-related stimuli). Specific stimuli may engage more processing resources because of the activation of specific cognitive structures that are associated with threats (Beck et al., 1985), or because of the need to act in order to deal with a potentially new situation (MacLeod & Dunbar, 1988; Mathews & MacLeod, 1994). Beck and Clark's (1997) three-stage information processing theory suggests that in the first stage automatic processing of stimuli takes place. After the identification of a stimulus as threatening in the second stage, an elaborative processing of threat-related material is activated and almost all attentional resources are allocated towards the threat stimuli. At stage three, current concerns and personal issues are activated and are involved in a person's reflections of the situation and his/her abilities to cope with the situation.

According to the aforementioned theories, a distressing condition is related to disproportional

alertness towards distress-related stimuli. In fact, a series of studies have repeatedly shown that threatened people exhibit excessive attentional biases towards information related to the source of their anxieties (Buckley, Blanchard, & Neill, 2000; Kindt & Brosschot, 1997; Mathews & MacLeod, 1985; Williams, Mathews, & MacLeod, 1996). However, attentional biases are not just a by-product of the entire cognitive process. They play a central role in the generation of distress and its maintenance (Beck et al., 1985; Clark, 1988). Even a small disturbance in emotions may lead to increased retrieval and use of relevant information, and increased identification of relevant stimuli. This process is associated with elevations in distress and, potentially greater processing biases.

A commonly used method to assess the extent to which individuals exhibit an attentional bias to specific threatening stimuli, is the emotional Stroop task (MacLeod, 1991). The emotional Stroop task has been developed as a modification of the original Stroop procedure (Golden, 1978; Stroop, 1935). During this task, individuals are asked to name the colour of a word presented to them as quickly and as accurately as possible, while ignoring the meaning of the word. Usually, the task includes neutral words and words containing a threatening or otherwise related to a specific condition meaning. Participants are expected to show delays or make more errors in colour-naming for words related to their concerns compared to neutral words (and this fact is referred to as the 'interference effect'). Interference is used as an indicator of attentional and informational biases towards a particular set of stimuli (words). The emotional Stroop task and the interference effect have been consistently demonstrated to be valid and reliable measures of processing/attentional biases (Coles & Heimberg, 2002; Dyer, 1973; MacLeod, 1991; Williams et al., 1996).

There is a coherent body of research demonstrating the existence of attentional biases in diverse distressing situations or populations. Studies using the emotional Stroop task have identified biases, for example, in emotional disorders (Coles & Heimberg, 2002; Mathews & MacLeod, 1985; Williams et al., 1996), eating disorders (Dobson & Dozois, 2004), and post-traumatic stress disorder (Buckley et al., 2000). Regarding physical conditions, recently, Erbllich, Montgomery, Cloitre, Valdimarsdottir and Bovbjerg (2003) have shown that a sample of women with stress of having a family history of breast cancer exhibited greater interference on a task with

cancer-related stimuli than women without cancer in the family. Williams, Wasserman and Lotto (2003) found that individuals with poorer self-assessed health showed enhanced interference for illness versus non-illness words. Lecci and Cohen (2002) found that hypochondriacal tendencies were related to greater interference for illness-related words. Also, Waters et al. (2003) showed that smokers who tried to quit smoking and exhibited greater attentional bias in smoking-related versus neutral words, were at significantly greater risk for a relapse in the short term. Finally, Jessop, Rutter, Sharma and Albery (2004) found that individuals with asthma displayed more interference for asthma versus general negative words, whereas more interference was associated with the highest or lowest levels of self-reported adherence.

Research on processing biases within the context of physical health or illness is, however, limited. Based on existing literature and relevant theories, it is expected that individuals with health problems would exhibit a different cognitive processing of health-related stimuli which are relevant to their own condition compared to other, irrelevant, stimuli. The purpose of the present study was to examine whether individuals with a recent health problem would show information processing biases towards health-related stimuli, by use of a modified Stroop task. Our main hypothesis was that individuals with a recent health problem (even a minor one), would be more 'sensitive' to health or illness-related words, compared to general threat or neutral words. These biases were not expected for the healthy comparison group. A second hypothesis was that other cognitive-emotional structures, such as individuals' perceived distress or perceived satisfaction with life, would likely moderate the association between recent health problems and information biases. The theoretical framework developed by Beck et al. (1985) and especially by Beck and Clark (1997) suggests that not only threatening stimuli can cause an altered processing of relevant information, but also that personal schemata and prior knowledge are eventually involved in that process. However, this is not a sequential process, since knowledge about the self and the world exists prior to the information processing of stimuli. Hence, we hypothesized that an evaluation of specific states of a persons' life (e.g. perceived stress and satisfaction with life), interferes with information processing of health and illness-related stimuli. Previous research has demonstrated that negative

states or mood are associated with greater information bias towards negative stimuli (e.g. MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002; Segerstrom, 2001). Therefore, we specifically hypothesized that persons with a recent health problem and more stress or lower satisfaction with life would show greater biases towards health or illness-related stimuli, when compared with a healthy comparison group.

Method

Participants

Fifty psychology students participated in the study. Students were recruited through announcements in the class and received extra credit for their participation. Assignment to different groups was based on the presence or absence of health-related problems. The first group (HP+) consisted of five males and 20 females who reported having experienced a rather minor health problem (flu or minor accident) within the past four weeks. The nature of the problem had to be such that 'interrupted the every-day activities of the students' for at least four days. This description and the time frame were set so as to ensure that the problems reported would be 'minor' but not unimportant events. The comparison group (HP-) consisted of students (five males, 20 females) who were free of any health problem within the past four weeks. The two groups were matched in terms of gender distribution, mean age, basic health behaviours (i.e. smoking, exercise, alcohol consumption, dietary habits), and self-reported current physical and mental health. Group characteristics are shown in Table 1.

The number of participants was ascertained a priori using Cohen's (1992) criteria for attaining power levels equal to .80. Based on Cohen's (1988, 1992) conventions an estimated sample size of 26 participants per group would be adequate in order to have acceptable levels of power (see Onwuegbuzie, Leven, & Leach, 2003) for a two-tailed-test means test at an alpha level equal to 5 per cent, given a large effect (i.e. an effect size equal to .80 units of SD). Our *n* size of 25 per group was very close to that estimation. Thus, adequate levels of power were available for the identification of large effects using a *t* or *F*-test. Although, with inspection of large effects one risks the possibility to commit a Type-II error, it is rather unlikely to commit a Type-I error. Thus, the emergence of statistically significant effects would be rather stable and meaningful, and not an artefact of large *n* sizes.

Table 1. Group characteristics

Characteristic	HP+ group (SD)	HP- group (SD)	t-test	p
Age (in years)	18.92 (1.38)	19.38 (1.84)	-.98	>.05
Times of more than 15 mins exercise per week	.76 (1.50)	1.00 (1.29)	-.61	>.05
Drinks containing alcohol per day during the week	.56 (.71)	.76 (1.01)	-.81	>.05
Drinks containing alcohol per day during the weekend	2.36 (1.97)	2.60 (1.76)	-.45	>.05
Avoidance of high cholesterol food (1 = never, 4 = always)	2.20 (.76)	2.36 (.91)	-.68	>.05
Smokers/Non-smokers	8/17	8/17		
Evaluation of overall physical health	74.80 (15.61)	76.24 (15.43)	-.33	>.05
Overall GHQ score	.52 (.50)	.48 (.58)	2.57	>.05

Note: HP+ group = participants with a recent health problem; HP- group = participants without a history of any recent health problem

Measures

Matching variables Health behaviours were assessed by use of direct questioning (see Table 1), whereas perceived physical health was assessed with a question about current personal health status using a scale ranging from 0 (worst possible health) to 100 (excellent health). Current mental health was assessed using the General Health Questionnaire—28, adapted for the Greek population (Moutzoukis, Adamopoulou, Garyfallos, & Karastergiou, 1990). Alpha of this scale was .90.

Distress and satisfaction with life Participants completed the 10-item version of the Perceived Stress Scale (Cohen, Kamarck, & Mermelstein, 1983), as a measure of general distress experienced by the person (Cronbach $\alpha = .88$). They also completed the Satisfaction with Life Scale (Diener, Emmons, Larsen, & Griffin, 1985), as a measure of life satisfaction (Cronbach $\alpha = .82$).

The Stroop task The Genov Modified Stroop task (GMST), developed by Genov, Shay and Boone (2002) was implemented in the present study. The GMST is a recent computerized version of the emotional Stroop paradigm, demonstrated to be valid in previous Stroop studies (e.g. Kirsh, Olczak, & Mounts, 2005). It presents words in the centre of a circular, 20-colour palette. The words appear in colour in the middle of the colour circle. After the word is presented, the

respondent has to select the correct colour from the palette by using the mouse only. Subsequently, the respondent has to click on a small circle in the centre of the screen to initiate the presentation of the next word. The software accurately records participants' reaction time between the presentation of the word and the selection of the corresponding colour. It also records the actual colour selected by the respondent. Each time the GMST is run, the word-colour pairs are presented in a different, random order. Each word is presented only once.

Participants were asked to select correctly the colours of words derived from four word lists developed for the purposes of the present study: (1) health and well-being-related words; (2) illness words; (3) general threat words; and (4) neutral words. Each list consisted of 10 words (see Appendix). Initially, analyses of variance were performed to demonstrate equivalence of the word lists in terms of word length, number of syllables and frequency of usage in the Greek language (as appeared in the Hellenic National Corpus of the Greek Institute for Language and SpeechProcessing; <http://hnc.ilsp.gr/statistics.asp>). No significant differences between lists regarding word length, $F(3, 36) = 1.91, p > .05$, number of syllables, $F(3, 36) = 1.50, p > .05$ or frequency of usage (per million occurrences), $F(3, 36) = 1.54, p > .05$, were identified. Results are shown in Table 2.

Table 2. Word list characteristics

List	Word length		No. of syllables		Word frequency (per million)	
	M	SD	M	SD	M	SD
Health	6.60	.97	2.90	.57	5.40	6.07
Illness	8.70	2.83	4.00	1.76	1.42	1.54
General threat	7.10	1.97	3.60	1.26	4.03	5.05
Neutral	7.90	2.23	3.80	1.25	2.45	2.11

Note: All characteristics refer to the original Greek words used in this study

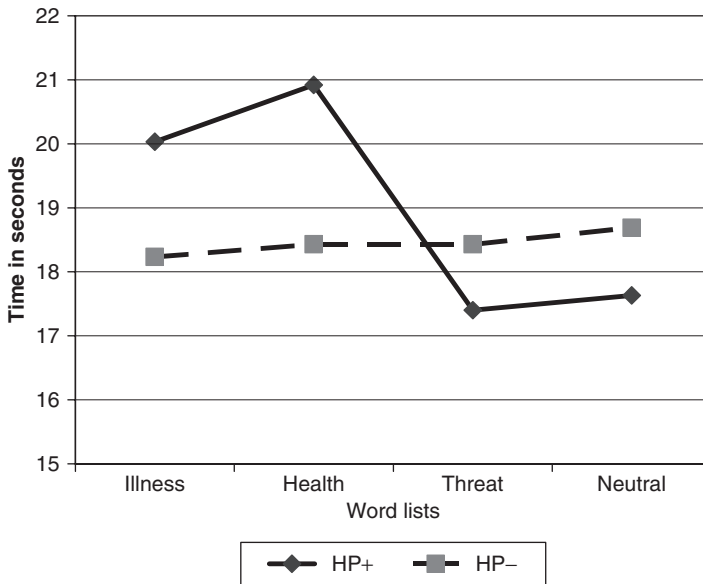


Figure 1. Mean Stroop colour-naming times for students with (HP+group) and without a recent health problem (HP- group).

Procedures

Participants were individually tested in a psychology lab containing a PC with the computerized application. They were seated in front of the PC and were informed that words written in different colours would be presented on the screen. The participants would have to indicate as rapidly and as accurately as possible the correct colour of every presented word. When the students consented that they understood the procedure, they were administered a practice list of five irrelevant words in order to familiarize them with the task and avoid the error that could be introduced in the first stimuli due to unfamiliarity with the procedure. Following the warm-up trials and after all questions were answered and the procedure was explained in detail, administration of the four word

lists commenced. At the end of the activity, participants were asked to fill out a set of questionnaires (see earlier ‘Measures’ section).

Results

Colour-naming latencies

A repeated-measures analysis of variance (ANOVA) was performed, with word list being the within-subjects factor and group (HP+ or HP-) the between-subjects independent variable. The omnibus group x word list interaction was tested with time spent on the words being the dependent variable. Given the small sample sizes, the Geisser-Greenhouse correction was applied, which resulted in more conservative estimates of effects.

Table 3. Repeated-measures analyses of variance for response latency and colour-naming errors

Source	d.f.	F
<i>Response latency</i>		
List	3, 126	3.24*
Group	3, 126	.22
List × Group	3, 126	6.13**
List × Stress	3, 126	2.27
List × Satisfaction with life	3, 126	2.82
List × Group × Stress	3, 126	.91
List × Group × Satisfaction	3, 126	4.32*
<i>Colour-naming errors</i>		
List	3, 126	3.91*
Group	3, 126	1.28
List × Group	3, 126	7.68**
List × Stress	3, 126	4.30**
List × Satisfaction with life	3, 126	.47
List × Group × Stress	3, 126	1.70
List × Group × Satisfaction	3, 126	.72

* $p < .05$; ** $p < .01$

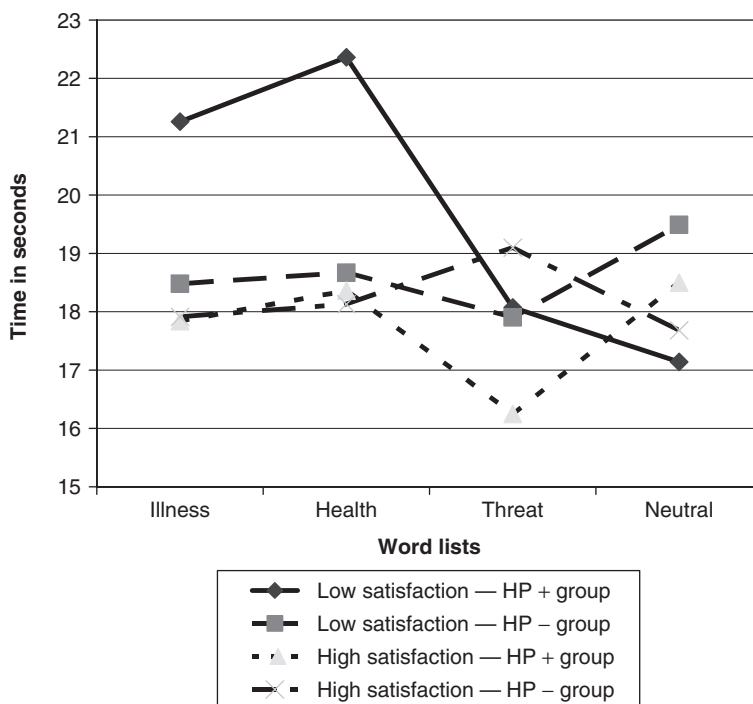


Figure 2. Mean Stroop colour-naming times for students with (HP+Group) and without a recent health problem (HP-group) at high and low satisfaction with life level (median split).

The results of the ANOVA revealed a significant main effect for word list, with the health and illness-related words producing longer latencies ($M = 19.68$ and $M = 19.13$, respectively) compared to the general threat-related latencies ($M = 17.92$), $F(3, 126) = 3.24$, $p = .05$). No significant main effects for grouping were evident (i.e. between the HP+ ($M = 18.99$) and HP- ($M = 18.48$) groups, $F(1, 48) = .22$, $p > .05$). Most important, however, there was a significant group \times list interaction, $F(3, 63) = 6.13$, $p < .01$. In order to explore this interaction (see Fig. 1), a follow-up repeated measures ANOVA for each group was performed. No significant effect of list within the HP- group was found, $F(3, 72) = .12$, $p > .05$. On the contrary, a significant effect was found in the HP+ group, $F(3, 72) = 5.13$, $p < .05$. Simple contrasts revealed that illness and health colour-naming latencies were significantly larger compared to the other lists (alpha levels were adjusted to $p < .02$, using Bonferroni's suggestion).

Next, a three-way interaction was tested by creating a dichotomy that defined perceived stress levels (i.e. low-high using median splits) and one which defined satisfaction with life (using also median split). These dichotomies were created after satisfying the assumption of normality for both variables using the Kolmogorov-Smirnov test, suggesting that ample numbers of participants were available to form sub-groups (Perceived Stress K-S = 0.746, $p = .634$, Satisfaction K-S = 0.570, $p = .901$). Two three-way interactions were then tested: A word list \times group \times perceived stress and a list \times group \times satisfaction with life interaction to evaluate the moderating role of per-

ceived stress or satisfaction with life. As shown in Table 3, a significant interaction emerged for the word list by group by satisfaction with life interaction. As previously, to explore further this interaction follow-up repeated-measures ANOVAs were conducted at each level (i.e. low/high) of the moderating 'satisfaction with life' variable (see Fig. 2). No significant word list \times group interaction emerged within the high satisfaction group, $F(3, 54) = 2.13$, $p > .05$. In the low satisfaction group, however, a significant word list \times group interaction emerged, $F(3, 84) = 4.12$, $p < .05$. Within that level of the moderating variable (i.e. low satisfaction), contrasts pointed to the fact that illness and health-related latencies were significantly prolonged, compared to the remaining latencies.

Colour-naming errors

Although only a few errors were recorded in total, a significant main effect for errors on word list was revealed. This significant effect suggested that illness and health list colour-naming errors ($M = .68$ and $.90$, respectively) were significantly elevated compared to the general threat and neutral colour-naming lists ($M_{General Threat} = .54$ and $M_{Neutral} = .48$), $F(3, 126) = 3.91$, $p < .05$. As in the colour-naming times, no significant main effect emerged regarding errors for students with and without a recent health problem ($M_{health problems} = .72$, $M_{No report of HP} = .57$, $F(1, 42) = 1.28$, $p > .05$).

Interestingly, two significant two-way interactions emerged with regard to errors. One of the effects was with regard to group and word list, $F(3, 126) = 7.68$,

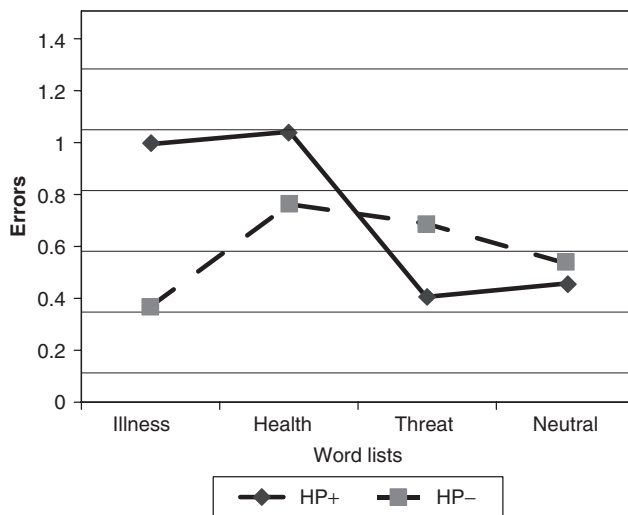


Figure 3. Mean Stroop colour-naming errors for students with (HP+group) and without a recent health problem (HP- group).

$p < .01$, and the other with regard to stress levels and word list, $F(3, 126) = 4.30, p < .01$. No other significant interaction exceeded conventional levels of significance (see Table 3). To further explore the group \times word list interaction (see Fig. 3), follow-up within-groups repeated-measures ANOVAs were performed. Specifically, for the comparison group (HP-) no significant effect for word list was found, $F(3, 63) = 2.38, p > .05$, contrary to the findings for the HP+ group, $F(3, 63) = 7.76, p < .01$. Within conditions contrasts revealed that for the HP+ group the number of errors was significantly higher for the illness and health-related stimuli, compared to the general threat and neutral word lists (p 's $< .02$).

Discussion

The purpose of the present study was to examine whether recent minor health problems influence the information processing of health and illness-related stimuli. The results confirmed our hypotheses that persons with a history of minor health problems took significantly longer time and made more errors in making the correct associations for health-related stimuli in comparison to general threat and neutral stimuli. This finding did not emerge for the healthy, comparison group. To our knowledge, this is the first study that attempted to identify health-information processing biases in individuals having recent minor health problems.

Existing studies suggest that, when people are threatened, they display significant attentional biases towards information related to the source of their concern (e.g. Buckley et al., 2000; Williams et al., 1996). Several theorists (e.g. Beck & Clark, 1997; Bower, 1981) suggested that as soon as an individual identifies a stimulus as threatening, corresponding cognitive-emotional schemata come forth and relevant processing is activated. As a consequence, almost all attentional resources are allocated towards the threat stimuli, and attentional biases become evident (interference effect). Past studies (e.g. Erblich et al., 2003; Wells et al., 2003; Williams et al., 2003) have shown that health concerns are related to significant attentional biases. The results of this study suggest that such a process is also activated for persons with a recent history of health adversities.

However, the attentional biases towards health and illness-related information found in the present study are not interesting just on their own. As shown in previous studies (e.g. Clark, 1988; MacLeod

et al., 2002), attentional biases play a significant role in mediating the relationship between emotional reactions and specific outcomes (behaviours). Relevant research also demonstrates that several everyday thoughts, decisions and behaviours are guided by automatic cognitive processes (Bargh & Chartrand, 1999). Thus, the retrieval and elaboration of health-related information and cognitions, activated by relevant attentional biases, can cause distress, anxiety and feelings of apprehension and worry (see MacLeod & Rutherford, 1992), or alternatively can facilitate health-related decisions and actions (such as care seeking or preventive behaviours, Cioffi, 1991). In other words, the biases observed in the first stages of information processing among individuals with recent health adversities found in this study, may act as a mediator of the relationship between emotional reactions and subsequent health-related behaviours. Certainly, further research is needed to examine this proposition also replicating this study's findings.

The importance of health information processing biases is further reflected in their relation with health-related cognitions, affect and behaviours, particularly given recent evidence that this processing may involve distinct parts of the brain (van Veen & Carter, 2005). Once a stimulus is identified as important, and the existing cognitive-emotional material is activated, the interaction of this material with new information commences (Beck & Clark, 1997; Singer & Salovey, 1991). This interaction between health-related appraisals or knowledge and new information is likely to be associated with the formation or modification of health-related cognitions. Theories such as the Common Sense Model provide a description of the schemata or other cognitions that a person might hold during a specific health state (condition). Beliefs, knowledge and evaluations about the reasons of the problem, its progression, severity, possible outcomes, etc., are parts of the health-related material (Leventhal, Brissette, & Leventhal, 2003). The activation and elaboration of such material may be more intense or more frequent for those who exhibit attentional biases towards health-related stimuli.

The results of this study also provide support for our second hypothesis, that other cognitive-emotional structures also impact the processing of health and illness-related stimuli. Even though no significant interactions emerged between health status and perceived stress, the persons with a health problem and lower satisfaction with life

showed greater attention biases towards health and illness-related stimuli. This finding suggests that health-related information is not processed in isolation or in reference only to matching knowledge and appraisals. Other cognitions are likely to be involved as well. For example, the way a person understands his/her own health is influenced not only by health-related perceptions and experience, but also by general cognitions about the self and the world. An implication of this finding is that health-related interventions (preventive or therapeutic) should also consider a person's broader perceptions. Future studies assessing information processing in real conditions (e.g. health counselling) are needed to test these speculations.

Methodologically speaking, the present study highlights the importance and use of the emotional Stroop paradigm as a means to identify the presence of latent cognitive schemata and processes that have implications for health and functioning. In the present study, it was obvious that attentional biases were evident for individuals with recent health adversities. Previous studies have also demonstrated the utility of the emotional Stroop task to demonstrate attentional biases in patients with various health conditions (e.g. Erlich et al., 2003; Jessop et al., 2004; Williams et al., 1996).

This study is also limited by a number of factors. First, the participants were drawn from a university population, with almost no experience of severe or chronic diseases, whereas the number of participants was modest. Future studies should

examine health information processing in other age groups and populations, especially chronic patients. Also, the participants were mostly female; therefore, generalization of the present findings to males is not justified. Third, based on the cross-sectional nature of the study, we could not assess whether such biases are evident over time, following a health problem. Longitudinal studies are necessary to enlighten us on this issue. As Williams et al. (2003) noted, health information processing should also be examined in relation to the changing physical status of the person. In this way, valuable information about health-related perceptions and behaviours would be gained. Fourth, we only examined two possible moderators of information processing: perceived stress and satisfaction with life. The investigation of other possible contributing variables such as expectations, motives, attitudes or traits will enrich our understanding of information processing in health and illness (see Block, 2005). Last, in the present study, a novel (and more difficult compared to the traditional) version of the emotional Stroop paradigm was employed.

We believe that the study of health information processing and its association with health-related perceptions and behaviours will grow in the future and will provide us with many useful findings with significant theoretical and clinical implications. The results of this and other studies reveal an interesting prospect that will expand our understanding of health cognitions and behaviours.

Appendix

Word-lists used in the modified Stroop task

<i>Illness words</i>	<i>Health and well-being words</i>	<i>General threat words</i>	<i>Neutral words</i>
Disability	Vigour	Danger	Museum
Death	Longevity	Disasters	Tree
Debility	Control	Menace	World
Germes	Happiness	Crimes	Pencil
Medication	Potency	Uncertainty	Dog
Heredity	Fitness	Violence	Couch
Malaise	Strength	Vulnerability	Sky
Malnutrition	Ableness	Adversity	Book
Disease	Healthiness	Alarm	Theatre
Infection	Tranquillity	Constriction	Shoes

Note: Translated from the original Greek word lists

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Author biographies

EVANGELOS C. KARADEMAS is an assistant professor of Clinical Health Psychology at the Department of Psychology, University of Crete, Greece. His research interests include the cognitive processes in health and illness, issues in quality of life and well-being and the cognitive representations of health and illness.

GEORGIOS D. SIDERIDIS is associate professor of Statistics and Research Methods at the

Department of Psychology, University of Crete. He is interested in issues regarding motivation and achievement. He is currently the Editor of *Learning Disabilities: A Contemporary Journal*.

KONSTANTINOS KAFETSIOS is assistant professor of Social Psychology at the Department of Psychology, University of Crete. His scientific interests include issues regarding emotions and their relationship to human functioning and health.