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Validation of the Tripartite Reciprocal Empathy-State Scale (TRESS): Measuring Empathy as a Multicomponential, Somatically Grounded, and Interpersonal Process

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Abstract

Background

Empathy, as a core construct in life and human sciences, has been extensively investigated in recent decades, involving the development of numerous self-report instruments. However, current scientific literature still appears to lack measures grounded in an interpersonal, state-dependent, and neuroscientifically informed conceptualization of empathy, as well as evidence of cross-modal construct validation. Based on such premises, this exploratory study aimed to validate the Tripartite Reciprocal Empathy-State Scale (TRESS), a brief self-report measure grounded in a conceptualization of empathy, encompassing affective sharing, mentalizing, and prosocial concern components, and available in two reciprocal forms (i.e. the expressed-from-the-self form, TRESS-ES; and the others-received form, TRESS-OR).

Methods

From an initial pool of 45 items, a 9-item measure was administered to 168 participants after a dyadic interaction task. The factor structure of each form was tested through confirmatory factor analysis. Convergent validity was assessed against the Empathic Understanding subscale of the Barrett-Lennard Relationship Inventory, controlling for self-esteem and social desirability. Correspondence between TRESS-ES and TRESS-OR ratings was computed within dyads. In a subsample of 37 dyads, electrodermal activity was recorded to examine interpersonal physiological synchronization as a cross-modal indicator of convergent validity.

Results

Confirmatory factor analysis supported a second-order three-factor solution for both forms (CFI = 1.000, RMSEA = 0.000), which fitted the data better than a unidimensional model. Both forms correlated significantly with the Empathic Understanding subscale, independently of self-esteem and social desirability. A moderate correlation emerged between TRESS-ES and TRESS-OR ratings within dyads (r = .34). TRESS-ES scores were associated with both the amount and the lag of physiological synchrony.

Conclusions

The TRESS assesses the three components of empathy from both the self-report and the partner-report perspective. By addressing gaps in existing literature, it is a promising instrument for clinical and research use.

1. Background

1.1 Empathy general overview

Empathy is broadly defined as the ability and tendency to share, understand, and respond to the internal states of others, often described as “putting oneself in someone else’s shoes” [1]. It represents a crucial determinant of social life, particularly within the complexity of the current social scenario [2]. Identified as a cornerstone of human interaction, it underpins a broad spectrum of complex psychological phenomena [3], and its heuristic value is

reflected in the growing interest it has received in the scientific literature over the past two decades, not only in psychology but also across disciplines such as education, sociology, economics, anthropology, and neuroscience (see [4] for a review). Many theoretical models portray empathy as a multifaceted construct, encompassing cognitive [5], affective [6], and prosocial or empathic concern components [7], as well as compassionate [8] and self- versus other-oriented empathy [9, 10]. Research in developmental, affective, and social neuroscience supports this view, converging on evidence that empathy comprises dissociable components that interact and operate in parallel [11].

To date, affective, cognitive, and prosocial components have been the ones most clearly associated with distinct neural underpinnings. For instance, studies have linked affective and cognitive empathy to specific personality alterations and clinical disorders [12, 13], as well as to neurodegenerative conditions [14]. Limbic structures such as the amygdala, the anterior insula, and the anterior cingulate cortex have been reported to be part of the neural bases of affective empathy [15]. The prefrontal cortex, including dorsolateral, ventromedial, and orbitofrontal regions, have in turn long been described as related to cognitive empathy [15]. Prosocial concern recruits brain areas that only partially overlap with the previous networks, with additional activation observed in the dorsolateral and ventromedial prefrontal cortices [16].

Increasingly, researchers are examining physiology both as an index of empathy and as one of the mechanisms that may contribute to empathic responding. Responses to others' emotions appear to involve embodied reenactment [17], while empathic responses are further shaped by contextual, bottom-up, and top-down processes [18]. Taken together, these findings suggest that empathy may unfold as a dynamic interpersonal process in which others' affective cues influence one's physiological state, which in turn may shape subsequent empathic responding. Supporting this view, growing evidence suggests that empathic processes are associated with physiological synchronization during interpersonal interactions [19–24], leading authors to suggest that a multimethod approach that combines self-report, behavioral, and psychophysiological measures has the potential to substantially broaden and advance our understanding of empathy [25].

1.2 Existing Empathy Scales: a literature review between strengths and limits

Considering the relevance of empathy and its multiple facets across scientific, clinical, and social domains, a variety of instruments have been developed to assess it. However, a closer examination reveals that they are affected by several limitations, which either limit their clinical adoption, or constrain their ability to fully capture the complexity of the construct. Systematic reviews of self-report empathy measures [26, 27] consistently identify the Interpersonal Reactivity Index (IRI) [9], the Empathy Quotient (EQ) [28], and the Questionnaire of Cognitive and Affective Empathy (QCAE) [29] as the most widely used instruments. Among these, the IRI is by far the most prevalent [26, 27]. It comprises 28 items divided into four 7-item subscales: Perspective Taking, Fantasy, Empathic Concern, and Personal Distress. Despite its widespread adoption, it is noted that some IRI subscales do not strictly measure empathic components. Namely, the Personal Distress scale exhibits severe deficiencies in construct validity [30] and the Fantasy scale seems to be difficult to integrate into a clinical empathy framework, as it measures imaginative identification with fictional characters [28]. The Empathy Quotient (EQ) [28] is a 60-item measure that conceptualizes empathy as a single factor without differentiating between its distinct components; moreover, its administration can be time-consuming in applied contexts. Finally, the Questionnaire of Cognitive and Affective Empathy (QCAE) [29] distinguishes between at least two of the core components of empathy, although due to its considerable length (65 items) its adoption in clinical practice remains limited.

Beyond these specific issues, a set of common limitations characterizes all the available self-report measures. First, these instruments conceptualize empathy strictly as a trait, i.e., a stable personality-like factor, thereby overlooking variability at the state or situational level, which is a fundamental dimension of the construct [18]. However, neuroscientific evidence indicates that trait and state components represent ontologically distinct aspects of empathy [31], thereby underscoring the need for an instrument capable of evaluating empathy at the state level [18, 32].

Second, available self-report measures of empathy have traditionally focused on intrapersonal and intrapsychic dimensions [33], neglecting the context-sensitive and inherently interpersonal nature of empathy [34]. Yet, self-perception, and thus the self-assessment of one's own empathy, is neither objective nor neutral. Rather, it is shaped by individuals' limited capacity to accurately appraise their internal states, which inevitably constrains the precision of such assessments [35]. Taken together, these considerations underscore the importance of considering how an individual's empathic responses are perceived by others, and thus the need for an instrument capable of capturing empathy from the perspectives of both the empathic agent and the empathic target.

To date, the only instrument that explicitly evaluates empathy from a situational perspective while accounting for its reciprocal nature is the Empathic Understanding (EU) subscale of the Barrett-Lennard Relationship Inventory (BLRI) [36]. The EU is a relatively brief 16-item measure comprises two reciprocal forms: the *Other Toward Self* form, which assesses empathy perceived by the subject (e.g. client, patient, or interlocutor), and the *Myself Toward Others* form, which evaluates empathy that the subject (e.g. therapist, counselor, or interlocutor) believes they have communicated to the other member of the dyad. Notwithstanding these strengths, the EU does not distinguish empathy components according to neuroscientific criteria.

1.3 The Tripartite Reciprocal Empathy-State Scale (TRESS)

Considering these gaps, the present study introduces the Tripartite Reciprocal Empathy-State Scale (TRESS) as a novel self-report instrument for the assessment of empathy.

To address the need for a self-report measure grounded in a neuroscientifically informed framework, the TRESS was developed based on the multidimensional model proposed by Zaki and Ochsner [37, 38]. This model distinguishes three empathy components based on the peculiar neural underpinnings described in paragraph 1.1. The first component, called "experience sharing", captures the automatic capacity to share others' sensorimotor, visceral, and emotional states. The second one, called "mentalizing", corresponds to definitions of perspective taking, and theory of mind, and involves the ability to infer others' mental states through explicit reasoning. The third one, called "prosocial concern", reflects the motivational aspect of empathy, namely the tendency to care for and promote others' well-being.

Furthermore, to address the need for an instrument that captures both empathy state-dependent expression [18, 32] and its inherently interpersonal nature [34] - while simultaneously overcoming the limitations of self-assessment [35, 39] - the TRESS was designed to evaluate empathy as it unfolds within dyadic interactions at state-level, including both a self-assessment of one's own empathy (i.e., the expressed-from-the-self form; TRESS-ES) and a reciprocal form capturing how empathic the individual is perceived by the interaction partner (i.e., the others-received form; TRESS-OR).

Moreover, responding to the need for a parsimonious instrument, the TRESS was derived from a broad initial pool of items (see Section 2.2) to retain only the most representative items for each component, resulting in a reliable

9-item measure (three items for each facet).

Finally, to extend convergent validity beyond self-report measures, physiological synchronization (PS) was used as an implicit assessment of empathic attunement [21, 24, 40].

1.4 Aims and research hypotheses

In validating the TRESS, in both of its variants (ES and OR), and integrating the objectives outlined above, the following research hypotheses (RH) are formulated:

RH1. The TRESS is expected to demonstrate a three-factor structure corresponding to the core components of empathy proposed in Zaki and Ochsner's [37, 38] model, namely experience sharing, mentalizing, and prosocial concern.

RH2. The TRESS, in both its forms, is expected to demonstrate adequate convergent validity with the EU [36] in its corresponding forms EU-OS and EU-MO, as the only available instrument suitable for such comparison.

RH3. The TRESS is expected to exhibit low or non-significant associations with self-esteem and social desirability, thereby supporting its divergent validity.

RH4. The TRESS is expected to capture the interpersonal dimension of empathic processes, as reflected in the correspondence between TRESS-ES and TRESS-OR scores within interacting dyads. This correspondence is expected to be moderate, accounting for the distinct perspectives captured by the two forms.

RH5. Physiological synchronization (PS) between interacting dyads is expected to be positively associated with TRESS total scores in both forms, in line with previous empirical findings linking empathy to physiological synchronization. More broadly, PS will also be examined to explore general patterns of synchronization emerging within interacting dyads in relation to the different components of empathy assessed by the TRESS.

2. Methods

2.1 Sample size determination and Participants

The sample size was determined a priori based on the rule of thumb of a minimum of 5 subjects per freely estimated parameter in structural equation modeling and confirmatory factor analysis [41]. Given that the specified model comprises 21 free parameters (i.e., 9 factor loadings, 9 residual variances, and 3 factor covariances), a minimum of 105 participants was required; the final sample of 168 participants exceeds this threshold.

The sample included 41 males (24.4%) and 127 females (75.6%), aged between 18 and 71 years (*mean* = 32.05, *SD* = 13.52). Participants varied in educational level, as follows: secondary school diploma (n = 16, 9.5%), vocational qualification (n = 7, 4.2%), high school diploma (n = 57, 33.9%), university degree (n = 86, 51.2%), and higher education such as a PhD or graduate school (n = 2, 1.2%). Electrodermal activity was collected from a subsample of participants (37 dyads, *N* = 74 individuals): 37 males (50%) and 37 females (50%), aged between 23 and 29 years (*mean* = 25.16, *SD* = 2.05).

Participants were recruited from the general population using a snowball sampling procedure implemented through social media dissemination. Inclusion criteria involved: (A) being a native Italian speaker, (B) being at least

18 years of age, (C) not currently using psychoactive medication and (D) having access to a smartphone or laptop with an internet connection. The study was approved by the Ethical Committee for Psychological Research of the University of Padova (03/06/2021#4222). Each participant signed a written informed consent.

2.2 The Development Procedure of the Questionnaire

The item pool for the TRESS was developed through a three-step procedure. First, an initial set of 45 items was generated by a panel of researchers with expertise in empathy models (authors AP and EP), drawing on the items with the highest factor loadings from the most frequently used empathy questionnaires, and then adapted to reflect the three components of empathy as defined by Zaki and Ochsner [37, 38]. Initially, 15 items were assigned to each component. Second, the items underwent a review process among the researchers to refine content accuracy and phrasing, while ensuring clarity and unambiguous wording. Third, the items were evaluated by seven independent psychologists, distinct from the previous researchers, who served as blind judges. These judges received the full set of items - presented in a pseudo-random order unique to each judge - along with the definitions of the three empathy components according to Zaki and Ochsner's model [37, 38]. The evaluation was conducted via a computer-based procedure. Based on the provided definitions, judges were asked to independently assign each item to the empathy component they deemed most representative. Subsequently, within each component, judges rank-ordered the items according to their perceived degree of representativeness. For each component, the three items with the highest average representativeness ratings across judges were retained for the final questionnaire. This selection process reduced the item pool from 45 items (15 per component) to a final set of 9 items, comprising the three most representative items for each empathy component.

The final 9-item TRESS was translated using a forward–backward translation procedure. This process involved independent forward translations by two bilingual translators fluent in both languages and familiar with psychological terminology, followed by back-translation by two independent bilingual translators who were blind to the original Italian version. Notably, discrepancies between the initial forward translations were minimal, likely due to the brevity of the items. Discrepancies were subsequently resolved through a reconciliation process to ensure semantic, idiomatic, and conceptual equivalence across language versions. The Italian and English versions of the TRESS are reported in Additional file 1.

2.3 Dyads Interaction Task

An interaction task inspired by the paradigm developed by Coutinho et al. [42] was designed to closely resemble natural dyadic interactions. The task consisted of a structured discussion, in which each partner described positive and negative emotional life events that were unknown to the other member of the dyad. During each interaction phase, one participant initially assumed the role of speaker while the other acted as listener; the roles were then reversed. The order of positive vs. negative events disclosure was randomized across dyads. On average, each phase (positive and negative sharing) lasted approximately 10 minutes, resulting in a total duration of about 20 minutes for the full interaction task. At the end of each interaction phase, members of the dyad completed the TRESS-OR, TRESS-ES, EU-OS, and EU-MO scales in an alternating manner.

In the 37 dyads in which electrodermal activity (EDA) was recorded, participants were instructed to abstain from alcohol, nicotine, and caffeine for at least 4 hours before data collection to improve the quality of the electrophysiological signal [43].

2.4 Measures

Participants individually completed a sociodemographic form and a series of self-report questionnaires via Qualtrics© (Qualtrics, Provo, UT), using either a smartphone or a personal computer.

Tripartite Reciprocal Empathy-State Scale (TRESS). The TRESS is a 9-item questionnaire designed to measure empathy during dyadic interactions, based on the tripartite model of empathy proposed by Zaki and Ochsner [37, 38]. Its structure is divided into affective empathy (AFF), cognitive empathy (COG), and prosocial concern (PRO) corresponding to experience sharing, mentalizing, and prosocial concern. Moreover, consistently with the proposed theoretical background, an overarching second-order general factor was assumed: total state empathy (EMP). Each item has two versions, TRESS-OR and TRESS-ES, designed to capture the perspectives of both individuals involved in the interaction. The TRESS-ES (expressed-from-the-self) measures empathy as self-assessed by the individual (e.g., "*My emotional state changed in response to his/her emotional state*"), whereas the TRESS-OR (others-received) measures empathy as perceived in the partner (e.g., "*He/she accepted me without judgment*"). This allows for a more complete depiction of the interpersonal process of empathy, entailing not only self-rated own empathy but also the extent to which partners' empathy matches their partner's perception of received empathy, thus overcoming the common limitations of self-report assessments. Participants rated the items on a four-level response scale, adopted to prevent from selecting a central, neutral option, thereby reducing central tendency bias and encouraging more discriminative responses: 1 = "Almost none of the time", 2 = "The least of the time", 3 = "Most of the time", 4 = "Almost all of the time". Higher scores indicate higher levels in that empathic dimension. The TRESS administration lasts less than five minutes. Scoring procedures are reported in Additional file 2.

Empathic Understanding subscale (EU) [20, 36]. The EU [20, 36] is a subscale of the Relationship Inventory [36] and is available in two reciprocal forms. The *Other Toward Self* form (EU-OS), which assesses the degree of empathy that individuals perceive as being directed toward them, and the *Myself Toward Others* form (EU-MO), which measures the empathy that individuals believe they have conveyed to the other member of the dyad [20]. Each form consists of 16 items. Responses are provided on a scale ranging from − 3 (strongly disagree) to + 3 (strongly agree), without a neutral midpoint. Negatively worded items (items 2, 4, 6, 7, 10, 12, 13, and 15) were reverse-scored. In this study, the EU showed good to acceptable internal consistency: Cronbach's alpha = .85 for the Other Toward Self (OS) form and Cronbach's alpha = .69 for the Myself Toward Others (MO) form.

Socially Desirable Response Set Five-Item Survey (SDRS-5) [44]. The SDRS-5 [44] is a five-item scale designed to measure the tendency to provide socially desirable responses rather than accurate self-assessments. Each item is scored dichotomously (0 = no, 1 = yes), yielding a total score ranging from 0 to 5. Higher scores indicate a greater propensity for socially desirable responding. In this study, SDRS-5 showed modest internal consistency values: Cronbach's α = .56.

Rosenberg Self-Esteem Scale (RSES) [45, 46]. The Rosenberg Self-Esteem Scale (RSES) [45, 46] is a widely used 10-item self-report instrument designed to assess global self-esteem. Items are rated on a 4-point Likert scale ranging from 1 ("strongly disagree") to 4 ("strongly agree"). The total score is computed by summing item responses, yielding a possible range from 10 to 40, with higher scores indicating higher levels of self-esteem. In this study, the RSES showed good internal consistency values: Cronbach's alpha = .89.

2.5 EDA Data Collection and pre-processing

Shimmer3 GSR+ wireless acquisition devices were used to register direct current skin conductance via AgCl reusable electrodes. Classical guidelines were followed regarding the application of wireless amplifiers and

electrodes, placed on the distal phalanx of the index and middle fingers of the non-dominant hand of each participant [43]. The signals were collected at 100 Hz and processed offline through a 1 Hz low-pass band filter to remove electrical noise and motion artifacts. The signals were then graphically analyzed for remaining artefacts, and the damaged parts of the signal were corrected (where appropriate) or removed. Finally, all data were resampled to 10 Hz before proceeding with further analysis.

2.6 Statistical analysis

Psychometric analysis. Statistical analyses were conducted using R and JASP. The structural validity of the TRESS was assessed through two confirmatory factor analyses (CFA), one for each perspective (ES and OR). Prior to conducting the confirmatory factor analyses, the adequacy of the sample was evaluated through the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy. The overall KMO value was 0.84 and 0.83 for the TRESS-ES and the TRESS-OR, respectively, exceeding the recommended threshold of .60 [47], thereby indicating that the sample was adequate for the planned factor-analytic procedures. According to the theoretical background as well as the semantic content of the items, a three-factor structure was specified [47]: each item loaded onto its respective first-order factor reflecting the three main empathy components - namely, affective empathy, cognitive empathy, and prosocial concern (Fig. 1). Given the response scale of the TRESS, the diagonally weighted least squares (DWLS) estimator was used to perform the CFAs [47]. Model fit was assessed using the Root-Mean Square Error of Approximation (RMSEA), the Comparative Fit Index (CFI), and the Standardized Root Mean Square Residual (SRMR) [41]. The following cut-off criteria were chosen to evaluate the goodness of fit: (A) an RMSEA lower than 0.08, (B) a CFI higher than 0.90, and (C) an SRMR lower than 0.08 [47, 48]. The internal consistency of each scale was calculated with Cronbach's alpha. Furthermore, to evaluate the hierarchical structure of the TRESS, a second-order factor model - in which the three first-order factors (i.e., affective empathy, cognitive empathy, and prosocial concern) loaded onto a single higher-order general factor (i.e., state empathy) - was specified and compared against a unidimensional model in which all nine items loaded onto a single factor. Given that the two models are not nested, model comparison was based on the inspection and comparison of their respective fit indices (RMSEA, CFI, and SRMR) [41]. Convergent validity was evaluated using Spearman correlation coefficients between TRESS total and TRESS subscale scores (in both ES and OR forms) and the corresponding EU forms (OS and MO) [20, 36]. Divergent validity was assessed by examining the pattern of associations between TRESS scores and social desirability (SDRS-5) [44] and self-esteem (RSES) [45, 46]. To further examine whether the association between TRESS and EU was independent of potential confounding variables, linear regression analyses were conducted. In these models, TRESS scores were entered as predictors of EU, while controlling for social desirability and self-esteem. Finally, the correspondence between self-reported empathy (TRESS-ES) and partner-perceived empathy (TRESS-OR) was assessed using within-dyad correlation analyses. Specifically, for each dyad, Pearson correlation coefficients were computed across the nine items by matching each participant's TRESS-ES scores with the corresponding ratings provided by their partner (TRESS-OR). Two directional correlations were obtained for each dyad (A→B and B→A). To derive a single dyadic index, these coefficients were first transformed using Fisher's z transformation, averaged in *z*-space, and then back-transformed to Pearson's *r*. An overall sample-level index was computed by averaging dyad-level coefficients in *z*-space and back-transforming the result.

EDA data analysis. Physiological Synchronization (PS) was calculated through the DyadSync package [49]. PS was computed employing the Adaptive Matching Interpolated Correlation algorithm (AMICo v1.1) [49], a dynamic time-warping algorithm that estimates the best skin conductance responses matches between persons, based on temporal proximity and similarity. This approach better models fast co-regulatory processes compared to traditional cross-correlation analyses with fixed lag analysis [22]. Three summarizing indexes of PS were

calculated for each interaction in order to explore the relationship between PS and self-reported empathy: first, as a measure of centrality we calculated "*high_sync*" as the third quartile of the distribution of moment-by-moment synchrony, ranging between − 1 and 1. This was chosen over a more traditional median value due to the highly skewed distributions. Secondly, since PS is not constantly maintained, but rather is dynamically engaged and disengaged according to the different conversational processes, we calculated a variability index "*sync_sd*" based on the standard deviation of PS in each interaction. Finally, we calculated "sync_lag" as the median lag at which PS was observed, ranging from + 4 to -4 seconds, as a metric of whether the physiological co-regulation was led by the listener or the speaker. Positive lag values indicate that the speaker's EDA followed the listener's, whereas negative values indicate that the listener followed the speaker.

3. Results

3.1 Part I: Psychometric properties of the TRESS

3.1.1 TRESS-ES Structural validity and convergent validity

The TRESS-ES second-order model showed an excellent fit to the data: $\chi^2(24) = 12.159$, $p = .978$, CFI = 1.000, RMSEA = 0.000, 90% CI [0.000, 0.000], SRMR = 0.045. As reported in Table 1, all first-order factor loadings were statistically significant and ranged from 0.551 (Item 7) to 0.856 (Item 9). Second-order factor loadings of the three first-order factors onto the general state empathy factor were also statistically significant: AFF = 0.884, COG = 0.988, and PRO = 0.635.

Table 1
Item descriptive statistics, item psychometric properties, and confirmatory factor analysis for the TRESS-OR and TRESS-ES.

	TRESS-OR					TRESS-ES				
	M	**SD**	**KMO**	**Loading**	**R^2**	**M**	**SD**	**KMO**	**Loading**	**R^2**
Item 1	3.02	.725	0.849	0.611	0.373	3.13	.753	0.887	0.582	0.338
Item 2	2.69	.837	0.776	0.736	0.541	2.70	.815	0.814	0.701	0.492
Item 3	3.13	.694	0.808	0.885	0.783	3.09	.750	0.811	0.819	0.671
Item 4	3.34	.595	0.839	0.711	0.505	3.41	.621	0.865	0.561	0.314
Item 5	3.41	.548	0.813	0.784	0.614	3.43	.585	0.901	0.676	0.457
Item 6	3.46	.575	0.866	0.669	0.447	3.44	.575	0.909	0.567	0.322
Item 7	3.63	.540	0.826	0.615	0.378	3.59	.550	0.737	0.551	0.304
Item 8	3.69	.476	0.815	0.617	0.381	3.67	.507	0.772	0.630	0.397
Item 9	3.40	.644	0.888	0.726	0.526	3.49	.628	0.884	0.856	0.732
AFF	8.83	1.893		0.674	0.454	8.92	1.880		0.884	0.781
COG	10.21	1.417		0.898	0.807	10.28	1.349		0.988	0.975
PRO	10.72	1.314		0.887	0.787	10.75	1.349		0.635	0.404
EMPATHY	**29.77**	**3.784**				**29.95**	**3.724**			

Notes: AFF = Affective empathy; COG = Cognitive empathy; PRO = Prosocial concern; EMPATHY = Total score of the TRESS-ES or TRESS-OR; M= mean; SD = standard deviation; KMO = Kaiser-Meyer-Olkin (KMO) test; Loading = standardized loading from CFA; R^2 = explained variance.

Furthermore, the second-order model was compared against a unidimensional model in which all nine items loaded onto a single factor. The single-factor model showed a poorer fit to the data: $\chi^2(27) = 36.569$, $p = .103$, CFI = 0.984, RMSEA = 0.046, 90% CI [0.000, 0.081], SRMR = 0.077. The comparison of fit indices suggested that the second-order three-factor solution provided a substantially better representation of the data compared to the unidimensional model.

Considering internal consistency, the TRESS-ES showed adequate to good values for each domain. Cronbach's alpha values were: AFF = .739, COG = .628, PRO = .714, and total scale = .816.

Convergent validity was evaluated via Spearman correlation coefficients between TRESS-ES total and subscale scores and the corresponding EU-MO scores. TRESS-ES total scores were positively correlated with EU-MO (r = .46), with subscale correlations ranging from$r$ = .26 (PRO) to r = .44 (COG). Correlation coefficients are reported in Table 2. TRESS-ES scores showed weak or non-significant correlations with social desirability (SDRS-5; r = .06) and self-esteem (RSES; r = .14). To further examine whether the association between TRESS-ES and EU-MO was independent of potential confounding variables, a linear regression analysis was conducted, with EU-MO as the dependent variable and TRESS-ES, SDRS-5, and RSES as predictors. TRESS-ES significantly predicted EU-MO (B = 1.41, SE = 0.23, $t(127) = 6.18$, $p < .001$), indicating that it is not attributable to response bias or self-evaluation.

Table 2
Spearman correlations among TRESS-ES and TRESS-OR scores and validation measures.

Variable	1	2	3	4	5	6	7	8	9	10	11
1. EMP OR											
2. EMP ES	.68										
	[.58, .76]										
3. AFF OR	.81	.49									
	[.75, .86]	[.35, .62]									
4. COG OR	.83	.59	.48								
	[.77, .87]	[.46, .69]	[.36, .59]								
5. PRO OR	.81	.57	.45	.63							
	[.75, .86]	[.44, .67]	[.32, .56]	[.53, .71]							
6. EU OS	.62	.52	.48	.52	.53						
	[.51, .70]	[.38, .64]	[.35, .58]	[.40, .62]	[.41, .63]						
7. AFF ES	.54	.85	.50	.40	.37	.37					
	[.41, .65]	[.80, .89]	[.35, .62]	[.24, .54]	[.21, .51]	[.21, .51]					
8. COG ES	.62	.82	.40	.61	.51	.47	.56				
	[.50, .72]	[.76, .86]	[.24, .53]	[.49, .71]	[.37, .63]	[.32, .59]	[.45, .66]				
9. PRO ES	.46	.74	.24	.42	.52	.42	.41	.48			
	[.32, .59]	[.66, .80]	[.07, .40]	[.26, .55]	[.38, .63]	[.26, .55]	[.28, .53]	[.36, .59]			

Notes: AFF = Affective empathy; COG = Cognitive empathy; PRO = Prosocial concern; EMP = Total score of the TRESS-ES or TRESS-OR; EU = Empathic Understanding subscale; OS = Other Toward Self form (EU-OS); MO = Myself Toward Others form (EU-MO), RSES = Rosenberg Self-Esteem Scale; SDRS-5 = Socially Desirable Response Set Five-Item Survey. Values in square brackets indicate the 95% confidence interval for each correlation. All coefficients are Spearman's rank-order correlations (r) computed on pairwise complete observations (n = 128–174).

Variable	1	2	3	4	5	6	7	8	9	10	11
10. EU MO	.32	.46	.20	.27	.31	.63	.41	.44	.26		
	[.16, .47]	[.32, .59]	[.03, .36]	[.10, .42]	[.14, .46]	[.51, .72]	[.26, .54]	[.29, .57]	[.10, .42]		
11. SDRS-5	.00	.06	− .04	− .02	.03	− .04	.10	.01	.03	.14	
	[-.17, .17]	[-.11, .23]	[-.20, .13]	[-.18, .15]	[-.14, .20]	[-.21, .13]	[-.08, .26]	[-.16, .18]	[-.15, .20]	[-.03, .30]	
12. RSES	.04	.14	.07	.06	− .02	.12	.10	.10	.13	.11	.02
	[− .13, .21]	[− .03, .30]	[− .10, .23]	[− .11, .23]	[− .19, .15]	[− .05, .28]	[− .07, .27]	[− .07, .27]	[− .04, .30]	[− .07, .27]	[− .13, .18]

Notes: AFF = Affective empathy; COG = Cognitive empathy; PRO = Prosocial concern; EMP = Total score of the TRESS-ES or TRESS-OR; EU = Empathic Understanding subscale; OS = Other Toward Self form (EU-OS); MO = Myself Toward Others form (EU-MO), RSES = Rosenberg Self-Esteem Scale; SDRS-5 = Socially Desirable Response Set Five-Item Survey. Values in square brackets indicate the 95% confidence interval for each correlation. All coefficients are Spearman's rank-order correlations (r_s) computed on pairwise complete observations (n = 128–174).

3.1.2 TRESS-OR Structural validity and convergent and divergent validity

The TRESS-OR second-order model showed an excellent fit to the data: $\chi^2(24) = 17.632$, p = .820, CFI = 1.000, RMSEA = 0.000, 90% CI [0.000, 0.039], SRMR = 0.052. As reported in Table 1, all first-order factor loadings were statistically significant and ranged from 0.611 (Item 1) to 0.885 (Item 3). Second-order factor loadings of the three first-order factors onto the general state empathy factor were also statistically significant: AFF = 0.674, COG = 0.898, and PRO = 0.887.

Furthermore, the second-order model was compared against a unidimensional model in which all nine items loaded onto a single factor. The single-factor model showed a poorer fit to the data: $\chi^2(27) = 51.211$, p = .003, CFI = 0.972, RMSEA = 0.072, 90% CI [0.041, 0.102], SRMR = 0.089. The comparison of fit indices suggested that the second-order three-factor solution provided a substantially better representation of the data compared to the unidimensional model.

Considering internal consistency, the TRESS-OR showed adequate to good values for each domain. Cronbach's alpha values were: AFF = .785, COG = .763, PRO = .689, and total scale = .840.

Convergent validity was evaluated via Spearman correlation coefficients between TRESS-OR total and subscale scores and the corresponding EU-OS scores. TRESS-OR total scores were positively correlated with EU-OS (r_s = .62), with subscale correlations ranging from r_s = .48 (AFF) to r_s = .53 (PRO). Correlation coefficients are reported in Table 2. TRESS-OR scores showed weak or non-significant correlations with social desirability (SDRS-5; r_s = .00) and self-esteem (RSES; r_s = .04).

To further examine whether the association between TRESS-OR and EU-OS was independent of potential confounding variables, a linear regression analysis was conducted, with EU-OS as the dependent variable and

TRESS-OR, SDRS-5, and RSES as predictors. TRESS-OR significantly predicted EU-OS (B = 1.84, SE = 0.26, t(131) = 7.06, p < .001), even after controlling for SDRS-5 and RSES, indicating that it is not attributable to response bias or self-evaluation.

3.1.3 Dyadic Correspondence between TRESS-ES and TRESS-OR Scores

Associations between TRESS-ES and TRESS-OR scores within dyads were examined. A positive dyadic correspondence was observed (r = .34), based on item-level profile matching, indicating a moderate level of alignment between self-reported empathy and partner-perceived empathy across dyads.

3.2 Part II: EDA

Associations between physiological synchronization indices and TRESS scores were examined within the dyads for which electrodermal activity (EDA) was recorded. The *high_sync* index showed a mean of 0.73 (SD = 0.17), with observed scores ranging from 0.07 to 0.88. Pearson correlations showed a small positive association between *high_sync* and the TRESS total scores, for the speaker's TRESS-OR (r = 0.26) and the listener's TRESS-ES (r = 0.30). Similarly, the *sync_sd* index showed a mean of 0.51 (SD = 0.06), with values ranging from 0.26 to 0.59, and a weak correlation with the TRESS total scores for the speaker's TRESS-OR (r = 0.23) and the listener's TRESS-ES (r = 0.36). Finally, the *sync_lag* index showed a mean of 0.03s (SD = 0.44), with values ranging from − 0.65s to 1.40s, and a weak negative (r = -0.23) correlation with the listener's TRESS-ES total score, describing how higher synchrony led by the speaker was associated with a higher self-perceived empathy in the listener. An exploration of this latter result on the TRESS-ES subscales showed that this association was larger for the prosocial component (r = -0.39).

4. Discussion

The present study aimed to develop and provide initial validation of the Tripartite Reciprocal Empathy-State Scale (TRESS). In line with the needs that emerged from the examination of the existing literature on empathy assessment, the TRESS was designed, developed and validated to address several limitations characterizing the currently available instruments. Namely, the scientific panorama lacks a self-report measure of empathy that: (1) integrates a neuroscientifically informed model rooted in the distinction between its core components, (2) adopts a situational (state) perspective, (3) enables reciprocal dyadic assessment, (4) ensuring brevity, and (5) integrates physiological measurement into the validation procedure. In this vein, the TRESS is characterized to be anchored in the neuroscientifically based tripartite model proposed by Zaki and Ochsner [37, 38]. Moreover, it is articulated in two reciprocal forms, namely the expressed-from-the-self form (TRESS-ES) and the others-received form (TRESS-OR). Finally, its brevity, namely its 9-item format, ensures rapid administration, and its validity is preliminarily supported at the psychophysiological level through its association with physiological synchronization between interacting partners who completed the questionnaire. Regarding structural validity, the results supported RH1. The confirmatory factor analyses, conducted separately for the TRESS-ES and the TRESS-OR, demonstrated that the second-order three-factor model - in which affective empathy, cognitive empathy, and prosocial concern loaded onto a higher-order general state empathy factor - showed an excellent fit to the data for both versions. Furthermore, the inspection of fit indices from the comparison with a unidimensional model indicated that the three-factor solution provided a substantially better representation of the data, thereby supporting the theoretical distinction among the three empathy components as proposed by Zaki and Ochsner [37, 38]. It should be noted, however, that given the use of the DWLS estimator, information criteria were not available, and the two models are not nested; consequently, the comparison relied on the descriptive inspection of fit indices rather than on a formal

statistical test. Notwithstanding this caveat, the magnitude of the differences in fit indices between the two models was consistent across both versions of the instrument, lending further confidence to the superiority of the three-factor solution. These findings are consistent with neuroscientific evidence indicating that the affective, cognitive, and prosocial components of empathy are subserved by partially distinct neural networks [16, 37] while at the same time sharing a common higher-order construct, as reflected in the significant second-order factor loadings observed in both versions of the instrument.

Notably, the pattern of second-order factor loadings differed between the two forms. In the TRESS-ES, the cognitive empathy factor showed a very high loading onto the general state empathy factor (.988), followed by affective empathy (.884), whereas prosocial concern showed a comparatively lower loading (.635). This pattern may suggest that, when individuals self-assess their own empathic engagement, empathy is primarily experienced as an internal process of understanding and sharing the other's states, whereas the intentional, behavioral expression of care is experienced as partially distinct from this overall empathic experience. In the TRESS-OR, a different pattern emerged: cognitive empathy and prosocial concern showed the strongest loadings onto the general factor (.898 and .887, respectively), whereas affective empathy showed a comparatively lower loading (.674). This pattern may indicate that, when individuals assess the empathy received from their interaction partner, the perception of being understood, that is, the sense that the other person has accurately inferred one's mental states, together with the partner's observable caring behaviors, constitutes the most salient marker of the overall empathic experience. Conversely, the affective sharing component involves more automatic and pre-reflective processes, such as sensorimotor and visceral mirroring [37], which are less directly observable by the interaction partner and may therefore be perceived as partially distinct from the overall empathy received. Moreover, the confirmation of a three-factor structure in both forms of the TRESS represents an advancement relative to existing measures.

Considering internal consistency, the TRESS showed adequate to good internal consistency across both versions. In the TRESS-ES, Cronbach's alpha values for the affective empathy (.739) and prosocial concern (.714) subscales reached satisfactory levels, whereas the cognitive empathy subscale yielded a lower value (.628) [50]. In the TRESS-OR, the affective empathy (.785) and cognitive empathy (.763) subscales were satisfactory, whereas the prosocial concern subscale showed a somewhat lower, yet still acceptable, value (.689). Taken together, these values should be interpreted considering the brevity of the instrument, given that each subscale comprises only three items, a condition that is known to attenuate internal consistency estimates [50]. Indeed, it has been widely noted that alpha is a function not only of item intercorrelations but also of the number of items composing the scale, such that shorter scales tend to yield lower alpha values even when the underlying construct is measured with precision [50]. Moreover, when the total scale comprising all nine items was considered, both versions demonstrated good internal consistency (TRESS-ES $\alpha = .816$; TRESS-OR $\alpha = .840$), thereby indicating that the TRESS as a whole captures the overarching empathy construct. Overall, the trade-off between parsimony and internal consistency appears to be acceptable in the context of a 9-item state-level measure designed for use in research and, sometimes, in clinical settings in which additional assessments are typically administered.

Regarding convergent validity, the results support RH2 with respect to the comparison with the only available measure assessing state empathy from both perspectives, i.e. the EU in its MO and OS forms. The moderate-to-strong associations between TRESS-ES and EU-MO (r = .46), and between TRESS-OR and EU-OS (r = .62), suggest that both forms of the TRESS effectively capture empathic processes in a manner consistent with well-validated measures while maintaining sensitivity to distinct empathic components.

Divergent validity was also supported by the results (RH3). Specifically, TRESS scores showed weak, non-significant associations with both social desirability and self-esteem, for both the TRESS-ES (SDRS-5: r^2 = .06; RSES: r^2 = .14) and the TRESS-OR (SDRS-5: r^2 = .00; RSES: r^2 = .04), suggesting that the measure is not substantially confounded by response bias or general self-evaluation. It is particularly relevant given the well-known susceptibility of self-report instruments that, as they rely exclusively on the individual's perspective, are systematically shaped by self-presentation biases and lack of self-awareness, including motivational biases and limited introspective access [35, 39].

Moreover, the expected correspondence between TRESS-ES and TRESS-OR scores (RH4) is supported by the observed results (r = .34), suggesting that the TRESS is sensitive to dyadic aspects of empathy and captures the relational nature of empathic processes across interacting individuals. In other terms, self-reported empathy tends to be aligned with partner-reported empathy, as assessed through the two forms of the TRESS. Notably, in line with expectations, the association is positive yet moderate, as the two forms reflect individual differences and capture distinct perspectives on empathy. The inclusion of the two reciprocal forms represents an important advancement over existing measures, as it allows for adequately capturing the inherently relational nature of empathy [34] and addresses the well-documented limitations of self-reports of empathy that, as shown by recent research, seem to be unrelated with empathic abilities [51].

Preliminary support for convergent validity also emerged from the observed correlations between TRESS scores and the interpersonal physiological synchronization indexes. The idea that the phenomenon of physiological synchrony acts as a root mechanism enabling empathy has long been suggested theoretically and empirically [19, 21–23]. While the observed correlations in this study were generally small, they were in the expected direction across roles and indexes, providing preliminary support for the validity of the TRESS through its expected association with PS. The most interesting result stems from the exploratory analysis of lag in the TRESS-ES subscale, where high self-rating of prosocial empathy in the listener was associated (r = -0.39) with a higher tendency to follow the speaker’s EDA, hinting toward a possible link between intentional empathic behaviors and a tendency to be more flexible and adaptable during physiological co-regulation dynamics. Given the limitations inherent in self-report measures of empathy, complementing the use of such measures with other indices, such as physiological ones, represents a relevant methodological contribution. Indeed, psychophysiological measures not only provide new insights, but also give methodological tools otherwise not possible with past research approaches [25]. To our knowledge, this study is among the first to incorporate a physiological perspective into the validation of a self-report psychological measure, thereby aligning with the call for multimethod approaches to broaden our understanding of such a complex and multifaceted construct as empathy [25].

Overall, the development of the TRESS addresses key gaps in literature and offers several advantages. Among these, we consider its tripartite structure to be particularly relevant, especially regarding its potential applications in both clinical research and practice, as it enables a more differentiated assessment of distinct empathic components.

From a psychopathological and psychiatric perspective, the TRESS may contribute to a more refined discrimination of diagnostic profiles, particularly regarding the distinction between the cognitive and affective components of empathy. It is interesting to note that some evidence, also drawing on neuroscientific literature, suggest that affective empathy indeed appears markedly impaired in certain personality disorders, such as narcissism [13] whereas cognitive empathy appears selectively impaired in clinical conditions such as schizophrenia [52] or Asperger syndrome [53], as well as in borderline [12]. A different, yet complementary pattern

emerges in depression, with individuals exhibiting an imbalance across empathic components, marked by heightened affective empathy alongside reduced or relatively preserved cognitive empathy [54]. Moreover, distinct components of empathy are associated with the three levels of personality functioning (i.e., neurotic, borderline, and psychotic) as conceptualized within the psychodynamic perspective. For instance, the affective dimension appears to play a key role in accounting for personality organization across the diagnostic taxonomy [10]. The relevance of a more fine grained assessment of empathic functioning is further supported by reference diagnostic systems, such as the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) [55] and the Psychodynamic Diagnostic Manual, Third Edition (PDM-3) [56] in which empathy is considered a relevant criterion in the diagnosis of clinical and personality disorders. More specifically, within the DSM-5 hybrid dimensional-categorical Alternative Model of Personality Disorders, empathy represents one of the two core criteria for the assessment of interpersonal functioning and is implicated in six out of ten personality disorders. Similarly, in the assessment of mental functioning within Axis M of the PDM-3, the capacity for empathy, encompassing its cognitive, affective, and prosocial components, represents a domain reflecting the quality of relational and interpersonal functioning, which is central to adaptive engagement with others (PDM-3) [56]. Research in neurodegenerative diseases also indicates that different clinical conditions are best understood within a multi-component model of empathy [57]. Notably, empathy appears to exhibit a double dissociation in neurodegenerative diseases, as highlighted in the review by Pick and colleagues [14]. Specifically, affective empathy appears markedly impaired in Frontotemporal Dementia and Parkinson's disease, whereas the core deficit in patients with Alzheimer's disease, Huntington's disease, and Amyotrophic Lateral Sclerosis appears to lie primarily in the domain of cognitive empathy.

Extending this perspective, a further advantage of the TRESS lies in its capacity to assess the prosocial facet of empathy, which is particularly relevant in helping professions. In these contexts, sustained empathic engagement has been associated with adverse consequences for professionals (e.g., emotional burden, personal distress, burnout, and compassion fatigue), with implications for both performance and well-being [58]. Nevertheless, it should be noted that this view largely stems from the conceptualization of empathy as a unitary construct. Indeed, evidence suggests that empathic costs are not attributable to empathic engagement per se, but rather to specific empathic components [59].

More broadly, the ability of the TRESS to capture how empathy unfolds at the state level within interactions is particularly relevant given the central role of empathy in therapeutic relationships as a common factor associated with positive therapeutic outcomes across diverse theoretical orientations and treatment modalities [60], especially with regard to perceived empathy [61]. This feature represents a critical contribution to advancing clinical understanding and informing more effective therapeutic interventions.

From a research standpoint, the ability of the TRESS to capture the dyadic dimension of empathy represents a notable strength. Specifically, it addresses the need to understand empathic processes as they unfold in specific interpersonal contexts, thereby distinguishing transient, context-dependent expressions of empathy from stable dispositional tendencies [18, 31, 32]. Moreover, the brevity of the TRESS lends itself particularly well to research settings in which multiple measures or assessments are usually administered, thereby satisfying the criterion of parsimony that several existing instruments fail to meet.

4.1 Limitations

Notwithstanding these strengths, some limitations of the present study should be acknowledged. First, the sample size, although exceeding the minimum threshold determined a priori on the basis of the number of freely estimated parameters [41, 62], remains relatively modest. It should also be noted that the sample was characterized by a gender imbalance, with females representing 75.6% of the total sample. Second, the subsample in which electrodermal activity was recorded was comparatively small, and the statistical power associated with this subsample may not have been sufficient to detect smaller effects. Therefore, the generalizability of the findings should be interpreted with caution. Third, as noted above, the comparison between the second-order three-factor model and the unidimensional model relied on the descriptive inspection of fit indices rather than on a formal statistical test, given that the two models are not nested and information criteria (such as Akaike and Bayesian information criteria; AIC/BIC) were not available with the DWLS estimator. Although the magnitude of the differences in fit indices was consistent across both versions, future studies employing alternative estimation methods may provide a more rigorous basis for model comparison. Fourth, as is inherent to a scale comprising only three items per subscale, some of the internal consistency values – particularly for the cognitive empathy subscale of the TRESS-ES and the prosocial concern subscale of the TRESS-OR – were below the conventional threshold of .70 [50], although, as discussed above, this attenuation is expected given the brevity of the instrument. Fifth, in the TRESS-ES, the cognitive empathy factor showed a very high second-order loading (.988), approaching the upper boundary. This finding may be partially attributable to the relatively modest sample size, which may have resulted in less stable parameter estimates, and may warrant further investigation in larger samples aimed at evaluating the discriminant validity of the TRESS-ES subscales. Finally, the present study focused on a community sample, and the psychometric properties of the TRESS in clinical populations remain to be examined.

4.2 Future directions

Future studies should aim to replicate the present findings in larger and more heterogeneous samples, including balanced gender distributions, to establish the generalizability of the psychometric properties observed in the present study. In this regard, it would be particularly valuable to examine the psychometric properties of the TRESS in clinical populations in which specific empathy components are known to be selectively impaired. Moreover, such investigations would be of particular interest given that current knowledge in these populations is largely based on the assessment of trait empathy, with limited understanding of how empathic abilities operate at state level, across different contexts, ranging from more intimate to more public ones. As such, these investigations would not only provide further evidence regarding the sensitivity of the instrument to differential impairments across the three empathy dimensions but would also contribute to elucidating the clinical utility of a state-level, tripartite assessment of empathy. The assessment of test–retest reliability would represent an equally important step, as it would allow the temporal stability of the TRESS to be established and enable examination of the extent to which state-level empathy fluctuates across different interpersonal contexts.

Given the promising associations between physiological synchronization and the TRESS observed in the present study, future research should seek to extend these findings in larger samples of interacting dyads. Moreover, further research could incorporate additional physiological measures beyond electrodermal activity, such as cardiac heart rate variability (HRV) or neural indices, in order to provide a more comprehensive characterization of the physiological underpinnings of the three empathy components and to examine the interrelationships among different psychophysiological measures to more accurately assess the construct of empathy.

Furthermore, future studies should aim to disentangle the three dimensions of empathy at the item level in order to examine whether specific items capture distinct processes, thereby examining related constructs that overlap with empathy to determine both shared and distinctive features. For instance, this may involve differentiating processes within the affective component of empathy, such as identification. As also emphasized by seminal authors within the psychoanalytic tradition [63], these constructs are indeed closely entangled [64, 65]. However, these processes operate within the relationship in distinct, yet still insufficiently delineated, ways. Therefore, clarifying these distinctions may contribute to a more precise conceptualization of both constructs and their underlying mechanisms.

Finally, studies support the argument that empathy is intertwined with a wide range of individual, social, and cultural factors rather than constituting a fixed, solely psychological construct. Given the role of social dynamics, cultural influences, and related dimensions such as cultural norms, intergroup biases, and group membership in shaping how individuals empathize with others (see [66] for a review), cross-cultural validation of the TRESS would be desirable to examine its validity across different linguistic and cultural contexts.

5. Conclusions

The present study provides a valid and brief measure of empathy conceived as a tripartite and reciprocal construct. Previous measures do not account for a multifaceted assessment of empathy in conjunction with psychophysiological validation. Moreover, to the best of our knowledge, the TRESS is the only self-report measure that considers empathy as a state- and context-dependent construct. Although further research is needed to confirm the reliability and validity of the TRESS across different populations, including through cross-cultural validation, current evidence suggests that it appears to be a valuable new tool for the assessment of empathy. The range of applications across clinical and research settings is broad. In particular, the assessment of empathic components as distinct dimensions in psychopathological and neurological contexts may enable a more nuanced understanding of patients' functioning.

Abbreviations

AFF
Affective empathy
AIC
Akaike information criterion
AMICo
Adaptive Matching Interpolated Correlation
BIC
Bayesian information criterion
BLRI
Barrett-Lennard Relationship Inventory
CFA
Confirmatory factor analysis
CFI
Comparative fit index
COG
Cognitive empathy

DSM-5
Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition
DWLS
Diagonally weighted least squares
EDA
Electrodermal activity
EMP
Total state empathy
EQ
Empathy Quotient
EU
Empathic Understanding subscale
EU-MO
Empathic Understanding subscale, Myself Toward Others form
EU-OS
Empathic Understanding subscale, Other Toward Self form
HRV
Heart rate variability
IRI
Interpersonal Reactivity Index
KMO
Kaiser-Meyer-Olkin measure of sampling adequacy
PDM-3
Psychodynamic Diagnostic Manual, Third Edition
PRO
Prosocial concern
PS
Physiological synchronization
QCAE
Questionnaire of Cognitive and Affective Empathy
RH
Research hypothesis
RMSEA
Root mean square error of approximation
RSES
Rosenberg Self-Esteem Scale
SDRS-5
Socially Desirable Response Set Five-Item Survey
SRMR
Standardized Root Mean Square Residual
TRESS
Tripartite Reciprocal Empathy-State Scale
TRESS-ES
Tripartite Reciprocal Empathy-State Scale, expressed-from-the-self form

TRESS-OR
Tripartite Reciprocal Empathy-State Scale, others-received form

Declarations

Ethics approval and consent to participate

This study was conducted in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethical Committee for Psychological Research of the University of Padova (03/06/2021#4222). Informed consent was obtained from all individual participants included in the study.

Consent for publication

Not applicable.

Competing interests

The authors have no competing interests to declare that are relevant to the content of this article.

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Author Contribution

The study conception and design were primarily conducted by AP, with all authors contributing originally to the development of the study. Material preparation, data collection, and analysis were performed by VCP, JRK, EP, and VC. The first draft of the manuscript was written by VCP, JRK, and DR, each contributing their specific areas of expertise. AP supervised the process as the lead, integrating the sections. All authors commented on this version of the manuscript. After a final feedback process, all authors read and approved the final manuscript.

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Data Availability

The data and analysis scripts supporting the findings of this study are available in the Open Science Framework repository: https://osf.io/y5afe/overview?view_only=5f88bd3fb35945c7a684b5a39f8c1c1b

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Figures

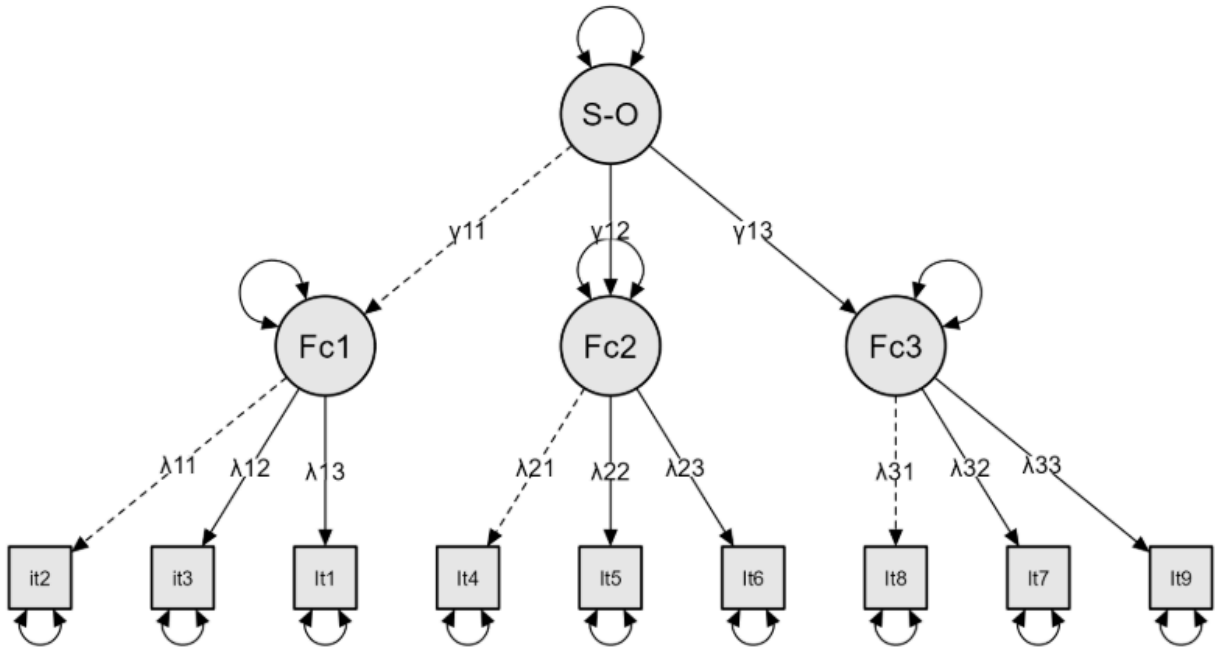


Figure 1

Graphical representation of the TRESS model, for both perspectives

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