A novel construct of anhedonia revealed in a Chinese sample via the Revised Physical and Social Anhedonia Scales

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Abstract

Background: Anhedonia is experienced as a symptom of a number of mental disorders including major depressive disorder, posttraumatic stress disorder, obsessive-compulsive disorder, schizophreniaand schizotypal personality disorder, and schizophrenia (as a negative symptom). The Revised Physical Anhedonia Scale (RPAS) and the Revised Social Anhedonia Scale (RSAS) have been applied in clinical and non-clinical samples since 1980s. However, the factor structure of the RPAS has not been determined and the structure of the RSAS remains controversial. The construct of a unified RPAS&RSAS has never been explored. Therefore, the purpose of our study was to examine the factor structure of the RPAS, the RSAS and the unified RPAS&RSAS.

Methods: The internal consistency and test-retest reliability of the RPAS and the RSAS were determined in a sample of 3,435 Chinese young adults. Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were each conducted in halves of the sample to reveal the constructs of the RPAS and the RSAS. CFA was used to evaluate first- and second-order models for the unified RPAS&RSAS .

Results: The psychometric robustness of the RPAS and the RSAS were confirmed by high internal consistency (Cronbach's α = 0.884, 0.835) and test-retest reliablity (r = 0.572, 0.602) values. EFA and CFA indicated 2-factor structures for both scales, with the factors being defined as anticipatory physical/social anhedonia and consummatory physical/social anhedonia. The second-order model of the unified RPAS&RSAS had satisfactory fit index values (CFI=0.901, RMSEA=0.055).

Conclusions: The unified simplified Chinese RPAS&RSAS can be used to assess anhedonia in young adults. A novel second-order structure of anhedonia was revealed.

Background

Anhedonia, defined as a diminished or absent ability to experience pleasure in normally pleasurable daily activities [1], has been associated with a neurotransmitter imbalance in reward processing circuitry involving multiple neuroanatomical areas[2-4] and dopamine dysregulation [3, 5, 6]. Conceptually, anhedonia has been suggested to be composed of two major components, namely anticipatory anhehonia and consummatory anhedonia [7]. Anticipatory pleasure is generated by reward motivation and behaviors aimed at future rewards (i.e.,"wanting") while consummatory pleasure refers to pleasure in the present moment and reward attainment (i.e., "liking") [7]. Furthermore, results obtained from the Research Domain Criteria project, whose aim is to integrate information from genomics and circuits to behavior and self-reports in psychiatric disorders [8, 9], suggested that anhedonia may involve two domains, a Negative Valence Systems domain and a Social Processes domain (see www.nimh.nih.gov/research-priorities/rdoc/index.shtml).

Anhedonia is experienced as a symptom of a number of mental disorders [10, 11], including major depressive disorder [12-16], posttraumatic stress disorder [11], obsessive-compulsive disorder [17], schizophreniaand schizotypal personality disorder [18, 19], and schizophrenia (as a negative symptom) [1, 20-23]. Therefore, there is a need for assessment and differential diagnosis with instruments that are not specific to a particular diagnosis.

The Chapman psychosis-proneness scales, which were developed in the late 1970s and early 1980s [24], are a series of scales that were designed to assess schizotypy tendencies in psychiatrically normal people [19, 25-27]. Four of the scales in this series, namely the Perceptual Aberration Scale, Magical Ideation Scale, Physical Anhedonia Scale, and Social Anhedonia Scale, form a schizotypy assessment battery known as the Wisconsin schizotypy scales (WSS). In recent years, revised versions of the two anhedonia scales within the WSS, known as the Revised Physical Anhedonia Scale (RPAS) and the Revised Social Anhedonia Scale (RSAS), have been used alone [28] across different cultures [29-31] and in various kinds of sample populations [19, 32, 33]. The RPAS assesses the lack of pleasure experienced in physical sensations, whereas the RSAS assesses the lack of pleasure in the social realm [34].

The RPAS and the RSAS are broadly appreciated for the inclusive information they cover, and their simple format, which requires participants to answer true/false questions. Testing of the psychometric robustness of the RSAS and RPAS has shown them both to have good reliabilities (RPAS α = 0.74–0.92, RSAS α =0.79–0.95; $r_{test\text{-}retest}$ = 0.65–0.909) and good validities in the USA [1, 35], France [36], Germany [37], Turkey [31], Spain [29], Northern Finland [38], and China [30](see Table S1). Although earlier the RSAS/RPAS studies involved primarily clinical samples, recent studies have focused on non-clinical populations. For example, Chan et al. showed that the RPAS and RSAS, both of which are self-report scales used to assess anhedonia severity across multiple neuropsychiatric stages [39], could be used to examine trait anhedonia in a non-clinical sample (i.e. college students) [30, 40]. The RSAS and RPAS have been used principally to assess schizotypy rather than anhedonia per se, and most previous studies have not included a large number of participants [30, 39, 40], Thus, questions remain regarding the applicability of the RSAS and the RPAS, particularly with Chinese respondents.

Although the factor structures of Chapman's physical and social anhedonia scales have long been considered unidimensional, as was the intention when they were developed [1, 41], and that single dimension has been classified as a negative dimension of schizotypy in the context of Meehl's model [29], emerging evidence indicates that the RPAS and RSAS may have more complicated structures [42, 43]. The structure of the RPAS alone has not yet been reported, and that of the RSAS remains controversial, with studies reporting one [29, 42], two [44], and four [43] factor model fits, depending on language and subject sample. The two factors of the 2-factor RSAS model were defined as social apathy/aversion and social withdrawal, which are associated with the symptoms of the schizophrenia [44]. When the RSAS was loaded in both positive and negative WSS factors, model fitness outcomes were better than when RSAS was loaded in a purely negative factor [39, 45-47]. Although the two components of anhedonia (anticipatory and consummatory) have been distinguished in behavioral and psychometric studies [48], it remains to be clarified whether the anticipatory and consummatory anhedonia

components exist in both the physical and social fields, and whether there is a hierarchical relationship between them [49]. Besides, although the RPAS and RSAS have been used together across different cultures [29, 30, 50], they have never been recognized as a combined unified scale (referred to as the RPAS&RSAS from here forward) , and the factor structure of the RPAS&RSAS remains unrevealed.

The RPAS and RSAS, generally considered to be traditional anhedonia scales, were designed for patients with schizophrenia [1] and have been used extensively to assess anhedonia in schizophrenia studies [51]. Their appropriateness in other populations is unclear and has not been validated empirically [16]. Thus, there is a need to investigate their reliabilities and validities in other patient populations and non-clinical samples. The aim of this study was to analyze the individual structures of the RPAS and RSAS separately and the RPAS&RSAS as a combined unified scale to explore the underlying construct of anhedonia in a non-clinical sample. First, we used exploratory factor analysis (EFA) and CFA to explore the structures of the RPAS and RSAS. Then, we analyzed the structure of the unified RPAS&RSAS for how it fits into a potential hierarchical model. The results obtained may be used to broaden the application of the RPAS and RSAS as measures of anhedonia, including in the context of various neuropsychiatric conditions, including anxiety and depression.

Methods

Participants

We collected data from 3,985 freshmen at two universities in Changsha, Hunan, yielding complete data for 3,435 participants (age range, 16–22 years), including 1,633 males and 1,802 females, with mean ages ± standard deviations of 18.37 ± 0.23 years and 18.11 ± 0.28 years, respectively. The exclusion criteria were: any mental disorders according to the Diagnostic and Statistical Manual of Mental Disorders, 4th edition (APA, 1994); a family history of any mental disorder; or any diagnosed general nervous system disease (e.g. inflammatory, traumatic, or epileptic). Halves of the samples (randomly selected) were used for EFA and CFA, respectively. A subgroup of these participants (N = 223) were retested after a 4-week interval for test-retest reliability testing. Written informed consent forms were completed by all participants. This study was approved by the ethics committee of Second Xiangya Hospital, Central South University.

Materials

Chinese versions of the RPAS and RSAS that were translated by linguists and psychologists from English into Chinese were used [34, 52]. The RPAS focuses on typically pleasurable physical stimuli (e.g. food), whereas the RSAS assesses anhedonia related social stimuli and connection with others. The RPAS and RSAS contain 61 and 40 true-false items, respectively. The items are scored relative to standard answers. If the response to an item matches the item's standard answer, it is scored as a "1"; otherwise, it is scored as a "0". Higher scores are indicative of more severe anhedonia and elevated risk of mental disorders. Both the original English RPAS/RSAS (α = 0.74/0.85) and the Chinese RPAS/RSAS (Cronbach's α = 0.75/0.94) have good internal consistencies (see Table S1).

Data analysis

IBM SPSS Statistics 20.0 was used for descriptive statistics and M-plus 7.11 software was used for factor analysis (EFA and CFA). Data from participants with missing data and participants that met the exclusion criteria were excluded. Mean descriptive statistic values are reported with 95% confidence intervals (CIs). Cronbach's α values were calculated to evaluate reliability (i.e. internal consistency). Test-retest reliability was assessed with Pearson correlation analyses. Some items (physical, 1/4/9/40/53, and social 33) with low relevance or inappropriate meaning were excluded from the Chinese RPAS and RSAS to make them more suitable for Chinese youth. The excluded items had Pearson r values <0.100, indicating very weak associations with pleasure capacity in Chinese youth. Additionally, four of the excluded physical items (1, 9, 40, and 53) address sexual issues; these items can be excluded when applied to teenagers with limited sexual experience [53].

In the EFA, categorical variables were analyzed with the mean and variance adjusted (WLSMV) estimator, the most common and effective analysis method for categorical variables [54], in the M-plus program. Parceling was not performed in the EFA because the scale structures were unknown [55, 56].

In preparation for CFA, items were parceled into individual factors according to the internal consistency approach for multidimensional scales to simplify the unified RPAS&RSAS. A random algorithm was used in the parceling for its convenience and validity. For four-item parceled items, mean parcel scores were used as final scores, thereby changing categorical variables into quantitative variables. CFA of the simplified unified RPAS&RSAS was thus conducted with a maximum likelihood (ML) estimator for the first-order (physical anhedonia and social anhedonia) and second-order (anticipatory physical/social anhedonia and consummatory physical/social anhedonia) models. The Tucker-Lewis index (TLI), comparative fit index (CFI), standard root mean square residuals (SRMR), and root mean square error of approximation (RMSEA) methods were used to determine goodness of fit [57]. The criteria for accepting the model were: TLI $\geq$ 0.900, CFI $\geq$ 0.900, SRMR $\leq$ 0.080, and RMSEA $\leq$ 0.080 [58].

Results

Descriptive statistics

The mean aggregate RPAS and RSAS scores for the final sample (N = 3,435), after exclusion of participants with incomplete questionnaires or who met the exclusion criterion (i.e. mental disorder diagnoses), were 14.089 (95%CI, 13.837–14.341) and 8.376 (95%CI, 8.186–8.566), respectively. The mean total aggregate score for the uniformed RPAS&RSAS was 22.465 (95%CI, 22.079–22.851). The coefficients of correlation (*r* values) obtained between each RPAS&RSAS item and the total score are listed in Table S2 in supplementary material.

Reliability: Internal consistency and test-retest reliability

The Cronbach's α values obtained for the RPAS&RSAS, RPAS, and RSAS were 0.884, 0.835, and 0.827, respectively, which indicated good reliability with respect to internal consistency. The Pearson's *r* values obtained for the RPAS&RSAS, RPAS, and RSAS test-retest scores were 0.644 ($p < 0.001$), 0.572 ($p < 0.001$), and 0.602 ($p < 0.001$) in a subsample of 197 participants, indicating good test-retest reliability.

Construct validity: RPAS/RSAS factor analysis

After the elimination of six items for culture inappropriateness or poor relevance (see Methods), EFA of the RPAS (56 items) and RSAS (39 items), involving half of the participants, was conducted with a WLSMV estimator. The model fit indexes obtained for the RPAS and RSAS are presented in Table 1 and Table 2, respectively. The RPAS fit well with a 4-factor structure model (CFI = 0.924, TLI = 0.912, SRMR = 0.053, RMSEA = 0.024) and the RSAS fit well with a 2-factor structure model (CFI = 0.941, TLI = 0.934, SRMR = 0.063, RMSEA = 0.028). The factor loadings of each item are reported in Table S3 and Table S4 in the supplementary material.

In the RPAS, the physical anhedonia items segregated into four factors as follows: Factor 1 contains items 5, 6, 8, 10, 11, 12, 13, 14, 16, 17, 18, 20, 22, 23, 26, 27, 28, 29, 32, 33, 43, 44, 48, 50, 51, 52, 55, 56, and 57; Factor 2 contains items_2, 3, 19, 21, 24, 25, 30, 31, 34, 35, 36, 37, 39, 41, 45, 46, 47, 49, 54, 58, 59, 60, and 61; Factor 3 contains items 7 and 15; and Factor 4 contains items 38 and 42. As can be seen in Table S4, Factors 3 and Factor 4 each have only two items, and all four of these items had relatively high loadings (loadings > 0.350) in the first two factors. Thus, we spread these four items into the first two factors according to loading parameters. Accordingly, item 5 was placed with Factor 1 and items 7, 38, and 42 were placed with Factor 2 (Table S3 in supplementary material). Although the fitness indexes of the resultant 2-factor model were not as desirable as those obtained for the 4-factor model, the conceptualization of anhedonia and the associations of these items' contents with the first two factors support a 2-factor model.

The RPAS items gathered in Factor 1 (P1) were related to consummatory physical pleasure whereas the RPAS items gathered in Factor 2 (P2) were related to anticipatory physical pleasure. Regarding items gathered in Factors 3 and 4, the content of item 15 (There aren't many things I really like to do) associated well with "liking", thus relating it to consummatory physical anhedonia (Factor 1). In contrast, the content of items 7 (The taste of food has always been important tome), 38 (The beautiful scenery can make me feel delighted). and 42 (I seldom have the idea of singing in the bath) associated well with "wanting", thus relating them to anticipatory physical anhedonia (Factor 2).

The RSAS items gathered in Factor 1 (S1)—that is, items 1, 2, 3, 6, 10, 13, 14, 17, 21, 22, 23, 26, 27, 28, 29, 32, 34, 35, 37, 38, 39, and 40—were related to the consummatory social pleasure. The RSAS items gathered in Factor 2 (S2)—that is, items 4, 5, 7, 8, 9, 11, 12, 15, 16, 18, 19, 20, 24, 25, 30, 31, and 36—were related to anticipatory social pleasure.

For CFA, we parceled randomized four items and simplified the scales because the RPAS/RSAS items seemed excessive and scattered. There were 14 parcels in the RPAS (7 in P1 and 7 in P2) and 9 parcels in

the RSAS (5 in S1 and 4 in S2). As is shown in Table 3, fit index values supported a good fit with a 2-factor model for the RSAS (CFI = 0.967, TLI = 0.957, SRMR = 0.037, and RMSEA = 0.048) and a very good fit with a 2-factor model for the RPAS (CFI = 0.947, TLI = 0.936, SRMR = 0.039, RMSEA = 0.052) in CFA, consistent with our EFA results.

Factor analysis of the RPAS&RSAS

Based on the good fits of the 2-factor models for the two individual scales and good first-order model fitness results for the RPAS&RSAS (reported above), CFA confirmed a novel second-order model for the RPAS&RSAS as a unified scale. The acceptable model fit indexes (CFI = 0.901, TLI = 0.899, RMSEA = 0.055, and SRMR = 0.086) support a simpler construct of anhedonia, as is shown in Figure 1. Although the fit indexes of the second-order model are not as good as those of the first-order model for the RSAS&RPAS (Table 4), the advantages of the second-order model, including a lower number of degrees of freedom and a more simple structure make the second-order model desirable. Additionally, the second-order model supports the view of multiple dimensions of anhedonia, which combines observable behavioral symptoms and underlying biological mechanisms.

Discussion

As anhedonia is composed of consummatory anhedonia and anticipatory anhedonia from the reward processing models in the neurobiology, the construct of RPAS&RSAS (the “goldstandard” for measuring hedonic capacity [59]) is of great possibility to be consistent with the components of anhedonia.

The current study examined the psychometric properties of a unified RPAS&RSAS as a distinct anhedonia assessment tool in a large sample of young Chinese adults for the first time and supported an underlying hierarchical structure of anhedonia. Traditionally, the RPAS and the RSAS have instead been viewed as components of a traditional scale battery aimed at detecting psychosis-related symptoms and proneness [1]. The present results showed that the RPAS and the RSAS have good reliabilities and validities in Chinese healthy youth. The present EFA and CFA support 2-factor structures of the RPAS and the RSAS, and CFA supported a second-order model of the unified RPAS&RSAS. The two factors were defined as diminished consummatory pleasure and diminished anticipatory pleasure. Furthermore, our results revealed a not previously described multi-dimensionality of anhedonia of the RPAS&RSAS, in which the first dimension is composed of physical anhedonia and social anhedonia. The second dimension, represented in each first-dimension factor, is composed of anticipatory and consummatory components. The current study showed that it is feasible and suitable to use a unified RPAS&RSAS instrument as a novel distinct instrument with which to assess the multi-dimensionality of anhedonia.

With respect to reliability, acceptable Cronbach’s α values (α_{RPAS}= 0.835, α_{RSAS}= 0.827; $\alpha_{RPAS\&RSAS}$ = 0.884) and test-retest Pearson’s r values (r_{RPAS} = 0.572, $p < 0.001$; r_{RSAS} = 0.602, $p < 0.001$; $r_{RPAS\&RSAS}$ = 0.644, $p < 0.001$) were obtained. The Cronbach’s α estimates that we obtained for the RPAS and the RSAS are consistent with previous studies (α_{RPAS} = 0.74–0.92, α_{RSAS} = 0.79–0.95, summarized in Table S1) [1, 19,

29-32, 35, 38-41, 50, 60, 61]. The $r_{test\text{-}retest}$ values that we obtained for the RPAS and the RSAS are slightly lower than those reported in other studies (r_{RPAS} = 0.65–0.909; r_{RSAS} = 0.75–0.902, see Table S1). Test-retest interval differences can produce variance in test-retest reliability coefficients; neither internal consistency nor test-retest reliability have been reported previously for the RPAS&RSAS. The high Cronbach's α values obtained for the RPAS&RSAS in the present study indicate good internal consistency for anhedonia (physical and social), and the high RPAS&RSAS test-retest reliability coefficient obtained indicates, for the first time to our knowledge, temporal stability of anhedonia findings with the RPAS&RSAS.

The RSAS was found to have a 2-factor structure in this study, with the two components being defined as consummatory and anticipatory social anhedonia. This result is consistent with Cicero's et al.'s study [44]. Our study and Cicero et al.'s study support a 2-factor model, with only items 24 and 25 having different factor designation relative to the EFA results. Cicero defined their two RSAS factors as social apathy/aversion and social withdrawal based on an emotion and behavior perspective, and in the context of potential symptoms of schizophrenia [44]. Given the factor structure consistency between Cicero et al.'s study and our study, it is possible that the factor definitions of both studies may reflect some underlying mechanisms and it is likely that they overlap with prior descriptions in the literature [62]. Anticipatory social anhedonia, or social withdrawal, is characterized by a loss of the motivation to connect to others; consummatory social anhedonia, or social apathy/aversion, is characterized by a lack of emotional connection or involvement in social activities [7]. The terms consummatory social anhedonia and anticipatory social anhedonia can be related to potential biological mechanisms whereas the terms social withdrawal and social apathy are derived from schizotypy symptoms. It is hoped that the context and links made in this study may promote application of the RSAS for assessment of a broader range of mental disorders (beyond the schizophrenia spectrum) in the future [7, 13, 48].

Similar to our findings with the RSAS, we also obtained a 2-factor structure for the RPAS: consummatory physical anhedonia and anticipatory physical anhedonia. We excluded items 1, 4, 9, 40, and 53 from the RPAS due to their low relevance, consistent with a previous study [53]. The RPAS has long been assigned to the negative schizotypy dimension in the WSS, in which its unidimensionality has been taken for granted [1, 63]. However, animal behavioral experiments in depression [64, 65] and schizophrenia [66, 67] models suggested that physical anhedonia has more than one dimension. For example, the sucrose preference test relies on an affinity for a physical stimulus (consummatory pleasure) whereas the forced swimming test relates to "wanting" (anticipatory pleasure) [16]. Elucidation of the hedonic capacity concept [7], including consummatory and anticipatory components, in the context of neurobiological arguments underscores an inherent complexity of the RPAS construct. Meanwhile, the potential utility for using the RPAS to assess anhedonia generally over the lifespan also points to its potential multi-dimensionality [51]. Finally, data from other measures support a psychometric multidimensionality of physical anhedonia. For example, some items in the Temporal Experience of Pleasure Scale involve the pleasure of tasting food and these aspects of pleasure were represented in the consummatory and anticipatory components of the RPAS [48], as indicated in our 2-factor model.

The notion of anhedonia as encompassing social and physical aspects was developed in the 1970s. There is a long history and broad acceptance of viewing mental disorders in relation to physical sensation and social function, and this perspective is well represented in diagnostic criteria. These bases are also amenable to experimental exploration of the nature of anhedonia in animal experiments [68, 69]. The more recent temporal components of anhedonia, namely anticipatory anhedonia and consummatory anhedonia [7], were also supported by our hierarchy analysis of the concept of anhedonia.

We accepted a simple, accurate second-order model of the RPAS&RSAS, which was confirmed to have a good fit, supporting the robust construct validity of the combined unified scale. In this model (Fig. 1), anhedonia is divided firstly into physical and social anhedonia and secondly each these aspects of anhedonia is divided into anticipatory and consummatory components. The unified RPAS&RSAS, separate from the WSS, has proven to be a scale of simple construction that integrates multiple levels of information related to anhedonia, which makes it a convenient and useful tool for researchers and clinical psychologists. Hedonic capacity has been related to genetics, neurochemical disorders, and specific brain regions [2, 49]. Anhedonia, as an emotion processing deficiency, is thought to reflect an endophenotype (i.e. an intermediate phenotype of trait that is expressed along a spectrum) that can be a component of multiple mental disorders, including schizophrenia and depression [12, 70]. Neuropsychiatric deficit endophenotypes have been linked to genetic signatures and molecular mechanisms [71-73]. Thus, the second-order structure found for the RPAS&RSAS can help provide insight into the integration of multiple levels of information, including genetic, endophenotype, and symptom expression, in various mental disorders from the perspective of an anhedonia measure.

The present investigation has a couple noteworthy limitations. Firstly, reliance on an undergraduate student sample may limit the generalizability of our findings to individuals in other age bands. Secondly, this study lacked analyses from clinical samples to support the RPAS/RSAS structure findings.

Conclusion

The RPAS and the RSAS were demonstrated to be valid and reliable in a large sample of healthy young Chinese adults. EFA and CFA indicated that both scales have a 2-factor structure. Based on existing theoretical models and knowledge regarding the biological mechanisms of anhedonia, the two factors were defined as diminished consummatory and anticipatory physical/social pleasure. Furthermore, a second-order model of the RPAS&PSAS was selected over a first-order model for its ability to optimize simplicity and accuracy. A new construct for anhedonia was developed in this study. The present results support the application of a unified RPAS&RSAS in healthy Chinese young adults and the recognition of anhedonia as a dimension in multiple neuropsychiatric diagnoses.

Abbreviations

RPAS, Revised Physical Anhedonia Scale; RSAS, Revised Social Anhedonia Scale; RPAS&RSAS, unified, simplified RPAS and RSAS; EFA, exploratory factor analysis; CFA, confirmatory factor analysis; WSS,

Wisconsin schizotypy scales.

Declarations

Ethics approval and consent to participate

This study was approved by the ethics committee of Second Xiangya Hospital, Central South University. All participants were over 16 years old and had written informed consent.

Consent for publication

Not applicable

Availability of data and materials

The datasets generated and analysed during the current study are not publicly available due to no permission from participants to share anonymized participant data publicly but are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

XW and SY supervised the study. QW and JH performed the analysis and wrote paper. SF, XL and PZ contributed to the analysis. JZ, YX and FL provided substantial modification to the manuscript. All co-authors revised and approved the version to be published.

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Tables

Table 1 The fitness indicators in the EFA of the models of the RPAS

Model	Chi-Square	df	CFI	TLI	SRMR	RMSEA（90%CI）
1-factor	7866.714	1430	0.625	0.611	0.133	0.051 (0.050, 0.052)
2-factor	4036.320	1367	0.845	0.833	0.073	0.034 (0.032, 0.035)
3-factor	3226.631	1375	0.897	0.884	0.060	0.028 (0.027, 0.029)
4-factor	2567.392	1271	0.924	0.912	0.053	0.024 (0.023, 0.026)

Note: Physical_1/4/9/40/53 were excluded before EFA. EFA = Exploratory Factor Analysis; RPAS = Revised Physical Anhedonia Scale; d.f. = Degree of Freedom; CFI = Comparative Fit Index; TLI = Tucker Lewis Index; SRMR = Standard root mean square residuals; RMSEA = Root Mean Square Error of Approximation; 90% CI = 90% Confidence Interval.

Table 2 The fitness indicators in the EFA of the models of the RSAS

Model	Chi-Square	df	CFI	TLI	SRMR	RMSEA（90%CI）
1-factor	4436.681	702	0.756	0.742	0.130	0.056 (0.054, 0.057)
2-factor	1569.098	664	0.941	0.934	0.063	0.028 (0.026, 0.030)

Note: Social_33 were excluded before EFA. EFA = Exploratory Factor Analysis; RSAS = Revised Social Anhedonia Scale; d.f. = Degree of Freedom; CFI = Comparative Fit Index; TLI = Tucker Lewis Index; SRMR = Standard root mean square residuals; RMSEA = Root Mean Square Error of Approximation; 90% CI = 90% Confidence Interval.

Table 3 The fitness indicators in the CFA of the models of the RPAS and the RSAS

	Chi-Square	df	CFI	TLI	SRMR	RMSEA(90%CI)
RPAS	445.376	76	0.947	0.936	0.039	0.052 (0.048, 0.057)
RSAS	171.468	34	0.967	0.957	0.037	0.048 (0.041, 0.055)

Note: Items in the RPAS and the RSAS were devided into 14 parcels and 9 parcels respectively. CFA = Confirmatory Factor Analysis; RPAS = Revised Physical Anhedonia Scale; RSAS = Revised Social Anhedonia Scale; d.f. = Degree of Freedom; CFI = Comparative Fit Index; TLI = Tucker Lewis Index; SRMR = Standard root mean square residuals; RMSEA = Root Mean Square Error of Approximation; 90% CI = 90% Confidence Interval.
Note: Items in the RPAS and the RSAS were devided into 14 parcels and 9 parcels respectively.

Table 4 The fitness indicators in the CFA of the models of the RPAS&RSAS

	Chi-Square	df	CFI	TLI	SRMR	RMSEA(90%CI)
First-order model	1628.053	224	0.941	0.934	0.038	0.042 (0.040, 0.044)
Second-order model	2592.801	225	0.901	0.899	0.086	0.055 (0.053, 0.056)

Note: Items in the RPAS and the RSAS were devided into 14 parcels and 9 parcels respectively. CFA = Confirmatory Factor Analysis; RPAS = Revised Physical Anhedonia Scale; RSAS = Revised Social Anhedonia Scale; d.f. = Degree of Freedom; CFI = Comparative Fit Index; TLI = Tucker Lewis Index; SRMR = Standard root mean square residuals; RMSEA = Root Mean Square Error of Approximation; 90% CI = 90% Confidence Interval.

Figures

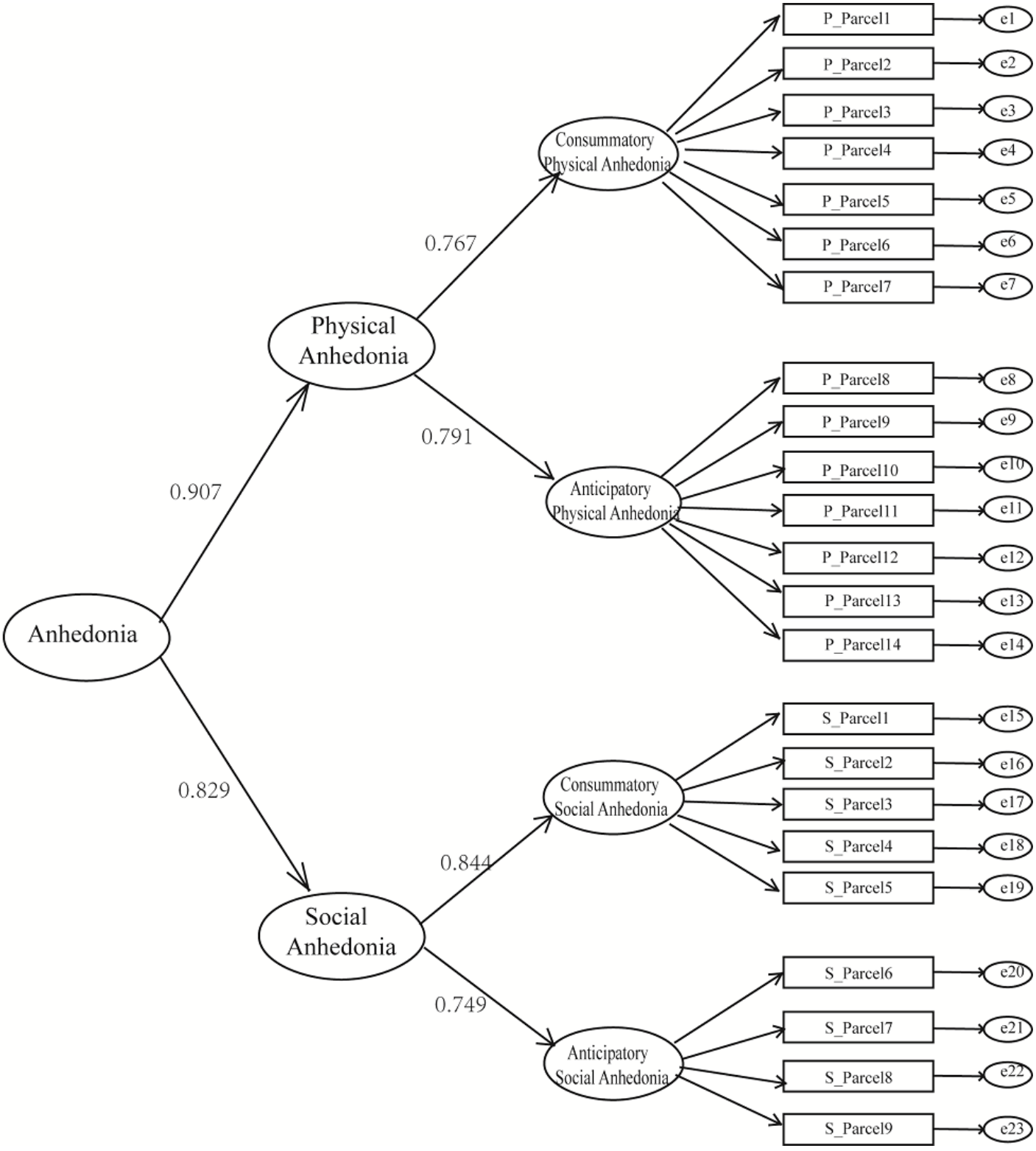

Figure 1

Second-order model of the Revised Physical and Social Anhedonia Scales (RPAS and RSAS) and the underlying construct of anhedonia.

Supplementary Files

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