**SUPPLEMENTAL MATERIALS FOR Two Factors, Five Factors, or Both?**

**External Validation Studies of Negative Symptom Dimensions in SchizophreniA**

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**External Variables in Study 1**

**Cognition**: We defined Cognition as a single-factor latent variable that influences domain scores from the cognitive measure administered in each sample.

Sample 1: RBANS Immediate Memory, Visuospatial, Language, Attention, Delayed Memory, and WAIS-III IQ Score

Sample 2: MCCB Processing Speed, Attention/Vigilance, Working Memory, Verbal Learning, Visual Learning, Reasoning/Problem Solving, Social Cognition

Sample 3: BACS Verbal Memory, Digit Sequencing, Verbal Fluency, Symbol Coding, Token Motor Task, Towers of Learning

**Function**: We defined Function as a single-factor latent variable that influences domain scores from the social functioning measure administered in each sample.

Sample 1: LOF domains--Work, Social, Clinical, Activities of Daily Living, and Subjective

Sample 2: PSP domains--Socially Useful Activities, Personal Relationships, Self-care, and Aggression

Sample 3: ILS domains—Appearance, Hygiene, Health, Transportation, Leisure, Care of Possession, Food, Money, Job Seeking, and Job Maintenance.

SLOF domains—Interpersonal Relationships, Social Acceptability, Activities, Work Skills

**Symptoms:** We defined Symptoms as a single-factor latent variable that influences domain scores from the measure(s) of psychopathology administered in each sample.

Sample 1: BPRS Positive Symptoms, Reality Distortion, Depression/Anxiety, and Mania; CDSS Total Score

Sample 2: PANSS Positive, Disorganization, Emotional Distress, Excitement/Agitation; and CDSS Total Score

Sample 3: BPRS Positive Symptoms, Reality Distortion, Disorganization, Depression/Anxiety, and Mania

In each sample, we excluded all negative symptom items in the specification of the external variable.

**External Variables in Study 2**

In Study 2, we included the external variables—Positive Affect; Negative Affect; and DPB total scores— as observed rather than latent variables in the structural models.

**Factor Score Computations used in Study 3**

**Unidimensional Model:**

Total Score = (Item 1 \* 0.760) + (Item 2 \*.645) + (Item 3 \* 0.718) + (Item 5 \* 0.771) + (Item 6 \* 0.759) + (Item 7 \* 0.384) + (Item 8 \* 0.352) + (Item 9 \* 0.672) + (Item 10 \* 0.552) + (Item 11 \* 0.718) + (Item 12 \* 0.531) + (Item 13 \* 0.605)

**Two-Factor Model**:

MAP = (Item 1 \* .736) + (Item 2 \* .857) + (Item 3 \* .663) + (Item 5 \* .845) + (Item 6 \* .877) + (Item 7 \* .860) + (Item 8 \* .905)

EXP = (Item 9 \* .907) + (Item 10 \* .909) + (Item 11 \* .929) + (Item 12 \* .974) + (Item 13 \* .973)

**Five Factor Model:**

ANHEDONIA = (Item 1 \* .769) + (Item 2 \* .938) + (Item 3 \* .658).

ASOCIALITY = (Item 5 \* .925) + (Item 6 \* .970)

AVOLITION = (Item 7 \* .972) + (Item 8 \* .944)

BLUNTED AFFECT = (Item 9 \* .954) + (Item 10 \* .948) + (Item 11 \* .952)

ALOGIA = (Item 12 \* .97) + (Item 13 \* .992)

**Hierarchical Model**:

MAP = (ANHEDONIA \* .894) + (ASOCIALITY \* .867) + (AVOLITION \* .905)

EXP = (BLUNTED AFFECT \*.924) + (ALOGIA \* .953)

Supplemental Table S1. SANS Items and Domains in Sample 1

|  |  |  |  |
| --- | --- | --- | --- |
| SANS Items and Domains | Means (SD) | Range | Measurement Models for Structural Equations |
|  |  |  | Unidimensional (1-Factor) | MAP/EXP(2-Factor) | Consensus(5-Factor) | Consensus (HM) |
|  |  |  |  |  |  | 1st Order | 2nd Order |
| **Anhedonia** |  |  |  |  |  |  |  |
| Recreational Interests and Activities | 1.41 (1.32) | 0–5 | 1 | 1 | 1 | 1 | 1 |
| **Asociality** |  |  |  |  |  |  |  |
| Sexual Interest and Activity | 2.60 (1.70) | 0–5 | 1 | 1 | 2 | 2 | 1 |
| Ability to Feel Intimacy and Closeness | 1.81 (1.37) | 0–5 | 1 | 1 | 2 | 2 | 1 |
| Relationships with Friends and Peers | 2.04 (1.33) | 0–5 | 1 | 1 | 2 | 2 | 1 |
| **Avolition** |  |  |  |  |  |  |  |
| Grooming and Hygiene | 1.04 (1.25) | 0–5 | 1 | 1 | 3 | 3 | 1 |
| Work/School--Level of Role Function | 3.39 (1.75) | 0–5 | 1 | 1 | 3 | 3 | 1 |
| Physical Anergia | 2.38 (1.38) | 0–5 | 1 | 1 | 3 | 3 | 1 |
| **Blunted Affect** |  |  |  |  |  |  |  |
| Unchanging Facial Expression | 1.73 (1.38) | 0–5 | 1 | 2 | 4 | 4 | 2 |
| Decreased Spontaneous Movements | 1.03 (1.26) | 0–5 | 1 | 2 | 4 | 4 | 2 |
| Paucity of Expressive Gestures | 1.51 (1.45) | 0–5 | 1 | 2 | 4 | 4 | 2 |
| Poor Eye Contact | 0.91 (1.09) | 0–5 | 1 | 2 | 4 | 4 | 2 |
| Affective Nonresponsivity | 0.79 (1.14) | 0–5 | 1 | 2 | 4 | 4 | 2 |
| Lack of Vocal Inflection | 1.21 (1.39) | 0–5 | 1 | 2 | 4 | 4 | 2 |
| **Alogia** |  |  |  |  |  |  |  |
| Poverty of Speech | 0.99 (1.25) | 0–4 | 1 | 2 | 5 | 5 | 2 |
| Blocking | 0.13 (0.54) | 0–5 | 1 | 2 | 5 | 5 | 2 |
| Increased Latency of Response | 0.51 (0.88) | 0–4 | 1 | 2 | 5 | 5 | 2 |

Supplemental Table S2. BNSS Items and Domains in Sample 2

|  |  |  |  |
| --- | --- | --- | --- |
| BNSS Items and Domains | Means (SD) | Range | Measurement Models for Structural Equations |
|  |  |  | Unidimensional (1-Factor) | MAP/EXP(2-Factor) | Consensus(5-Factor) | Consensus (HM) |
|  |  |  |  |  |  | 1st Order | 2nd Order |
| **Anhedonia** |  |  |  |  |  |  |  |
| Intensity of past-week pleasure | 2.16 (1.46) | 0–5 | 1 | 1 | 1 | 1 | 1 |
| Frequency of past-week pleasure | 2.22 (1.46) | 0–6 | 1 | 1 | 1 | 1 | 1 |
| Intensity of expected pleasure | 1.97 (1.57) | 0–6 | 1 | 1 | 1 | 1 | 1 |
| **Asociality** |  |  |  |  |  |  |  |
| Asociality—Behavior | 2.29 (1.33) | 0–6 | 1 | 1 | 2 | 2 | 1 |
| Asociality—Internal Experience | 1.88 (1.33) | 0–6 | 1 | 1 | 2 | 2 | 1 |
| **Avolition** |  |  |  |  |  |  |  |
| Avolition—Behavior | 2.32 (1.39) | 0–6 | 1 | 1 | 3 | 3 | 1 |
| Avolition—Internal Experience | 2.25 (1.37) | 0–6 | 1 | 1 | 3 | 3 | 1 |
| **Blunted Affect** |  |  |  |  |  |  |  |
| Facial Expression | 2.35 (1.52) | 0–6 | 1 | 2 | 4 | 4 | 2 |
| Vocal Expression | 1.92 (1.53) | 0–6 | 1 | 2 | 4 | 4 | 2 |
| Expressive Gestures | 2.19 (1.65) | 0–6 | 1 | 2 | 4 | 4 | 2 |
| **Alogia** |  |  |  |  |  |  |  |
| Quantity of Speech | 1.38 (1.42) | 0–5 | 1 | 2 | 5 | 5 | 2 |
| Spontaneous Elaboration | 1.79 (1.75) | 0–5 | 1 | 2 | 5 | 5 | 2 |

Supplemental Table S3. CAINS Items and Domains in Sample 3

|  |  |  |  |
| --- | --- | --- | --- |
| CAINS Items and Domains | Means (SD) | Range | Measurement Models for Structural Equations |
|  |  |  | Unidimensional (1-Factor) | MAP/EXP(2-Factor) | Consensus(5-Factor) | Consensus (HM) |
|  |  |  |  |  |  | 1st Order | 2nd Order |
| **Anhedonia** |  |  |  |  |  |  |  |
| Motivation for Recreational Activities | 2.06 (1.13) | 0–4 | 1 | 1 | 1 | 1 | 1 |
| Frequency of Recreational Activities--past week | 1.94 (1.16) | 0–4 | 1 | 1 | 1 | 1 | 1 |
| Frequency of Expected Recreational Activities—next week | 1.92 (1.22) | 0–4 | 1 | 1 | 1 | 1 | 1 |
| **Asociality** |  |  |  |  |  |  |  |
| Motivation for Close Relationships | 1.90 (1.37) | 0–4 | 1 | 1 | 2 | 2 | 1 |
| Motivation for Friendships/Romantic Relationships | 2.03 (1.21) | 0–4 | 1 | 1 | 2 | 2 | 1 |
| Frequency of Social Activities—Past Week | 2.12 (1.33) | 0–4 | 1 | 1 | 2 | 2 | 1 |
| Frequency of Exp. Pleasure from social activities—Next Week | 2.23 (1.26) | 0–4 | 1 | 1 | 3 | 2 | 1 |
| **Avolition** |  |  |  |  |  |  |  |
| Motivation Work/School Activities | 2.81 (1.18) | 0–4 | 1 | 1 | 3 | 3 | 1 |
| Freq. Expect. Work/School-Next Week | 3.40 (0.89) | 0–4 | 1 | 1 | 3 | 3 | 1 |
| **Blunted Affect** |  |  |  |  |  |  |  |
| Facial Expression | 1.42 (1.26) | 0–4 | 1 | 2 | 4 | 4 | 2 |
| Vocal Expression | 1.08 (1.22) | 0–4 | 1 | 2 | 4 | 4 | 2 |
| Expressive Gestures | 1.08 (1.18) | 0–4 | 1 | 2 | 4 | 4 | 2 |
| **Alogia** |  |  |  |  |  |  |  |
| Quantity of Speech | 0.71 (1.03) | 0–4 | 1 | 2 | 5 | 5 | 2 |

Supplemental Table S4. SANS Items and Domains in Sample 3

|  |  |  |  |
| --- | --- | --- | --- |
| SANS Items and Domains | Means (SD) | Range | Measurement Models for Structural Equations |
|  |  |  | Unidimensional (1-Factor) | MAP/EXP(2-Factor) | Consensus(5-Factor) | Consensus (HM) |
|  |  |  |  |  |  | 1st Order | 2nd Order |
| **Anhedonia** |  |  |  |  |  |  |  |
| Recreational Interests and Activities | 2.39 (1.30) | 0–5 | 1 | 1 | 1 | 1 | 1 |
| **Asociality** |  |  |  |  |  |  |  |
| Sexual Interest and Activity | 0.15 (0.74) | 0–5 | 1 | 1 | 2 | 2 | 1 |
| Ability to Feel Intimacy and Closeness | 2.11 (1.46) | 0–5 | 1 | 1 | 2 | 2 | 1 |
| Relationships with Friends and Peers | 2.57 (1.42) | 0–5 | 1 | 1 | 2 | 2 | 1 |
| **Avolition** |  |  |  |  |  |  |  |
| Grooming and Hygiene | 1.25 (1.29) | 0–5 | 1 | 1 | 3 | 3 | 1 |
| Work/School--Level of Role Function | 2.62 (1.28) | 0–5 | 1 | 1 | 3 | 3 | 1 |
| Physical Anergia | 2.14 (1.21) | 0–5 | 1 | 1 | 3 | 3 | 1 |
|  |  |  |  |  |  |  |  |
| **Blunted Affect** |  |  |  |  |  |  |  |
| Unchanging Facial Expression | 1.71 (1.48) | 0–5 | 1 | 2 | 4 | 4 | 2 |
| Decreased Spontaneous Movements | 1.07 (1.22) | 0–4 | 1 | 2 | 4 | 4 | 2 |
| Paucity of Expressive Gestures | 1.04 (1.24) | 0–5 | 1 | 2 | 4 | 4 | 2 |
| Poor Eye Contact | 1.10 (1.30) | 0–4 | 1 | 2 | 4 | 4 | 2 |
| Affective Nonresponsivity | 0.96 (1.31) | 0–5 | 1 | 2 | 4 | 4 | 2 |
| Lack of Vocal Inflection | 1.15 (1.36) | 0–5 | 1 | 2 | 4 | 4 | 2 |
| **Alogia** |  |  |  |  |  |  |  |
| Poverty of Speech | 0.90 (1.21) | 0–4 | 1 | 2 | 5 | 5 | 2 |
| Blocking | 0.72 (1.24) | 0–4 | 1 | 2 | 5 | 5 | 2 |
| Increased Latency of Response | 0.94 (1.13) | 0–4 | 1 | 2 | 5 | 5 | 2 |

Supplemental Table S5. BNSS Items and Domains in Sample 4

|  |  |  |  |
| --- | --- | --- | --- |
| BNSS Items and Domains | Means (SD) | Range | Measurement Models for Structural Equations |
|  |  |  | Unidimensional (1-Factor) | MAP/EXP(2-Factor) | Consensus(5-Factor) | Consensus (HM) |
|  |  |  |  |  |  | 1st Order | 2nd Order |
| **Anhedonia** |  |  |  |  |  |  |  |
| Intensity of past-week pleasure | 1.47 (1.57) | 0–6 | 1 | 1 | 1 | 1 | 1 |
| Frequency of past-week pleasure | 2.30 (1.63) | 0–6 | 1 | 1 | 1 | 1 | 1 |
| Intensity of expected pleasure | 1.07 (1.49) | 0–6 | 1 | 1 | 1 | 1 | 1 |
| **Asociality** |  |  |  |  |  |  |  |
| Asociality—Behavior | 2.20 (1.65) | 0–6 | 1 | 1 | 2 | 2 | 1 |
| Asociality—Internal Experience | 1.46 (1.67) | 0–6 | 1 | 1 | 2 | 2 | 1 |
| **Avolition** |  |  |  |  |  |  |  |
| Avolition—Behavior | 2.37 (1.75) | 0–6 | 1 | 1 | 3 | 3 | 1 |
| Avolition—Internal Experience | 2.04 (1.80) | 0–6 | 1 | 1 | 3 | 3 | 1 |
| **Blunted Affect** |  |  |  |  |  |  |  |
| Facial Expression | 2.11 (1.80) | 0–6 | 1 | 2 | 4 | 4 | 2 |
| Vocal Expression | 1.79 (1.88) | 0–6 | 1 | 2 | 4 | 4 | 2 |
| Expressive Gestures | 1.75 (1.85) | 0–6 | 1 | 2 | 4 | 4 | 2 |
| **Alogia** |  |  |  |  |  |  |  |
| Quantity of Speech | 1.00 (1.55) | 0–6 | 1 | 2 | 5 | 5 | 2 |
| Spontaneous Elaboration | 1.18 (1.69) | 0–6 | 1 | 2 | 5 | 5 | 2 |

Supplemental Table S6: External (Criterion) Variables used in Each Study Sample

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Cognition Measures** | M (SD) | **Function Measures** | M (SD) | **Symptoms** | M (SD) |
| **Sample 1: RBANS and WAIS-III** |  | **Sample 1: LOF Domains** |  | **Sample 1: BPRS and CDSS** |  |
| Immediate Memory | 75.65 (17.71) | Duration of Hospitalization | 3.72 (0.91) | Positive Symptoms | 9.48 (4.54) |
| Visuospatial | 81.37 (18.34) | Frequency of Social Contacts | 2.21 (1.49) | Reality Distortion | 6.53 (3.01) |
| Language | 84.74 (15.37) | Quality of Social Relations | 2.11 (1.43) | Depression/Anxiety | 8.27 (3.29) |
| Attention | 76.83 (17.06) | Usefully Employed | 1.29 (1.46) | Mania | 4.34 (1.72) |
| Delayed Memory | 79.04 (17.70) | Quality of Useful Work | 1.45 (1.36) | CDSS Total | 2.21 (2.47) |
| WAIS-III IQ Score | 86.13 (17.55) | Symptoms (In Past Month) | 2.25 (1.15) | **Sample 2: PANSS and CDSS** |  |
| **Sample 2: MCCB Domains** |  | Ability to Meet Own Basic Needs | 3.39 (0.99) | Positive Symptoms | 9.73 (4.41) |
| Processing Speed | 34.32 (11.97) | Fullness of Life | 1.92 (0.88) | Disorganization | 17.01 (5.21) |
| Attention/Vigilance | 38.81 (12.09) | Overall Level of Function | 1.85 (0.91) | Emotional Distress | 9.95 (3.53) |
| Working Memory | 43.67 (11.51) | **Sample 2: PSP Domains** |  | Excitement/Agitation | 5.25 (1.80) |
| Verbal Learning | 43.86 (10.29) | Socially Useful Activities | 2.42 (1.37) | CDSS Total | 3.18 (3.57) |
| Visual Learning | 41.13 (14.27) | Personal Relationships | 2.77 (1.12) | **Sample 3: BPRS** |  |
| Reasoning/Problem Solving | 36.56 (9.23) | Self-Care | 2.18 (1.11) | Positive Symptoms | 10.24 (3.98) |
| Social Cognition | 51.32 (15.31) | Aggression | 0.99 (0.56) | Reality Distortion | 7.84 (3.48) |
| **Sample 3: BACS Subtest** |  | **Sample 3: ILS Domains** |  | Disorganization | 5.62 (2.77) |
| Verbal Memory | 27.55 (12.59) | Appearance | 0.91 (0.14) | Depression/Anxiety | 8.34 (3.98) |
| Digit Sequencing | 31.22 (11.77) | Hygiene | 0.82 (0.17) | Mania | 6.40 (2.52) |
| Verbal Fluency | 37.84 (10.65) | Health | 0.87 (0.16) | **Trait Affectivity** | M (SD) |
| Symbol Coding | 35.07 (12.29) | Transportation | 0.54 (0.20) | **Sample 4: PANAS**  |  |
| Token Motor Task | 30.24 (10.70) | Leisure | 0.37 (0.16) | Positive Affect | 28.09 (7.34) |
| Towers of London | 38.07 (15.19) | Care of Possession | 0.82 (0.24) | Negative Affect | 20.89 (8.18) |
|  |  | Food | 0.86 (0.20) |  |  |
|  |  | Money | 0.92 (0.17) | **Attitude** | M (SD) |
|  |  | Job Seeking | 0.16 (0.28) | **Sample 5: DAS** |  |
|  |  | Job Maintenance | 0.94 (0.18) | Defeatist Beliefs | 52.58 (17.26) |
|  |  | **Sample 3: SLOF Domains** |  |  |  |
|  |  | Interpersonal Relationships (Interviewer) | 3.10 (0.66) | **Biochemical** | M (SD) |
|  |  | Activities (Interviewer) | 3.94 (0.73) | **Sample 6: MRS** |  |
|  |  | Work Skills (Interviewer) | 3.36 (0.69) | ACC GABA | 1.83 (0.26) |
|  |  | Interpersonal Relationships (Informant) | 3.10 (0.77) | ACC Glutamate | 8.96 (0.91) |
|  |  | Activities (Informant) | 4.10 (0.77) |  |  |
|  |  | Work Skills (Informant) | 3.07 (0.81) |  |  |

Supplemental Table S7. Detailed Goodness-of-Fit Estimates Obtained from Fitting Alternate Negative Symptom Factor Models with Cognition

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Measure/Model** | **Cognition Measure** | **Chi-Square** | **CFI** | **TLI** | **RMSEA** | **WRMR** | **LL** | **k** | **AIC** | **BIC** | **SSA-BIC** |
| Sample 1: SANS |  |
| Unidimensional (1-Factor)  | RBANS, WAIS-III | X2(56)=492.27, p < 0.001 | 0.846 | 0.882 | 0.159 | 2.043 | -9112.73 | 118 | 18,461.47 | 18901.62 | 18527.37 |
| MAP/EXP (Two Factor) | RBANS,WAIS-III | X2(59)=266.84, p < 0.001 | 0.924 | 0.945 | 0.107 | 1.422 | -8,990.45 | 121 | 18,202.90 | 18,653.85 | 18,270.09 |
| Five Factor | RBANS,WAIS-III | X2(58)=134.53, p < 0.001 | 0.972 | 0.979 | 0.066 | 0.956 | -8,928.099 | 132 | 18,120.20 | 18,612.14 | 18,193.50 |
| **Hierarchical****(2nd Order Five Factor)** | **RBANS,****WAIS-III** | **X2(59)=141.27, p < 0.001** | **0.970** | **0.978** | **0.067** | **1.000** | **-8,899.13** | **122** | **18,042.26** | **18,496.94** | **18,110.01** |
| Sample 2: BNSS |  |
| Unidimensional(1-Factor) | MCCB | X2(18)=263.76, p < 0.001 | 0.855 | 0.911 | 0.306 | 2.084 | -4052.96 | 103 | 8,311.93 | 8619.24 | 8293.30 |
| MAP/EXP (Two Factor) | MCCB | X2(27)=110.02, p < 0.001 | 0.949 | 0.980 | 0.145 | 0.985 | -3,834.23 | 105 | 7,878.46 | 8,191.74 | 7,859.47 |
| Five Factor | MCCB | X2(24)= 29.15,p = 0.2149 | 0.997 | 0.999 | 0.038 | 0.446 | -3,764.16 | 116 | 7,760.32 | 8,106.42 | 7,739.34 |
| **Hierarchical****(2nd Order Five Factor)** | **MCCB** | **X2(27)= 37.69,****p = 0.083** | **0.994** | **0.997** | **0.052** | **0.561** | **-3,737.48** | **106** | **7,686.95** | **8,003.21** | **7,667.78** |
| Sample 3: CAINS |  |
| Unidimensional(1-Factor) | BACS | X2(38)=419.36, p < 0.001 | 0.808 | 0.870 | 0.231 | 2.096 | -6915.02 | 84 | 13,998.04 | 14265.31 | 13999.29 |
| MAP/EXP (Two Factor) | BACS | X2(39)=272.73, p < 0.001 | 0.882 | 0.918 | 0.183 | 1.668 | -6,822.69 | 86 | 13,817.39 | 14,091.02 | 13,818.67 |
| Five Factor | BACS | X2(47)=62.26,p = 0.067 | 0.992 | 0.996 | 0.043 | 0.613 | -6,717.82 | 97 | 13,629.64 | 13,938.27 | 13,631.09 |
| **Hierarchical****(2nd Order Five Factor)** | **BACS** | **X2(43)=79.14,****p = 0.007** | **0.982** | **0.989** | **0.069** | **0.828** | **-6,667.26** | **87** | **13,508.52** | **13,785.34** | **13,509.82** |
| Sample 3: SANS |  |  |  |  |  |  |  |  |  |  |  |
| Unidimensional(1-Factor) | BACS | X2(43)=274.58, p < 0.001 | 0.892 | 0.927 | 0.174 | 1.583 | -7,330.57 | 104 | 14,869.14 | 15,200.04 | 14,870.69 |
| MAP/EXP (Two Factor) | BACS | X2(50)=115.43, p < 0.001 | 0.969 | 0.982 | 0.086 | 0.918 | -7,233.01 | 106 | 14,678.01 | 15,015.28 | 14,679.59 |
| Five Factor | BACS | X2(50)=90.37, p < 0.001 | 0.981 | 0.989 | 0.067 | 0.749 | -7,256.27 | 117 | 14,646.53 | 15,118.80 | 14,748.27 |
| **Hierarchical****(2nd Order Five Factor)** | **BACS** | **X2(50)=93.56, p < 0.001** | **0.980** | **0.988** | **0.070** | **0.821** | **-7,189.05** | **107** | **14,592.11** | **14,932.56** | **14,593.70** |

Notes. Preferred model is highlighted in bold font. RBANS=Repeatable Battery for the Assessment of Neuropsychological Status; WAIS-III=Wechsler Adult Intelligence Scale—Third Edition; MCCB=MATRICS Consensus Cognitive Battery; BACS=Brief Assessment of Cognition in Schizophrenia.

Cognition was defined as a single-factor latent variable that influences domain scores from the measures listed under each sample.

Sample 1: RBANS Immediate Memory, Visuospatial, Language, Attention, Delayed Memory; and WAIS-III IQ Score

Sample 2: MCCB Processing Speed, Attention/Vigilance, Working Memory, Verbal Learning, Visual Learning, Reasoning/Problem Solving, Social Cognition

Sample 3: BACS Verbal Memory, Digit Sequencing, Verbal Fluency, Symbol Coding, Token Motor Task, Towers of London

LL = loglikelihood; k = number of free parameters; AIC = Akaike Information Criterion; BIC=Bayesian Information Criterion, aBIC = sample size adjusted BIC;

CFI = Confirmatory Fit Index; TLI = Tucker Lewis Index; RMSEA = Root Mean Square error of Approximation; WRMR = Weighted root Mean Square Residual;

CFA = Confirmatory Factor Analysis. Both Weighted Least Square (WLSMV) and Maximum Likelihood (MLR) estimators were used in the analyses.

Monte Carlo-based numerical integration was used in the estimation of models to ease computation time.

Chi-Square for the Baseline model in Sample 1 (SANS): X2(43) = 2,789.20, p < 0.0001, Sample N = 308

Chi-Square for the Baseline model in Sample 2 (BNSS): X2(11) = 1,702.46, p < 0.0001, Sample N = 146
Chi-Square for the Baseline model in Sample 3 (CAINS): X2(27) = 2,002.66, p < 0.0001, Sample N = 178

Chi-Square for the Baseline model in Sample 3 (SANS): X2(29) = 2,168.74, p < 0.0001, Sample N = 178

Supplemental Table S8. Detailed Goodness-of-Fit Estimates Obtained from Fitting Alternate Negative Symptom Factor Models with Function

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Measure/Model** | **Function Measure** | **Chi-Square** | **CFI** | **TLI** | **RMSEA** | **WRMR** | **LL** | **k** | **AIC** | **BIC** | **SSA-BIC** |
| Sample 1: SANS |  |
| Unidimensional(One-Factor) | LOF | X2(55)=270.50,p < 0.001 | 0.849 | 0.884 | 0.160 | 1.565 | -4,147.94 | 139 | 8,573.88 | 8,996.02 | 8,556.06 |
| MAP/EXP (Two Factor) | LOF | X2(57)=139.75,p < 0.001 | 0.942 | 0.957 | 0.097 | 1.085 | -4,083.08 | 141 | 8,448.16 | 8,876.37 | 8,430.09 |
| Five Factor | LOF | X2(55)=116.41,p < 0.001 | 0.957 | 0.967 | 0.075 | 0.963 | -4,073.68 | 152 | 8,437.71 | 8,779.11 | 8,329.65 |
| **Hierarchical****(2nd Order Five Factor)** | **LOF** | **X2(57)=131.65,****p < 0.001** | **0.952** | **0.961** | **0.080** | **1.000** | **-4,031.93** | **142** | **8,347.86** | **8,668.96** | **8,419.51** |
| Sample 2: BNSS |  |
| Unidimensional (One-Factor) | PSP | X2(14)=282.68,p < 0.001 | 0.870 | 0.907 | 0.363 | 2.430 | -3,179.05 | 94 | 6,546.10 | 6,826.56 | 6,529.10 |
| MAP/EXP (Two Factor) | PSP | X2(26)=167.24,p < 0.001 | 0.931 | 0.974 | 0.193 | 1.203 | -2,960.45 | 96 | 6,112.91 | 6,399.33 | 6,095.54 |
| Five Factor | PSP | X2(27)=86.59,p < 0.001 | 0.972 | 0.990 | 0.081 | 0.673 | -2,856.31 | 108 | 5,928.61 | 6,250.84 | 5,909.08 |
| **Hierarchical****(2nd Order Five Factor)** | **PSP** | **X2(27)=71.99,****p < 0.001** | **0.978** | **0.992** | **0.077** | **0.751** | **-2,865.82** | **97** | **5,925.64** | **6,215.05** | **5,908.10** |
| Sample 3: CAINS |  |
| Unidimensional (One-Factor) | ILS, SLOF | X2(58)=418.44,p < 0.001 | 0.702 | 0.841 | 0.187 | 1.864 | -3,408.65 | 108 | 7,033.29 | 7,376.93 | 7,034.90 |
| MAP/EXP (Two Factor) | ILS, SLOF | X2(60)=310.97,p < 0.001 | 0.793 | 0.893 | 0.153 | 1.524 | -3,270.90 | 113 | 6,767.80 | 7,127.34 | 6,769.49 |
| Five Factor | ILS, SLOF | X2(62)=155.52,p < 0.001 | 0.923 | 0.961 | 0.076 | 0.968 | -3,204.51 | 127 | 6,663.02 | 7,067.11 | 6,664.91 |
| **Hierarchical****(2nd Order Five Factor)** | **ILS, SLOF** | **X2(61)=162.16,****p < 0.001** | **0.916** | **0.958** | **0.082** | **1.079** | **-3,087.87** | **117** | **6,409.74** | **6,782.01** | **6,411.48** |
| Sample 3: SANS |  |  |  |  |  |  |  |  |  |  |  |
| Unidimensional(1-Factor) | ILS, SLOF | X2(61)=360.95, p < 0.001 | 0.772 | 0.880 | 0.166 | 1.653 | -3,821.03 | 128 | 7,898.06 | 8,305.32 | 7,899.96 |
| MAP/EXP (Two Factor) | ILS, SLOF | X2(63)=205.44, p < 0.001 | 0.892 | 0.945 | 0.113 | 1.205 | -3703.82 | 130 | 7,667.63 | 8,081.27 | 7,669.57 |
| Five Factor | ILS, SLOF | X2(63)=191.48, p < 0.001 | 0.902 | 0.950 | 0.107 | 1.118 | -3,698.05 | 141 | 7,678.09 | 8,126.72 | 7,680.19 |
| **Hierarchical****(2nd Order Five Factor)** | **ILS, SLOF** | **X2(63)=193.46, p < 0.001** | **0.901** | **0.950** | **0.108** | **1.165** | **-3,686.53** | **131** | **7,635.06** | **8,051.87** | **7,637.01** |

Notes. Preferred model is highlighted in bold font. LOF=Level of Function Scale; PSP=Personal and Social Performance Scale; ILS= Independent Living Scale; SLOF=Specific Level of Function;

Function was defined as a single-factor latent variable that influences domain scores from the measures listed under each sample.

Sample 1: LOF domains—Hospitalization, Frequency of Social Contacts, Quality of Social Relationships, Usefully Employed, Quality of Useful Work, Symptoms (Past Month), Ability of Meet Own Basic Needs, Fullness of Life, Overall Level of Function

Sample 2: PSP domains--Socially Useful Activities, Personal Relationships, Self-care, and Aggression

Sample 3: ILS domains—Appearance, Hygiene, Health, Transportation, Leisure, Care of Possession, Food, Money, Job Seeking, Job Maintenance

Sample 3: SLOF domains—Interpersonal Relationships, Social Acceptability, Activities, Work Skills

LL = loglikelihood; k = number of free parameters; AIC = Akaike Information Criterion; BIC=Bayesian Information Criterion, aBIC = sample size adjusted BIC;

CFI = Confirmatory Fit Index; TLI = Tucker Lewis Index; RMSEA = Root Mean Square error of Approximation; WRMR = Weighted root Mean Square Residual;

CFA = Confirmatory Factor Analysis. Both Weighted Least Square (WLSMV) and Maximum Likelihood (MLR) estimators were used in the analyses.

Monte Carlo-based numerical integration was used in the estimation of models to ease computation time.

Chi-Square for the Baseline model in Sample 1 (SANS): X2(42) = 1,465.64, p < 0.0001, Sample N = 308

Chi-Square for the Baseline model in Sample 2 (BNSS): X2(10) = 2,070.50, p < 0.0001, Sample N = 146
Chi-Square for the Baseline model in Sample 3 (CAINS): X2(31) = 1,241.17, p < 0.0001, Sample N = 178

Chi-Square for the Baseline model in Sample 3 (SANS): X2(32) = 1,348.44, p < 0.0001, Sample N = 178

Supplemental Table S9. Goodness-of-Fit Estimates Obtained from Fitting Alternate Negative Symptom Factor Models with Symptoms

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Measure/Model** | **Symptoms Measure** | **Chi-Square** | **CFI** | **TLI** | **RMSEA** | **WRMR** | **LL** | **k** | **AIC** | **BIC** | **SSA-BIC** |
| Sample 1: SANS |  |
| Unidimensional (One-factor) | BPRS, CDSS | X2(42)=249.43, p < 0.001 | 0.759 | 0.799 | 0.179 | 1.654 | -4,698.42 | 110 | 9,616.83 | 9,950.90 | 9,602.73 |
| MAP/EXP (Two Factor) | BPRS, CDSS | X2(45)=152.41, p < 0.001 | 0.875 | 0.903 | 0.124 | 1.229 | -4,615.42 | 112 | 9,454.84 | 9,794.98 | 9,440.48 |
| Five Factor | BPRS, CDSS | X2(44)=125.70,p <0.001 | 0.955 | 0.964 | 0.091 | 0.980 | -4,614.61 | 122 | 9,473.22 | 9,843.73 | 9,457.58 |
| **Hierarchical****(2nd Order Five Factor)** | **BPRS, CDSS** | **X2(46)=129.49,****p <0.001** | **0.953** | **0.966** | **0.090** | **0.990** | **-4,593.46** | **113** | **9,412.92** | **9,756.09** | **9,398.43** |
| Sample 2: BNSS |  |
| Unidimensional (One-Factor) | PANSS, CDSS | X2(12)=220.38, p < 0.001 | 0.911 | 0.926 | 0.345 | 2.221 | -3,710.57 | 91 | 7,603.15 | 7,874.66 | 7,586.69 |
| MAP/EXP (Two Factor) | PANSS, CDSS | X2(25)=121.49, p < 0.001 | 0.959 | 0.983 | 0.163 | 0.979 | -3,492.46 | 93 | 7,170.92 | 7,488.40 | 7,154.10 |
| Five Factor | PANSS, CDSS | X2(27)=45.86,p = 0.0132 | 0.992 | 0.997 | 0.069 | 0.445 | -3,471.48 | 104 | 7,150.97 | 7,461.26 | 7,132.16 |
| **Hierarchical****(2nd Order Five Factor)** | **PANSS, CDSS** | **X2(27)=44.47,****p = 0.0185** | **0.993** | **0.997** | **0.067** | **0.502** | **-3,402.30** | **98** | **7,000.60** | **7,292.99** | **6,982.88** |
| Sample 3: CAINS |  |
| Unidimensional (One-Factor) | BPRS | X2(31)=261.54, p < 0.001 | 0.885 | 0.904 | 0.204 | 1.922 | -4,932.55 | 81 | 10,027.10 | 10,284.82 | 10,028.30 |
| MAP/EXP (Two Factor) | BPRS | X2(29)=155.99, p < 0.001 | 0.937 | 0.943 | 0.157 | 1.583 | -4,916.91 | 80 | 9,993.82 | 10,248.36 | 9,995.01 |
| Five Factor | BPRS | X2(29)=74.23,p < 0.0001 | 0.977 | 0.980 | 0.074 | 0.928 | -4,867.80 | 90 | 9,915.61 | 10,201.97 | 9,916.95 |
| **Hierarchical****(2nd Order Five Factor)** | **BPRS** | **X2(32)=84.01,****p < 0.001** | **0.974** | **0.979** | **0.076** | **0.976** | **-4,684.60** | **88** | **9,545.19** | **9,825.19** | **9,546.50** |
| Sample 3: SANS |  |  |  |  |  |  |  |  |  |  |  |
| Unidimensional(1-Factor) | BPRS | X2(34)=243.79,p < 0.001 | 0.898 | 0.919 | 0.186 | 1.741 | -5,571.51 | 100 | 11,343.02 | 11,661.20 | 11,344.52 |
| MAP/EXP (Two Factor) | BPRS | X2(36)=107.11,p < 0.001 | 0.965 | 0.974 | 0.105 | 1.086 | -5,474.65 | 102 | 11,153.30 | 11,477.84 | 11,154.82 |
| Five Factor | BPRS | X2(33)=87.19,p < 0.001 | 0.974 | 0.978 | 0.096 | 0.949 | -5,526.36 | 113 | 11,138.73 | 11,638.27 | 11,280.41 |
| **Hierarchical****(2nd Order Five Factor)** | **BPRS** | **X2(36)=94.01,****p < 0.001** | **0.972** | **0.979** | **0.095** | **1.011** | **-5,426.49** | **103** | **11,058.98** | **11,386.71** | **11,060.52** |

Notes. Preferred model is highlighted in bold font. BPRS=Brief Psychiatric Rating Scale; CDSS=Calgary Depression Scale for Schizophrenia; PANSS=Positive and Negative Syndrome Scale.

Symptoms was defined as a single-factor latent variable that influences domain scores from the measures listed under each sample.

Sample 1: BPRS Positive Symptoms, Reality Distortion, Depression/Anxiety, and Mania; CDSS Total Score

Sample 2: PANSS Positive, Disorganization, Emotional Distress, Excitement/Agitation; and CDSS Total Score

Sample 3: BPRS Positive Symptoms, Reality Distortion, Disorganization, Depression/Anxiety, and Mania

LL = loglikelihood; k = number of free parameters; AIC = Akaike Information Criterion; BIC=Bayesian Information Criterion, SSA-BIC = sample size adjusted BIC;

CFI = Confirmatory Fit Index; TLI = Tucker Lewis Index; RMSEA = Root Mean Square error of Approximation; WRMR = Weighted root Mean Square Residual;

CFA = Confirmatory Factor Analysis. Both Weighted Least Square (WLSMV) and Maximum Likelihood (MLR) estimators were used in the analyses.

Monte Carlo-based numerical integration was used in the estimation of models to ease computation time.

Chi-Square for the Baseline model in Sample 1 (SANS): X2(35) = 894.32, p < 0.0001, Sample N = 308

Chi-Square for the Baseline model in Sample 2 (BNSS): X2(27) = 2,343.57, p < 0.0001, Sample N = 146
Chi-Square for the Baseline model in Sample 3 (CAINS): X2(26) = 2,032.83, p < 0.0001, Sample N = 178

Chi-Square for the Baseline model in Sample 3 (SANS): X2(27) = 2,083.89, p < 0.0001, Sample N = 178

Supplemental Table S10. Goodness-of-Fit Estimates Obtained from Fitting Alternate Negative Symptom Factor Models with Psychological Variables

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Measure/Model** | **External Variable Measure** | **Chi-Square** | **CFI** | **TLI** | **RMSEA** | **WRMR** | **LL** | **k** | **AIC** | **BIC** | **SSA-BIC** |
| BNSS (Sample 4) |  |
| Unidimensional (One Factor) | PANAS(Positive Affect) | X2(18)=209.24, p < 0.001 | 0.957 | 0.967 | 0.246 | 1.835 | -3318.65 | 87 | 6,811.30 | 7,086.63 | 6,811.13 |
| MAP/EXP (Two Factor) | PANAS(Positive Affect) | X2(19)=74.53, p < 0.001 | 0.988 | 0.991 | 0.131 | 1.009 | -3,166.24 | 89 | 6,510.48 | 6,792.15 | 6,510.31 |
| Five Factor | PANAS(Positive Affect) | X2(21)=27.15, p = 0.1661 | 0.999 | 0.999 | 0.041 | 0.361 | -2,572.79 | 98 | 5,341.58 | 5,651.16 | 5,340.83 |
| **Hierarchical****(2nd Order Five Factor)** | **PANAS****(Positive Affect)** | **X2(22)=36.45, p = 0.0271** | **0.997** | **0.998** | **0.061** | **0.531** | **-2,467.22** | **88** | **5,110.43** | **5,388.43** | **5,109.77** |
| BNSS (Sample 4) |  |
| Unidimensional (One Factor) | PANAS(Negative Affect) | X2(17)=245.72, p < 0.001 | 0.959 | 0.971 | 0.276 | 1.857 | -2774.69 | 84 | 5,717.38 | 5,984.18 | 5,718.16 |
| MAP/EXP (Two Factor) | PANAS(Negative Affect) | X2(21)=94.03, p < 0.001 | 0.987 | 0.993 | 0.140 | 1.012 | -2,611.88 | 87 | 5,397.76 | 5,674.08 | 5,398.57 |
| **Five Factor** | **PANAS****(Negative Affect)** | **X2(21)=24.01, p = 0.2924** | **0.999** | **1.000** | **0.028** | **0.329** | **-2,468.72** | **99** | **5,135.44** | **5,449.88** | **5,136.36** |
| Hierarchical(2nd Order Five Factor) | PANAS(Negative Affect) | X2(23)=35.11, p = 0.0508 | 0.998 | 0.999 | 0.055 | 0.494 | -2,569.36 | 88 | 5,314.71 | 5,594.21 | 5,315.53 |
| CAINS (Sample 5) |  |
| Unidimensional (One Factor) | DPB(Defeatist Beliefs) | X2(22)=283.55, p < 0.001 | 0.882 | 0.898 | 0.260 | 2.115 | -2,871.40 | 66 | 5,874.80 | 6,084.05 | 5,875.04 |
| MAP/EXP (Two Factor) | DPB(Defeatist Beliefs) | X2(22)=148.37, p < 0.001 | 0.945 | 0.955 | 0.180 | 1.420 | -2,771.47 | 68 | 5,678.94 | 5,894.53 | 5,679.19 |
| Five Factor | DPB(Defeatist Beliefs) | X2(28)=43.70, p = 0.0297 | 0.993 | 0.995 | 0.056 | 0.538 | -2,690.41 | 79 | 5,538.81 | 5,789.28 | 5,539.11 |
| **Hierarchical****(2nd Order Five Factor)** | **DPB****(Defeatist Beliefs)** | **X2(28)=54.05, p = 0.0022** | **0.988** | **0.992** | **0.073** | **0.732** | **-2,629.37** | **69** | **5,396.74** | **5,615.50** | **5,396.99** |

Notes. Preferred model is highlighted in bold font. PANAS=Positive and Negative Affective Scale. DPB= Defeatist Performance Beliefs

External variables: Positive Affect, Negative Affect, and DPB total scores included in models as observed variables.

LL = loglikelihood; k = number of free parameters; AIC = Akaike Information Criterion; BIC=Bayesian Information Criterion, SSA-BIC = sample size adjusted BIC;

CFI = Confirmatory Fit Index; TLI = Tucker Lewis Index; RMSEA = Root Mean Square error of Approximation; WRMR = Weighted root Mean Square Residual;

CFA = Confirmatory Factor Analysis. Both Weighted Least Square (WLSMV) and Maximum Likelihood (MLR) estimators were used in the analyses.

Monte Carlo-based numerical integration was used in the estimation of models to ease computation time.

Chi-Square for the Baseline model in the BNSS Positive Affect sample: X2(14) = 4,489.35, p < 0.0001, Sample N = 177

Chi-Square for the Baseline model in the BNSS Negative Affect sample: X2(12) = 5,655.73, p < 0.0001, Sample N = 177
Chi-Square for the Baseline model in the CAINS sample: X2(19) = 2,237.92, p < 0.0001, Sample N = 176

Supplemental Table S11. Pearson Correlations between BNSS Factor-Derived Scores

and ACC GABA and Glutamate Levels

|  |  |  |
| --- | --- | --- |
|   | **ACC** | **ACC** |
|   | **GABA** | **Glutamate** |
| Unidimensional | **-0.337, p=0.036** | -0.291, p=0.073 |
| MAP | **-0.377, p=0.018** | **-0.371, p=0.020** |
| Anhedonia | -0.234, p=0.152 | -0.193, p=0.239 |
| Asociality | -0.309, p=0.056 | -0.234, p=0.148 |
| Avolition | **-0.427, p=0.007** | **-0.541, p<0.001** |
| EXP | -0.256, p=0.116 | -0.207, p=0.205 |
| Blunted Affect | -0.312, p=0.053 | -0.229, p=0.161 |
| Alogia | -0.084, p=0.613 | -0.112, p=0.496 |

Notes. Significant associations are in bold font. BNSS subscale scores were created by aggregating rating multiplied

by standardized factor loadings.