PSILOGOS

Artigo Original / *Original Article*

open-access

Comparative Analysis and Validation of the Portuguese Version of the Interpersonal Reactivity Index

Análise Comparativa e Validação da Versão Portuguesa do Índice de Reactividade Interpessoal.

Lucas Manarte*, António Ramos Andrade**

ABSTRACT

Introduction: Empathy has received greater attention in research with the creation of an Interpersonal Reactivity Index, designed to measure this factor through a multidimensional approach. The Interpersonal Reactivity Index is assessed using a 28-item self-reported questionnaire with four seven-item scales. The index and the questionnaire have been translated into many languages, namely Portuguese.

Objective: The present study aims to develop, translate and validate the Interpersonal Reactivity Index for the Portuguese language. Moreover, it compares the original four-factor model with several modified models in the literature.

Methods: A sample (n=275) was analysed using Confirmatory Factor Analysis. The original model was contrasted with modified models, reporting internal consistency statistics and their fit indices. The same structure was found in the sample with good fit indices.

Results: The internal reliability of the Interpersonal Reactivity Index was not excellent (<0.90), but it is in line with the literature.

Conclusions: The comparison with other modified versions of the Interpersonal Reactivity Index's latent factor structure revealed two models with better fits than the original version, and the potential for a shortened version of the Interpersonal Reactivity Index. The latter is a valid instrument to measure empathy in the Portuguese population, in line with previous findings, namely with a previous validation into Portuguese. However, some changes to the original latent structure provide a better data fit than the original one.

Key-Words: Interpersonal Reactivity Index; Empathy; Validation; Portuguese; Confirmatory Factor Analysis.

RESUMO

Introdução: *Com a criação do índice de reactividade interpessoal, a empatia passou a ser medida de forma multidimensional e tornou-se alvo de maior atenção. O índice*

*Departamento de Psiquiatria e Saúde Mental, Faculdade de Medicina, Universidade de Lisboa. ✉ manarte@campus.ul.pt.
** IDMEC, Instituto Superior Técnico, Universidade de Lisboa, Portugal.
antonio.ramos.andrade@tecnico.ulisboa.pt.
https://orcid.org/0000-0002-9771-8179

Recebido / *Received:* 09/08/2018 • Aceite / *Accepted:* 23/07/2019

de reactividade interpessoal é avaliado com um questionário de 28 perguntas, constituído por quatro sub-escalas de sete itens cada. Este índice já foi traduzido para diversas línguas, nomeadamente para português.

Objectivos: *Este trabalho, além de desenvolver, traduzir e validar o índice de reactividade interpessoal para português, efectua uma análise comparativa do modelo original com diversos modelos modificados já relatados na literatura.*

Métodos: *A amostra (n=275) foi analisada usando o factor de análise confirmatória. O modelo original é comparado com modelos modificados, sendo avaliados a sua consistência interna e os seus* fit indices.

Resultados: *A fiabilidade interna está em linha com a restante literatura, apesar de não ter sido excelente (<0.90). A comparação com outras versões modificadas da estrutura dos factores do índice de reactividade interpessoal revelou dois modelos com melhor performance do que o modelo original e a possibilidade de desenvolver uma versão reduzida do índice de reactividade interpessoal.*

Conclusões: *Este índice é um instrumento válido para medir a empatia na população portuguesa e está em linha com outros resultados prévios, nomeadamente com uma validação anterior para português. No entanto, algumas modificações na estrutura dos factores latentes geram melhores resultados do que na estrutura latente original.*

Palavras-Chave: *Índice de Reactividade Interpessoal; Empatia; Validação; Português; Factor de Análise Confirmatória.*

Acronyms list	
AGFI	Adjusted Goodness-of-Fit index
AIC	Akaike Information Criterion
CFA	Confirmatory Factor Analysis
CSS	Considerate Social Style
CVLT	California Verbal Learning Test
DEE	Disorganized Emotional empathy
EC	Empathic Concern
FS	Fantasy Scale
GFI	Goodness-of-Fit index
I	Impassiveness
IE	Intelectual empathy
IRI	Interpersonal Reactivity Index
PD	Personal Distress
PT	Perspective Taking
RMSEA	Root-Mean-Squared Error of Approximation
SFL	Standard Factor Loading

INTRODUCTION

The Interpersonal Reactivity Index (IRI) has been proposed as a multi-dimensional instrument and commonly used in psychiatric research[1–4]. The IRI consists of a 28-item self-reported questionnaire, where each item is rated using a five-point Likert scale, with the following anchors: "0: does not describe me well" to "4: describes me very well". Davis identified four factors using an Exploratory Factor Analysis (with oblique rotation, i.e. allowing inter-correlation between factors)[1]. Four factor scales were identified:

i) Perspective-Taking (PT) scale;
ii) Fantasy (FS) scale;
iii) Empathic Concern (EC) scale;
iv) Personal Distress (PD) scale.

The PT scale assesses spontaneous attempts to adopt the perspective of other people and see things from their point of view; the FS scale assesses the tendency to identify with characters in movies, theatre plays or fictional situations; the EC scale assesses the capacity to feel warmth and compassion for others; finally, the PD scale focuses on negative experiences concerning others and negative events.

The multidimensional index, the associated scales and the questionnaire have been validated and translated into many languages, and in different countries, cultures and contexts. Therefore, the aim of the present paper is to further validate the IRI into Portuguese, while comparing different latent structures proposed in the literature.

A previous validation study into Portuguese was published in 2010 by Limpo *et al*[24]. The authors conducted an exploratory analysis, and in spite of finding similar scores on the main quality indexes – Comparative Fit Index (CFI), Goodness of Fit Index (GFI) and Root-Mean-Squared Error of Approximation (RMSEA), they decided to eliminate four questions – one in each sub-scale (questions 1, 10, 15, 18) – thus, their proposed IRI consisted of 24 questions, instead of the usual 28. We think that there is not a significant advantage in this reduction, as the statistical indexes found for those questions were quite good, and the IRI's application time does not change significantly with the removal of four questions. Since 2010, many different latent structures have been proposed in the literature and an extensive comparison between such models is lacking. Therefore, we took this opportunity to pursue a second validation into Portuguese that also allows a comparison/benchmark of the different latent structures proposed in the literature.

The Interpersonal Reactivity Index is a frequently used measure of empathy[1], tapping two of its different facets: the EC subscale assesses the tendency to experience feelings of sympathy and compassion for other people's misfortune, and the PD subscale taps the tendency to experience distress and discomfort in response to extreme distress in others.

Baron-Cohen defined empathy as i) the identification of another's mental state, including their emotional state, and ii) an appropriate emotional response to their mental state. Empathy is thought to reach its highest developmental stage during late adolescence[5]. A lack of empathy, on the contrary, implies the inability to view the world from other individuals' perspective, or to sympathize with their suffering[7], and a predisposition towards prejudice[6].

Davis defined empathy as a multidimensional construct[1], whose conceptualization includes two dimensions: i) an *emotional* dimension and ii) a *rational/cognitive* dimension. According to the author, empathy is an innate human capacity, a stable dispositional characteristic which occurs overtly in specific situations[1]. Empathy is also considered to be the tendency to vicariously experience other individuals' emotional states and an emotional response focused more on another person's situation or emotion than on one's own[7,8] .

Many other authors have published on the concept of empathy. Any instrument that aims to measure empathy in individuals should provide separate assessments of their cognitive perspective-taking and emotional reactivity.

We are not going to comment on all of these, since a comprehensive revision of the concept is not the aim of this paper.

Although there has been an upsurge in the number of studies investigating the construct of empathy, the basic approach for measuring this phenomenon still consists in the use of self-reported questionnaires, quite frequently the *Hogan empathy scale*[8], the questionnaire measuring emotional empathy and its more recent version, the *Balanced empathy emotional scale*[9], but mostly the IRI, which has been adapted to, and validated in, many different countries.

Table I summarizes several validation studies of the IRI conducted in many different countries and languages: Sweden[10], Spain[11,22], China[12], the Netherlands[13], Chile[14], Japan[15], France[16] and even Portugal[24]; with the original questionnaire being translated into at least seven languages (Spanish, French, Japanese, Swedish, Chinese, Dutch and Portuguese). This table shows the reliability/internal consistency measures for each scale (given by the Cronbach's alphas) and provides some information on sample size, reliability measures, and fit indices. As some information was not available or not reported in some studies, it was not compiled in Table I. This table was based on a search in the Web of Science, using "Interpersonal Reactivity Index" and "validation" as search topics. Some references were removed, as they were not validation studies of the IRI using Confirmatory Factor Analysis (CFA).

Table I. Validation studies of the 4-factor model structure of the Interpersonal Reactivity Index (IRI).

Reference	Country	Language	Size of the sample (n)	Reliability measures (Cronbach's alphas)				Fit indices			
				PT	FS	EC	PD	χ^2/df	CFI	AGFI	RMSEA
Cliffordson, 2001	Sweden	Swedish	221	-	-	-	-	2.04	-	-	0.069
			137	-	-	-	-	1.79	-	-	0.076
Pérez-Albéniz *et al.*, 2003	Spain	Spanish	1997	0.75/0.74	0.77/0.80	0.71/0.67	0.69/0.71	9.29	-	0.88	-
			692	0.70/0.64	0.71/0.71	0.67/0.63	0.70/0.64	6.38	-	0.80	-
			515	0.73/0.75	0.76/0.75	0.68/0.70	0.70/0.72	2.48	-	0.87	-
Siu & Shek, 2005	China	Chinese (Cantonese)	580	-	-	-	-	6.54	0.65	0.85	0.06
De Corte *et al.*, 2007	Netherlands	Dutch	651	0.73	0.83	0.73	0.77	2.93	0.86	0.87	0.06
Ortiz *et al.*, 2011	Spain	Spanish	360	0.71	0.78	0.68	0.77	14.38	-	0.67	0.136
Fernández *et al.*, 2011	Chile	Spanish	435	0.73	0.76	0.73	0.70	2.27	0.81	-	0.054
Nomura & Akai, 2012	Japan	Japanese	95	0.66	0.73	0.70	0.60	2.40	-	0.96	-
Gilet *et al.*, 2013	France	French	322	0.71	0.81	0.70	0.78	2.29	0.81	-	0.065
Limpo *et al.*, 2010	Portugal	Portuguese	478	0.74	0.83	0.77	0.81	2.46	0.75	-	0.08

Note: "/" separates values for females from values for males in (Pérez-Albéniz *et al.*, 2013).

METHODS

This study was approved by the Ethics Committee of the Northern Lisbon Hospital Centre – Santa Maria Hospital and by the Scientific Committee of the Faculty of Medicine – University of Lisbon. The English version of the IRI questionnaire was translated into Portuguese by a team of professional translators. The Portuguese translation was conducted in accordance with the standardized back-translation procedure in order to guarantee the semantic equivalence to the original IRI[17] . The procedure involved two translations: the first one from the original English version into Portuguese and the second one from Portuguese back into English. The latter was then compared with the original English version in order to discuss the existing discrepancies and to reach a final consensus, which was then taken into account for the final Portuguese version. Each step of the process was conducted by a separate translator. The Portuguese translation of the questionnaire is provided in Appendix 1.

The questionnaire was administered to adults (aged 18 or over), without known psychiatric morbidity, and the results were analyzed using SPSS and AMOS software, with a total of 275 valid answers, 137 from male and 138 from female respondents. The mean age of the respondents was 25.8 years, with a standard deviation of 9.6 years and the educational level ranged from 4 to 21 years (mean: 14.2; standard deviation: 3.0). Their marital status was the following: 24% were married, 71% single, 3% divorced and 2% widowed.

Our samples' education levels and ages are more representative of the Portuguese population than those of the previous validation, as we have based our work on a general population sample and not, as Limpo's team, on a group of students.

The index's psychometric properties were analyzed following the recommendations of the international test commission[26].

RESULTS

Regarding the reliability of each scale, *i.e.* the internal consistency measured by the Cronbach's alpha[27], and noting that each scale exhibited values from 0.60 (for the PD scale) up to 0.83 (for the FS scale) in previous studies (as shown in Table I), we have obtained acceptable values for the Cronbach's alpha reliability measure, with 0.75 for the PT scale, 0.71 for the FS and the PD scales and a lower internal consistency of 0.69 for the EC scale. These reliability values are thus comparable to those found in other studies.

Regarding the goodness-of-fit measures, our sample's fit shows acceptable values for the χ^2/df, CFI, AGFI and RMSEA, i.e. 2.13, 0.77, 0.81 and 0.064, respectively. Comparing our sample fit with those of previous studies, we must emphasize that our sample shows better goodness-of-fit values than the previous validation into Portuguese (with a lower RMSEA value: 0.064 compared with 0.08; and a higher CFI value: 0.77 compared with 0.75). Overall, these values are in line with previous validation studies reported in Table I, indicating an acceptable fit of the original four-factor model, except perhaps in Ortiz *et al.*[22], who obtained a high value for the RMSEA.

Table II provides some statistical measures (means, standard deviations, ranges and internal reliability estimates) for the four scales of the IRI: PT, FS, EC and PD. The Pearson's correlations between IRI scales are also provided. Note that the EC factor is the one with the highest scores and the PD the one with the lowest scores on average. Regarding the internal reliability, the PT factor has the highest Cronbach's alpha (0.75), indicating a reasonably good internal consistency, whereas the EC factor has the lowest value (0.69), indicating an internal consistency that is still fair, in line with the previous research.

Each scale consists of seven items, rated using a five-point Likert scale (0= "does not describe me well"; 4= "describes me very well").

Confirmatory Factor Analysis (CFA) was conducted in order to test the original four-factor structure proposed by Davis in 1983[1]. CFA is a method for evaluating *a priori* hypotheses regarding relationships among and between observed measures and their underlying latent constructs[18].

Table III provides the Standardized Factor Loadings (SFL) for each item of the IRI in the oblique four-factor solution (obtained using CFA). Note that all loadings are reasonably high and statistically significant at the 1% significance level, except for item 13, that loads on to the factor PD with a SFL of 0.12. Therefore, we have found no significant reason to remove the items excluded in Limpo *et al.*[24].

Table II. Means, standard deviations, ranges, internal reliability estimates for the PT, FS, EC and PD scale scores.

Number of the sub-scale	IRI scale	Mean	SD	Range	Internal reliability (Cronbach's alphas)	Pearson's correlations		
						2	3	4
1	PT	18.35	4.89	0-28	0.75	0.09	0.39**	-0.12*
2	FS	16.59	5.39	3-28	0.71	-	0.27**	0.21**
3	EC	19.95	4.68	2-28	0.69		-	0.12*
4	PD	12.37	5.11	2-23	0.71			-

Note: IRI = Interpersonal Reactivity Index; PT = Perspective Taking factor; FS = Fantasy factor; EC = Empathic Concern factor; PD = Personal *distress* factor.
* p-value < 0.05; ** p-value < 0.01.

Table III. Standardized Factor Loadings (SFL) for each item of the IRI in the oblique four-factor solution obtained using CFA.

		IRI scale			
	Item number and item content	**PT**	**FS**	**EC**	**PD**
P1	I daydream and fantasise, with some regularity, about things that might happen to me.	0	.38	0	0
P2	I often have tender, concern feelings for people less fortunate than me.	0	0	.53	0
P3	I sometimes find it difficult to see things from the "other guy's" point of view.	.44	0	0	0
P4	Sometimes I don't feel very sorry for other people when they are having problems.	0	0	.31	0
P5	I really get involved with the feelings of the characters in a novel.	0	.62	0	0
P6	In emergency situations, I feel apprehensive and ill-at-ease.	0	0	0	.59
P7	I am usually objective when I watch a movie or play, and I don't often get completely caught up in it.	0	.37	0	0
P8	I try to look at everybody's side of a disagreement before I make a decision.	.54	0	0	0
P9	When I see someone being taken advantage of, I feel kind of protective towards them.	0	0	.51	0
P10	I sometimes feel helpless when I am in the middle of a very emotional situation.	0	0	0	.64
P11	I sometimes try to understand my friends better by imagining how things look from their perspective.	.55	0	0	0
P12	Becoming extremely involved in a good book or movie is somewhat rare for me.	0	.22	0	0
P13	When I see someone get hurt, I tend to remain calm.	0	0	0	.12
P14	Other people's misfortunes do not usually disturb me a great deal.	0	0	.42	0
P15	If I'm sure I'm right about something, I don't waste much time listening to other people's arguments.	.42	0	0	0
P16	After seeing a play or movie, I have felt as though I were one of the characters.	0	.63	0	0
P17	Being in a tense emotional situation scares me.	0	0	0	.69
P18	When I see someone being treated unfairly, I sometimes don't feel very much pity for them.	0	0	.40	0
P19	I am usually pretty effective in dealing with emergencies.	0	0	0	.44
P20	I am often quite touched by things that I see happen.	0	0	.72	0
P21	I believe that there are two sides to every question and try to look at them both.	.58	0	0	0
P22	I would describe myself as a pretty soft-hearted person.	0	0	.57	0
P23	When I watch a good movie, I can very easily put myself in the place of a leading character.	0	.79	0	0
P24	I tend to lose control during emergencies.	0	0	0	.63
P25	When I'm upset at someone, I usually try to "put myself in his shoes" for a while.	.63	0	0	0
P26	When I am reading an interesting story or novel, I imagine how I would feel if the events in the story were happening to me.	0	.66	0	0
P27	When I see someone who badly needs help in an emergency, I go to pieces.	0	0	0	.52
P28	Before criticizing somebody, I try to imagine how I would feel if I were in their place.	.67	0	0	0

IRI = Interpersonal Reactivity Index; PT = Perspective Taking factor; FS = Fantasy factor; EC = Empathic Concern factor; PD = Personal *distress* factor.

Note: All factors were allowed to correlate, and each item was allowed to load freely on its hypothesized factor, but not allowed to load on other factors. All standardized factor loadings are significant at 1% significance level, except P13 with PD.

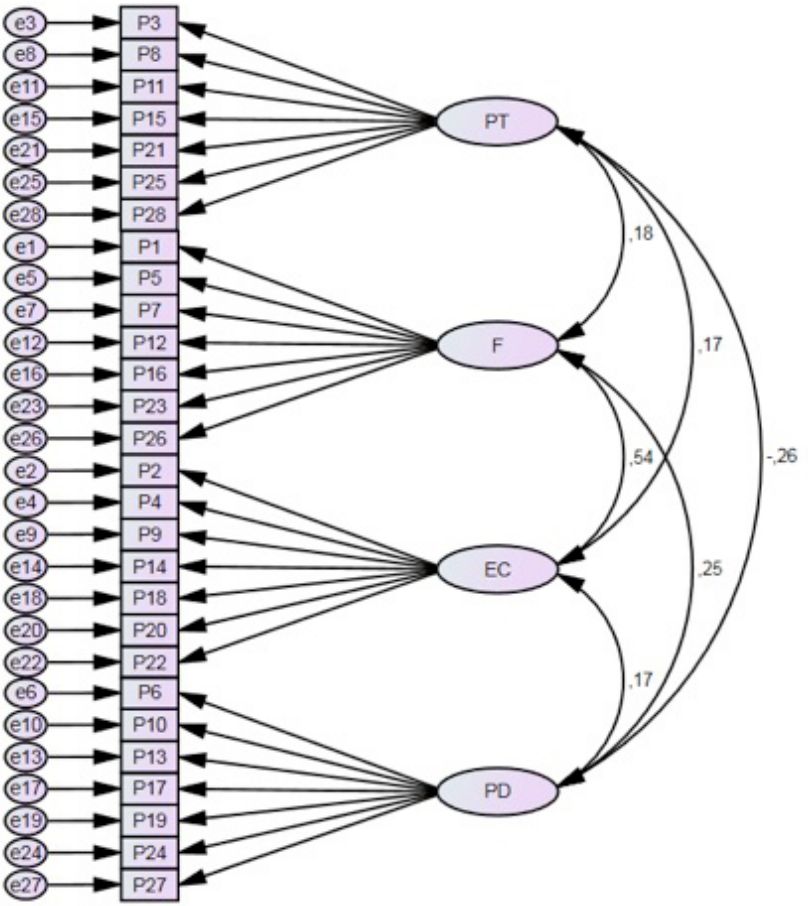

Figure 1. Four-factor model of the IRI (with the factor structure identified by each item number from P1 up to P28) and factor inter-correlations.

Figure 1 provides the factor structure, where each item (P1 to P28) loads on its hypothesized factor (PT, F, EC and PD) and all factors are allowed to correlate with each other (using arrows between factors). All items P1 up to P28 have measurement errors (e1 up to e28) independent from each other. Note that the factor structure shown in Table I follows the original four-factor structure; the PT factor loads into items P3, P8, P11, P15, P21, P25 and P28; and the other three factors load into their respective items. Figure 1 also exhibits the factor inter-correlations (e.g. 0.18 between PT and F factors).

Table IV. Gender differences and effect sizes for the four IRI scales.

IRI scale	Male (n=137)			Female (n=138)			Levene's F-test value	*t*-test for equality of means
	Mean	SD	St. Error Mean ($SD/\sqrt{n}$)	Mean	SD	St. Error Mean ($SD/\sqrt{n}$)		
PT	17.94	4.90	0.419	18.75	4.87	0.414	0.277	1.378
FS	16.18	5.44	0.465	17.00	5.32	0.453	0.006	1.271
EC	19.18	4.59	0.392	20.72	4.65	0.392	0.002	2.767*
PD	12.35	4.91	0.420	12.39	5.31	0.452	0.448	0.066

* p-value < .01

Table IV provides a comparison between the scores of the IRI scales obtained by male (n=137) and female (n=138) respondents. The female respondents tend to score higher than the male respondents in all four scales on average, and that difference is statistically significant as showed in Pérez-Albeniz[11]. In our sample, there is a statistically significant difference in the mean scores of the EC factor, but not in the PT, FS and PD factors.

DISCUSSION

The present work examined the IRI's psychometric properties, reliability and validation in a Portuguese adult population. Since Davis's original model structure with four factors was put forward[1], different modifications have been proposed in the literature. In this section, nine modified structures were identified, described and compared using CFA.

As noted in table IV, we found significant gender differences. As expected, female participants tend to score higher in empathy and emotion in general[25]. In this study in particular, the female group scored higher in the empathic concern. In accordance with the literature, girls are known to show more prosocial behavior[28], especially due to empathic concern (vs. boys, who show more perspective taking). Empathic concern changes across ages but tends to be higher among women, regardless of age. Most of the research in this field grounds this finding in culture and education differences between genders, but also in hormonal and biological variables, like estrogen and oxytocin[20].

Table V compiles all the different structures identified in the literature. For an easier interpretation, we decided to name the original version as 'model 0' and the nine other modified structures 'model 1' to 'model 9'. Two additional measures of goodness-of-fit are provided for model comparison: the Goodness-of-Fit index (GFI) and the Akaike Information Criterion (AIC)[23]. The GFI is an index that should fall between 0 and 1, with larger values indicating a better data-model fit[18]. The AIC is an information criterion that balances goodness-of-fit with model complexity (i.e. number of parameters). The lower the AIC, the better the data fit to the model.

Table V. Models and its structure (first order and second order factors and associated items).

Reference	Model	1st order Factors	Items loaded on 1st order factor	2nd order Factors	Factors loaded on 2nd order factor	Additional remarks	Fit indices				
							χ^2/df	CFI	AGFI	RMSEA	AIC
Davis, 1983	0: "Original" 4 1st order factor model	PT	3, 8, 11, 15, 21, 25, 28.	-	-	-	2.13	0.77	0.81	0.064	856.46
		FS	1, 5, 7, 12, 16, 23, 26.								
		EC	2, 4, 9, 14, 18, 20, 22.								
		PD	6, 10, 13, 17, 19, 24, 27.								
De Corte *et al.*, 2007	1: "Modified" 4 1st order factor model	PT	3, 8, 11, 15, 21, 25, 28.	-	-	Error variances between Fantasy items were freed up (7-12, 16-23, 5-12, 7-26, 12-16, 1-26, 12-26)	2.13	0.77	0.81	0.064	854.88
		FS	1, 5, 7, 12, 16, 23, 26.								
		EC	2, 4, 9, 14, 18, 20, 22.								
		PD	6, 10, 13, 17, 19, 24, 27.								
Tello *et al.*, 2013	2: "Hierarchical" 5 1st order + 1 2nd order factor model	IE	8, 11, 21, 25, 28.	CSS	IE, PEE.	-	2.45	0.71	0.79	0.073	965.54
		PEE	2, 9, 19, 20, 22.								
		DEE	6, 7, 10, 12, 17, 24, 27.								
		VE	1, 3, 5, 16, 23, 26.								
		I	4, 5, 12, 13, 14, 15, 18.								
Hawk, 2013	3: "Hierarchical" 4 1st order + 1 2nd order factor model	PT	3, 8, 11, 15, 21, 25, 28.	E	PT, FS, EC, PD.	-	2.15	0.76	0.81	0.065	864.15
		FS	1, 5, 7, 12, 16, 23, 26.								
		EC	2, 4, 9, 14, 18, 20, 22.								
		PD	6, 10, 13, 17, 19, 24, 27.								
Pulos *et al.*, 2004	4: "Hierarchical" 4 1st order + 2 2nd order factor model	PT	3, 8, 11, 15, 21, 25, 28.	GE	PT, FS, EC.	-	2.14	0.77	0.81	0.064	859.45
		FS	1, 5, 7, 12, 16, 23, 26.								
		EC	2, 4, 9, 14, 18, 20, 22.	ECo	PT, PD						
		PD	6, 10, 13, 17, 19, 24, 27.								

Reference	Model	1st order Factors	Items loaded on 1st order factor	2nd order Factors	Factors loaded on 2nd order factor	Additional remarks	Fit indices				
							χ^2/df	CFI	AGFI	RMSEA	AIC
Siu and *Shek*, 2005	5: "Shortened" and "hierarchical" 3 1st order factor model	FS	5, 12, 16, 26.	IR	FS, E, PD.	Items 1, 3, 4, 7, 19 and 23 were removed.	2.77	0.69	0.80	0.080	665.63
		E	2, 8, 9, 11, 14, 15, 18, 21, 22, 25, 28.								
		PD	6, 10, 13, 17, 20, 24, 27.								
Braun *et al*, 2015	6: "Shortened" 4 1st order factor model	PT	8, 11, 25, 28.			Items 1, 3, 4, 6, 7, 10, 12, 14, 15, 17, 18, 21 and 22 were removed.	2.22	0.87	0.88	0.067	258.40
		FS	5, 16, 23, 26.								
		EC	2, 9, 20.								
		PD	13, 19, 24, 27.								
Pérez-Albéniz, A., 2003	7: "Modified" 4 1st order factor model	PT	3, 8, 11, 15, 21, 25, 28.			Item 13 changes from factor PD to factor EC.	2.14	0.77	0.81	0.064	859.68
		FS	1, 5, 7, 12, 16, 23, 26.								
		EC	2, 4, 9, 13, 14, 18, 20, 22.								
		PD	6, 10, 17, 19, 24, 27.								
Ortiz, M. Á. C, 2011	8: "Modified" 4 1st order factor model	PT'	2, 8, 9, 11, 19, 20, 21, 22, 25, 28.			Item 12 is loaded on factors FS' and PD'.	2.77	0.64	0.75	0.080	1076.64
		FS'	1, 3, 5, 16, 23, 26.								
		EC'	4, 12, 13, 14, 15, 18.								
		PD'	6, 7, 10, 12, 17, 24, 27.								
Ortiz, M. Á. C, 2011	9: "Modified" 4 1st order factor model	PT'	2, 8, 9, 11, 19, 20, 21, 22, 25, 28.			Item 12 is loaded on factors FS' and PD' and item 5 on factors FS' and EC'.	2.78	0.63	0.75	0.081	1082.32
		FS'	1, 3, 5, 16, 23, 26.								
		EC'	4, 5, 12, 13, 14, 15, 18.								
		PD'	6, 7, 10, 12, 17, 24, 27.								

NOTE: Factors PT', FS', EC' and PD', who´s similar in meaning to that of the original ones, according to the authors.

Model 0 is the *original* model with four factors put forward by Davis[1]. Model 1 is a *modified* Belgian model with four factors[13], in which seven error variances between FS items were freed up (e7-e12, e16-e23, e5-e12, e7-e26, e12-e16, e1-e26 and e12-e26). Model 2 is a hierarchical model with five first-order factors - Cognitive/Intellectual Empathy (IE), Positive Emotional Empathy (PEE)[17], Disorganized Emotional Empathy (DEE), Virtual Empathy (VE) and Impassiveness (I), and one second-order factor - Considerate Social Style (CSS), which loads on IE and PEE[17]. Model 3 is a hierarchical model with all IRI latent factors loaded on to a secondary global empathy factor[19] . Model 4 is also a hierarchical model, with the usual first-order factors (the four scales of the IRI) and two second-order factors (General Empathy, which loads on PT, FS and EC; and Emotional Control, which loads on PT and PD)[21]. Model 5 is a three-factor model with FS, Empathy scale and PD, in which some items were removed (i1, i3, i4, i7, i19 and i23)[12] ; Model 6 is a shortened French adaptation with four factors, but only fifteen items[25]. Model 7 is a modified four-factor model in which item thirteen changed factor from PD to EC[11] . Model 8 is a modified four-factor model with i12 being loaded to two factors[22]. Finally, model 9 is a modified four-factor model with item i12 and i5 loaded to two factors[22] .
Regarding the validation of the original model (model 0) to the data, fit indices are χ^2/df=2.13, CFI=0.77, GFI=0.77, AGFI=0.81, RMSEA=0.064 (90% CI: 0.052-0.076) and AIC=856.46, suggesting a good data fit to the four-factor latent structure model. Nevertheless, there might be models that exhibit a better fit. Models 5 and 6 have items that were removed, and therefore they cannot be compared with the other models using the AIC value. Yet the fit indices for model 5, χ^2/df=2.77, CFI=0.69, GFI=0.69, AGFI=0.80, RMSEA=0.080 (90% CI: 0.068-0.092) and AIC=665.63 suggest a poor fit, whereas the fit indices for model 6, χ^2/df=2.22, CFI=0.87, GFI=0.87, AGFI=0.88, RMSEA=0.067 (90% CI: 0.055-0.079) and AIC=258.40, indicate a good fit, suggesting that a shortened version of the IRI might be pursued[25] . This version is left for further research. Moreover, note that all other models (apart from models 5 and 6) have 28 items, and that the model exhibiting a lower AIC is model 1, with fit indices χ^2/df=2.13, CFI=0.77, GFI=0.77, AGFI=0.81, RMSEA=0.064 (90% CI: 0.052-0.076), and AIC=854.88, indicating that the modified Belgian four-factor model exhibits a better data fit to that model structure when compared to others. This fact suggests that freeing up the error variances between FS items (e7-e12, e16-e23, e5-e12, e7-e26, e12-e16, e1-e26, e12-e26) would improve the model fit, as previously reported[13] . This finding was replicated in our sample. The low value for the AIC in model 4 is also comparable to model 1.
Moreover, the two translations into Portuguese, although very similar, have some differences. In our view, the present translation is closer to the original version*[1].
Finally, this comparison revealed that none of the models is clearly better than the oth-

* See notably items 7, 8, 12, 16, 18. The imprecisions found in the previous translation are relevant insofar as they can lead to changes in the respondents' quantitative assessment of their feelings and atitudes.

ers with regard to the different latent structures investigated in this section. The original four-factor structure seems to provide reasonably good measures of fit, apart from being the most robust and tested structure.

CONCLUSIONS

Empathy as a concept involves several dimensions, namely emotional and cognitive. The IRI has been proposed to comprehend these dimensions, namely perspective-taking, fantasy, empathic concern and personal *distress*. The original version of the IRI questionnaire was translated and administered to a sample of Portuguese native speakers. The four-factor structure was validated using a CFA approach, and the data exhibited a reasonable fit to the original four-factor structure, validating the IRI scales, as already found in Limpo *et al.*[24]. Moreover, several modified structures proposed in the literature were tested and compared, with the modified versions proposed in De Corte *et al.*[13], exhibiting a better fit than all the others with lower AIC. There is some potential for a Portuguese shortened version of the IRI, with a reasonably good fit, similar to the shortened latent structure proposed in Braun *et al.*[25]. Regarding further research, it is very important to use validated instruments, observing standardized methods of analysis. This, however, entails the validation of the IRI scale into Portuguese, with an extensive analysis of different latent structures already proposed in the literature.

Acknowledgements:
The authors wish to thank Bernardo Ferro for the work on translation and text revision.

Funding:
This work was supported by FCT, through IDMEC, under LAETA, project UID/EMS/50022/2019

Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

Conflicting Interests:
The authors declare they have no conflicting interests and they received no funding from any institution for this work.

References/*Bibliografia*

1. Davis MH. Measuring individual differences in empathy: Evidence for a multidimensional approach. J Pers Soc Psychol. 1983;44(1):113-126.
2. Davis MH. The effects of dispositional empathy on emotional reactions and helping: A multidimensional approach. J Pers. 1983;51(2):167-84.
3. Davis MH, Franzoi SL. Stability and Change in Adolescent Self-Consciousness and Empathy. J Res Pers. 1991;87:70-87.
4. Davis MH. Empathy. In: Stets JE, Turner JH (eds) Handbook of the Sociology of Emotions. Boston MA: Springer. 2006;443-466.
5. Preti A, Vellante M, Baron-Cohen S, Zucca G, Petretto DR, Masala C. The Empathy Quotient: A cross-cultural comparison of the Italian version. Cogn Neuropsychiatry. 2011;16(1):50-70. doi:10.1080/13546801003790982.

6. McFarland SG, Adelson S. Toward a typology of prejudiced persons. Paper presented at the annual convention of the International Society for Political Psychology. 1998.
7. Davis MH. Empathy: A social psychological approach. Routledge; 2018.
8. A Mehrabian; N Epstein. A measure of emotional empathy. J Pers. 1972;40:525-543.
9. Mehrabian A. Relation among personality scales of agression, violence, and empathy: validation evidence bearing on the risk eruptive violence scale. Agressive Behav. 1997;23:443-445.
10. Cliffordson C. Parent's Judgments and Students' Self-Judgments of Empathy: The Structure of Empathy and Agreement of Judgment Based on the Interpersonal Reactivity Index (IRI). Eur J Psychol Assess. 2001;17(1):36-47. doi:10.1027//1015-5759.17.1.36.
11. Pérez-Albéniz A, De Paúl J, Etxeberría J, Montes MP, Torres E. Adaptación de Interpersonal Reactivity Index al español. Psicothema. 2003;15:267-272.
12. Siu AM, Shek DT. Validation of the interpersonal reactivity index in a Chinese context. Res Soc Work Pract. 2005;15(2):118-126. doi:10.1177/1049731504270384.
13. De Corte K, Buysse A, Verhofstadt LL, Roeyers H, Ponnet K, Davis MH. Measuring Empathic Tendencies: Reliability And Validity of the Dutch Version of the Interpersonal Reactivity Index. Psychol. Belg. 2007;47(4):235-60. doi:10.5334/pb-47-4-235.
14. Fernández AM, Dufey M, Kramp U. Testing the Psychometric Properties of the Interpersonal Reactivity Index (IRI) in Chile: Empathy in a Different Cultural Context. Eur J Psychol Assess. 2011;27:179-185.
15. Nomura K; Akai S. Empathy with Fictional stories: reconsideration of the fantasy scale of the interpersonal reactivity index. Psychol Rep. 2012; 110(1):304-14.
16. Gilet AL, Mella N, Studer J, Grühn D, Labouvie-Vief G. Assessing dispositional empathy in adults: A French validation of the interpersonal reactivity index (IRI). Can J Behav Sci Rev Can des Sci du Comport. 2013;45(1):42-48.
17. Tello FP, Egidio BD, Ortiz MA, Gandara MD. Interpersonal Reactivity Index: Analysis of invariance and gender differences in Spanish youths. Child Psychiatry Hum Dev. 2013;44(2):320-333. doi:10.1007/s10578-012-0327-9.
18. Mueller RO. Basic Principles of structural equation modeling: An introduction to LISREL and EQS. Springer Sci Bus Media. 1999.
19. Hawk ST, Keijsers L, Branje SJ, Graaff JV, Wied MD, Meeus W. Examining the Interpersonal Reactivity Index (IRI) among early and late adolescents and their mothers. J Pers Assess. 2013;95(1):96-106. doi:10.1080/00223891.2012.696080.
20. Hysek CM, Schmid Y, Simmler LD, Domes G, Heinrichs M, Eisenegger C, Preller KH, Quednow BB, Liechti ME. MDMA enhances emotional empathy and prosocial behavior. Soc Cogn Affect Neurosci. 2014;9(11):1645-1652. doi:10.1093/scan/nst161.
21. Pulos S, Elison J, Lennon R. The hierarchical structure of the interpersonal reactivity Index. Soc Behav Personal an Int J. 2004;32:355-360.
22. Ortiz MÁ, Egido BD, García MI, Tello FP, del Barrio Gándara MV. Propriedades psicometricas del Interpersonal Reactivity Index (IRI) en poblacion infantil y adolescente española Revista (Psicothema). 2011;23:824-831.

23. H Akaike. Akaike's Information Criterion. Int Encycl Stat Sci Springer Berlin Heidelb. 2011;25.
24. Limpo T, Alves RA, Castro SL. Medir a empatia : Adaptação portuguesa do Índice de Reactividade Interpessoal. Laboratório de Psicologia. 2010;8(2):171-184.
25. Braun S, Rosseel Y, Kempenaers C, Loas G, Linkowski P. Self-Report of Empathy: A Shortened French Adaptation of the Interpersonal Reactivity Index (IRI) Using Two Large Belgian Samples. Psychol Rep. 2015;117(3):735-753. doi:10.2466/08.02.PR0.117c23z6.
26. International Test Commission. The ITC guidelines for translating and adapting tests. Second Edition. 2017;1:20-12.
27. Cronbach, L. J. Coefficient alpha and the internal structure of tests. Psychometrika. 1951. 16(3), 297-334.
28. Hoffman, M. L. Toward a comprehensive empathy-based theory of prosocial moral development. In A. C. Bohart, & D. J. Stipek (Eds.), Constructive and destructive behavior implications for family, school and society. 2001: 61-86. Washington, DC, USA: American Psychological Association.