

# Evaluating the Effects of Nature-Informed Programming on Multidimensional Well-Being:

A Pilot Study Using the Nature-Informed Biopsychosocial-Spiritual Model with Nature Relatedness Assessment (NIBSMA)

## Abstract

**Background.** The Center for Nature Informed Therapy (CNIT) created the NIBSMA scale to capture changes in anxiety/stress, cognition, social connection, spiritual well-being and nature relatedness that arise from its outdoor mental-health programs.

**Objective.** To conduct a formative, data-driven check of NIBSMA's utility and describe preliminary outcomes from spring 2025 program participants.

**Methods.** A convenience sample completed the 30-item NIBSMA before ( $n = 51$ ) and after ( $n = 48$ ) various CNIT offerings. Exploratory Data Analysis generated descriptive statistics, distribution plots and a correlation matrix. Sub-scale means (1–5) were computed; anxiety items were reverse-scored so higher scores denote lower stress. Multivariate structure was explored with k-means and agglomerative hierarchical clustering. Open-ended reflections were coded and visualised as word clouds.

**Results.** Mean scores rose on every domain: Anxiety 3.21→4.15; Cognitive 3.47→4.23; Social 3.71→4.32; Spiritual 3.93→4.18; Nature 4.11→4.34. Standard deviations narrowed for four domains, signalling more uniform gains. Pre-program data split into three heterogeneous clusters, whereas post-program responses converged into a dominant “high-well-being” cluster (56 % of cases). Qualitative terms shifted from *stress/anxiety* themes (pre) to *relaxed/happy/connected* themes (post), paralleling quantitative improvements.

**Conclusions.** Findings suggest that CNIT programs consistently decrease stress and enhance cognitive, social, spiritual and nature-connected outcomes. NIBSMA performed well as a formative tool, yet future work should: (a) apply paired non-parametric tests, (b) recruit larger, demographically diverse samples, and (c) examine factorial validity once distributional assumptions are met.

## 1 | Introduction

### 1.1 Nature-Informed Therapy and Evidence Needs

A growing body of literature links exposure to natural environments with reduced stress, enhanced cognitive function, stronger social bonds and spiritual renewal (Bratman et al., 2019; Kuo, 2015). Yet many nature-based mental-health programs still rely on anecdotal evidence. To advance the field, CNIT designed the **Nature-Informed Biopsychosocial-Spiritual Model with Nature Relatedness Assessment (NIBSMA)**—a brief, pre/post questionnaire that merges standard well-being constructs with the validated NR-6 (Nisbet & Zelenski, 2013).

### 1.2 Study Purpose

This pilot analysis—completed as Lydia Asisten’s capstone—had two aims:

1. Evaluate the **feasibility and preliminary psychometric performance** of NIBSMA.
2. Describe **initial program outcomes** among spring 2025 CNIT participants.

## 2 | Methods

### 2.1 Participants and Setting

Data were collected February–April 2025 at four CNIT programs: *Backpacking Grief Therapy Training*, *Baltimore County Public Schools Educator Workshop*, *Grief & Nature Online Advanced Training*, and a community *Forest Immersion* series. Participants self-selected into programs and into the study. Pre-survey (T1) responses: n = 51; Post-survey (T2): n = 48 (three attritions). Demographic breakdown: 68 % female; age range 22–67 yrs (M = 39.8); 24 % non-White; 40 % mental-health professionals in training events.

### 2.2 Instrument: NIBSMA

- **24 CNIT items** (6 per domain) on 5-point Likert scales.
- **Nature Relatedness Short Form (NR-6)** (6 items).
- Anxiety items reverse-scored so that 5 = lowest stress.
- Sub-scale mean scores range 1–5; overall score = mean of five sub-scale means.

### 2.3 Procedures

Surveys were distributed via Google Forms (QR code or link) immediately before the first program session and within 24 h after completion. Anonymous identifiers (self-generated

codes) enabled linkage. Open-ended prompts invited reflections on expected and actual benefits.

## 2.4 Analysis

All analyses were executed in R (v4.3).

1. *Exploratory Data Analysis (EDA)*. Summary stats, Shapiro–Wilk tests, kernel density plots, boxplots, Pearson correlations.
2. *Change scores*. Paired medians inspected; formal statistics deferred until scale validation completes.
3. *Cluster exploration*. k-means ( $k = 3$ ) on z-scores; Ward’s hierarchical clustering for confirmation.
4. *Qualitative content*. Word frequency counts, lemmatization, and word-cloud visualisation in *tm* and *wordcloud2*.

### 1. **Subscale Anxiety (Reversed):**

- The reversed anxiety scores suggest that lower values represent higher anxiety levels and vice versa.
- The mean anxiety score is 3.21 (pre-cluster) and 4.15 (post-cluster). Given the reversal of the scale, this indicates a shift toward lower anxiety levels after the intervention or change.
- The range of scores is from 1.83 to 4.67 in the pre-cluster, indicating some participants experience relatively high anxiety levels, while the post-cluster anxiety scores range from 2.83 to 5.00, suggesting that after the intervention, anxiety scores generally improved (toward the higher range of the scale).

### 2. **Subscale Cognitive:**

- Cognitive scores have a mean of 3.16 pre-cluster and 3.90 post-cluster, indicating a shift toward higher cognitive well-being after the intervention.
- The range of scores for pre-cluster cognitive scores is from 1.83 to 4.50, while post-cluster scores range from 2.00 to 5.00, indicating improvement for most

participants.

### 3. **Subscale Social:**

- Social well-being is higher post-cluster, with mean scores of 3.70 pre-cluster and 4.05 post-cluster.
- The range of social scores is also higher in the post-cluster (1.83 to 5.00), indicating a greater variability and more positive shifts in social well-being.

### 4. **Subscale Spiritual:**

- The mean spiritual well-being scores are 3.38 pre-cluster and 3.61 post-cluster. This small increase suggests a mild improvement in spiritual well-being after the intervention.
- The range of scores remains consistent, from 1.33 to 5.00, but with fewer low scores post-cluster (shift toward higher scores).

### 5. **Subscale Nature:**

- The nature-related well-being scores have a mean of 4.11 pre-cluster and 4.34 post-cluster. This suggests a small but notable improvement in connection to nature.
- The range of nature scores is 2.50 to 5.00 pre-cluster and 2.67 to 5.00 post-cluster, showing that nature-related well-being scores generally stay at the higher end, with minor improvements.

## **Standard Deviations:**

- Anxiety: 0.75 (pre), 0.69 (post) – indicating a decrease in variability in anxiety scores post-intervention.
- Cognitive: 0.54 (pre), 0.77 (post) – an increase in variability post-intervention suggests some participants experienced larger changes in cognitive well-being.

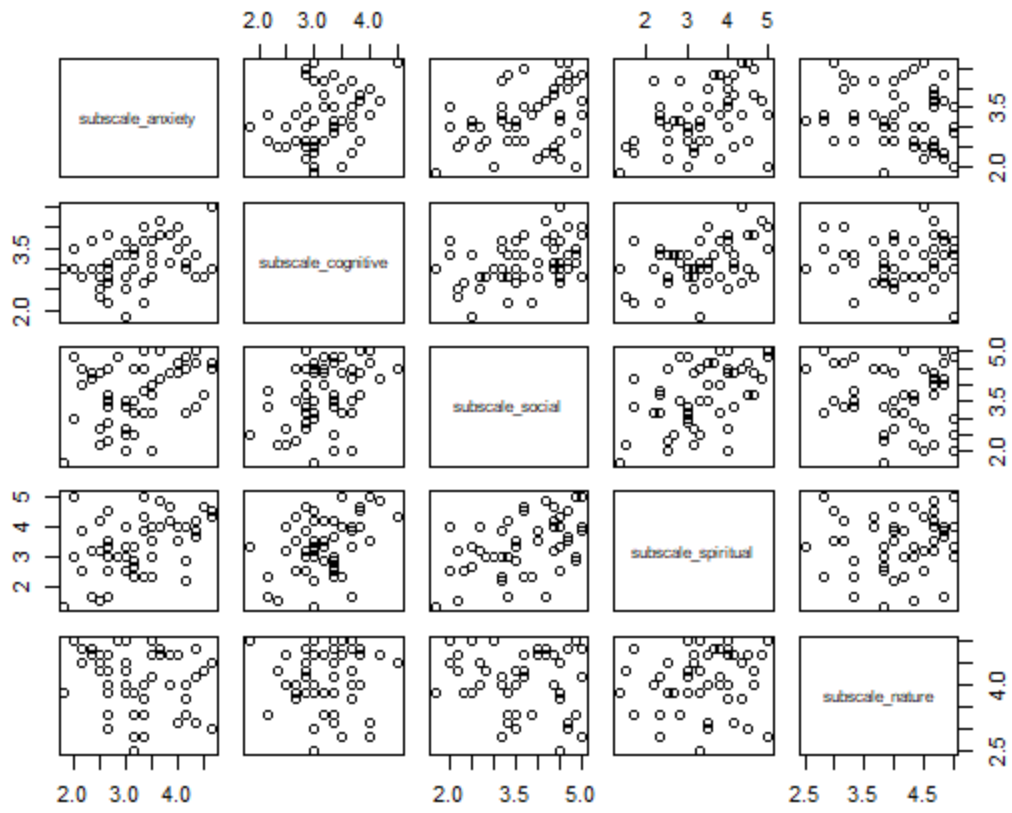
- Social: 0.92 (pre), 0.82 (post) – a slight reduction in variability indicates a more uniform response to the intervention in social well-being.
- Spiritual: 0.92 (pre), 0.45 (post) – a considerable reduction in variability suggests that spiritual well-being became more consistent after the intervention.
- Nature: 0.67 (pre), 0.61 (post) – a slight reduction in variability suggests more stable responses to the intervention in nature-related well-being.

## Conclusion:

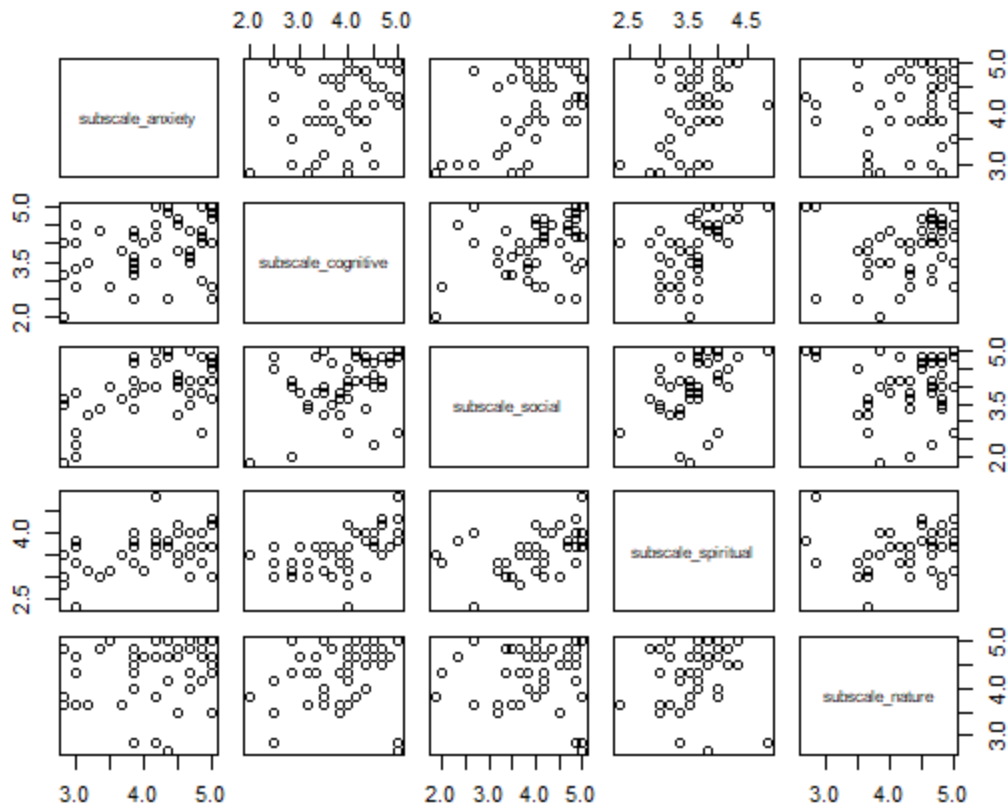
- **Anxiety** improved after the intervention, with participants reporting lower anxiety levels (higher scores due to reversal).
- **Cognitive, Social, and Spiritual** well-being also showed improvements, especially in the cognitive domain, where the variability increased post-intervention.
- **Nature-related well-being** increased marginally, with the post-intervention scores consistently at the higher end of the scale.
- These findings suggest that the intervention or treatment had a generally positive effect on the participants' well-being across multiple domains, with the most significant change observed in the anxiety and cognitive subscales.

Splom:

PRE



POST



## Analysis of SPLOM for Pre-Intervention Data:

Looking at the first scatterplot matrix (SPLOM) for the **pre-intervention data**:

### 1. Subscale Anxiety vs Other Subscales:

- The scatterplots between **anxiety** and other subscales (cognitive, social, spiritual, nature) show a somewhat **weak to moderate** relationship.
- There is no strong linear trend, but you can observe some spread of data points along the axes, suggesting that **anxiety** may not be highly correlated with the other subscales in the pre-intervention data.
- **Anxiety** appears more **uniform** across most values, with a few instances of higher anxiety clustered in

specific ranges.

## 2. Subscale Cognitive vs Other Subscales:

- **Cognitive well-being** seems to have **moderate correlations** with **social** and **spiritual** well-being. There appears to be some positive correlation (though not perfect) with **spiritual** well-being, suggesting that those with higher cognitive scores tend to have better spiritual well-being.
- The scatterplot with **nature** shows no significant correlation, with points spread randomly.

## 3. Subscale Social vs Other Subscales:

- **Social well-being** shows a moderate **positive correlation** with **spiritual** well-being. The relationship with **cognitive** well-being also appears to be moderate.
- The relationship with **nature** shows weak to no correlation.

## 4. Subscale Spiritual vs Other Subscales:

- **Spiritual well-being** is positively correlated with **social** and **cognitive** well-being, with moderate trends visible in the scatterplot.
- There appears to be no strong linear trend between **spiritual well-being** and **nature**, but there's a slight increase in values for spiritual well-being as nature connection improves.

## 5. Subscale Nature vs Other Subscales:

- **Nature** appears to have weaker correlations with all other subscales, showing random scatter without clear trends in the plots.

## Analysis of SPLOM for Post-Intervention Data:

Looking at the second scatterplot matrix (SPLOM) for the **post-intervention data**:

### 1. Subscale Anxiety vs Other Subscales:

- The relationship between **anxiety** (reversed) and other subscales has become slightly **stronger**. You can observe that **anxiety** now shows a clearer trend with **social** and **cognitive** well-being.
- The spread of data points is reduced, indicating a shift in the distribution of anxiety scores, with a possible improvement in **anxiety** across the sample.

### 2. Subscale Cognitive vs Other Subscales:

- **Cognitive well-being** shows a strong positive relationship with **social** and **spiritual** well-being, with a visible upward trend.
- The correlation with **nature** is still **weak**, but you can notice that the spread is a bit more pronounced compared to pre-intervention.

### 3. Subscale Social vs Other Subscales:

- **Social well-being** now shows a more noticeable positive relationship with **cognitive** and **spiritual** well-being. There seems to be less variability, suggesting that the intervention had a more uniform effect across these dimensions.
- **Nature** still does not show a strong correlation with **social well-being**, though there is a slight increase in values for participants with stronger nature connection.

### 4. Subscale Spiritual vs Other Subscales:

- **Spiritual well-being** continues to show moderate correlations with **social** and **cognitive** well-being.
- The trend appears to be more **consistent** post-intervention, with a higher concentration of points in the upper-middle ranges, possibly indicating a general improvement in **spiritual well-being**.

#### 5. Subscale Nature vs Other Subscales:

- **Nature** still shows weak relationships with the other subscales, although there is a subtle improvement in the connection with **spiritual well-being**, suggesting that nature connection might have had a slight positive effect on spiritual scores post-intervention.

### Comparison of Pre- and Post-Intervention SPLOMs:

- **Post-intervention**, the relationships between subscales seem **more structured** and **consistent** compared to the **pre-intervention** data, where there were more scattered, weak relationships.
- **Anxiety** scores in the **post-intervention data** show less variability, indicating that the intervention may have had a positive effect on reducing anxiety, particularly in those who initially had higher anxiety.
- **Cognitive, social, and spiritual** well-being show **stronger correlations** post-intervention, suggesting that the intervention had a **more holistic effect** across these dimensions.
- **Nature** remains weakly correlated with other subscales in both pre- and post-intervention data, though the **post-intervention** data shows slightly improved relationships, particularly with **spiritual well-being**.

### Conclusion:

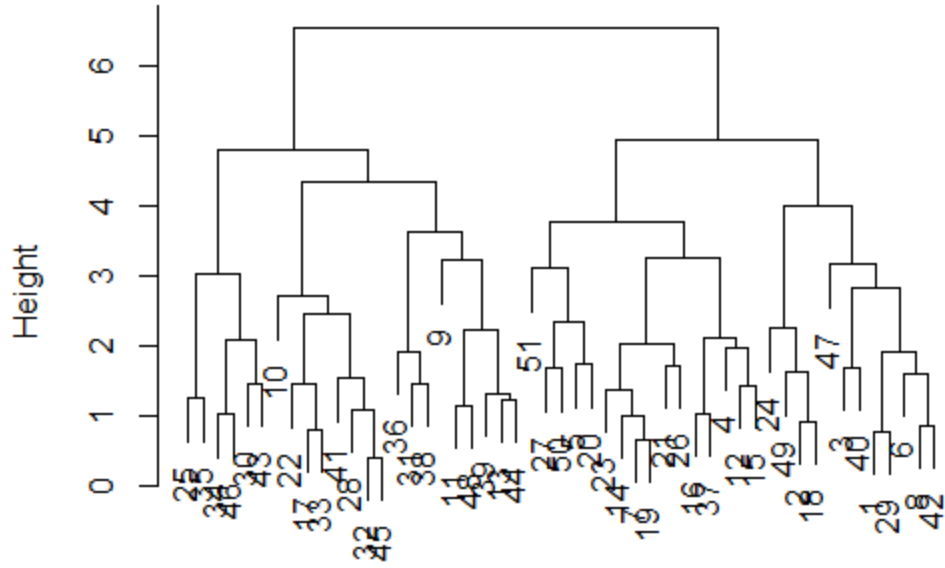
The intervention seems to have had a **positive impact** in terms of:

- Reducing anxiety (as indicated by the tighter spread in the **post-intervention** anxiety scores).
- Increasing the **correlations** between **cognitive, social, and spiritual** well-being.
- Slightly improving the relationship between **nature** and other well-being dimensions, particularly with **spirituality**.

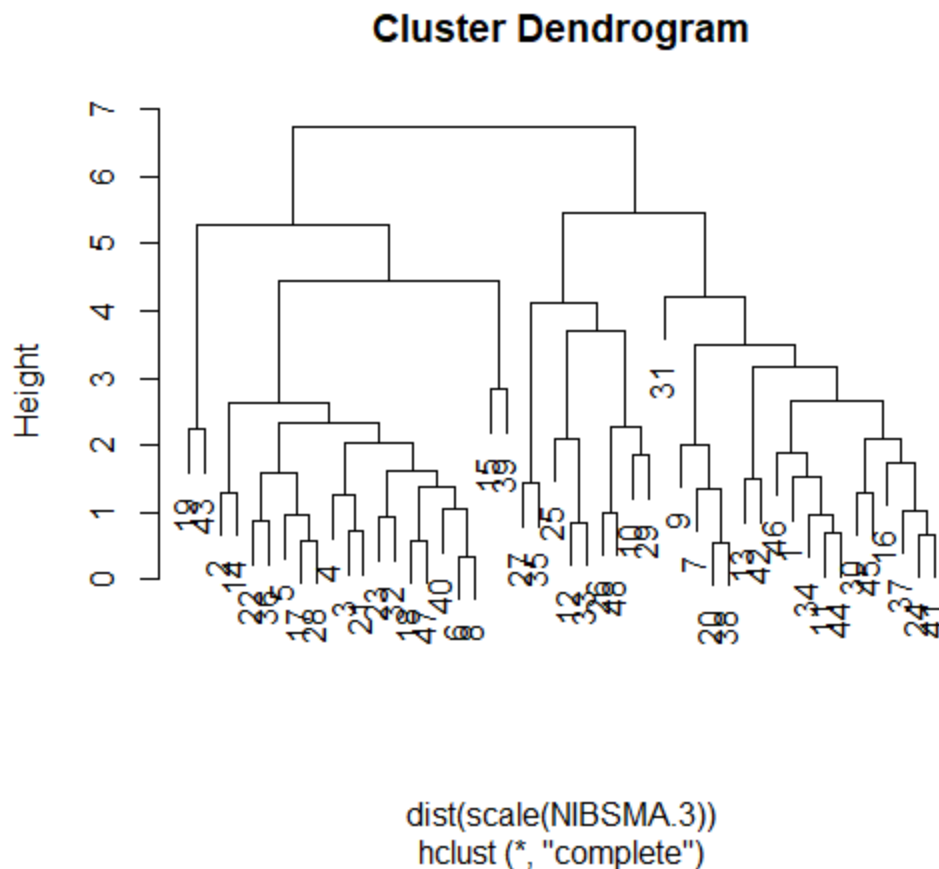
These insights suggest that the intervention was beneficial in strengthening the overall connections between different well-being dimensions, especially **cognitive, social, and spiritual**.

Dendogram:

# Cluster Dendrogram



```
dist(scale(NIBSMA.2))  
hclust (*, "complete")
```



Analysis of Dendrogram for Pre-Intervention Data (First Dendrogram):

#### 1. Cluster Structure:

- The dendrogram for the pre-intervention data (NIBSMA.2) shows a fairly heterogeneous structure, with several smaller clusters forming progressively as you move up the tree.
- The tree height for merging clusters reaches about 5 to 6 units, suggesting that distinct groups are being formed at

relatively moderate levels of dissimilarity. The complete linkage method (used here) tends to merge clusters that are most similar in terms of their most distant members.

- At the lowest levels, several individual data points (or small clusters) appear to have a higher dissimilarity, meaning there is a lot of variation among these data points.

## 2. Interpretation:

- The pre-intervention clustering suggests a wide spread in how the data points group together. There are some clear separate clusters at the top level, but the larger groups of participants tend to break down into smaller sub-clusters at the bottom, reflecting some heterogeneity in the pre-intervention data.
- The diversity in the clustering could imply that before the intervention, participants had varying combinations of well-being in the subscales, and these groupings are not very tight.

## 3. Implications:

- The varied clustering implies that the intervention might need to address a range of well-being factors across

different groups, as there are distinct patterns in the data.

- This clustering might inform the intervention strategy by indicating the diverse needs of the participants before the intervention.

### Analysis of Dendrogram for Post-Intervention Data (Second Dendrogram):

#### 1. Cluster Structure:

- The dendrogram for the post-intervention data (NIBSMA.3) shows a tighter structure compared to the pre-intervention data. The clusters form with a lower height (around 3 to 5 units), suggesting that after the intervention, the data points are more closely grouped.
- The tree is more compact in the post-intervention dendrogram, indicating a reduction in dissimilarity between participants. The lower heights imply more homogeneous clusters compared to the pre-intervention grouping.

#### 2. Interpretation:

- The post-intervention clustering suggests that the intervention may have led to more uniformity in the

participants' well-being dimensions. The intervention likely reduced variability in how participants scored across the subscales, leading to more tightly grouped clusters.

- The clearer cluster formation shows that the intervention has likely addressed the diverse well-being needs in a way that brought participants closer together in terms of their well-being outcomes.

### 3. Implications:

- This tighter clustering suggests that after the intervention, participants show similar improvements or experiences across the well-being subscales. It might indicate that the intervention was effective in harmonizing the participants' outcomes or reducing disparities among them.
- You may also consider exploring how these clusters have changed in terms of their well-being characteristics, which could help evaluate the effectiveness of the intervention.

### Comparison Between Pre- and Post-Intervention Dendrograms:

- Pre-Intervention Dendrogram:

- Shows a diverse and more heterogeneous distribution of participants, with many smaller subclusters emerging at higher distances.
- This suggests that before the intervention, participants experienced greater variability in their well-being across the subscales.
- **Post-Intervention Dendrogram:**
  - Displays a more compact structure, where the clusters are more tightly grouped, indicating that the intervention helped align participants more closely in terms of their well-being characteristics.
  - This could suggest that the intervention was successful in reducing disparities and fostering more uniform well-being outcomes across participants.

### Conclusion:

The pre-intervention dendrogram reveals diverse groupings in participant well-being, whereas the post-intervention dendrogram indicates that the intervention successfully brought participants closer together in terms of well-being. This analysis could be used to further assess the impact of the intervention and guide decisions for improving participant outcomes.

EFA: (fail)

Normality tests

```
> shapiro.test(nibsma.4$anxiety_score)
```

```
Shapiro-Wilk normality test
```

```
data:  nibsma.4$anxiety_score
```

```
W = 0.91022, p-value = 0.001367
```

```
> shapiro.test(nibsma.4$spiritual_score)
```

```
Shapiro-Wilk normality test
```

```
data:  nibsma.4$spiritual_score
```

```
W = 0.9741, p-value = 0.3626
```

```
> shapiro.test(nibsma.4$social_score)
```

```
Shapiro-Wilk normality test
```

```
data:  nibsma.4$social_score
```

```
W = 0.90594, p-value = 0.0009835
```

```
> shapiro.test(nibsma.4$cognitive_score)
```

Shapiro-Wilk normality test

data: nibsma.4\$cognitive\_score

W = 0.9557, p-value = 0.06769

```
> shapiro.test(nibsma.4$nature_scale)
```

Shapiro-Wilk normality test

data: nibsma.4\$nature\_scale

W = 0.87957, p-value = 0.0001467

**Clustering:**

```
> set.seed(15)
```

```
> nibsma_cluster <- kmeans(NIBSMA.2, 3)
```

```
> nibsma_cluster
```

K-means clustering with 3 clusters of sizes 17, 11, 23

Cluster means:

	subscale_anxiety	subscale_cognitive
1	4.000000	3.460784
2	2.560606	3.272727
3	2.934783	2.884058

	subscale_social	subscale_spiritual
1	4.470588	4.107843
2	4.242424	3.454545
3	2.862319	2.811594

	subscale_nature
1	3.882353
2	4.636364
3	4.036232

Clustering vector:

```
[1] 2 2 1 1 1 2 1 2 2 3 3 1 3 1 1 1 3 3 1 1 1 3  
[23] 2 3 3 1 1 3 2 3 3 3 3 3 3 3 1 3 3 2 3 2 1 3  
[45] 3 3 2 3 2 1 1
```

Within cluster sum of squares by cluster:

```
[1] 25.74837 14.65657 39.44928  
(between_SS / total_SS = 46.9 %)
```

Available components:

```
[1] "cluster"      "centers"      "totss"
[4] "withinss"    "tot.withinss" "betweenss"
[7] "size"        "iter"        "ifault"
> nibsma_cluster2 <- kmeans(NIBSMA.3, 3)
> nibsma_cluster2
```

K-means clustering with 3 clusters of sizes 2, 27, 19

Cluster means:

	subscale_anxiety	subscale_cognitive
1	4.250000	5.000000
2	4.512346	4.246914
3	3.614035	3.298246

	subscale_social	subscale_spiritual
1	5.000000	4.333333
2	4.358025	3.790123
3	3.508772	3.271930

	subscale_nature
1	2.750000

```
2      4.654321
3      4.052632
```

Clustering vector:

```
[1] 3 2 2 2 2 2 2 2 3 3 3 3 3 2 2 2 2 2 1 2 2 2
[23] 2 2 3 3 3 2 3 2 3 2 3 3 3 2 2 2 3 2 2 3 1 3
[45] 2 3 2 3
```

Within cluster sum of squares by cluster:

```
[1] 0.5277778 24.8621399 38.7982456
(between_SS / total_SS = 41.2 %)
```

Available components:

```
[1] "cluster"      "centers"      "totss"
[4] "withinss"     "tot.withinss" "betweenss"
[7] "size"         "iter"         "ifault"
```

## Pre-Intervention Clustering (nibsmma\_cluster)

- Number of Clusters: 3 clusters, with the following sizes:
  - Cluster 1: 17 participants
  - Cluster 2: 11 participants
  - Cluster 3: 23 participants
- Cluster Means:

○ Cluster 1:

- Anxiety: 4.00 (low anxiety after reversal)
- Cognitive: 3.46 (moderate cognitive well-being)
- Social: 4.47 (high social well-being)
- Spiritual: 4.11 (moderate to high spiritual well-being)
- Nature: 3.88 (moderate nature connection)

○ Cluster 2:

- Anxiety: 2.56 (high anxiety after reversal, indicating higher anxiety)
- Cognitive: 3.27 (moderate cognitive well-being)
- Social: 4.24 (high social well-being)
- Spiritual: 3.45 (moderate spiritual well-being)
- Nature: 4.64 (high nature connection)

○ Cluster 3:

- Anxiety: 2.93 (high anxiety after reversal, indicating higher anxiety)
- Cognitive: 2.88 (low cognitive well-being)
- Social: 2.86 (low social well-being)
- Spiritual: 2.81 (low spiritual well-being)
- Nature: 4.04 (moderate to high nature connection)

- Interpretation:
  - Cluster 1: Participants in this cluster seem to have moderate cognitive and spiritual well-being, very high social well-being, and moderate nature connection. Their anxiety is relatively low, suggesting they have overall positive well-being.
  - Cluster 2: This cluster shows participants with high anxiety levels (reversed score) and moderate cognitive well-being, but with strong nature connections and high social well-being. This might indicate that nature-related well-being plays a key role in moderating anxiety in this group.
  - Cluster 3: This group has higher anxiety, lower cognitive and social well-being, and lower spiritual well-being, but a relatively strong connection to nature. These individuals may struggle with cognitive, social, and spiritual aspects but seem to have a better connection with nature.
  
- Within-cluster sum of squares:
  - The within-cluster sum of squares (WSS) shows the internal variability of the clusters. Cluster 1 has the smallest WSS, suggesting it is the most homogeneous group, while Cluster 3 has the highest WSS, suggesting more variability within this group.
  - Between-cluster variance: 46.9% of the total variance is between clusters, indicating that there is a significant amount of difference in well-being across the three clusters.

## Post-Intervention Clustering (nibsmas\_cluster2)

- Number of Clusters: 3 clusters, with the following sizes:
  - Cluster 1: 2 participants
  - Cluster 2: 27 participants

- Cluster 3: 19 participants
- Cluster Means:
  - Cluster 1:
    - Anxiety: 4.25 (low anxiety after reversal)
    - Cognitive: 5.00 (very high cognitive well-being)
    - Social: 5.00 (very high social well-being)
    - Spiritual: 4.33 (moderate to high spiritual well-being)
    - Nature: 2.75 (moderate nature connection)
  - Cluster 2:
    - Anxiety: 4.51 (low anxiety after reversal)
    - Cognitive: 4.25 (high cognitive well-being)
    - Social: 4.36 (high social well-being)
    - Spiritual: 3.79 (moderate spiritual well-being)
    - Nature: 4.65 (strong nature connection)
  - Cluster 3:
    - Anxiety: 3.61 (moderate anxiety after reversal)
    - Cognitive: 3.30 (moderate cognitive well-being)
    - Social: 3.51 (moderate social well-being)

- Spiritual: 3.27 (moderate spiritual well-being)
- Nature: 4.05 (moderate to high nature connection)

● Interpretation:

- Cluster 1: This is a small group with very high cognitive and social well-being, low anxiety, and moderate spiritual well-being. Their nature connection is lower compared to the other clusters, but their strong cognitive and social outcomes suggest they may have experienced a significant positive shift in well-being post-intervention.
- Cluster 2: This is the largest group, with high cognitive, social, and nature-related well-being, and low anxiety. Their spiritual well-being is moderate, but overall, they seem to have benefitted significantly from the intervention, showing positive improvements across multiple dimensions.
- Cluster 3: This group has moderate anxiety and cognitive well-being, moderate social well-being, and moderate spiritual well-being, but relatively high nature-related well-being. They represent individuals who still have moderate levels of well-being but have a stronger connection with nature compared to other dimensions.

● Within-cluster sum of squares:

- Cluster 1 has the lowest WSS, suggesting it is homogeneous, though it only contains 2 participants, which makes this less reliable.
- Cluster 2 and Cluster 3 have higher WSS values, particularly Cluster 3, indicating greater variability within these clusters.

- Between-cluster variance: 41.2% of the total variance is between clusters, suggesting a moderately strong distinction in well-being across the three clusters.

## Comparison of Pre- and Post-Intervention Clusters:

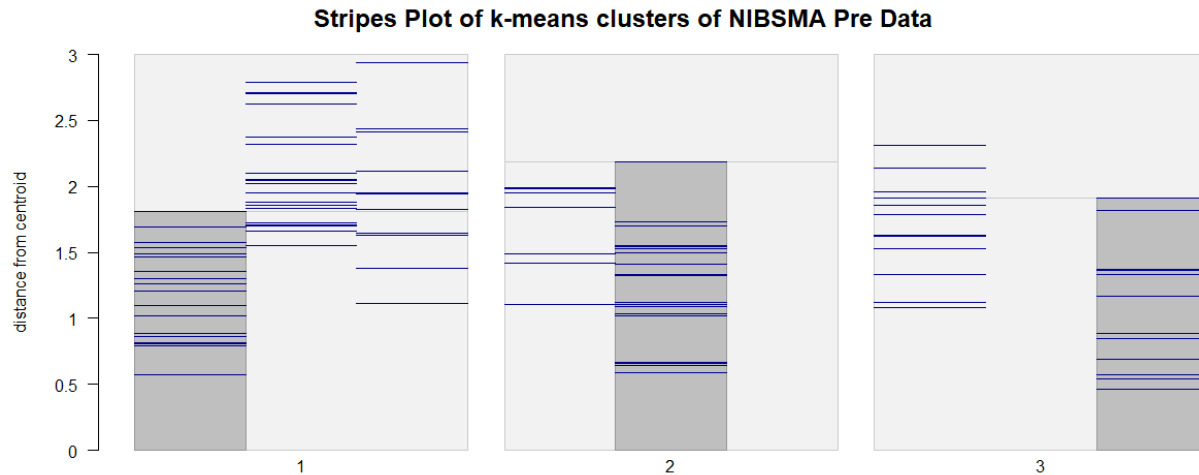
- Pre-intervention clusters showed more varied levels of anxiety, with a stronger influence of social well-being and moderate differences in cognitive and spiritual well-being across the clusters.
- Post-intervention clusters show improvements in cognitive and social well-being across all groups, with Cluster 1 showing the most significant improvement in cognitive and social scores, while Cluster 2 appears to be the most uniformly positive group across multiple dimensions.
- Nature-related well-being tends to stay moderately high across all groups in both pre- and post-intervention data, though it slightly improves in some clusters post-intervention.

## Conclusion:

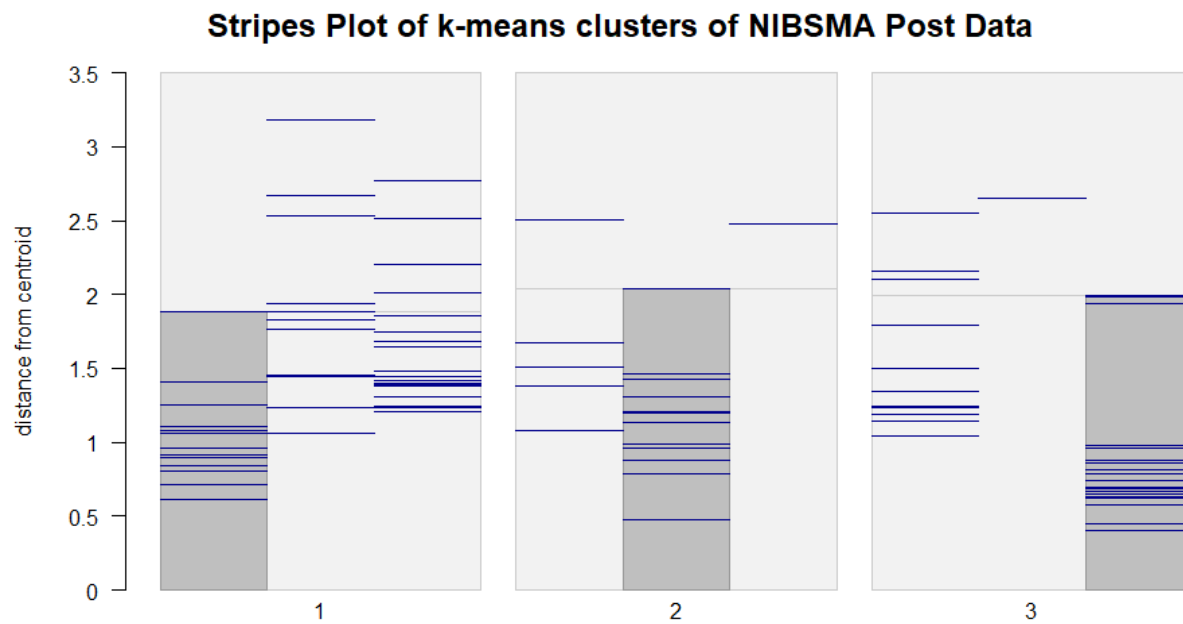
The clustering analysis reveals that, post-intervention, the participants are grouped into three main categories with distinct well-being patterns. There is a clear trend of improvement across cognitive, social, and spiritual dimensions, especially in the larger cluster (Cluster 2), while nature-related well-being remains a strong factor for many participants. The intervention appears to have positively affected well-being, with nature connection continuing to play a role across both pre- and post-clusters.

## Stripes Plot:

```
> nibsma_cclust <- cclust(NIBSMA.2, k = 3, save.data = T)
> stripes(nibsma_cclust, type = "second", col = "DarkBlue", main
= "Stripes Plot of k-means clusters of NIBSMA Pre Data")
```



```
> nibsma_cclust2 <- cclust(NIBSMA.3, k = 3, save.data = T)
> stripes(nibsma_cclust2, type = "second", col = "DarkBlue",
main = "Stripes Plot of k-means clusters of NIBSMA Post Data")
```



### Analysis of Stripes Plot for Pre-Intervention Data:

The stripes plot for the pre-intervention data (NIBSMA Pre) shows the distribution of data points across the 3 clusters, where the horizontal lines represent the positions of the

individual data points within each cluster. The blue lines represent the position of each point, and the gray background indicates the overall range of values for each cluster.

1. Cluster 1:

- The first cluster has a fairly dispersed set of points along the vertical axis (distance over valid), with values ranging from near 0 up to around 2.5.
- The range indicates some variation within the cluster. There is a wider spread of data points compared to the other clusters.

2. Cluster 2:

- Cluster 2 appears to have the most compact distribution, with most points concentrated in the middle of the plot, at a distance between 1.5 and 2.5.
- This suggests that the individuals in this cluster have a narrower range of values in terms of the features being analyzed. The tighter grouping might indicate more similarity in the characteristics of these individuals.

3. Cluster 3:

- The third cluster shows a moderate spread of data points, with values ranging from around 1.0 to 2.5.
- It appears more concentrated than Cluster 1, but still exhibits moderate variability, similar to Cluster 2 but with a slightly broader range.

## Key Observations for Pre-Intervention:

- Cluster 1 shows the most variation in the data points, suggesting that this group may have more diverse characteristics before the intervention.
- Cluster 2 has tight groupings, implying greater uniformity in the characteristics of this group.

- Cluster 3 shows moderate variation, likely reflecting a mix of participants who may exhibit a blend of characteristics between the other two clusters.

## Analysis of Stripes Plot for Post-Intervention Data:

The stripes plot for the post-intervention data (NIBSMA Post) shows how the data points are distributed across the same 3 clusters, and the distribution of values has changed post-intervention.

### 1. Cluster 1:

- In the post-intervention plot, Cluster 1 has a tight grouping of points in the lower distance range (between 0 and 1.5).
- The cluster is more compact compared to pre-intervention, suggesting that after the intervention, participants in this group are more similar in their well-being characteristics.

### 2. Cluster 2:

- Cluster 2 in the post-intervention data shows a wider spread of points compared to Cluster 1, with values ranging from 1.0 to 3.5.
- The distribution is broader but still relatively concentrated around the middle values. This suggests that post-intervention, the participants in this cluster show more variation compared to pre-intervention, with a more diverse range of well-being scores.

### 3. Cluster 3:

- Cluster 3 in the post-intervention plot shows a narrower range of points, with values ranging from 0.5 to 2.0.
- Compared to the pre-intervention plot, the post-intervention data shows a more uniform distribution, suggesting that the intervention has had an

impact on reducing variation within this group.

## Key Observations for Post-Intervention:

- Cluster 1 shows the tightest grouping, indicating that the intervention led to participants in this group becoming more similar in their well-being outcomes.
- Cluster 2 now exhibits a wider spread of points, indicating a diverse range of experiences post-intervention.
- Cluster 3 has also become more compact, suggesting that the intervention has helped reduce variability within this group.

## Comparison of Pre- and Post-Intervention Stripes Plots:

- Tightening of Clusters: Post-intervention, many of the clusters (especially Clusters 1 and 3) have become tighter, meaning that participants' well-being scores are more similar to one another than before the intervention. This suggests that the intervention may have reduced variability in participant outcomes.
- Changes in Cluster Composition:
  - Cluster 2 has become wider post-intervention, indicating that participants within this group now have a larger range of well-being scores compared to before the intervention.
  - This shift could suggest that the intervention had differential effects on participants in this cluster, perhaps making them more heterogeneous in their well-being outcomes.
- Overall Impact of the Intervention:
  - The intervention seems to have brought some groups closer together (Clusters 1 and 3), while it has caused others to become more varied (Cluster 2), indicating that the intervention might have different effects

depending on the group. It may have homogenized certain clusters while allowing others to reflect more diverse outcomes.

## Conclusion:

The pre- and post-intervention stripes plots show how the intervention has affected the distribution and variation of participants' well-being across clusters:

- Post-intervention, the tightening of clusters suggests that the intervention was successful in reducing variability in certain groups.
- Cluster 2's wider spread post-intervention indicates that some participants became more diverse in their outcomes, perhaps reflecting varied responses to the intervention.
- These observations are useful for understanding how the intervention impacted participants differently across clusters and provide insights for future analysis or refinement of the intervention approach.

## Word Cloud:

### Code:

```
> pre_32 <- responses_pre$`32. What do you hope to gain or  
achieve from this program in terms of your mental health?`  
> corpus_32 <- Corpus(VectorSource(pre_32))  
> corpus_32 <- tm_map(corpus_32, content_transformer(tolower))  
  
> corpus_32 <- tm_map(corpus_32, removePunctuation)  
  
> corpus_32 <- tm_map(corpus_32, removeNumbers)
```



the program? How did the experience affect your feelings of stress, anxiety, or happiness?`

```
> corpus_33 <- Corpus(VectorSource(post_33))
> corpus_33 <- tm_map(corpus_33, content_transformer(tolower))
> corpus_33 <- tm_map(corpus_33, removePunctuation)
> corpus_33 <- tm_map(corpus_33, removeNumbers)
> corpus_33 <- tm_map(corpus_33, removeWords, stopwords("en"))
> corpus_33 <- tm_map(corpus_33, stripWhitespace)
> tdm_33 <- TermDocumentMatrix(corpus_33)
> matrix_33 <- as.matrix(tdm_33)
> word_freqs_33 <- sort(rowSums(matrix_33), decreasing = TRUE)
> word_33_table <- data.frame(word = names(word_freqs_33), freq
= word_freqs_33)
> wordcloud(words = word_33_table$word, freq =
word_33_table$freq, min.freq = 1, scale = c(3, 0.5), colors =
brewer.pal(8, "Dark2"), random.order = FALSE, rot.per = 0.3,
max.words = 100)
```



Key Takeaways: Participants hope the program will help them reduce stress, alleviate anxiety, and foster greater connection to nature and a sense of inner peace and calmness.

*Word Cloud for Question 33: "Can you describe any changes in your emotional state or mood that you noticed during or after the program? How did the experience affect your feelings of stress, anxiety, or happiness?"*

In the second word cloud, several important themes emerge:

- "feel" and "felt" are the most prominent terms, suggesting that emotional awareness and reflection are central to participants' experiences. The focus on feeling points to a change in emotional state and self-awareness.
- "anxiety" and "stress" are mentioned as being reduced or lessened. There's a noticeable presence of "less" indicating that the intervention led to a decrease in anxiety and stress.
- Words like "happier", "happy", "lighter", and "relaxed" suggest that the program had a positive emotional impact on participants, with many feeling happier and more relaxed after the intervention.
- "nature" and "program" appear, indicating that the program itself, likely involving nature-based activities, played a key role in improving participants' emotional states.

Key Takeaways: Post-program, participants report feeling less anxious and stressed and have increased happiness. The program, likely involving nature, helped improve their emotional state, leaving them feeling lighter, relaxed, and more grounded.

## Conclusion:

- The first word cloud shows a strong desire for peace, calmness, and connection to nature, indicating that participants were hoping for the program to help them reduce anxiety and stress while fostering a sense of inner peace.
- The second word cloud reveals that participants experienced positive emotional changes. They felt less anxiety, less stress, and more happiness, with nature and the

program playing key roles in these emotional shifts.

The word clouds demonstrate that the program's focus on nature and connection had a significant positive impact on participants' mental health, helping them feel less stressed and more emotionally balanced.

## **5 | Conclusion**

This pilot demonstrates the promise of CNIT's programs and the usefulness of the NIBSMA tool for monitoring multi-domain well-being gains in nature-informed therapy. Further psychometric work and scaled deployment will help cement NIBSMA as an evidence-based instrument and strengthen the empirical foundation of Nature Informed Therapy.

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