Measuring Depression and Anxiety with 4 items? Adaptation of the PHQ-4 to increase its Sensitivity to Subclinical Variability

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The PHQ-4 is an ultra-brief (4 items) screening questionnaire for depression and anxiety. In this brief report, we test the benefits of adding one additional response option ("Once or twice", in between "Not at all" and "Several days") to improve the scale's sensitivity to milder alterations, and thus increase its usefulness in subclinical populations. In study 1 (n=485), we provide evidence using Item Response Theory (IRT) that the new response option does improve the scale's psychometric quality and extends the sensitivity to the measured constructs on the lower end of the spectrum. In study 2 (n=836), we show that the refined version offers an improved sensitivity to subclinical variability in depression (indexed by the BDI-II) as compared to the original version. In conclusion, adding the "once or twice" response option is a low-cost no-downsides way of increasing the PHQ-4's sensitivity to subclinical variability, making it a tool of choice for general population research.

Keywords: PHQ-4, depression, anxiety, brief questionnaire validation, ultra short scale

The Patient Health Questionnaire-4 (PHQ-4) is an ultra brief measurement of core signs of depression and anxiety (Kroenke et al., 2009). It consists of two items for depression (PHQ–2, Kroenke et al., 2003) and anxiety (GAD–2, Kroenke et al., 2007), each corresponding to DSM-5 diagnostic symptoms for major depressive disorder (MDD) and generalized anxiety disorder (GAD). It has been validated across many languages and populations (Christodoulaki et al., 2022; Materu et al., 2020; Mendoza et al., 2022), becoming one of the most popular screening instruments for depression and anxiety (Maurer et al., 2018).

While the scale has been validated and used in the general population and non-clinical samples (Hajek & König, 2020; Löwe et al., 2010), its initial purpose was to reliably discriminate and identify potential MDD/GAD patients. This discriminative goal materializes in the scale's design and the existence of categorical cut-offs, which does not necessary entail a focus on the sensitivity to milder mood alterations. In particular, the gap between the two lowest possible answers, "Not at all" and "Several days", is quite large and possibly leaves out the possibility of more subtle occurrences. While this is not necessarily an issue in clinical and diagnostic contexts, it might lead to a sub-optimal discrimination of affective levels on the lower end of the spectrum, important for instance in the context of subclinical variability quantification.

This brief report aims at testing the possibility of enhancing - with minimal changes to the original scale - the PHQ-4 sensitivity to mild mood level inflections. In the first study, we will evaluate whether the new response option is prevalently used by participants, and whether it does capture a specific part of the latent measurand. In the second study, we will compare the refined PHQ-4 version to the original one in terms of sensitivity to subclinical variability in depression, using the Beck Depression Inventory (BDI-II, Beck et al., 1996) and the State Trait Anxiety Inventory (STAI-5, Zsido et al., 2020) as our ground-truth measures of depression and anxiety.

Study 1

Method

Participants

The sample consists of 485 English-speaking participants (Mean age = 30.1 +- 10.1 [18, 73]; 50.3% females) from the general population recruited via *Prolific*, a crowd-sourcing platform recognized for providing high quality data (Peer et al., 2022). The only inclusion criterion was a fluent proficiency in English to ensure that the task instructions would be well-understood. This study was approved by the NTU Institutional Review Board (NTU IRB-2022-187). All participants provided their informed consent prior to participation and were incentivized after completing the study.

Measures

In the original PHQ-4, the instructions *"Over the last 2 weeks, how often have you been bothered by the following problems?"* are followed with 4 items (A1 - *Feeling nervous, anxious or on edge*; A2 - *Not being able to stop or control worrying*; D1 - *Little interest or pleasure in doing things*; D2 - *Feeling down, depressed, or hopeless*). The original answer options are "Not at all" (0), "Several days" (1), "More than half the days" (2), "Nearly every day" (3). The total score is computed by summing the responses of each facet resulting in a 0-6 score for depression and anxiety.

For the refined version, we added a "Once or twice" option between "Not at all" and "Several days"in order to better capture potential mild mood inflections (see Dobson & Mothersill, 1979 for the choice of the label). This new option was scored as 0.5 to preserve the same scoring as the original version.

Procedure

Participants were administered the refined PHQ-4 online as part of another study, which contained additional questionnaires and tasks not relevant fort the current analysis. The PHQ-4 was presented in a randomized order with other questionnaires. The data is available in open-access at https://github.com/RealityBending/IllusionGameReliability.

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Results

The analysis was carried out using *R 4.4* (R Core Team, 2023), the *tidyverse* (Wickham et al., 2019), and the *easystats* collection of packages (Lüdecke et al., 2019, 2020, 2021; Patil et al., 2022). All reproducible scripts and complimentary analyses are available open-access at https://github.com/DominiqueMakowski/PHQ4R

Descriptive Statistics

The reliability of the anxiety ($Cronbach's\ \alpha = 0.903$; RMSEA = 0.031) and depression ($Cronbach's\ \alpha = 0.841$; RMSEA = 0.044) subscales is excellent. The proportion of response types stratified by item (see Figure 1) shows that the new "Once or twice" option was the most prevalent response for all items (on average selected in 29.12% of cases).

Item Response Theory

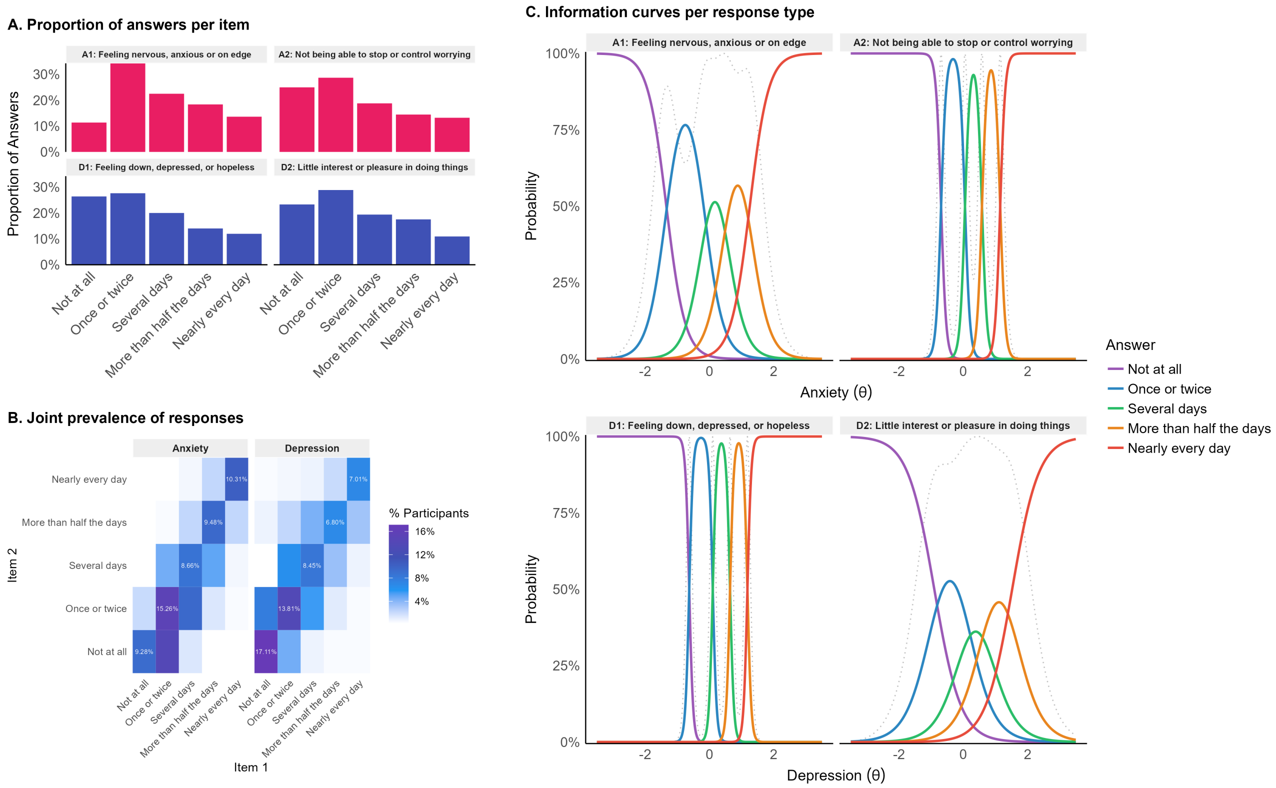
Item Response Theory (IRT) provides insights into how well items and responses capture an underlying latent trait θ. For each of the subscales, we fitted a unidimensional graded response model (GRM, Samejima, 1997). For anxiety, the two items captured 89.2% of the variance of the latent anxiety dimension ($\theta_{anxiety}$). The discrimination parameters suggested that the first item was less precise ($\alpha = 3.42$) than the second item ($\alpha = 12.55$) in its ability to discriminate between various levels of anxiety (i.e., each response on the second item covers a more exclusive range of $\theta_{anxiety}$, as can be seen in **Figure 1B**). The two depression items captured 82.8% of the variance of its latent trait ($\theta_{depression}$), and the opposite pattern was found: the first item had a higher precision ($\alpha = 16.46$) than the first ($\alpha = 2.41$). However, it is important to note that the "less precise" items were also the ones covering a larger portion of the latent space (being more sensitive especially on the lower end of the spectrum), offering an interesting trade-off between sensitivity and precision. Importantly for our objective, the added "Once or twice" option did cover a selective and unique portion of the latent space.

Discussion

The fact that the new "Once or twice" response option was the most prevalent response speaks to its usefulness in capturing more accurately participants' expression. The IRT analysis further revealed that this response tracks with precision a unique portion of the variability in the latent factors measured by the instrument. Taken together, our results suggest that adding this option response increases the scale's potential to discriminate average mood levels (which are superior to zero) from lower-end extremes (the true zero).

Figure 1

A) Proportion of answers of each type to the four items. B) Prevalence of answer pairs. C) Item Information Curves from IRT showing the coverage by each item and response of the latent dimension. Typically, an optimally informative item would display a large coverage over theta, with each response presenting a narrow coverage (high discrimination between different levels).



Study 2

Method

Participants

The initial sample consisted of 1053 participants, recruited (181 were recruited on *Prolific*, 772 students from the University of Sussex via *SONA*, and the rest through convenience sampling as part of dissertation students' data collection). We used attention checks as the primary target for participant exclusion. We excluded 194 participants (18.42%) for failing at least one attention check, and 23 (2.18%) that were outliers ($|z_{robust}| > 2.58$) on measures significantly related to the probability of failing attention checks (namely, the standard deviation of all the items of the IAS, as well as the multivariate distance obtained with the OPTICS algorithm, see Thériault et al., 2024). The experiment duration was not related to the probability of failing attention checks and was thus not used as an exclusion criterion.

The final sample included 836 participants (Mean age = 25.1 +- 11.3 [18, 76]; 73.8% women). This study was approved by the University of Sussex' Ethics Committee (**ER/…**).

In this sample, 51 participants (6.10%) were labelled as having Depression, as indexed by the self-reported presence of MDD together with the use of a treatment (antidepressent, anxiolytic and/or therapy), and 87 participants (10.41%) were labelled as having Anxiety, as indexed by the self-reported presence of GAD or Panic Disorder, also together with the use of a treatment.

Measures

TODO

The total scores for the original version are 0-6 scores for depression and anxiety. The refined version creates more possible scores (0.5, 1.5, 2.5, etc.) due to the presence of an item scored 0.5.

Procedure

TODO

Results

As all the scripts, analysis details and results tables are available open-access at https://github.com/DominiqueMakowski/PHQ4R, we will focus on reporting the main results.

PHQ-4 Depression vs. *BDI-II*

The linear regression predicting the BDI-II total score with the PHQ-4 depression score showed no interaction related to the PHQ-4 version ($\Delta Intercept_{\text{refined}} = TODO; \Delta\beta_{\text{refined}} = TODO$), suggesting no differences in the relationship pattern between the two versions (see Figure 2).

Moreover, Bayesian *t*-tests comparing the BDI-II scores between the refined and the original version at each integer score (0, 1, 2, 3) yielded no evidence in favour of a significant difference (BF > 3). In other words, having the same score on the refined version as on the original version was related to the same outcome on the BDI-II.

However, the low in-between scores from the refined version are overall capturing significantly different levels of depression compared to the adjacent scores. Scoring 0.5 was associated with a higher BDI-II score than scoring 0 (BF > 30), and lower scores than scoring 1 (BF > 30). Similarly, scoring 1.5 was associated with a higher BDI-II score than scoring 1 (BF > 30), but not lower scores than scoring 2 (BF = 0.234).

PHQ-4 Anxiety vs. *STAI-5*

The linear regression predicting the STAI-5 general score with the PHQ-4 anxiety score showed no interaction related to the PHQ-4 version ($\Delta Intercept_{\text{refined}} = TODO; \Delta\beta_{\text{refined}} = TODO$), suggesting no differences in the relationship pattern between the two versions.

Moreover, Bayesian *t*-tests comparing the STAI-5 scores between the refined and the original version at each integer score yielded no evidence in favour of a significant difference. In other words, having the same score on the refined version as on the original version was related to the same outcome on the STAI-5.

However, comparing in-between scores with adjacent scores yielded mixed results. Scoring 0.5 on the PHQ-4 anxiety was not significantly associated with a different level of STAI-5 compared to scoring 0 (BF = 1.83), but was with scores of 1 (BF > 30). Similarly, there was no evidence that scoring 1.5 was different from scoring 1 (BF = 0.605), but strong evidence that it was different from scoring 2 (BF > 30).

Correlation Differences

While the relationship pattern (i.e., the slope of the linear relationship) was not affected by the PHQ-4 version, we focused next on testing the difference in the strength (i.e., the precision) of the relationship, in particular at the lower end of the spectrum (i.e., for sub-clinical threshold scores of the BDI-II and STAI-5). We bootstrapped (2000 iterations) the difference in correlation between the refined and the original version for each of the two ground-truth measures, separately for the BDI-II subsamples (minimal to mild <= 18; moderate to severe > 18) and the STAI-5 subsamples (minimal to mild < 2; moderate to severe >= 2).

The results suggested that in the subclinical range of the BDI-II, the correlation between its score and the PHQ-4 Depression score was marginally higher (although not significantly, $p_{one-sided} = 0.161$) for the refined version compared to the original one. No correlation differences were observed in the moderate to severe range of the BDI-II.

For the STAI-5, there was no difference in the correlation between the refined and the original version in the subclinical range of the STAI-5. Surprisingly, we observed a stronger correlation between the refined PHQ-4 Anxiety score and the STAI-5 in the moderate to severe range compared to the original version ($p_{one-sided} = 0.027$).

Predictive Power

Finally, we tested the predictive power of the PHQ-4 depression and anxiety scores on the presence of a depression or anxiety disorder, respectively. We modeled the relationship with a logistic regression. While the PHQ-4 was overall a strong predictor of the outcome, there was no significant difference between the two PHQ-4 versions.

However, the ROC curves for the refined and the original version of the PHQ-4, suggested that the refined version had a better sensitivity / specificity trade-off (AUC = 78.36%) compared to the original version (AUC=75%), in particular on the lower end of the spectrum. The difference was negligible for anxiety.

Discussion

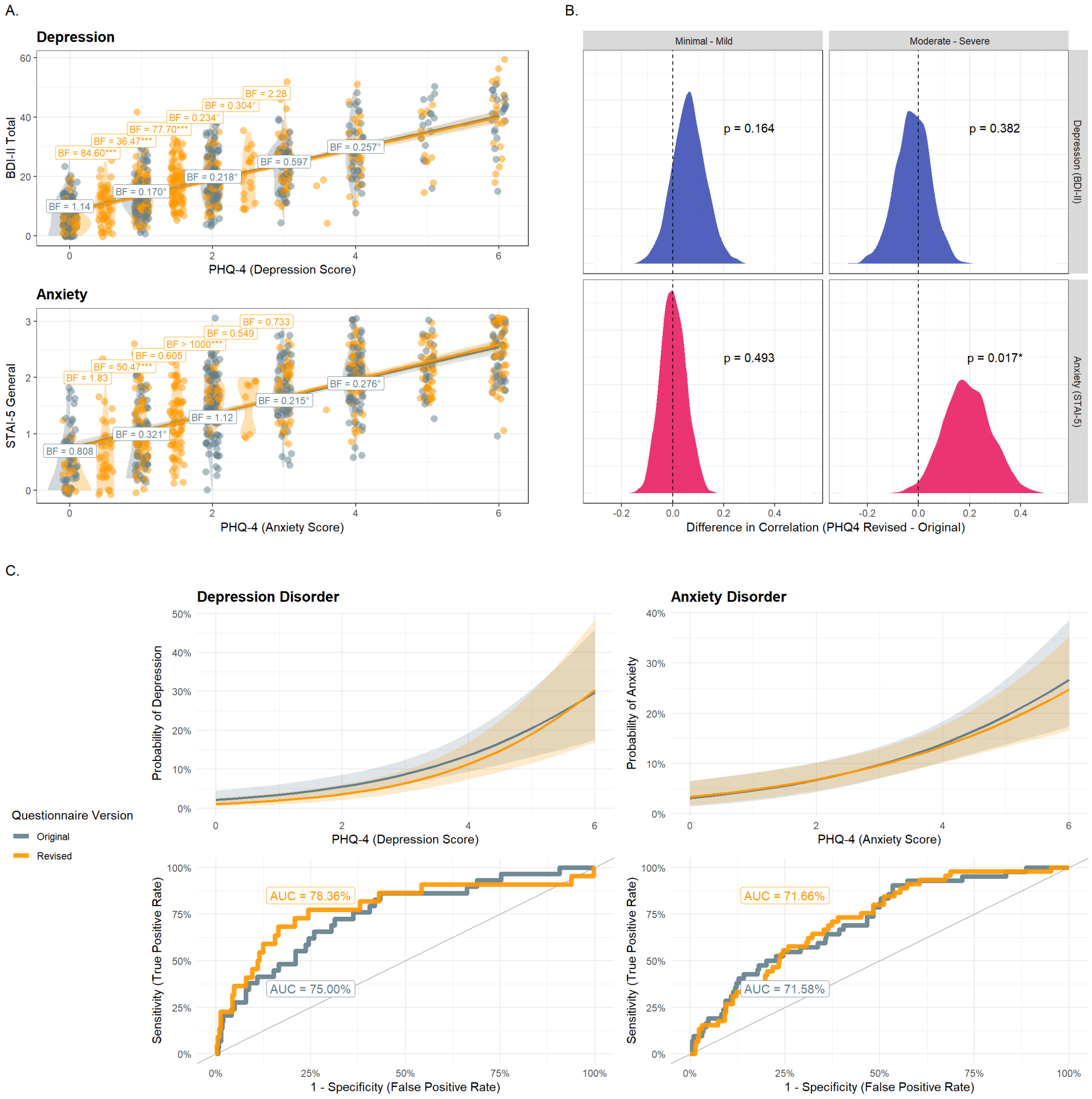
These results suggest that the new “Once or twice” response option to the PHQ-4 does help capturing more fine-grained variations of depressive symptoms, particularly in the subclinical range. Importantly, adding this new response option with the scoring of 0.5 does not disrupt the quality of the scale, which scores remain comparable to that of the original version.

The results for the anxiety subscale appear more mixed, with less evident benefits. However, this might have been partly caused by our design decision regarding the questionnaire used for the ground-truth measure of anxiety. Indeed, we used the abridged version of the STAI, which only included 5 items, arguably limiting the sensitivity of the anxiety measure in the first place.

Finally, although we used a stricter criterion for classifying participants as having a depression or an anxiety disorder by restricting it to participants also reporting undergoing

Figure 2

A) PHQ-4 depression and anxiety scores against their respective ground-truth measures, the BDI-22 and the STAI-5. Bayes factors in grey tell if there is a difference, for the same PHQ-4 score, between the original and the refined version (BFs < 1 suggest no difference and thus evidence for a comparability of the refined version with respect fo the original scale. Bayes factors in yellow represent how new in-between scores (0.5, 1.5, 2.5, …) available with refined version differ from the adjacent scores (BFs > 3 suggest that half a point of difference on the refined PHQ-4 relates to a significant difference on the ground truth measure). BF < 1/3°, BF > 3, BF > 10**, BF > 30***. B) Bootstrapped distributions of the difference of correlation between the revised PHQ-4 scores and the original one for sub-clinical threshold scores of depression and anxiety. Positive differences suggest that the correlation between the ground-truth measure and the refined PHQ-4 score was stronger compared to the original version. C) Predictive power of the PHQ-4 scores on the presence of a depression or anxiety disorder. The upper plots show the relationship modelled by a logistic regression, while the above plots represent the ROC curves (in which a line further away from the diagonal represents a higher combination of sensitivity and specificity).*



a medical treatment, it was still based on self-reported data. Studies in controlled clinical settings are needed to confirm the potential benefits of the refined PHQ-4 in mood disorders detection accuracy.

General Discussion

The objective of this study was to test the introduction of a “Once or twice” response option to the PHQ-4 to enhance its sensitivity to milder mood fluctuations. In the first study, we showed that the new response option was used prevalently by participants and did capture a unique portion of the depression and anxiety underlying dimensions. In the second study, we showed that the refined version of the PHQ-4 was able to better differentiate lower levels of depression compared to the original version, while remaining comparable. Although the benefits of this refinement appear to be fairly minor, and particularly marked for the depression score compared to anxiety, this cost-free improvement appear useful to implement when measuring depression and anxiety using the PHQ-4 ultra-short screening questionnaire.

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