EPSi Item Combination for Universal Screening in Primary Care

DS5110: Fall 2025

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EMES Study

Maine Medical Center MaineHealth	Human Research Protection Program Good Clinical Practice **Guidance for Investigators** **Research Protocol Template:** **Social Science/ Behavioral/ Educational**	

Project title: Developing universal psychosis screens for use with Maine youth in primary care
Name of principal investigator: Kristen Woodberry, MSW, PhD
Name of co-investigator(s): Merelise Ametti, Ph.D., Susan Santangelo, ScD

This project is part of a larger research initiative to test the psychometric properties of different screens for **psychotic spectrum symptoms (PSS)** in adolescents and young adults

- Psychosis involves an altered experience of reality.
  - Identifying symptoms as close to onset as possible helps support early intervention

→ *More at: www.psychosisscreening.org*

- A shorter **duration of untreated psychosis** is associated with better outcomes
- Facilitating entry into care such as the **PIER program**(mhir.org/pier) is essential

→ ***Requires efficient expansion of screening and early detection methods***

Self Report Screening Tool

EPSi: Early Psychosis Screener for Internet (64 questions)

- To help identify individuals experiencing PSS or at high risk of developing a psychotic disorder in the next 12 months
- Based on interviews of 14-35 year olds with and without PSS
- Well documented predictive validity, all items at or below 5th grade reading level
    - ***Likert Scale (1-5):*** *Never, Rarely, Sometimes, Often, Always*

→ **64 Q's -** not optimal for universal screening

Sample EPSi Questions:

1. I was unsure if my experiences were real.
6. I thought other people could hear my thoughts.
16. I felt strange sensations on or under my skin that I could not explain.
20. I thought people might be plotting against me.
35. I heard a sound but could not tell if it was real.
50. I felt like someone was touching me but no one was there.

Project Goal

- Examine the latent structure of Early Psychosis Screen for internet, a 64-item psychosis screen
    - *Is there a reliable factor structure?*
    - *If yes, what items contribute to the different factors?*

<u>This project augments analyses of the overall aim:</u>

→ **<u>Aim 1</u>:** Identify the best-performing brief screen derived from items in the longer EPSi.

<u>Key questions of the larger study:</u>

- *What EPSi item combination/short self-report psychosis screen has the most promising psychometric profile for use as a universal screen for PSS in a large fully-powered study of A/YA primary care patients?*

Analysis Methods

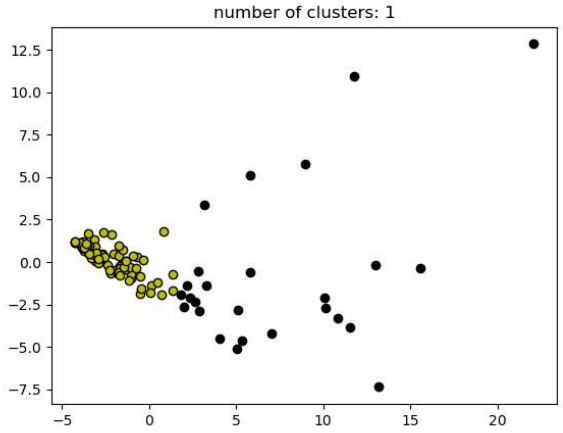
- Principal Component Analysis
- Fuzzy Clustering
- Gaussian Mixture Model (GMM)
- Density Based Clustering Algorithm (DBSCAN)
- Factor Analysis

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import skfuzzy as fuzz
from sklearn.preprocessing import StandardScaler
from sklearn.decomposition import PCA
from sklearn.mixture import GaussianMixture
from sklearn.cluster import DBSCAN
from factor_analyzer import Factor Analyzer
```

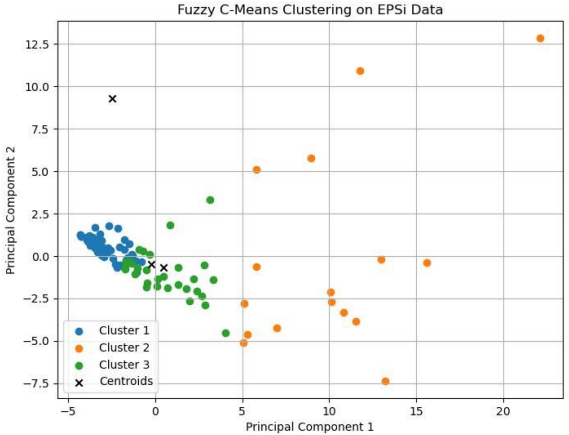
Description of Dataset

- Total n= 107
- Participants with known PSS: 13 (actively engaged in specialty care)
- Median Age = 17
- Range: 12 to 25 years old
- Sex assigned at birth:
  - Male (n= 43, 40.2%)
  - Female (n=63, 58.9%)
  - Prefer not to say (n=1, 0.9%)

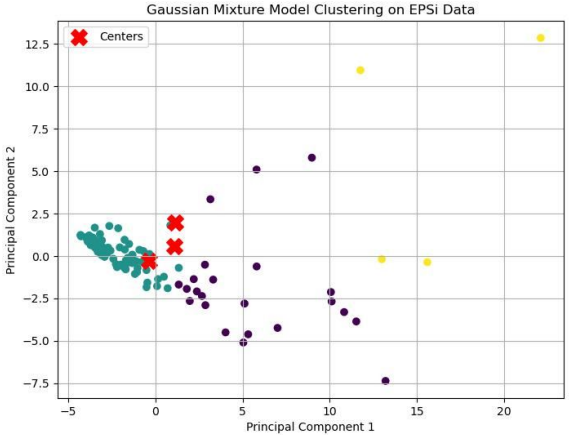
Clustering



DBSCAN allows for irregular cluster patterns.
Yellow= cluster
Black = noise
26 noise points



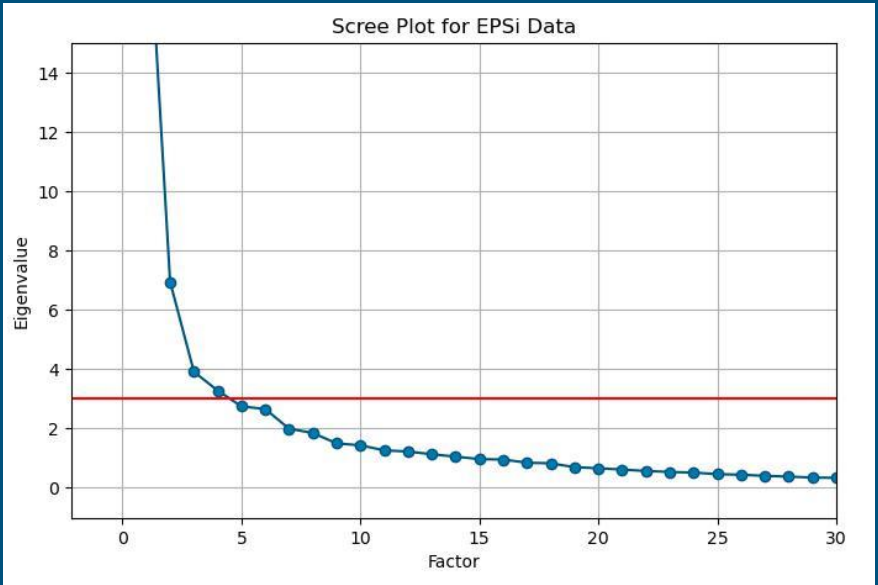
Fuzzy clustering allows points to fall in 2 clusters.
Too much overlap in cluster 1 and 3.
Fuzzy Partition Coefficient: 0.5278



GMM allows multiple distributions in data.
Yellow cluster was of interest.
BIC score: 12540.69
AIC score: -4656.29

Exploratory Factor Analysis
- First Pass

- 64 Variables / 107 responses
  - Kaiser-Meyer-Olkin(KMO): 0.741 (Middling/ Moderate Average)
  - Bartlett Test showed high correlation between variables (p-value = 0.000e+00)
- Scree Plot: 3 factor model optimal
- Identified low and cross-loading variables



≥	Items	DoF	DoF Baseline	Chi² (p-value)	Chi² Baseline	CFI	GFI	AGFI	NFI	TLI	RMSEA	AIC	BIC	LogLik
.4	56	1374	1431	4811.8 (0.0)	8050.66	.48	.40	.38	.40	.46	.159	125.76	414.94	48.12

```
from factor_analyzer.factor_analyzer import calculate_kmo, calculate_bartlett_sphericity
from semopy import Model, calc_stats
```

```
Variance Explained by Each Factor:
         SS Loadings  Proportion Var  Cumulative Var
Factor1       12.031           0.219           0.219
Factor2       10.151           0.185           0.403
Factor3        7.591           0.138           0.541
```

Cleaning

```
from factor_analyzer import FactorAnalyzer

FactorAnalyzer(n_factors=3, rotation="varimax")
```

- Cells with NaN values completed with same participant T2 responses
- 13 PIER participants dropped from final factor analysis

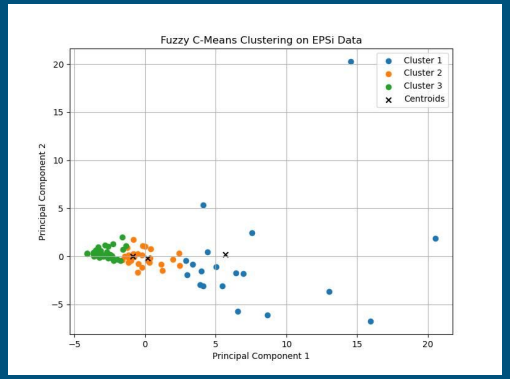
Low-loading variables
(<0.4 on all factors)

12. I thought the people on TV might be talking about me.
22. I thought I had superhuman powers.
26. I thought I was a genius.
56. I needed less sleep than usual.
58. I felt interested in everything.
64. I cared about how other people felt.

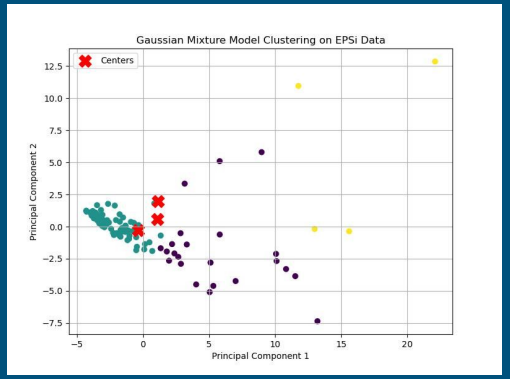
Cross-loading variables
(≥0.4 on more than one factor)

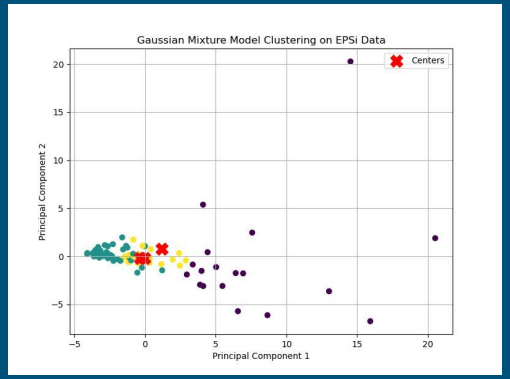
3. I thought I was outside my body observing my own life.
11. I thought people on TV said things because they knew I was watching.
16. I felt strange sensations on or under my skin that I could not explain.
18. I thought I was being followed.
28. I felt like thoughts were being placed in my head against my will.
29. My thoughts were being controlled against my will
44. The voice told me what to do.
51. My mind switched between subjects while I was talking.

Clustering Models After Removing PIER Program



There was slight distinction between the groups.
N= 107
FPC: 0.5278
N= 94
FPC: 0.4734





N= 107
BIC score: 12540.69
AIC score: -4656.29
N= 94
BIC score: 3106.74
AIC score: -13256.82

Exploratory Factor Analysis
- Next Pass

- KMO = 0.688;
- Bartlett's Chi-square = 7348.03, p-value = 0.000e+00
- n=50 variables, all > 0.4 loading onto one factor

Variance Explained by Each Factor:

	SS Loadings	Proportion Var	Cumulative Var
Factor1	9.714	0.194	0.194
Factor2	7.609	0.152	0.346
Factor3	7.588	0.152	0.498

- **Refinement criteria:** heavily loaded onto a single factor

Factor loadings → Confirmatory Factor Analysis model

	Factor1	Factor2	Factor3
epsi_unsure_exp_real	0.449529	0.357143	0.176728
epsi_daydreams_real	0.153951	0.212931	0.487737
epsi_something_strange	0.554309	0.319671	0.305278
epsi_exp_second_time	0.475850	0.116739	0.263871
epsi_hear_my_thoughts	0.269593	0.266466	0.660231
epsi_read_my_mind	0.259432	0.147186	0.688788
epsi_read_others_minds	0.278948	0.228046	0.771705
epsi_messages_things	0.122340	0.023993	0.602759
epsi_special_meaning	0.370263	0.194820	0.406702
epsi_gods_messenger	-0.008626	0.204744	0.860620
epsi_gods_work	0.168623	0.572464	0.071700
epsi_evil	0.248178	0.632357	0.041833
epsi_people_spying	0.232423	0.632319	0.182857
epsi_planning_hurt_me	0.308413	0.664846	0.223730
epsi_plot_against_me	0.382458	0.579333	0.097684
epsi_watching_everything	0.331242	0.551797	0.280552
epsi_predict_future	0.052641	-0.103557	0.692146
epsi_am_famous	-0.045282	0.266273	0.557501
epsi_famous_relationship	-0.113304	0.029717	0.802797
epsi_thoughts_removed	0.381488	0.303417	0.550378
epsi_not_really_exist	0.465938	0.076774	0.137301
epsi_world_real	0.502645	0.149704	0.218120
epsi_famous_romantic	-0.069665	0.017283	0.885408
epsi_romantic_messages	-0.009500	0.013659	0.816538
epsi_sensitive_sounds	0.412833	0.360643	0.180040
epsi_sound_real	0.646047	0.340366	0.038317
epsi_bang_click_hiss	0.524346	0.352088	0.144127
epsi_hear_speaking	0.756012	0.182443	-0.020172
epsi_hear_voices_alone	0.768826	0.139680	-0.081866
epsi_voice_uncertain_real	0.765747	0.281881	-0.067668
epsi_thought_voice_real	0.723473	0.216876	-0.058419
epsi_more_one_voice	0.768661	0.151765	0.100137
epsi_voice_about_me	0.726380	0.228019	0.005930
epsi_voice_mean	0.338845	0.473946	0.020772
epsi_voice_clear	0.759489	0.208663	0.064749
epsi_flashes_flames	0.548598	0.233449	-0.005374
epsi_sensitive_light	0.460865	0.317081	0.247623
epsi_saw_unsure_real	0.688139	0.239694	0.026038
epsi_people_animals	0.758556	0.093117	0.361877
epsi_felt_touching	0.744610	0.173466	0.062141
epsi_energy_trouble	0.319423	0.753542	0.096040
epsi_energy_control	0.283859	0.776843	0.216772
epsi_active_trouble	0.171559	0.633367	-0.019191
epsi_act_without_think	0.184870	0.620704	0.032456
epsi_more_talkative	0.156606	0.584705	0.073559
epsi_many_ideas	0.238177	0.573587	0.136284
epsi_owed_money	-0.074539	0.531712	0.347193
epsi_spent_beyond_means	0.024002	0.527274	0.286856
epsi_bought_expensive	0.214194	0.476305	0.084860
epsi_sexual	0.102526	0.349218	0.611914

```
from semopy import Model, calc_stats
```

Confirmatory Factor Analysis

- Fit Statistics

≥	Items	DoF	DoF Baseline	Chi^2 (p-value)	Chi^2 Baseline	CFI	GFI	AGFI	NFI	TLI	RMSEA	AIC	BIC	LogLik
.4	50	1172	1125	3940.4 (0.0)	6365.42	.46	.38	.35	.38	.43	.159	122.16	384.12	41.92
.5	41	776	802	2666.6 (0.0)	4874.36	.53	.45	.42	.45	.51	.162	113.26	329.44	28.37
.6	28	347	378	1300.3 (0.0)	3047.28	.64	.57	.54	.57	.61	.172	90.33	240.39	13.83
.7	**16**	**101**	**120**	**422.9 (0.0)**	**1680.86**	**.79**	**.75**	**.70**	**.75**	**.76**	**.185**	**61.00**	**150.02**	**4.50**

I thought I could read other people's minds
I thought I might be God's only messenger on Earth
I thought a famous person had a special relationship with me
I thought I had a secret romantic relationship with someone famous
I thought I received secret romantic messages from someone I did not know well
I heard someone speaking to me, but there was no one there
I heard voices when I was alone but could not tell where they were coming from
I heard a voice but could not tell if it was real

I thought the voice was real
There was more than one voice
The voice talked about me
The voice was clear
I saw people, animals, or things that might not have been real
I felt like someone was touching me, but no one was there
I had so much energy that I got into trouble
I had so much energy that I could not control myself


1. I was unsure if my experiences were real.
2. I thought my daydreams might be real.
4. I thought something strange was going on, but I did not know what it was.
5. I thought I was experiencing events a second time.
6. I felt like other people could hear my thoughts.
7. I thought people might be able to read my mind.
8. I thought I could read other people's minds.
9. I thought I was receiving special messages from things around me.
10. I thought that things happening around me might have a special meaning for me.
13. I thought I might be God's only messenger on Earth.
14. I was the only person who could do God's work on Earth.
15. I thought that I was evil.
17. I thought people were spying on me.
19. I thought people were planning to physically hurt me.
20. I thought people might be plotting against me.
21. I felt like I had to watch everything around me in order to feel safe.
23. I thought I could predict the future.
24. I thought I was famous.
25. I thought a famous person had a special relationship with me.
27. I thought my thoughts were being removed from my mind.
30. I thought I did not really exist.
31. I had difficulty knowing if the world around me was real.
32. I thought I had a secret romantic relationship with someone famous.
33. I thought I received secret romantic messages from someone I did not know well.
34. I was sensitive to sounds.
35. I heard a sound but could not tell if it was real.
36. I heard sounds like banging, clicking, hissing, clapping, or ringing, but could not tell if they were real.
37. I heard someone speaking to me, but there was no one there.
38. I heard voices when I was alone but could not tell where they were coming from.
39. I heard a voice but could not tell if it was real.
40. I thought the voice was real.
41. There was more than one voice.
42. The voice talked about me.
43. The voice said mean things about me.
45. The voice was clear.
46. I saw things like flashes, flames, figures, or shadows but could not tell if they were real.
47. I was sensitive to light.
48. I saw things that looked real, but I was not sure if they were real.
49. I saw people, animals, or things that might not have been real.
50. I felt like someone was touching me, but no one was there.
52. I had so much energy that I got into trouble.
53. I had so much energy that I could not control myself.
54. I was so active I got into trouble.
55. I acted without thinking.
57. I was more talkative than usual.
59. I had so many different ideas that it was difficult to work on only one.
60. I owed more money than usual.
61. I spent money that I did not have.
62. I bought expensive things that I did not need.
63. I did sexual things that I would not normally do.
Factor Loadings Heatmap (Final Model Items Annotated)
0.28 0.23 0.77
-0.01 0.20 0.86
-0.11 0.03 0.80
-0.07 0.02 0.89
-0.01 0.01 0.82
0.76 0.18 -0.02
0.77 0.14 -0.08
0.77 0.28 -0.07
0.72 0.22 -0.06
0.77 0.15 0.10
0.73 0.23 0.01
0.76 0.21 0.06
0.76 0.09 0.36
0.74 0.17 0.06
0.32 0.75 0.10
0.28 0.78 0.22
Factor1
Factor2
Factor3
1.0
0.8
0.6
0.4
0.2
0.0

Final Item Set → 16 Questions

- 3 Factor Model: Final items **≥ 0.7 loading onto a single factor** (<0.4 loading onto a second factor)

FACTOR 1

37. I heard someone speaking to me, but there was no one there.
38. I **heard voices** when I was alone but could not tell where they were coming from.
39. I heard a voice but could not tell if it was real.
40. I thought the voice was real.
41. There was more than one voice.
42. The voice talked about me.
45. The voice was clear.
49. I **saw people, animals, or things** that might not have been real.
50. I felt like someone was **touching** me, but no one was there.

- *Potential underlying construct: Hallucination related - auditory, visual and tactile experiences*

→ ***Atypical perceptual experiences***[†]

FACTOR 2

52. I had **so much energy** that I got into trouble.
53. I had so much energy that I **could not control myself.**

- *Potential underlying construct: Increased activity, changes to self-regulation*

→ ***Speech or behavior that was disorganized.***[†]

→ ***Often the initial signs of a psychotic disorder include shifts in a person's emotions or behavior.*** [†]

FACTOR 3

8. I thought I could **read other people's minds**.
13. I thought I might be God's only messenger on Earth.
25. I thought a famous person had a **special relationship** with me.
32. I thought I had a secret romantic relationship with someone famous.
33. I thought I received **secret romantic messages** from someone I did not know well.

- *Potential underlying construct: Grandiosity, ideas of reference and perceived abilities*

→ ***Thought disturbance or unusual beliefs.***[†]

→ ***A person may believe they are receiving special messages***[†]

[†] Center for Early Detection, Assessment, and Response to Risk (CEDAR), Massachusetts Child Psychiatry Access Project, BCHI / BIDMC. (2019, July). *Psychosis screening in primary care:* https://www.psychosisscreening.org/uploads/1/2/3/9/123971055/bidmc_psychosis_pcp_booklet_final.pdf

Issues/Limitations with Suggestions

- Smaller N- highly influenced by variable reduction
  - Obtain larger sample of individuals with and without PSS

- Ordinal data
  - **Consider use of alternate rating scale: would binary Y/N to endorse an experience be as efficacious as 5-point likert?**
    - How many respondents endorsed at least 1 item?
    - Does the granularity of the scale add significant value?

Future Work

- **Further investigations into EPSi questionnaire after factor analysis**
  - Are questions still predictive of early psychosis key indicators?
  - Does the reduced question order influence scoring?
  - Do questions included still cover the range of psychosis symptoms (somatic delusions, ideas of reference, paranoia, thought insertion, etc) adequately?
- **Consider the 13 PIER participants and responses to 16 final items**
  - ***Reflect upon these results with specific aim analysis of broader study:***
    - *Sensitivity and specificity of EPSi questions evaluated using* ***area under the curve (AUC)*** *for predictive validity*

Figure 4. Area under the curve (AUC)

$$y = (sensitivity) = \frac{\text{(interview "PSS" and EPSi item rating of "sometimes" or more)}}{\text{all interview "PSS"}}$$

$$x = (1 - specificity) = \frac{\text{(interview "no PSS" and EPSi item rating of "never" or "rarely")}}{\text{all interview "no PSS"}}$$

References

- https://www.psychosisscreening.org/uploads/1/2/3/9/123971055/bidmc_psychosis_pcp_booklet_final.pdf

“Protocol Title: Developing universal psychosis screens for use with Maine youth in primary care” Principal investigator: Kristen Woodberry, MSW, PhD

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