Appendix C.

Exploratory Factor Analysis (EFA) of the EmpathiSEr-U Scale: Final Three-Factor Solution

This appendix contains further details regarding the final three-factor solution from the EFA of the EmpathiSEr-U scale. EFA was conducted using **Principal Axis Factoring (PAF)** and an **oblique rotation method (Direct Oblimin).**

PAF was chosen over Principal Component Analysis (PCA) because the goal was to identify underlying latent constructs (i.e., psychological dimensions of empathy) rather than merely reduce data into uncorrelated components. While PCA treats all variance (common, unique, and error) as meaningful, PAF focuses only on shared variance among items, which is more appropriate for construct identification.

Direct Oblimin rotation was used instead of an orthogonal method like Varimax because the dimensions of empathy such as cognitive, emotional, and behavioural aspects, are theoretically expected to be correlated rather than independent. Oblique rotation allows for these correlations to emerge in the factor solution, enabling a more accurate and psychologically meaningful representation of the underlying factor structure.

SPSS 29 was used for conducting this analysis.

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Kaiser-Meyer-Olkin (KMO) measure and Bartlett Test of Sphericity

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.913
Bartlett's Test of Sphericity	Approx. Chi-Square	2128.475
	df	171
	Sig.	<.001

The overall **Kaiser-Meyer-Olkin (KMO)** measure of sampling adequacy was 0.913, which is classified as *"marvellous"* according to Kaiser's criterion. The KMO statistic evaluates the proportion of variance among variables that might be common variance, i.e., variance that could be explained by underlying factors. Values above 0.80 are considered excellent, indicating that the data are highly suitable for factor analysis and that patterns of correlations are compact enough to yield reliable factors.

Bartlett's Test of Sphericity assesses whether the observed correlations between items are significantly different from zero (i.e., whether the correlation matrix significantly differs from an identity matrix). An identity matrix is one in which variables are completely uncorrelated, which would make factor analysis inappropriate. In simpler terms, Bartlett's test checks whether there is enough shared variance among items to justify reducing the dataset into underlying latent factors. A statistically significant result (typically $p < .05$) indicates that the correlations between variables are sufficiently large for factor analysis to proceed. In this study, Bartlett's Test of Sphericity was statistically significant, $X^2(171) = 2128.475$, $p < .001$, meaning that the items were meaningfully interrelated and thus suitable for uncovering a factor structure.

Communalities

Communalities

	Initial	Extraction
emp_user_2	.567	.597
emp_user_3	.572	.628
emp_user_5	.226	.222
emp_user_7	.567	.594
emp_user_8	.152	.094
emp_user_9	.614	.636
emp_user_11	.576	.579
emp_user_14	.664	.698
emp_user_16	.581	.515
emp_user_17	.593	.619
emp_user_23	.584	.621
emp_user_24	.563	.609
emp_user_25	.156	.202
emp_user_26	.655	.688
emp_user_27	.257	.308
emp_user_33	.442	.403
emp_user_19	.660	.651
emp_user_20	.494	.520
emp_user_10	.388	.411

Extraction Method: Principal Axis Factoring.

Communalities in PAF represent the proportion of an item's variance that is explained by the common factors, i.e., the shared variance among items, excluding unique variance and measurement error. PAF focuses specifically on the variance that is common across items, making it more appropriate for identifying underlying latent constructs such as empathy dimensions. In this analysis, the initial communalities reflect the estimated shared variance, while the extracted communalities show how much of that shared variance is accounted for by the final three-factor solution. Higher extracted communalities (e.g. > .40) suggest that the items are well-represented by the factors identified in the EmpathiSEr-U scale.

Total Variance Explained

Total Variance Explained

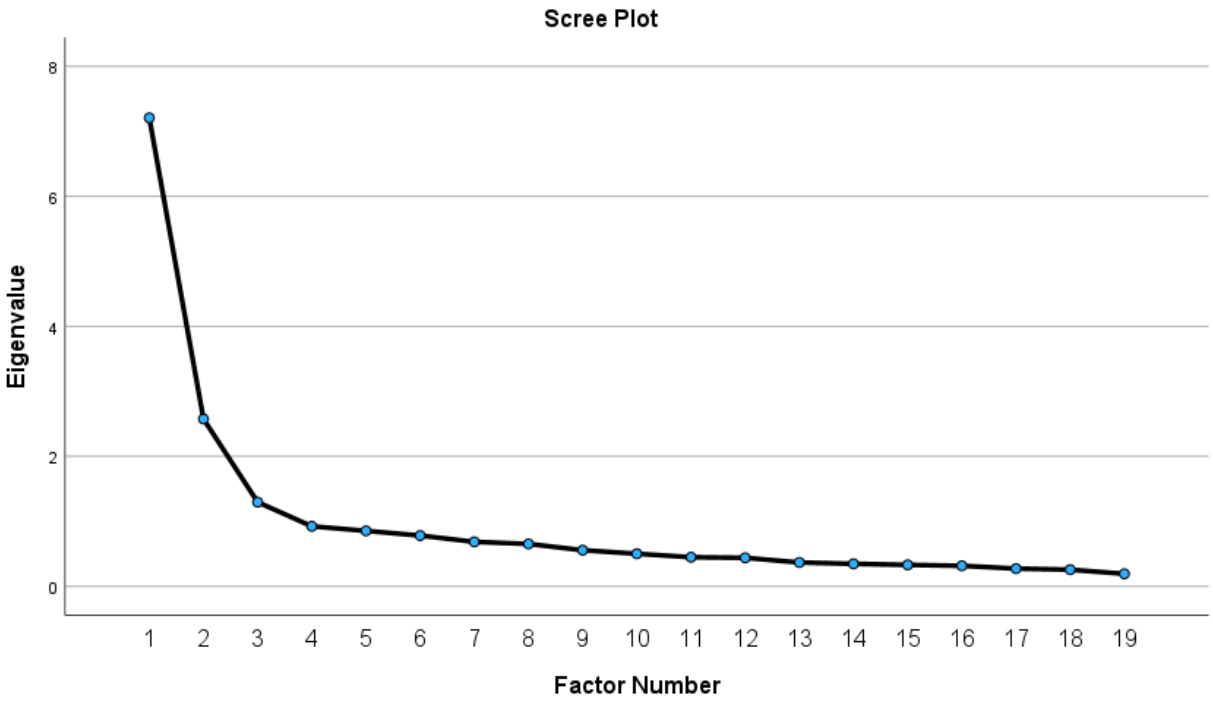
Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	7.206	37.926	37.926	6.775	35.659	35.659	5.486
2	2.575	13.555	51.481	2.162	11.381	47.040	4.624
3	1.295	6.818	58.299	.656	3.453	50.493	2.804
4	.924	4.861	63.160				
5	.854	4.493	67.652				
6	.781	4.113	71.765				
7	.684	3.602	75.367				
8	.653	3.436	78.803				
9	.556	2.927	81.730				
10	.501	2.639	84.369				
11	.448	2.360	86.728				
12	.439	2.309	89.038				
13	.367	1.934	90.971				
14	.346	1.823	92.795				
15	.330	1.739	94.534				
16	.316	1.664	96.197				
17	.273	1.438	97.635				
18	.257	1.350	98.985				
19	.193	1.015	100.000				

Extraction Method: Principal Axis Factoring.

a. When factors are correlated, sums of squared loadings cannot be added to obtain a total variance.

Total Variance Explained refers to the proportion of common variance in the data accounted for by each factor extracted during the EFA. This table displays the eigenvalues and the percentage of variance explained by each factor after extraction, i.e., the amount of shared variance among items that each factor captures. It also presents the cumulative variance, showing how much of the total common variance is explained by the solution as a whole. A higher cumulative variance indicates a more comprehensive and effective factor structure. In this study, the final three-factor solution explains 58.299% of the total common variance, suggesting that the factors adequately capture the underlying structure of the EmpathiSEr-U scale.

Scree Plot



Scree Plot is a visual tool used in EFA to help determine the optimal number of factors to retain. It displays the eigenvalues associated with each factor on the y-axis, plotted against the factor number on the x-axis. The key point of interest in the scree plot is the "elbow" or inflection point, the point at which the slope of the curve noticeably levels off. Factors above this elbow typically have higher eigenvalues and are considered meaningful, while those below represent smaller amounts of variance and are often interpreted as noise or less substantive factors. In this study, the scree plot suggested two to four factor solutions, as the curve began to flatten at the fifth factor, supporting the choice of the final factor structure of the EmpathiSEr-U scale.

Factor Matrix

Factor Matrix[a]

	Factor		
	1	2	3
emp_user_2	.627	-.408	
emp_user_3	.695		
emp_user_5	-.364		
emp_user_7	.682	-.324	
emp_user_8			
emp_user_9	.484	.595	
emp_user_11	.551	.512	
emp_user_14	.656	.510	
emp_user_16	.685		
emp_user_17	-.740		
emp_user_23	.719	-.321	
emp_user_24	.700	-.314	
emp_user_25			.355
emp_user_26	.659	.504	
emp_user_27	-.410		.359
emp_user_33	-.538	.333	
emp_user_19	.725	.352	
emp_user_20	-.678		
emp_user_10	-.585		

Extraction Method: Principal Axis Factoring.

a. 3 factors extracted. 5 iterations required.

Factor Matrix shows the factor loadings, which represent the correlations between each item and the extracted factors before rotation. These loadings indicate the extent to which each item is associated with each underlying factor. Higher absolute values (typically above 0.4) suggest a stronger relationship between the item and the factor. However, because this matrix reflects unrotated loadings, the interpretation may be less clear if multiple factors are present and items load on more than one factor. For this reason, rotated solutions (e.g., pattern matrix) is generally used for final interpretation. This unrotated factor matrix is included for completeness and to illustrate how items initially aligned with the emerging factor structure prior to rotation.

Pattern Matrix

Pattern Matrix[a]

	Factor		
	1	2	3
emp_user_2	.808		
emp_user_3	.779		
emp_user_5	-.461		
emp_user_7	.758		
emp_user_8			
emp_user_9		.846	
emp_user_11		.767	
emp_user_14		.806	
emp_user_16		.486	
emp_user_17	-.639		
emp_user_23	.706		
emp_user_24	.757		
emp_user_25			.433
emp_user_26		.776	
emp_user_27			.472
emp_user_33	-.577		
emp_user_19		.654	
emp_user_20	-.300		.395
emp_user_10			.393

Extraction Method: Principal Axis Factoring.
Rotation Method: Oblimin with Kaiser Normalization.[a]

a. Rotation converged in 7 iterations.

Pattern Matrix presents the rotated factor loadings from the EFA, showing the unique contribution of each item to each factor after rotation (in this case, direct oblimin). These loadings represent the partial regression coefficients of each item on the factors, indicating the strength and direction of the relationship while controlling for other factors. Higher absolute values (commonly above 0.3) suggest that an item strongly loads on that factor, meaning it is a good indicator of the underlying construct represented by that factor. Because direct oblimin rotation allows factors to correlate, the pattern matrix provides a clearer and more interpretable structure by separating overlapping variance between factors. The pattern matrix is typically used to decide which items belong to which factors, aiding in interpreting and naming the factors. In the above matrix, Factor 1 was named as Cognitive Empathy, factor 2 as Affective Empathy, and factor 3 as Empathic Responses. Emp_user_20 showed minor cross-loading (0.395 on ER, 0.300 on CE). It was retained due to its stronger loading on the ER factor and its clear conceptual fit with that construct.

Structure Matrix

Structure Matrix

	Factor		
	1	2	3
emp_user_2	.766		
emp_user_3	.767	.362	
emp_user_5	-.460		
emp_user_7	.766	.304	
emp_user_8			
emp_user_9		.780	
emp_user_11		.761	
emp_user_14	.313	.833	-.319
emp_user_16	.471	.628	-.465
emp_user_17	-.752	-.363	.494
emp_user_23	.775	.314	-.430
emp_user_24	.775	.323	-.301
emp_user_25			.409
emp_user_26	.308	.821	-.380
emp_user_27	-.352		.533
emp_user_33	-.619		.363
emp_user_19	.436	.762	-.456
emp_user_20	-.536	-.479	.599
emp_user_10	-.484	-.369	.555

Extraction Method: Principal Axis Factoring.
Rotation Method: Oblimin with Kaiser Normalization.

Structure Matrix displays the correlations between each item and the extracted factors in the EFA. While the pattern matrix provides a clear simple structure with items loading distinctly on single factors, the structure matrix often shows cross-loadings because it represents the total correlations between items and factors, including shared variance from factor inter-correlations. In other words, even if an item loads primarily on one factor in the pattern matrix, it can still correlate moderately with other factors in the structure matrix due to factor correlations allowed by the oblique rotation method. This difference highlights why the pattern matrix is generally preferred for determining factor membership, whereas the structure matrix offers insight into the broader relationships among items and factors.

Factor Correlation Matrix

Factor Correlation Matrix

Factor	1	2	3
1	1.000	.306	-.397
2	.306	1.000	-.330
3	-.397	-.330	1.000

Extraction Method: Principal Axis Factoring.
Rotation Method: Oblimin with Kaiser Normalization.

The Factor Correlation Matrix shows the degree of correlation between the extracted factors in the final solution. Since an oblique rotation method (Direct Oblimin) was used in the analysis, it allows the factors to be correlated rather than assuming they are completely independent (as in orthogonal rotations). The values in this matrix indicate how much the factors relate to each other. For example, a moderate to high correlation suggests that the constructs measured by the factors may share some underlying conceptual overlap, which is expected in psychological constructs like empathy. This correlation structure justifies the use of oblique rotation, as it reflects the theoretical assumption that different dimensions of empathy (e.g., cognitive, emotional, behavioural) are related but not identical.

Cronbach's Alpha Values

This section reports Cronbach's alpha values for the overall EmpathiSEr-U scale and its individual subscales. Cronbach's alpha is a measure of internal consistency, indicating how closely related a set of items are as a group. It is commonly used to assess the reliability of a scale. Alpha values range from 0 to 1, with higher values suggesting greater reliability. A commonly accepted guideline is:

- ≥ .90 = Excellent
- .80 – .89 = Good
- .70 – .79 = Acceptable
- < .70 = May indicate limited internal consistency (depending on context and number of items)

In this study, cognitive and affective empathy subscales demonstrated good reliability, supporting the consistency of items within each construct. While the ER factor's alpha is slightly below the conventional threshold of 0.70, it is acceptable given the small number of items.

EmpathiSEr-U Scale:

Case Processing Summary

		N	%
Cases	Valid	229	100.0
	Excluded[a]	0	.0
	Total	229	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.899	18

Cognitive Empathy Subscale of EmpathiSEr-U Scale:

Case Processing Summary

		N	%
Cases	Valid	229	100.0
	Excluded[a]	0	.0
	Total	229	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.887	8

Affective Empathy Subscale of EmpathiSEr-U Scale:

Case Processing Summary

		N	%
Cases	Valid	229	100.0
	Excluded[a]	0	.0
	Total	229	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.896	6

Empathic Responses Subscale of EmpathiSEr-U Scale:

Case Processing Summary

		N	%
Cases	Valid	229	100.0
	Excluded[a]	0	.0
	Total	229	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.627	4

Descriptive Statistics

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
SE_user_Total_3Fac_PAF	229	2.17	7.00	5.0497	.88731
SE_user_Cog_3Fac_PAF	229	2.50	7.00	5.8160	.89754
SE_user_Affec_3Fac_PAF	229	1.00	7.00	4.0721	1.37482
SE_user_ER_3Fac_PAF	229	1.50	7.00	4.9836	1.06505
EQ_Total	229	.08	1.90	1.0538	.34157
IRI_Total	229	1.50	4.57	3.3395	.52230
IRI_PerspectiveTaking	229	1.29	5.00	3.7567	.66022
IRI_EmpathicConcern	229	1.00	5.00	3.8022	.76207
IRI_Fantasy	229	1.43	5.00	3.2832	.75935
IRI_PersonalDistress	229	1.00	4.86	2.5159	.75394
EmpaD_total	229	2.09	7.00	5.5629	1.01721
EmpaD_EmotionalAndPT	229	1.00	7.00	5.6492	1.22233
EmpaD_PersonalExp	229	1.00	7.00	4.9738	1.36263
EmpaD_SelfAwareness	229	2.33	7.00	5.7831	.97684
npi_total	229	.00	.92	.2427	.21646
NPI_EE	229	.00	1.00	.1794	.23697
NPI_LA	229	.00	1.00	.2893	.30723
NPI_GE	229	.00	1.00	.2559	.29083
sins_1	229	1.00	7.00	2.3319	1.49967
BIDR_Total	227	1.75	7.00	4.3395	.96563
BIDR_SDE	227	1.63	7.00	4.2930	1.09382
BIDR_IM	227	1.13	7.00	4.3860	1.20684
Empathy	229	.00	100.00	76.6594	21.31730
Compassion	229	.00	100.00	74.6769	21.54311
Humour	229	21.00	100.00	80.8603	17.87352
Valid N (listwise)	227				

This section presents descriptive statistics for the EmpathiSEr-U subscales as well as the established empathy-related scales used to assess convergent and discriminant validity. The table includes:

- **Mean**: Indicates the average score for each subscale across all participants. Higher means suggest a greater presence of the measured construct (e.g., cognitive empathy, empathic responses).
- **Standard Deviation (SD)**: Reflects the amount of variation in scores. Larger SDs indicate greater variability in how participants responded.
- **Minimum and Maximum**: Show the observed range of scores in the sample.

These statistics help assess the general distribution and central tendency of empathy scores across different dimensions and instruments. They also offer preliminary insight into whether the scores are approximately normally distributed, an assumption relevant for many statistical analyses.