Psychometric properties of the questionnaire of cognitive and affective empathy in a Portuguese sample

Andreia Queirós1*, Eugénia Fernandes1*, Renate Reniers2,3, Adriana Sampaio1, Joana Coutinho1, Ana Seara-Cardoso1,4*

1 Neuropsychophysiology Lab, CIPsi, University of Minho, Braga, Portugal, 2 Institute of Clinical Sciences, University of Birmingham, Birmingham, United Kingdom, 3 Institute for Mental Health, University of Birmingham, Birmingham, United Kingdom, 4 Division of Psychology and Language Sciences, University College London, London, United Kingdom

☯ These authors contributed equally to this work.
* ana.searacardoso@psi.uminho.pt

Abstract

Empathy is an important concept in psychology and cognitive neuroscience. Despite the controversy around its definition, most researchers would agree that empathy is a multidimensional phenomenon which involves a vicarious experience of another person’s affective state and an understanding of another person’s affective experience. Self-report measures of empathy constitute an important tool for both research and clinical practice. The main goal of this study was to adapt and study the psychometric properties of the Questionnaire of Cognitive and Affective Empathy (QCAE), a worldwide used measure of empathy, in a Portuguese community sample (N = 562). Confirmatory factor analyses supported the factor structure of the original QCAE. Results show that the Portuguese version of the QCAE has sound psychometric properties, with good structural validity and internal consistency for both scales (i.e., affective and cognitive) and respective subscales of the instrument (i.e., Emotion Contagion, Proximal Responsivity, Peripheral Responsivity, Perspective Taking and Online Simulation). We tested both a five correlated factor structure (Model 1) and a second-order model that postulates the affective and cognitive dimensions (Model 2). Our results show that while both models present acceptable goodness of fit indices, Model 1 performs slightly better. In conclusion, the Portuguese version of the QCAE may prove a useful tool for future cross-cultural assessments of empathy in both research and clinical practice.

Introduction

Empathy is an ubiquitous concept that has met with increasing interest from several basic and applied fields. It has steadily permeated the speeches of politicians (e.g., Barack Obama’s 2006 speech), business leaders and other public figures (e.g., Meryl Streep’s 2017 Golden Globes speech). It is a term now firmly embedded in the lexicon of business, finance and marketing fields. Its positive social impact is heralded in books targeting the general public, and
thousands of training programs have been outlined in order to instill empathic behavior in health practitioners and other social service professionals [1].

Unsurprisingly, the concept of empathy also draws immense research interest. Research has shown that empathy is strongly associated with general wellbeing and social functioning [2, 3] and is a critical factor for appropriate prosocial behavior [4]. Furthermore, empathy seems to be altered in a number of serious psychopathologies, including psychopathy [5–10], autism [11], social phobia [12], schizophrenia [13], depression [14] and borderline personality [15].

Just as other social science constructs, the conceptualization of empathy has evolved alongside the historically predominant perspectives in psychology and social sciences (for a review, see [1]). Even nowadays, conceptually distinct phenomena may be clustered under the same broad term that is empathy [16]. This lack of consensus as to its precise definition and as to its constitutive components poses a challenge to the study of empathy [17]. Nonetheless, most researchers would agree that empathy is a multidimensional phenomenon, which involves a vicarious experience of another person’s affective state and an understanding of another person’s affective experience (e.g.[18–22].

The emergence and advances of cognitive neuroscience have helped to shed light on the neurophysiological underpinnings of empathy in humans [23], pinpointing a complex network of neural regions and autonomic processes involved in the experience of empathy [10, 19, 24, 25]. Neuroscience findings indicate that empathy comprises a number of dissociable, but interacting, cognitive components, subserved by distinct, but interacting, neural networks [5, 26–28]. Many authors have thus adopted a two-component model of empathy, defining empathy as a multidimensional structure [18, 19, 29] that encompasses the ability to vicariously experience their emotional experience (affective empathy) and to comprehend other peoples’ experience (cognitive empathy) [29].

In the study of empathy, reliable self-report instruments are essential due to their relative good cost-effectiveness. By resorting to a questionnaire, a single researcher may be able to assess larger samples in a fast and collective manner. Furthermore, with this method, repeated measurements (e.g., longitudinal studies) are more easily implemented. The four most frequently used questionnaires of empathy in research are Hogan’s Empathy Scale (HES; [30]), Mehrbrian and Epstein’s Emotional Empathy Scale (EES; [31], Davis’ Interpersonal Reactivity Index (IRI; [32]), and Baron Cohen’s Empathy Quotient (EQ; [33]). However, these self-report instruments present some shortcomings. For example, most do not allow the distinction between affective and cognitive components of empathy, or their broader definitions hinder the disentanglement of empathy from related but distinct constructs, such as empathic concern or sympathy [29].

Recently, in an attempt to overcome some of these shortcomings, Reniers and colleagues [29] created the Questionnaire of Cognitive and Affective Empathy (QCAE), a novel self-report measure of empathy that takes into account the multidimensional nature of the construct as described above. The QCAE has been used worldwide [e.g. [34–37], showing good reliability and factor structure. The QCAE seems to be a psychometrically sound measure of empathy, both in the general population and in the context of clinical conditions (e.g., schizophrenia [38–41]; and psychopathy [42, 43]).

With the present study we aimed to analyze the psychometric properties of the QCAE in a large Portuguese community sample. This is important for a number of reasons: 1) to further probe the factor structure and reliability of the QCAE; 2) to further probe its validity in non-English-speaking cultures; and 3) to make a sound self-report instrument of empathy available for research with Portuguese samples, allowing for future cross-cultural assessments.
Materials and methods

Participants

Participants were invited to take part in this study via email through the Communication and Image departments of Portuguese universities across the country and through social media platforms such as Facebook and LinkedIn. After providing informed consent to participate, a total of 562 Portuguese adults (413 females and 149 males) filled in a standard demographics’ questionnaire and an online version of the QCAE. Age varied between 18 and 60 years old ($M = 27.5$, $SD = 10.32$); females had a mean age of 26.28 ($SD = 9.67$) whereas males had a mean age of 31.74 ($SD = 12.02$). Males were significantly older than females, as confirmed with a Welch’s $t$-test, $t(216) = 4.11, p<0.001$.

Ethics

The current study was conducted according to the principles expressed in the Declaration of Helsinki and was approved by the Ethics Committee of the University of Minho. After reading a consent statement with information about the study (e.g., voluntary participation, confidentiality/anonymity, right to withdraw) and about the research team, participants who agreed with these terms proceeded with the present study. First, they provided information about demographic variables, including sex, age, country of origin, and highest level of education achieved. Next, they were presented with the online version of the QCAE.

Questionnaire of cognitive and affective empathy (QCAE)

The QCAE [29] is a self-report measure of adults’ cognitive and affective empathy, comprised of 31 items answered on a 4-point Likert scale ranging from strongly disagree (1) to strongly agree (4). All of the QCAE’s items were originally drawn from a variety of well-known measurements, namely the Hogan Empathy Scale (HES;[30], the Empathy Subscale of the Impulsiveness-Venturesomeness Empathy Inventory (IVE; [44], the Interpersonal Reactivity Index (IRI; [18] and the Empathy Quotient (EQ; [33].

The affective empathy dimension assesses the ability to be sensitive to and to vicariously experience another’s emotional state, whereas the cognitive empathy dimension assesses the ability to form an understanding of another’s internal emotional state. The affective empathy dimension is subdivided into Emotion Contagion (4 items), Proximal Responsivity (4 items), and Peripheral Responsivity (4 items). Emotion contagion is characterized by the ability to automatically mirror other’s emotional states (e.g., “I am happy when I am with a cheerful group and sad when the others are glum”); while proximal responsivity is defined as the emotional state that is elicited through the perception of a close one’s feelings and moods (e.g., “Friends talk to me about their problems as they say that I am very understanding”); and lastly, peripheral responsivity is defined by the emotional response that emerges in response to social contexts that are more socially detached to the subject (e.g., “I often get deeply involved with the feelings of a character in a film, play, or novel”).

The cognitive empathy dimension is subdivided into Perspective Taking (10 items), and Online Simulation (9 items). Perspective Taking consists in the ability to infer things from other’s perspective (e.g., “I am quick to spot when someone in a group is feeling awkward or uncomfortable”), whilst the latter is the attempt to imagine oneself in another’s situation and infer their emotional state (e.g., “I find it easy to put myself in somebody else’s shoes”).

Scores of each subscale are obtained by summing up the corresponding individual item scores. Summing up the scores of emotion contagion, proximal responsivity, and peripheral responsivity provides a score for the affective empathy dimension; summing up the scores of
perspective taking and online simulation subscales provides a score for the cognitive empathy dimension. Lastly, summing up the scores of cognitive empathy and affective empathy provides a total score for Empathy. Scores for the five subscales of the QCAE achieved acceptable to very good internal consistency indicators in the original version (Cronbach’s alphas, $\alpha$, ranging from .65 to .85; [29]).

For the current study, a Portuguese version of the QCAE was created. A translation and back-translation approach was followed (Fig 1). Two English-Portuguese bilingual researchers independently translated the QCAE items from English to Portuguese and discussed their discrepancies together with a third researcher until a consensus was reached. This version was then independently back-translated to English by two other researchers (fluent in both English and Portuguese) who were unrelated to this project. The back-translated version was verified and approved by the first author of the original instrument, resulting in the Portuguese version of the QCAE, whose psychometric properties will be the focus of the current study.

Data analysis

The present study was intended as a psychometric analysis based on the internal structure and measurement invariance of the five-factor model of the instrument for both the first- and second-order structure originally proposed by Reniers and colleagues [29] (Fig 2). Specifically, the first-order structure (Model 1) tested the parcel loadings on the five subscales of the QCAE (i.e. Emotion Contagion, Proximal Responsivity, Peripheral Responsivity, Perspective Taking, and Online Simulation). The second-order structure (Model 2) builds on Model 1 by adding the hypothesized higher-order cognitive and affective empathy constructs. Both models were

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**Fig 1. Flowchart of the Portuguese adaptation of the QCAE.**

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assessed via confirmatory factor analysis (CFA), using R Studio version 3.2.4, through “Lavaan” package [45].

For completeness, and to obtain item loadings, we first conducted an item-level CFA analysis. Next, and similarly to the original version of the QCAE, we implemented a parceling approach to reduce the likelihood of bias in structural parameters [46, 47]. While the use of parcels to investigate factor structures might be arguable, we considered that, in the particular case of the QCAE, this was the most appropriate approach. The QCAE presents an uneven number of items per factor (e.g. the Perspective Taking subscale comprises 10 items whereas each of the Affective Empathy subscales comprise only 4 items each), making the factors differentially susceptible to different degrees of measurement error. By using parcels, because fewer indicators per construct are used, the amount of measurement error is mitigated [48]. Additionally, while the items tapping a construct would probably present non normal distributions, the resulting distribution of their parcels would more likely approach the “true” distribution of

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Fig 2. Model 1 (left) and Model 2 (right) representing the first-order (Model 1) and the second-order (Model 2) structure of the QCEA-Portuguese version. Boxes represent observed variables (parcels) and circles represent latent factors. Straight arrows represent factor loadings. The curved, double-headed arrows represent covariations. P21 = Parcel 1 of Factor 2 (OS), etc.; PT = Perspective taking; OS = Online simulation; EC = Emotion contagion; PrR = Proximal responsivity; PeR = Peripheral responsivity.
the construct [48]. Finally, the main goal of the current study was to replicate, as close as possible, Reniers and colleagues’ [29] methodology and to investigate whether their proposed factor structures for the QCAE held in a Portuguese large sample.

We have, however, changed the parceling strategy used in order to reduce the likelihood of bias in structural parameters [46, 47]. Instead of averaging the highest loading pairs of items, parcels within each factor were created by averaging the items with the highest and lowest item-scale correlations. The only exception to this strategy happened with factor 5 (i.e., Peripheral Responsivity) which only had three items since item 17 was excluded from this version due to an extremely low loading value (cf. Results and Discussion for further details). In this exception, to preserve the model’s structure and the described parceling strategy, the item with intermediate item-scale correlation was selected as a second “parcel” (I29). Therefore, in the CFA analyses, only this parcel was treated as an ordered variable (refer to Table A in S1 File for a complete description of the parcels). Nonetheless, to allow for a direct comparison with the analyses conducted on the original instrument, we ran a further set of CFA analyses using Reniers and colleagues’ parceling strategy (refer to Table B in S1 File for a complete description of the parcels).

Model fit was assessed by chi-square ($\chi^2$) goodness of fit test, Root Mean Squared Error of Approximation (RMSEA) and the Comparative Fit Index (CFI). Although the Chi-square test is usually reported in CFA, its use has been criticized due to its sensitivity to sample size effects, which may lead to too many type I errors when variables have non-normal distributions, with a high degree of kurtosis [49]. This and other additional measures are nonetheless presented to allow for a comparison with original versions of the instrument [29]. Model fit was evaluated according to the dual-criteria method proposed by Hu and Bentler [50] which set the acceptable threshold values for CFI at $\geq 0.90$ and for RMSEA at $\leq 0.08$.

In order to assess the extent of the models’ internal consistency, Cronbach’s coefficient alpha and Composite Reliability indexes were inspected. Cronbach’s alpha is the estimator most frequently reported in the literature. However, its use has been criticized as it provides a lower bound on true reliability [51], particularly when a model is not unidimensional [52]. Thus, as an alternative, reliability was also assessed through the Composite Reliability (CR) index [53, 54]. Bagozzi and Yi [55], as well as Hair and colleagues [56] recommend CR values $\geq 0.6$.

Finally, a sex invariance analysis (configural, metric, and scalar invariance) was conducted to ascertain whether the instrument validly assesses the same constructs in both genders. Lastly, sex differences in empathy scores were inspected with Welch $t$-tests which are considered to be more robust than Student’s $t$-tests [57], especially when sample sizes are unequal and thus unequal variances more difficult to be detected.

**Results**

**Confirmatory factor analysis (CFA) and internal consistency**

Analysis of responses indicated that the data did not follow a normal distribution (Mardia multivariate kurtosis = 39.60, $p < .001$; [58]) and thus the diagonally weighted least squares estimation method with robust standard errors (Satorra-Bentler scaled statistic) was selected in the CFA. Item-level CFA were performed on the five-factor structure models originally proposed by Reniers and colleagues [29]. Goodness of fit measures for the two models were as follows: for Model 1, $\chi^2(424) = 3466.083$ $p < .001$, CFI = .910, TLI = .901, SRMR = .091 and RMSEA = .096; for Model 2, $\chi^2(428) = 3413.284$ $p < .001$, CFI = .908, TLI = .900, SRMR = .094 and RMSEA = .096). All item loading values were significant, with the exception of item 17, which revealed a value lower than 0.50, namely 0.023 ($p = 0.419$). A careful examination of
item 17 highlighted its statistical and theoretical failure (cf. Discussion), and the item was therefore excluded from the Portuguese version of the QCAE. Following its removal, all 30 factor loadings were above .5 with \( p \)-values < .001 (Table A in S1 File).

Next, we followed a parceling approach to reduce the likelihood of bias in structural parameters (cf. Data Analysis). Items were parceled and the structure of the two models was assessed with a further set of five-factor CFA (Fig 1; Table C in S1 File). Of notice, and similarly to Reniers and colleagues [29], a negative residual variance was observed in the peripheral responsivity factor in Model 2; consequently, this factor was constrained to zero. All parcel loadings were above .5 and significant at \( p < .001 \), and total sample values ranged between .625 and .926 (Model 1) and between .608 and .926 (Model 2). In the male subsample, parcel loadings ranged between .528 and 1.054 (Model 1) and between .518 and 1.074 (Model 2). In the female subsample, parcel loadings ranged between .638 and .936 (Model 1) and between .633 and .937 (Model 2). As presented in Table 1, both Model 1 and 2 presented satisfactory values in the CFI and RMSEA goodness-of-fit indices for the total sample, as well as for separate female and male subsamples. The analyses using Reniers and colleagues’ parceling strategy provided similar results, as can be observed in Table D in S1 File.

Regarding internal consistency, Cronbach’s alphas at the subscale and total scale levels ranged from .62 to .87, while the cognitive and affective dimensions presented alphas of .87 and .80, respectively (Table E in S1 File). Importantly, the five subscale constructs of the two QCAE models presented good composite reliability (CR) values, ranging between .643 and .913 for the complete sample (Table 2). Similarly, both dimensions and total scale presented CRs above .90. In sum, these indices, that differently quantify the same concept, provided a consistent indication of adequate reliability.

**Measurement invariance across genders**

The two models were well fit both for male and female samples (Table 1), indicating configural invariance. Moreover, Model 1 presented full metric invariance across sexes (\( \Delta \text{CFI} = -0.001 \), \( \Delta \text{RMSEA} = 0.002 \), and non significant \( \chi^2 \) differences) and partial scalar invariance (\( \Delta \text{CFI} = -0.001 \), \( \Delta \text{RMSEA} = 0.000 \), and nonsignificant \( \chi^2 \) differences) was found after relaxing the
intercept of parcels P41, P11, P52, and P51. Model 2 presented full metric (ΔCFI = -0.000, ΔRMSEA = -0.002, and nonsignificant $\chi^2$ differences) and partial scalar invariance (ΔCFI = -0.000, ΔRMSEA = -0.000, and nonsignificant $\chi^2$ differences) after relaxing the intercept of parcels P41, P51, P52, P31 and P11. These results suggest that both models were reliable across genders.

**Gender differences in empathy**

Similar to the original study, females scored significantly higher than males on all empathy measures. Independent-samples Welch’s $t$-test confirmed these differences: on the affective empathy scale, females had a mean of 33.46 (SE = 0.24) and males had a mean of 29.30 (SE = 0.40), $t(560) = 8.83$, $p<0.001$; on the cognitive empathy scale, females had a mean score of 59.11 (SE = 0.36) whereas males had a mean of 56.68 (SE = 0.67), $t(560) = 3.38$, $p<0.05$. These differences were observed across all subscales (Table 3). GLM univariate analyses (Table F in S1 File) confirmed that these differences remained significant after controlling for age, with the exception of the cognitive empathy scale ($F(1, 558) = 2.49$, $p = .115$) and its perspective taking subscale ($F(1, 558) = .334$, $p = .563$).

**Discussion**

In the current study, the psychometric properties and validity of a Portuguese version of the QCAE, a recently developed self-report measure of empathy, were tested in a large community sample. The psychometric properties of the Portuguese version of the QCAE were assessed using confirmatory factor analysis (CFA) and structural equation modeling (SEM). The results indicated that the Portuguese version of the QCAE had good psychometric properties, with high composite reliability indices and adequate fit indices for both models.

### Table 2. Composite reliability indices obtained in the confirmatory factor analyses for the models in Fig. 2.

|                  | Total sample | Male subsample | Female subsample | Total sample | Male subsample | Female subsample |
|------------------|--------------|----------------|------------------|--------------|----------------|------------------|
| Total Score      | .948         | .944           | .946             | .950         | .947           | .951             |
| Cognitive Empathy| N.A.         | N.A.           | N.A.             | .913         | .913           | .912             |
| Perspective Taking| .877         | .882           | .874             | .877         | .882           | .874             |
| Online Simulation| .786         | .776           | .787             | .786         | .776           | .787             |
| Affective Empathy| N.A.         | N.A.           | N.A.             | .902         | .881           | .902             |
| Emotion Contagion| .675         | .504           | .708             | .675         | .506           | .708             |
| Proximal Responsivity| .643         | .611           | .621             | .742         | .711           | .726             |
| Peripheral Responsivity| .842         | .879           | .810             | .841         | .887           | .823             |

Note. N. A. = Not applicable

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### Table 3. Welch’s two sample t-test results comparing males and females on QCAE scores.

|                  | Males N = 149 | Females N = 413 | Welch’s $t$-test | Cohen’s $d$ | Hedges’ $g$ |
|------------------|---------------|-----------------|------------------|-------------|-------------|
| Total QCAE score | 85.98         | 92.57           | $t(563.04) = -204.77$, $p<0.001$ | 0.65        | 0.66        |
| Cognitive Empathy| 56.68         | 59.11           | $t(564.79) = -178.04$, $p<0.001$ | 0.31        | 0.32        |
| Perspective Taking| 29.44         | 30.98           | $t(570.02) = -140.47$, $p<0.001$ | 0.30        | 0.32        |
| Online Simulation| 27.24         | 28.13           | $t(574.72) = -157.07$, $p<0.001$ | 0.22        | 0.22        |
| Affective Empathy| 29.30         | 33.46           | $t(568.94) = -139.84$, $p<0.001$ | 0.84        | 0.84        |
| Emotion Contagion| 10.81         | 12.09           | $t(602.81) = -106.69$, $p<0.001$ | 0.58        | 0.58        |
| Proximal Responsivity| 11.09        | 12.44           | $t(607.91) = -116.38$, $p<0.001$ | 0.63        | 0.65        |
| Peripheral Responsivity| 7.41         | 8.93            | $t(602.47) = -73.617$, $p<0.001$ | 0.67        | 0.69        |

Note. N = sample size, M = Mean, SD = Standard Deviation.

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sample. Our goals were two-fold. We wanted to further probe the factor structure and reliability of the QCAE and probe its validity in non-English-speaking cultures. Most importantly, we wanted to make a sound self-report instrument of empathy available for research with Portuguese samples, allowing for future cross-cultural assessments. Here, we evaluated the internal structure of the five-factor models (a first-order structure and second-order structure) originally proposed by Reniers and colleagues [29] with a confirmatory factor analysis (CFA) procedure. Our results indicate that the Portuguese QCAE has sound psychometric properties, good structural validity with acceptable goodness-of-fit indices and internal consistency across the scales and subscales of the instrument.

Currently most researchers would agree that empathy is a multidimensional phenomenon, which involves a vicarious experience of another person’s affective state (i.e. affective empathy) and an understanding of another person’s experience (i.e. cognitive empathy) [e.g. [18–22]. Yet, most available measures of empathy do not reflect this definition. For example, some do not distinguish between the affective and cognitive dimensions, and some adopt broader definitions of related but distinct constructs, such as empathic concern or sympathy [29]. This distinction is particularly important for disentangling putative neurocognitive impairments commonly associated with a number of psychopathologies. For example, individuals with high levels of psychopathy, who are known to show little concern for their victims but are highly manipulative, have been found to present deficits in affective empathy but intact cognitive empathy abilities [59, 60]. In contrast, individuals with high autistic traits, who are characterized by problems with social interaction and communication, seem to show impairments in cognitive empathy abilities but not in affective empathy. This current and multidimensional definition of the construct of empathy is patent in the original QCAE. Our results demonstrate that the Portuguese version of the QCAE presents a similar internal structure making it a reliable measurement of empathy and its distinct dimensions in Portuguese samples.

All the items of the Portuguese QCAE presented good factor loadings, except for item 17 from the peripheral responsivity subscale (“It is hard for me to see why some things upset people so much”). This item revealed an extremely low loading value and had to be excluded from the Portuguese version. The three remaining items that compose this subscale (items 2, 11 and 29) address emotional responses to social contexts that are detached to the subject, such as narrative works of art (movies, plays, novels). Item 17, on the other hand, pertains to an even more detached and non-specific social context. Taken together, this evidence suggests a theoretical failure of item 17 in the Portuguese QCAE and this item was thus removed from the final version of the instrument. In fact, the peripheral responsivity subscale has been pointed out as one of the fragilities of the QCAE by authors who recently applied the measure to clinical samples [39, 41] and found that both the reliability and convergent validity of this subscale was not very satisfactory. As argued by these authors, the fact that the items that compose the peripheral responsivity scale focus on our response to the feelings of others in a detached social context, such as characters in movies, may be confusing or not very relevant to some individuals. Moreover, three out of four items included in this scale are reverse-coded and the wording of these items may be more confusing to the reader.

Another criticism that has been pointed out to the QCAE has to do with the label attributed to one of its cognitive empathy subscales called “online simulation”. This label may be misleading as an index of cognitive empathy because in social neuroscience simulation is traditionally used to refer to the automatic mirroring processes associated with affective empathy [e.g.[61].

The present study is not without its limitations. One of them is the unequal distribution of male and female participants, which could have biased our results. Our finding of measurement invariance across genders suggests that the same constructs are being measured across the two groups and, because partial scalar invariance was achieved, comparisons of the latent
means across groups can be conducted [62]. However, due to unequal sized groups of male and female participants, it is possible that the extent of non-invariance was underestimated. We consider, though, that this shortcoming is to some extent overcome by our overall results. First, both first- and second-order structures originally proposed by Reniers and colleagues [29] present acceptable goodness-of-fit indices in our complete sample and in gender-specific samples, thus indicating that data from both samples are well described by these models. Second, consistent with previous self-report studies on empathy (e.g., [63–65]), between gender-comparison analyses revealed that females scored significantly higher than males on most empathy subscales, even after controlling for age.

Another limitation is the absence of convergent validity tests of the QCAE with other measures of empathy. This was due to a lack of a validated Portuguese instrument assessing the same multidimensional conceptualization of empathy. A further concern, which is transversal to all self-report studies on empathy, is that self-report scores might not reflect actual abilities nor predict actual empathic responses in everyday situations. Future studies could include behavioral tasks of affective empathy, such as the Empathy for emotional facial expressions task [10, 42, 60]. This task presents strong correlations with other measures of empathy and related constructs, and is sensitive to individual differences in psychopathic traits in the general population [42, 59, 60]. Importantly, behavioral performance in this task has been shown to be modulated by brain regions deemed to be crucial for the generation of affective empathic responses [10]. Similarly, future studies could test for convergent validity of cognitive empathy by including measures of empathic accuracy that evaluate empathy as a performance variable rather than a self-report variable [66]. This is important because, as pointed out before, one’s evaluation of one’s ability to infer other people’s thoughts and feelings might be distinct from one’s actual ability [67].

Finally, although the structure of two correlated higher order factors of cognitive and affective empathy (Model 2) was still considered acceptable, the five correlated factor structure (Model 1) presented a slight advantage based on the examination of the goodness of fit indices. These results, which provide a stronger support for the five correlated factor model, are in line with recent data from Myszkowski and colleagues [68]. Additionally, similarly to both the original version of the QCAE and to the more recent French adaptation of the instrument [68], the two correlated higher order factor model presented a negative residual variance problem in the Peripheral Responsivity factor. As has been pointed out by Chen and colleagues [62], among the possible causes for improper solutions are, for example, sample size fluctuations, outliers or influential cases, or even model misspecification. Future studies should seek to more fully determine the conditions under which negative estimates of error variance occur in the QCAE, for example, by examining the contribution of overall sample size and a more proportionate distribution of gender sample sizes.

Nevertheless, the goals of this study were fulfilled. The analyses of the psychometric properties of the Portuguese version of the QCAE provide further support of the original QCAE factor structure and reliability. Our results also indicate that this is a reliable, valid, and structurally sound measure of empathy which can be used in Portuguese samples. Self-report instruments measuring empathy in the general Portuguese population are scarce and a necessity given the increasing research and clinical practice interest in this construct. Plus, they are essential for efficient research. They are inexpensive, easy to assess and easy to use. Self-report instruments allow a single researcher to assess larger samples in a fast and collective manner. Hopefully, the availability of a sound self-report instrument will enrich research on empathy in Portugal, providing an important tool for the assessment of empathy as a multidimensional construct and allowing the possibility of future multicultural assessments. A sound measure of empathy is important not only for the study of individual differences and for the
disambiguation of impairments in empathy in distinct psychopathologies (e.g., psychopathy, autism spectrum disorder), but also for the screening of general social cognition abilities or for gathering evidence-based information on the change of empathic abilities of subjects undergoing therapeutic interventions.

**Supporting information**

**S1 File. Supplementary materials.** Items of the Portuguese QCAE; Table A (Parcels composition for Models 1 and 2); Table A (Parcels composition according to Reniers and colleagues [29] and Myszkowski and colleagues [68]); Table C (Standardized loadings for parcels in Model 1 and Model 2); Table D (Goodness of fit tests and indices, using Reniers and colleagues [29] and Myszkowski and colleagues [68] parcels composition)); Table E (Cronbach’s Alpha values in the second-order model of the QCAE); Table F (GLM Univariate analyses of QCAE scores by Sex (factor) with age (covariate)).

(DOCX)

**S1 Dataset. Database of the Portuguese QCAE sample.**

(XLS)

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**Author Contributions**

**Conceptualization:** Joana Coutinho, Ana Seara-Cardoso.

**Data curation:** Andreia Queirós, Eugénia Fernandes.

**Formal analysis:** Andreia Queirós, Eugénia Fernandes.

**Funding acquisition:** Joana Coutinho, Ana Seara-Cardoso.

**Investigation:** Andreia Queirós, Eugénia Fernandes.

**Methodology:** Andreia Queirós, Eugénia Fernandes, Renate Reniers, Joana Coutinho, Ana Seara-Cardoso.

**Project administration:** Ana Seara-Cardoso.

**Supervision:** Adriana Sampaio, Ana Seara-Cardoso.

**Validation:** Joana Coutinho, Ana Seara-Cardoso.

**Writing – original draft:** Andreia Queirós, Eugénia Fernandes, Ana Seara-Cardoso.

**Writing – review & editing:** Eugénia Fernandes, Renate Reniers, Adriana Sampaio, Joana Coutinho, Ana Seara-Cardoso.

**References**

1. Segal EA, Gerdes KE, Lietz CA, Wagaman MA, Geiger JM. Assessing empathy. New York: Columbia University Press; 2017.
2. Khajani Z, Mosanezhad Jeddi E, Hekmati I, Khalilzade S, Etemadi Nia M, Andalib M, et al. Comparison of Cognitive Empathy, Emotional Empathy, and Social Functioning in Different Age Groups. Australian Psychologist. 2015; 50(1):80–8. https://doi.org/10.1111/ap.12099
3. Ryff CD. Psychological Well-Being in Adult Life. Current Directions in Psychological Science. 1995; 4 (4):99–104. https://doi.org/10.1111/1467-8721.ep1072395
4. Lockwood PL, Seara-Cardoso A, Viding E. Emotion regulation moderates the association between empathy and prosocial behavior. PLoS One. 2014; 9(5):e96555. https://doi.org/10.1371/journal.pone.0096555 PMID: 24810604
5. Bird G, Viding E. The self to other model of empathy: providing a new framework for understanding empathy impairments in psychopathy, autism, and alexithymia. Neurosci Biobehav Rev. 2014; 47:520–32. https://doi.org/10.1016/j.neubiorev.2014.09.021 PMID: 25454356
6. Blair RJ. Empathic dysfunction in psychopathic individuals. In: Farrow TFD, Woodruff PWR, editors. Empathy in Mental Illness. New York: Cambridge University Press.; 2007.
7. Decety J, Fotopoulou A. Why empathy has a beneficial impact on others in medicine: unifying theories. Front Behav Neurosci. 2014; 8:457. https://doi.org/10.3389/fnbeh.2014.00457 PMID: 25642175
8. Lockwood PL. The anatomy of empathy: Vicarious experience and disorders of social cognition. Behav Brain Res. 2016; 311:255–66. https://doi.org/10.1016/j.bbr.2016.05.048 PMID: 27235714
9. Malin AJ, Pos AE. The impact of early empathy on alliance building, emotional processing, and outcome during experiential treatment of depression. Psychother Res. 2015; 25(4):445–59. https://doi.org/10.1080/10503307.2014.901572 PMID: 24801633
10. Seara-Cardoso A, Sebastian CL, Viding E, Roiser JP. Affective resonance in response to others’ emotional faces varies with affective ratings and psychopathic traits in amygdala and anterior insula. Soc Neurosci. 2016; 11(2):140–52. https://doi.org/10.1080/17470919.2015.1044672 PMID: 25978492
11. Lim MM, Bielsky IF, Young LJ. Neuropeptides and the social brain: potential rodent models of autism. Int J Dev Neurosci. 2005; 23(2–3):235–43. https://doi.org/10.1016/j.jdevneu.2004.05.006 PMID: 15749248.
12. Chambless DL, Gillis MM. Cognitive therapy of anxiety disorders. J Consult Clin Psychol. 1993; 61 (2):248–60. PMID: 8473578
13. Horan WP, Blanchard JJ. Emotional responses to psychosocial stress in schizophrenia: the role of individual differences in affective traits and coping. Schizophr Res. 2003; 60(2–3):271–83. PMID: 12591589
14. Cacioppo JT, Hughes ME, Waite LJ, Hawkley LC, Thisted RA. Loneliness as a specific risk factor for depressive symptoms: Cross-sectional and longitudinal analyses. Psychology and Aging. 2006; 21 (1):140–51. https://doi.org/10.1037/0882-7974.21.1.140 PMID: 16594799
15. Benjamin LS. Interpersonal diagnosis and treatment of personality disorders. New York: The Guilford Press; 1996.
16. Batson CD. These things called empathy: eight related but distinct phenomena. In: Ickes J DW, editor. The Social Neuroscience of Empathy: The MIT Press; 2011.
17. Batson CD. These Things Called Empathy: Eight Related but Distinct Phenomena. The Social Neuroscience of Empathy: The MIT Press; 2009. p. 3–16.
18. Davis MH. Measuring individual differences in empathy: Evidence for a multidimensional approach. Journal of Personality and Social Psychology. 1983; 44(1):113–26. https://doi.org/10.1037/0022-3514.44.1.113
19. Decety J, Jackson PL. The functional architecture of human empathy. Behav Cogn Neurosci Rev. 2004; 3(2):71–100. https://doi.org/10.1177/1534582304267187 PMID: 15537986
20. Eisenberg N. Emotion, regulation, and moral development. Annu Rev Psychol. 2000; 51:665–97. https://doi.org/10.1146/annurev.psych.51.1.665 PMID: 10751984
21. Eisenberg N, Eggum N. Empathic responding: Sympathy and personal distress. In: Ickes J DW, editor. The Social Neuroscience of Empathy: The MIT Press; 2009.
22. Hoffman ML. Interaction of affect and cognition in empathy. In: Izard JC C., Zajonc RB, editors. Emotions, Cognition, and Behavior. New York: Cambridge University Press; 1984.
23. Bernhardt BC, Singer T. The neural basis of empathy. Annu Rev Neurosci. 2012; 35:1–23. https://doi.org/10.1146/annurev-neuro-062111-150536 PMID: 22715878
24. Decety J. Dissecting the Neural Mechanisms Mediating Empathy. Emotion Review. 2011; 3(1):92–108. https://doi.org/10.1177/1754073910374662
25. de Vignemont F, Singer T. The empathic brain: how, when and why? Trends Cogn Sci. 2006; 10 (10):435–41. https://doi.org/10.1016/j.tics.2006.08.008 PMID: 16949331
26. Nummenmaa L. Hirvonen J, Parkkola R, Hietanen JK. Is emotional contagion special? An fMRI study on neural systems for affective and cognitive empathy. Neuroimage. 2008; 43(3):571–80. https://doi.org/10.1016/j.neuroimage.2008.08.014 PMID: 18790065
27. Singer T. The neuronal basis and ontogeny of empathy and mind reading: review of literature and implications for future research. Neurosci Biobehav Rev. 2006; 30(6):855–63. https://doi.org/10.1016/j.neubiorev.2006.06.011 PMID: 16904182

28. Decety J, Bartal IB, Uzefovsky F, Knafo-Noam A. Empathy as a driver of prosocial behaviour: highly conserved neurobehavioural mechanisms across species. Philos Trans R Soc Lond B Biol Sci. 2016; 371(1688):20150077. https://doi.org/10.1098/rstb.2015.0077 PMID: 26644596

29. Reniers RL, Corcoran R, Drake R, Shryane NM, Vollm BA. The QCAE: a Questionnaire of Cognitive and Affective Empathy. J Pers Assess. 2011; 93(1):84–95. https://doi.org/10.1080/00223891.2010.528484 PMID: 21184334

30. Hogan R. Development of an empathy scale. J Consult Clin Psychol. 1969; 33(3):307–16. PMID: 4389335

31. Mehrabian A, Epstein N. A measure of emotional empathy. J Pers. 1972; 40(4):525–43. PMID: 4642390

32. Davis MH. A multidimensional approach to individual differences in empathy. JSAS Catalogue of Selected Documents in Psychology. 1980; 10:85.

33. Baron-Cohen S, Wheelwright S. The empathy quotient: an investigation of adults with Asperger syndrome or high functioning autism, and normal sex differences. J Autism Dev Disord. 2004; 34(2):163–75. PMID: 15162935

34. Cacciarelli J, Thieleman K, Killian M, Tavasolli K. Braving Human Suffering: Death Education and its Relationship to Empathy and Mindfulness. Social Work Education. 2015; 34(1):91–109. https://doi.org/10.1080/02615479.2014.940896

35. Decety J, Cowell JM, Lee K, Mahasneh R, Malcolm-Smith S, Selcuk B, et al. The Negative Association between Religiosity and Children’s Altruism across the World. Curr Biol. 2015; 25(22):2951–5. https://doi.org/10.1016/j.cub.2015.09.056 PMID: 26549259

36. Georgi E, Petermann F, Schipper M. Are empathic abilities learnable? Implications for social neuroscience research from psychometric assessments. Soc Neurosci. 2014; 9(1):74–81. https://doi.org/10.1080/17470919.2013.855253 PMID: 24215717

37. Giromini L, de Campora G, Brusadelli E, D’Onofrio E, Zennaro A, Zavattini GC, et al. Validity and Reliability of the Interpersonal Competence Questionnaire: Empirical Evidence from an Italian Study. Journal of Psychopathology and Behavioral Assessment. 2016; 38(1):113–23. https://doi.org/10.1007/s10862-015-9499-5

38. Berrada-Baby Z, Oker A, Courgeon M, Urbach M, Bazin N, Amorim MA, et al. Patients with schizophrenia are less prone to interpret virtual others’ empathetic questioning as helpful. Psychiatry Res. 2016; 242:67–74. https://doi.org/10.1016/j.psychres.2016.05.022 PMID: 27262087

39. Horan WP, Reise SP, Kern RS, Lee J, Penn DL, Green MF. Structure and correlates of self-reported empathy in schizophrenia. J Psychiatr Res. 2015; 66–67:60–6. https://doi.org/10.1016/j.jpsychires.2015.04.016 PMID: 25985922

40. Masssey SH, Stern D, Alden EC, Petersen JE, Cobia DJ, Wang L, et al. Cortical thickness of neural substrates supporting cognitive empathy in individuals with schizophrenia. Schizophr Res. 2017; 179:119–24. https://doi.org/10.1016/j.schres.2016.09.025 PMID: 27665257

41. Michaels TM, Horan WP, Ginger EJ, Martinovich Z, Pinkham AE, Smith MJ. Cognitive empathy contributes to poor social functioning in schizophrenia: Evidence from a new self-report measure of cognitive and affective empathy. Psychiatry Res. 2014; 220(3):803–10. PMID: 25632418

42. Seara-Cardoso A, Dolberg H, Neumann C, Roiser JP, Viding E. Empathy, morality and psychopathic traits in women. Personality and Individual Differences. 2013; 55(3):328–33. https://doi.org/10.1016/j.paid.2013.03.01

43. Robinson EV, Rogers R. Empathy Faking in Psychopathic Offenders: The Vulnerability of Empathy Measures. Journal of Psychopathology and Behavioral Assessment. 2015; 37(4):545–52. https://doi.org/10.1007/s10862-015-9479-9

44. Eysenck SB, Eysenck HJ. Impulsiveness and venturesomeness: their position in a dimensional system of personality description. Psychological Reports. 1978; 43(3f):1247–55. https://doi.org/10.2466/pr0.1978.43.3f.1247 PMID: 746091

45. Rosseel Y. lavaan: An R Package for Structural Equation Modeling. Journal of Statistical Software. 2012; 48(2). https://doi.org/10.18637/jss.v048.i02

46. Little TD, Cunningham WA, Shahar G, Widaman KF. To Parcel or Not to Parcel: Exploring the Question, Weighing the Merits. Structural Equation Modeling: A Multidisciplinary Journal. 2002; 9(2):151–73.

47. Little TD. Longitudinal structural equation modeling. New York: NY: Guilford press; 2013.

48. Matsunaga M. Item parceling in structural equation modeling: a primer. Communication Methods and Measures. 2008; 2(4):260–93.
49. Furr M. Scale construction and psychometrics for social and personality psychology: Sage Publications.; 2011.

50. Hu L, Bentler PM. Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. Structural Equation Modeling: A Multidisciplinary Journal. 1999; 6(1):1–55. https://doi.org/10.1080/10705519909540118

51. Peterson RA, Kim Y. On the relationship between coefficient alpha and composite reliability. Journal of Applied Psychology. 2013; 98(1):194–8. https://doi.org/10.1037/a0030767 PMID: 23127213

52. Green SB, Lissitz RW, Mulaik SA. Limitations of Coefficient Alpha as an Index of Test Unidimensionality. Educational and Psychological Measurement. 1977; 37(4):827–38. https://doi.org/10.1177/001316447703700403

53. Raykov T. Coefficient Alpha and Composite Reliability With Interrelated Nonhomogeneous Items. Applied Psychological Measurement. 1998; 22(4):375–85. https://doi.org/10.1177/014662169802200407

54. Fornell C, Larcker DF. Structural Equation Models with Unobservable Variables and Measurement Error: Algebra and Statistics. Journal of Marketing Research. 1981; 18(3):382. https://doi.org/10.2307/3150980

55. Baggozi RP, Youjae Y. On the Evaluation of Structural Equation Models. Journal of the Academy of Marketing Science. 1988; 16(1):74–94.

56. Hair JF, Black WC, Babin BJ, Anderson RE. Multivariate data analysis (7th ed). Upper Saddles River: Prentice Hall.; 2005.

57. Delacre M, Lakens D, Leys C. Why Psychologists Should not use Student’s t-test Instead of Student’s t-test. Int Rev Soc Psychol. 2017; 30(1):92.

58. Korkmaz S, Goksuluk D, Zararsiz G. MVN: An R package for assessing multivariate normality. The R Journal. 2014; 6(2):151–62.

59. Lockwood PL, Bird G, Bridge M, Viding E. Dissecting empathy: high levels of psychopathic and autistic traits are characterized by difficulties in different social information processing domains. Front Hum Neurosci. 2013; 7:780. https://doi.org/10.3389/fnhum.2013.00760 PMID: 24294197

60. Seara-Cardoso A, Neumann C, Roiser J, McCrory E, Viding E. Investigating associations between empathy, morality and psychopathic personality traits in the general population. Personality and Individual Differences. 2012; 52(1):67–71. https://doi.org/10.1016/j.paid.2011.08.029

61. Preston SD, de Waal FB. Empathy: Its ultimate and proximate bases. Behav Brain Sci. 2002; 25(1):1–20. PMID: 12625087

62. Chen FF. Sensitivity of Goodness of Fit Indexes to Lack of Measurement Invariance. Struct Equ Model A Multidiscip J 2007; 14:464–504.

63. Eisenberg N, Lennon R. Sex differences in empathy and related capacities. Psychological Bulletin. 1983; 94(1):100–31. https://doi.org/10.1037/0033-2909.94.1.100

64. Michalska KJ, Kinzlzer KD, Decety J. Age-related sex differences in explicit measures of empathy do not predict brain responses across childhood and adolescence. Dev Cogn Neurosci. 2013; 3:22–32. https://doi.org/10.1016/j.dcn.2012.08.001 PMID: 23245217

65. Muncer SJ, Ling J. Psychometric analysis of the empathy quotient (EQ) scale. Personality and Individual Differences. 2006; 40(6):1111–9. https://doi.org/10.1016/j.paid.2005.09.020

66. Zaki J, Weber J, Bolger N, Ochsner K. The neural bases of empathic accuracy. Proc Natl Acad Sci U S A. 2009; 106(27):11382–7. https://doi.org/10.1073/pnas.0902666106 PMID: 19549849

67. Ickes W. Empathic Accuracy: Its Links to Clinical, Cognitive, Developmental, Social, and Physiological Psychology. In: Decety J, Ickes W, editors. The Social Neuroscience of Empathy: The MIT Press; 2009.

68. Myszkowski N, Brunet-Gouet E, Roux P, Robieux L, Malézieux A, B. E. Is the Questionnaire of Cognitive and Affective Empathy measuring two or five dimensions? Evidence in a French sample. Psychiatry Research. 2017; 255:292–6. https://doi.org/10.1016/j.psychres.2017.05.047 PMID: 28600998