Attentional bias towards health-threat in health anxiety: A systematic review and three-level meta-analysis

SUPPLEMENTARY FILE

**Supplementary File A**

**Examples of the Full Search String**

**The full search string for the Web of Science (WoS; adapted for use in other English databases):**

TS = ("attent\* bias" OR "selective attent\*" OR "attent\*") AND TS = ("health anxiety" OR "illness anxiety" OR "hypochondri\*" OR "somatic symptom disorder" OR "somatoform disorders" OR "somatization disorder")

**Supplementary File B**

**The coding system for each study**

|  |  |
| --- | --- |
| Variable | Coding description |
| Study |  |
| Authors | Authors of the study |
| Year | Publication year of the study |
| Country | The country where the study was conducted |
| Sample |  |
| *N* health anxiety | Sample size for health anxiety group |
| *N* control | Sample size for control group |
| Age health anxiety | Mean age for health anxiety group |
| Age control | Mean age for control group |
| Female health anxiety | Percentage of females for health anxiety group |
| Female control | Percentage of females for control group |
| Health anxiety type | 0 = clinically diagnosed disorders related to health anxiety |
|  | 1 = self-reported health anxiety |
| Race/Ethnicity | The race and/or ethnicity of samples |
| Experimental procedure |  |
| Paradigm | 0 = dot-probe |
|  | 1 = modified/emotional Stroop |
|  | 2 = spatial cueing |
|  | 3 = visual search |
|  | 4 = eye-tracking |
| Stimuli type | 0 = pictures |
|  | 1 = words |
| Threat type | 0 = illness |
|  | 1 = symptom |
|  | 2 = health-threat (a mixture of illness and symptom) |
| Stimuli exposure time | 0 = less than 250 ms |
|  | 1 = 250-500 ms |
|  | 2 = more than 500 ms |
| Attentional bias type | 0 = vigilance |
|  | 1 = maintenance |

**Coding decisions for each study**

* Attentional bias was coded as vigilance for the vigilance index in the modified dot-probe task (i.e., subtracting mean RTs in congruent trials from those in neutral–neutral trials), for the facilitation score in the spatial cueing task (i.e., subtracting mean RTs in congruent threat trials from those in congruent neutral trials), and for early eye movements (i.e., first-fixation probability).
* Attentional bias was coded as maintenance for the delayed disengagement index in the modified dot-probe task (i.e., subtracting mean RTs in neutral–neutral trials from those in incongruent trials), for the difficulty in disengagement score (i.e., subtracting mean RTs in incongruent neutral trials from those in incongruent threat trials) and the reversed avoidance score in the spatial cueing task (i.e., subtracting mean RTs in congruent threat trials from those in congruent neutral trials), for the late eye movements (i.e., first-fixation duration, dwell time, overall gaze duration), and for the modified Stroop task.
* Stimuli exposure time was not coded in studies using direct measures (e.g., eye-tracking studies) where it is dissociated from the timing of the attentional bias, and not in studies using modified Stroop tasks where it varies with each participant’s response.
* When participants were assigned to more than two groups with different levels of health anxiety (e.g., high, medium, low), we selected the two extreme groups.
* When the study measured attentional bias before and after an intervention (e.g., a certain type of therapy), we selected the pre-intervention score.
* Multiple effect sizes were retrieved from the same study where (a) different types of paradigm were used to assess attentional bias; (b) different types of health-threat stimuli (i.e., stimuli type: words, pictures; threat type: illness, symptom, health-threat) were compared with neutral stimuli; (c) different length of stimuli exposure time was used; (d) different types of attentional bias (i.e., vigilance, maintenance) were assessed; and (e) attentional biases were examined for independent samples.

**Supplementary File C**

**Quality rating criteria**

**External validity**

|  |  |  |
| --- | --- | --- |
| Criterion | Coding | Description |
| Description of inclusion and exclusion criteria | 1: Adequate  0: Not adequate | A study should provide detailed information regarding the inclusion and exclusion criteria in terms of age range, sex, diagnosis or other relevant variables. |
| Description of demographics of participants | 1: Adequate  0: Not adequate | A study should provide information regarding the age, gender and socioeconomic status. |
| Description of health anxiety levels in the health anxiety group | 1: Adequate  0: Not adequate | A study should provide a detailed description of the health anxiety level of the participants with high health anxiety. |
| Description of health anxiety levels in the control group | 1: Adequate  0: Not adequate | A study should provide a detailed description of the health anxiety level of the control group. |
| Description of recruitment procedure | 1: Adequate  0: Not adequate | A study should provide information about the recruitment procedure. When participants are students the description should include whether they volunteered for credit points or money. When participants are participants, the description should include the recruitment procedure (advertisement, consecutive participants). When applicable, the study should describe how many participants refused participation. Of less importance are the reasons for refusal. |
| Description of the setting or location of the study for the health anxiety group | 1: Adequate  0: Not adequate | The study should provide information about the setting where participants were recruited (e.g. university undergraduates). |
| Description of the setting or location of the study for the control group | 1: Adequate  0: Not adequate | The study should provide information about the setting where the control group were recruited (e.g. general population, university students). |
| Description of data cleaning, and its criteria (outliers, missing values, invalid data) | 1: Adequate  0: Not adequate | Studies must report how data was cleaned, how outlying participants and data were removed and the percentages or number removed. Also, the study should report the percentage of missing values in the final data set. It is not necessary that the study investigates the pattern of the missing values (missing completely at random, missing at random or missing not at random). |

**Internal validity**

|  |  |  |
| --- | --- | --- |
| Criterion | Coding | Description |
| Relevance of health-related threatening information | 3: selection/check in (pilot) study, data reported  2: selection/check in (pilot) study, data not reported; or based upon relevant data from another study  1: based upon expertise of experimenter, or upon previous studies that did not provide data  0: no mentioning | The study should report that the health-related threatening stimuli are relevant for the health anxiety group of the study. Stimuli may be selected in a pilot study in which the participants are identical to the study participants. Stimuli may be rated for relevance by the participants themselves (score 3). It is not sufficient that stimuli have been shown to be health-threat relevant and valid in another study unless that study involves similar participants and context (score 2). A score of 2 is also given when the study reports that health-threat relevance has been investigated, but fails to report the data. Studies in which the health-related threatening stimuli are only based upon the experimenter’s expertise, or in which the same stimuli are used from previous studies that did not provide data about health-threat relevance, are scored 1. No mentioning of an internal check is scored 0. |
| Health-threat and neutral information adequately matched | 1: Adequate  0: Not adequate | Ideally, the health-related threatening stimuli and neutral stimuli are perfectly matched. Pictures should ideally have the same visual complexity, luminance. Words should be matched for familiarity and word length. |
| Participants engagement with task | 1: Adequate  0: Not adequate | Check for outliers, RTs from errors discarded, and exclusion of individuals not conforming to the task instructions, digit trials, or gaze fixations. Engagement can also be ascertained by the experimenter, with task motivation explicitly targeted. |

**Supplementary File D**

**Three-level meta-analysis**

As an extension of the traditional meta-analysis, the three-level meta-analysis takes into account the dependency among effect sizes by adding an intermediate level (Cheung, 2014; Van den Noortgate et al., 2015). The three-level random-effect model accounts for three sources of variance: the sampling variance of the effect sizes (Level 1); the variance between effect sizes from the same study (Level 2), allowing effect sizes to vary within a study; and the variance between studies (Level 3), allowing effect sizes to vary between studies (Hox et al., 2010; Van den Noortgate et al., 2013).

A three-level random-effect model can be expressed as

where is the *i*th effect size in the *j*th cluster, is the average population effect, Var() and Var() are the study-specific Level 2 and Level 3 heterogeneity, and Var() is the sampling variance in the *i*th effect size in the *j*th cluster.

We first used an unconditional three-level random-effect model (i.e., without any moderator) to compute the overall effect size and test the heterogeneity across levels. Heterogeneity in effect sizes was tested by conducting one-tailed log-likelihood-ratio-tests and by calculating the amount of variance attributable to the three levels. If there were significant variances at Lever 2 and/or Level 3, or the proportion of the total variance attributable to sampling variance was less than 75%, a moderator analysis was warranted to investigate the variables that could explain the variances within and/or between studies (Assink & Wibbelink, 2016; Hunter & Schmidt, 1990).

In our study, for the between-group comparison of attentional bias towards health-threat, variation within studies was significant ( = 0.053, (1) = 11.940, *p* < .001), as well as variation between studies ( = 0.049, (1) = 4.981, *p* = 0.026). Additionally, 32.64% of the total variance (i.e., less than 75%) was attributable to sampling variance (see Table 3). Taken together, it is necessary to conduct moderator analyses.

In the moderator analyses, we transformed categorical moderators into dummy variables, selected one subcategory as the reference group that was not entered into the model, and compared other categories against the reference group. Notable, only the subcategory that contained at least three studies was included in the analysis (van Eldik et al., 2020). Continuous moderators were directly entered into the model.

**References**

Assink, M., & Wibbelink, C. J. M. (2016). Fitting three-level meta-analytic models in R: A step-by-step tutorial. *The Quantitative Methods for Psychology, 12*(3), 154-174. https://doi.org/10.20982/tqmp.12.3.p154.

Cheung, M. W. L. (2014). Modeling dependent effect sizes with three-level meta-analyses: A structural equation modeling approach. *Psychological Methods, 19*(2), 211-229. http://dx.doi.org/10.1037/a0032968

Hox, J. J., Moerbeek, M., & van de Schoot, R. (2010). *Multilevel analysis: Techniques and applications*. Routledge.

Hunter, J. E., & Schmidt, F. L. (1990). *Methods of meta-analysis: Correcting error and bias in research findings*. Sage.

Van den Noortgate, W., López-López, J. A., Marín-Martínez, F., & Sánchez-Meca, J. (2013). Three-level meta-analysis of dependent effect sizes. *Behavior research methods, 45*(2), 576-594. https://doi.org/10.3758/s13428-012-0261-6

Van den Noortgate, W., López-López, J. A., Marín-Martínez, F., & Sánchez-Meca, J. (2015). Meta-analysis of multiple outcomes: A multilevel approach. *Behavior research methods, 47*(4), 1274-1294. https://doi.org/10.3758/s13428-014-0527-2

Van Eldik, W. M., De Haan, A. D., Parry, L. Q., Davies, P. T., Luijk, M. P. C. M., Arends, L. R., & Prinzie, P. (2020). The interparental relationship: Meta-analytic associations with children’s maladjustment and responses to interparental conflict. *Psychological Bulletin, 146*(7), 553–594. https://doi.org/10.1037/bul0000233

**Supplementary File E**

**Descriptive summary of included studies**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Author** | **Year** | **Country** | **Race / Ethnicity** | **HAG *n*** | **HAG mean age** | **HAG percentage of females %** | **HAG sample type** | **CG *n*** | **CG mean age** | **CG percentage of females %** | **Paradigm** | **Stimuli type** | **Threat type** | **Exposure time** | **Attentional bias type** | **Main findings** |
| Owens et al. | 2004 | Canada | NR | 26 | — | 50 | SR | 26 | — | 50 | ST | word | HT | UR | MT | greater bias towards illness words in HAG |
| Lees et al. | 2005 | UK | NR | 24 | 19.88 | 87.5 | SR | 24 | 20.63 | 83.3 | DP | word, picture | HT | 500, 1250 | — | no difference in the bias for both pictures and words |
| Witthöft et al. | 2008 | Germany | NR | 28 | — | — | SR | 26 | — | — | ST | word | SY, IL | UR | MT | greater bias towards symptom and illness words in HAG when presented first in task but not stable; no difference between bias towards symptom and towards illness words in HAG |
|  |  |  | NR | 26 | — | — | SR | 27 | — | — | ST | word | SY, IL | UR | MT |
| Jasper & Witthöft | 2011 | Germany | NR | 83 | 24.45 | 71.1 | SR | — | — | — | DP | picture | IL | 175, 500 | VG, MT | positive correlations of health anxiety with vigilance at 175 ms and with disengagement at 500 ms for illness pictures |
| Shields & Murphy | 2011 | Australia | NR | 26 | 22.5 | — | SR | 30 | 21.93 | — | VS | word | HT | UR | — | no difference in the bias for illness words |
| Lee et al. | 2013 | USA | Caucasian (80.4%), Asian (12.5%), African-American/Black (10.7%), Hispanic (5.4%), Pacific Islander (1.8%) | 56 | 21.16 | 64.3 | SR | — | — | — | DP | word | HT | 500 | — | no correlation of health anxiety with bias towards health-threat |
| Jacoby et al. | 2016 | USA | Caucasian (71.6%), African American (8.4%), Latinx (4.2%), Asian (11.6%), Other (4.2%). | 95 | 18.9 | 68.4 | SR | — | — | — | DP | word | HT | 500, 1250 | — | no correlations of health anxiety with bias towards health-threat at 500 ms and 1250 ms |
| Witthöft et al. | 2016 | Germany | Caucasian (100%) | 88 | 43.5 | 62.5 | CL | 52 | 42.1 | 59.6 | ST | word | HT | UR | MT | greater bias for health-threat in HYG |
| Stefan et al. | 2020 | Romania | NR | 31 | 20.61 | 90.32 | CL | 29 | 25.86 | 72.41 | SC | picture | HT | 175, 500, 1200 | VG, MT | weaker vigilance for health-threat in IAG; no difference in disengagement or avoidance |
| Cannito et al. | 2020 | Italy | NR | 132 | 24.4 | 91.7 | SR | — | — | — | DP | picture | IL | 1000 | — | a positive correlations of health anxiety with bias towards virus stimuli |
| Karademas et al. | 2008 | Greece | NR | 24 | — | — | SR | 27 | — | — | ST | word | HT | UR | MT | no difference in the bias for health-threat |
|  |  |  | NR | 34 | — | — | SR | 35 | — | — | ST | word | HT | UR | MT |
| Leonidou & Panayiotou | 2020 | Cyprus | NR | 100 | — | 77 | SR | — | — | — | ET | picture | HT | 6500 | MT | no correlations of health anxiety with bias towards health-threat in the FVT and CVT |
| Gropalis et al. | 2013 | Germany | NR | 32 | 35.6 | 59.4 | CL | 31 | 33.3 | 61.3 | ST | word | IL | UR | MT | a greater bias towards illness words and panic words in HYP |
| Witthöft et al. | 2013 | Germany | NR | 12 | 22.7 | 53.3 | SR | 12 | 23.1 | 46.7 | ST | word | SY, IL | UR | MT | a greater bias towards symptom words in HAG; no difference in the bias towards illness words in HAG |
| Mier et al. | 2017 | Germany | NR | 33 | 40.1 | 57.6 | CL | 31 | 42.3 | 54.8 | ST | word | HT | UR | MT | a greater bias towards health-threat in HYP |
| Zhang et al. | 2021 | China | NR | 30 | 30.03 | 36.67 | CL | 30 | 30.7 | 53.33 | ET | picture | IL | 2000 | VG, MT | weaker vigilance for illness pictures in IAG; greater delayed disengagement in IAG; no difference in avoidance |
| Albery et al. | 2021 | UK | White (79.8%), Black (6.4%), Asian (8.5%), Mixed Race (5%), Other (0.4%) | 286 | 46.34 | 49.7 | SR | — | — | — | DP | word | IL | 500 | VG, MT | no correlations of health anxiety with the bias towards illness words, vigilance and delayed disengagement |

*Note.* HAG = health anxiety group; CG = control group; NR = not reported; SR = self-reported; CL = clinically diagnosed; ST = Stroop; DP = dot-probe; ET = eye tracking; SC = spatial cueing; VS = visual search; HT = health-threat; SY = symptom; IL = illness; UR = until response; VG = attentional vigilance; MT = attentional maintenance; HYP = hypochondriasis group; IAG = illness anxiety disorder group; FVT = free viewing task; CVT = cued viewing task.

**Supplementary File F**

**Results of outlier and influence analyses**

