

## DIMENSIONS OF WELLNESS

### FACTOR AND CLUSTER ANALYSIS

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With the modern conceptualization of wellness reflecting a subjective evaluation of an overall state of being, measures of wellness have primarily focused upon the individual's quality of life — reflecting their level of contentment, happiness, satisfaction with life, and fulfillment. In actually assessing this concept there is considerable disagreement over how many dimensions of wellness there are and exactly what those dimensions reflect. Factor and Cluster analysis provides a means of understanding the relationship between the various dimensions of wellness and how they fit together.

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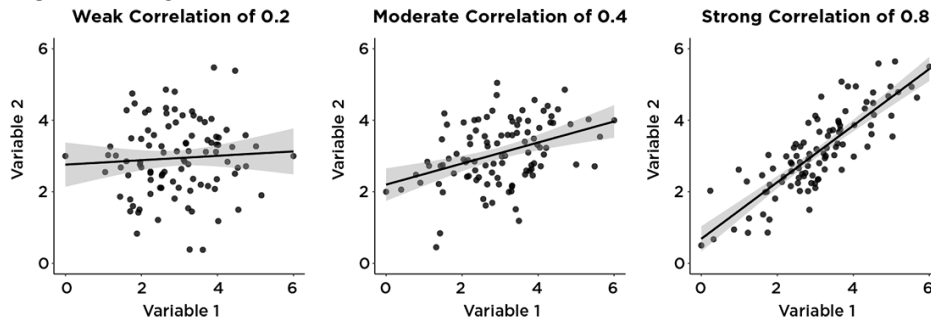
**Topics:** Correlation — Latent Variable — Two Dimension Model —  
Five Dimension Model — Eight Dimension Model

The analytical techniques of cluster analysis and factor analysis fly upon the correlation between variables. **Correlation is an assessment of the relationship** (association, similarity) **between two variables** (measures). If two variables reliably change in association with each other, they are said to be correlated. To bring this into the real world for a minute, consider, for instance, performance on 100m and 200m sprints. Individuals who perform well on the 100m sprint likely also perform well on the 200m sprint, while individuals who perform poorly on the 100m sprint likely also perform poorly on the 200m sprint. A variable that reliably increases when another variable increases — even if the increase is larger for one variable than for another — has a correlation of +1. If we also had performance on the 10,000m run, we would likely see that those individuals who perform well on the 100m sprint perform poorly on the 10,000m run. A variable that reliably decreases when another variable increases has a correlation of -1 and is said to be **inversely correlated**.

A variable that has no association with another has a correlation of 0. In practice, rarely do variables perfectly correlate (at +1 or -1) or have no correlation (at 0). As the correlation deviates from zero, the strength of the relationship between variables increases. Variables that have a **correlation of 0.2 are said to be weakly correlated**. Variables that have a **correlation of 0.4 are said to be moderately correlated**. Variables that have a **correlation of 0.8 are said to be strongly correlated**. In some fields (such as physiology) it is very common to see measures that are moderately to strongly correlated, whereas in other fields (such as psychology) weak to moderate correlations are far more

common.

**Figure:** Strength of Correlations.

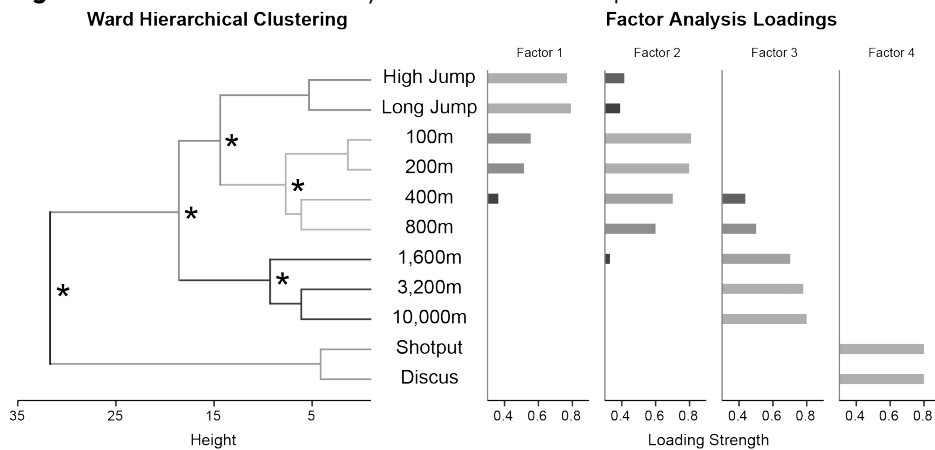


Cluster and Factor analyses consider the correlations between many different variables to try to determine where underlying patterns may allow for variables to group together. These groupings of highly correlated variables are called **latent variables** (i.e., dimensions). Again, to bring this into the real world, consider the situation where you are an athletic director at a small school. You would like to have the school provide a Track and Field team, but you have a limited budget for coaches. How would you determine the minimum number of coaches and allocate them to the team in a way to optimize the program's success? For those who have participated in track and field, you might immediately make the decision to have one coach over sprint events, one over field events, and one for distance events — simply because that is how your school did it when you were an athlete. But where do you draw the line between sprint and distance events? Should your high jump and long jump athletes work with the sprint athletes or the field athletes? Factor analysis would allow you the means of actually looking at performance across multiple events to determine how best to allocate those coaches, as well as to test if your decision (based upon prior experience) was actually a good one.

If we had every athlete perform every event, we could then perform factor analysis to look at the underlying relationships between the different events to identify the **latent variables** (i.e., dimensions) where performance aligns across different events. These latent variables would identify differences in the particular events that would justify having a unique coach.

So the data from high-school athletes might look like this:

**Figure:** Cluster and Factor analysis of track and field performance.



On the left side of the figure the Cluster analysis illustrates the structural relationship between performance on different events. As individuals exhibited highly similar performance on the 100m and 200m sprints, the cluster quickly groups those together into a common latent variable. As performance on the 400m and 800m runs are less similar (i.e., less strongly correlated), the cluster takes longer to come together to form a latent variable. But statistically, although performance on the 100/200 and 400/800 events are correlated, they are identified as distinct dimensions (one for the 100/200 event and one for the 400/800 event; indicated by the star).

The greater the height of the cluster, the greater the difference between the elements. So at minimum, the Cluster analysis would indicate that you would want to have two coaches — one for the shotput and discus events and one for all of the other events (looking at the figure from left to right). If you had the money to hire three coaches, it would be better to have one for shotput/discus events, one for the 1600/3200/10000 distance runs, and one coach to handle everything else. If you were able to hire four coaches, you could split the remaining events to have a dedicated coach for long jump/high jump and a separate coach for 100/200/400/800 events. A fifth coach could even be justified to split the 100/200 events from the 400/800 events.

On the right side of the figure the Factor analysis tells a very similar story. Based upon the relationship between performance on events, four unique factors (i.e., latent variables) were identified. The larger the bar indicating loading strength is, the more strongly performance on that event is aligned with that factor. The analysis does not assign a particular meaning to the factors, but rather allows for interpretation of what that latent variable might reflect.

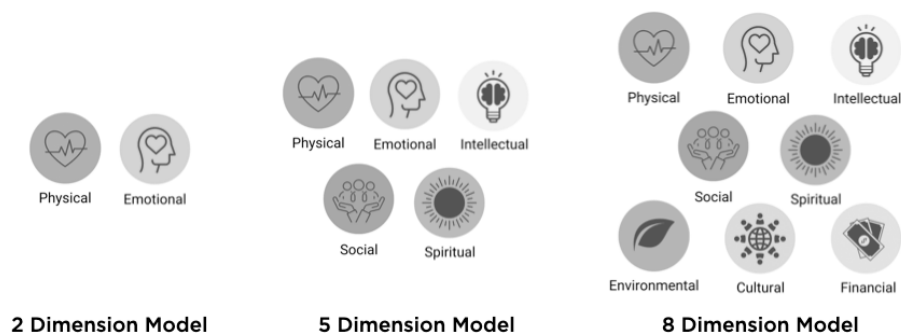
For instance, Factor 2 would seem to reflect some abilities most strongly aligned with the 100m and 200m sprints while Factor 3 would seem to reflect some abilities most strongly aligned with the 3,200m and 10,000m events. So it would not be a far stretch to suggest that Factor 2 reflects contributions associated with sprinting ability while Factor 3 reflects contributions associated with endurance. While the 800m run is traditionally thought of more as a distance event with high-school athletes in this event typically practicing with the 'distance' oriented coaches; factor analysis would highlight the issue with this approach. Certainly the 800m run has some aspects loading onto Factor 3, but the strongest loading is for Factor 2 associated with sprinting ability. But similar to the Cluster analysis, the data would not suggest it is fully a sprint event either.

So although the general conclusions of both approaches are similar they would have very different implications for approaches. The cluster approach — which is used by the vast majority of track and field programs — would allocate coaches by events and clustering events together under a common coach. In contrast, the factor approach would allocate coaches to the particular latent variable that needs to be trained. Athletes would then spend time training with a particular coach proportionate to the factor loading of their events. So an 100m athlete would spend the majority of their time with the coach allocated to Factor 2 (reflecting sprinting ability) but would also spend time with the coach allocated to Factor 1 (reflecting some aspect of jumping/power). While an 800m athlete would spend time training with coaches allocated for both Factor 2 (reflecting sprinting ability) and Factor 3 (reflecting endurance). At the Olympic level this approach is far more common with athletes having a general coach and then working with specialists to improve particular components of the event.

Research into the concept of wellness has relied upon looking at the underlying relationship between asking questions about different aspects of an individual's life to understand if there are underlying latent variables (i.e., dimensions) that should be focused upon. The question being what the relationship is between individuals subjective perceptions related to things like their physical status, social interactions, educational attainment, etc. Similar to the idea of having sufficient money to pay a coach, trying to assess a large number of wellbeing areas is associated with greater cost in terms of your time/effort and the individual's time/effort. Interventions to address and change wellness have costs that scale with the number of dimensions targeted — a program that targets improving social wellbeing costs less than a program that tries to improve social wellbeing and emotional wellbeing. So it is important to keep in mind that some field specific trends to focus only on particular wellbeing

areas has largely occurred in response to such cost constraints.

**Figure:** Dimensions of Wellness.



Research in this area have largely identified and focused upon 3 models of wellness with increasing complexity. The simplest perspective reflects a 2 dimensional model differentiating mental/emotional and physical wellbeing (remember that the term wellbeing reflects a particular wellness subdomain). The **physical dimension** characterizes the individual's subjective evaluation of their physical characteristics. This domain generally encompasses perceptions of overall physical condition, the absence of disease, absence of physical discomfort, behaviors such as eating habits and activity, and the ability to avoid injury. The **emotional dimension** characterizes the individual's subjective evaluation of their emotional characteristics. This domain generally encompasses perceptions of overall emotional and mental state of being, the absence of anxiety/depression/and poor mental health, attributes related to self-acceptance, self-esteem, and self-confidence, and other non-physical characteristics. Thus, aspects of a person's life that align with physical characteristics would cluster into the physical domain while aspects that might align with mental/emotional characteristics would cluster into the mental/emotional domain.

The 5 dimension model adds intellectual, social, and spiritual wellbeing onto the 2 dimensional model. Unlike the clean example of track and field, some aspects of mental/emotional and physical get broken up and allocated to the other domains. Nevertheless, the overarching concept is that these 5 dimensions reflect key aspects that contribute to an individual's wellness. The **intellectual dimension** characterizes the individual's subjective evaluation of their mental activity and curiosity. This domain generally encompasses perceptions of cognitive abilities, educational attainment, sensation seeking, and openness to new ideas. The **social dimension** characterizes the individual's subjective evaluation of their ability to develop and maintain satisfying and supportive relationships. This domain generally encompasses perceptions of the closeness of friends and family, communication skills, and the frequency and quality of social

interactions. The **spiritual dimension** characterizes the individual's subjective evaluation of their guiding beliefs, principles, and values that give a sense of purpose. This domain generally encompasses perceptions of qualities that give a sense of purpose, a sense of belonging, connection to something greater than oneself, and the alignment between actions and beliefs/values. Thus, while the label 'spiritual' usually brings to mind ideas of organized religion or faith, this domain is still present even for individual's who identify as religiously agnostic or atheist as the domain more generally reflects the individual's guiding beliefs, principles, and values that give them a sense of purpose.

The 8 dimensional model adds environmental, cultural, and financial wellbeing onto the 5 dimension model. The **environmental dimension** characterizes the individual's subjective evaluation of the livability of surroundings, community, and the planet. This domain generally encompasses perceptions of access to safe food and water, sense of community safety, and the presence of hazards that might compromise aspects of health and wellness. The **cultural dimension** characterizes the individual's subjective evaluation of their belonging to shared values, beliefs, traditions, and practices associated with the individual's relevant cultural groups. This domain generally encompasses perceptions of the extent to which they fit in and are accepted by their cultural group, as well as the alignment between the individual's actions and the values of their cultural group. The **financial dimension** characterizes the individual's subjective evaluation of their financial status. This domain generally encompasses perceptions of the individual's ability to live within their means, acquire items that have value to them, their financial resilience, and their sense of security.

Interestingly, in practice various groups frequently adapt the 8 dimension model to also include occupational wellbeing as a 9th dimension. The current state-mandated high-curriculum in Michigan actually uses this 9 dimension model. However, the evidence justifying the presence of such a 9th dimension is poor as occupational factors are typically viewed as a subdomain of financial wellbeing; although factor analysis also shows factor loading also occur with environmental, social, and intellectual wellbeing. So including occupational wellbeing as its own independent dimension is not well justified.

To make matters more complex, some fields have also adapted the 8 dimensional model but remove either the spiritual, environmental, cultural, or financial wellbeing (or sometimes more than one dimension). Essentially ignoring the presence of that domain for contributing to wellness while still using the 8 dimension model. There is often not a compelling reason for this beyond the particular domain of wellbeing not having strong relevance to the particular topic they are interested

in. Thus, while there is debate as to what model of wellness is the most appropriate; it is important to consider that this debate is really about how unique elements cluster and provide different insights. If assessing or focusing on occupational wellbeing takes additional time/resources but provides little to no additional information that other domains do not already get at; there is not a good justification for the expense in time/resources so it is likely to be excluded.

## Wellness

- Measures of wellness have primarily focused upon the individual's quality of life:
  - Level of contentment
  - Level of happiness
  - Satisfaction with life
  - Level of fulfillment
- There remains disagreement over how many dimensions of wellness there are (or should be) and what those dimensions reflect.

## Correlation

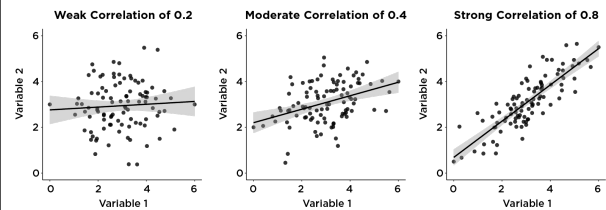
- Correlation is a measure of the relationship (association, similarity) between two variables (measures).
  - If one measure changes, what happens to the other measure.
- Correlation is independent of magnitude.
  - Two measures can be correlated even if one measure changes a lot and the other measure changes very little.

## Correlation

- Correlation provides a measure of how reliably changes in one variable correspond to changes in another variable.
  - Correlation of +1: one measure increases and the other measure reliably increases.
  - Correlation of -1: one measure increases and the other measure reliably decreases. (referred to as an inverse correlation)
  - Correlation of 0: one measure increases and the other measure has no association with the first.

## Correlation

In practice, rarely do variables perfectly correlate or have no correlation.



## Cluster & Factor Analyses

- Considers the correlations between many different variables to determine where underlying patterns may allow for variables to group together.

How strongly do you agree with the following statements:

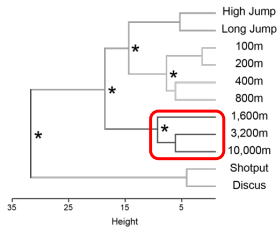
- I have enough money to be able to do all the things I want to do.
- I feel supported by my community.
- I feel satisfied with my level of physical health.
- I feel useful.
- I enjoy my life.
- I often feel fatigued.
- I am frequently stressed about my friendships.
- I am able to focus on what I need to.

## Cluster & Factor Analyses

- Considers the correlations between many different variables to determine where underlying patterns may allow for variables to group together.
  - Simplifies complex data into manageable chunks.
  - Identifies underlying elements where two variables may be measuring the same thing.
  - Can be used to make data driven decisions.

If we had athletes perform each event, we could look at the correlations between event performance to determine what underlying latent variables might exist.

Ward Hierarchical Clustering

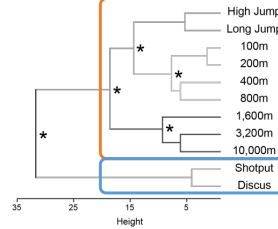


How do we "read" this figure?

- Height indicates similarity.
- Clusters occur when variables are sufficiently similar to reflect a common underlying latent variable.
  - The 3,200m and 10,000m are very similar and cluster together.
  - The 3,200m/10,000m cluster is similar to the 1,600m and eventually forms a cluster.

If we had athletes perform each event, we could look at the correlations between event performance to determine what underlying latent variables might exist.

Ward Hierarchical Clustering

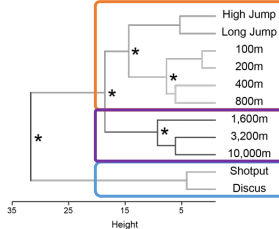


If you could only hire two coaches, what events would they cover?

- Shotput and Discus were identified as the most unique and differed from all other events.

If we had athletes perform each event, we could look at the correlations between event performance to determine what underlying latent variables might exist.

Ward Hierarchical Clustering

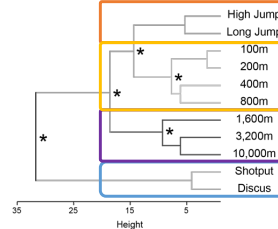


If you could only hire three coaches, what events would they cover?

- Shotput and Discus cluster together
- 1,600m, 3,200m, and 10,000m cluster together
- Jumping & 100m–800m cluster together

If we had athletes perform each event, we could look at the correlations between event performance to determine what underlying latent variables might exist.

Ward Hierarchical Clustering



If you could hire four coaches, what events would they cover?

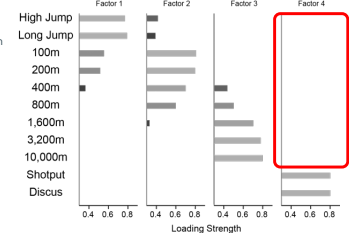
## Cluster & Factor Analyses

- Factor analyses have a similar concept but instead of focusing on how variables cluster together, the focus is on how each variable contributes (or loads) on an underlying latent variable.
  - Variables with a large loading strength align strongly with the latent variable.
  - Variables with a small or null loading strength do not align with the latent variable.

If we had athletes perform each event, we could look at the correlations between event performance to determine what underlying latent variables might exist.

How do we "read" this figure?

Factor Analysis Loadings

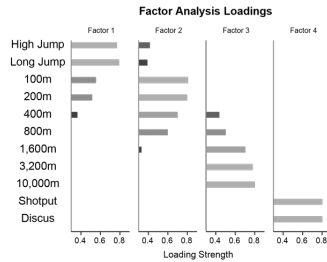


- Variables with a large loading strength align strongly with the latent variable.
- Variables with a small or null loading strength do not align with the latent variable.

If we had athletes perform each event, we could look at the correlations between event performance to determine what underlying latent variables might exist.

**How do we "read" this figure?**

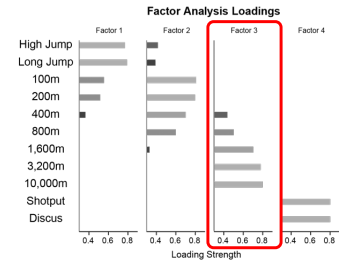
- Factor analyses determines how many unique underlying latent variables are in the data.
- Factor analyses do not assign meaning to latent variables.



If we had athletes perform each event, we could look at the correlations between event performance to determine what underlying latent variables might exist.

**What might Factor 3 reflect?**

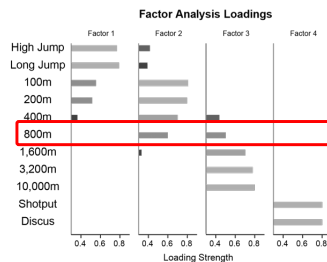
- Factor 2 might reflect contributions associated with sprinting ability.
- Factor 3 might reflect contributions associated with endurance ability.



If we had athletes perform each event, we could look at the correlations between event performance to determine what underlying latent variables might exist.

**If you ran the 800m in high-school, did you practice with the sprint coach or the distance coach?**

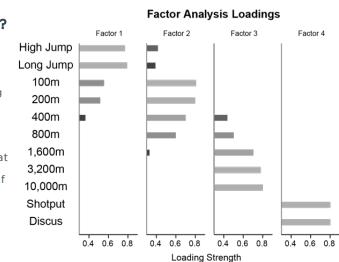
- While traditionally thought of as a distance event, data consistently shows it loads more heavily on "sprint" related factors.
- But it also has moderate loading associated with "endurance" related factors.



If we had athletes perform each event, we could look at the correlations between event performance to determine what underlying latent variables might exist.

**How does this tell me about coaching?**

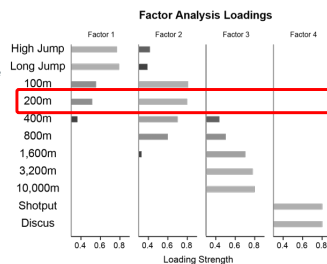
- Rather than assign coaches by event, coaches could be assigned to focus training on particular underlying latent variables.
- Athletes would then spend time training that factor proportionate to the factor loading of their events.



If we had athletes perform each event, we could look at the correlations between event performance to determine what underlying latent variables might exist.

**How does this tell me about coaching?**

- An athlete in 200m events would spend time training focused primarily on Factor 2 (reflecting sprinting ability).
- They would also spend time training on Factor 1 (reflecting some aspect of jumping/power).

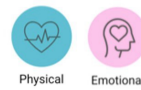


**Dimensions of Wellness**

- Cluster and Factor analyses have examined the correlations between various questions about a person's life to identify if there are underlying latent variables (i.e., dimensions) that should be focused upon.
  - i.e., are subjective perceptions of things like physical status, social interactions, educational attainment reflective of unique dimensions.

## Dimensions of Wellness

- Reflect cost considerations
  - How much time/effort does it take to answer questions?
    - Some measures of wellness are 5 questions, some 36, some 144...
  - Interventions to improve wellness have costs that scale with the number of dimensions.
    - Trying to improve social wellbeing costs less than trying to improve social wellbeing and emotional wellbeing.



### 2 Dimension Model

#### Physical Dimension

- Subjective evaluation of their physical characteristics.
- Generally characterizes:
  - Overall physical condition
  - Absence of disease
  - Absence of physical discomfort
  - Eating habits
  - Avoidance of injury

#### Emotional Dimension

- Subjective evaluation of their emotional characteristics.
- Generally characterizes:
  - Overall emotional/mental condition
  - Absence of anxiety/depression/poor mental health
  - Self-acceptance, self-esteem, self-confidence
  - Non-physical characteristics



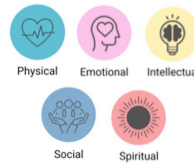
### 5 Dimension Model

Retains the Physical and Emotional domains but adds domains for:

- Intellectual
- Social
- Spiritual

Unlike the track & field example, there is not a clear hierarchy where questions/concepts reflect subcategories of another.

- i.e., Social wellbeing is not a subcategory of Emotional wellbeing but rather reflects its own latent variable.
- Questions that were in Emotional wellbeing in the 2 dimension model may break into different dimensions in the 5 dimension model.



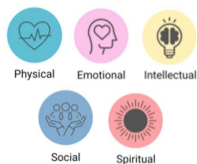
### 5 Dimension Model

#### Intellectual Dimension

- Subjective evaluation of their mental activity and curiosity.
- Generally characterizes:
  - Cognitive abilities
  - Educational attainment
  - Sensation seeking
  - Openness to new ideas

#### Social Dimension

- Subjective evaluation of their ability to develop and maintain satisfying and supportive relationships.
- Generally characterizes:
  - Closeness of friends/family
  - Communication skills
  - Frequency and quality of social interactions



### 5 Dimension Model

#### Spiritual Dimension


- Subjective evaluation of the guiding beliefs, principles, and values that give a sense of purpose.
- Generally characterizes:
  - Qualities that give a sense of purpose
  - Sense of belonging
  - Perceived connection to something greater than ones-self
  - Alignment between actions and beliefs/values



### 8 Dimension Model

Retains the 5 Dimension Model domains but adds domains for:

- Environmental
- Cultural
- Financial




**Environmental Dimension**

- Subjective evaluation of the perceived livability of the surroundings, community, and planet.
- Generally characterizes:
  - Access and safety of food and water
  - Sense of community safety
  - Presence of hazards

**Cultural Dimension**

- Subjective evaluation of the belonging to shared values, beliefs, traditions, and practices associated with cultural groups.
- Generally characterizes:
  - Integration with cultural group
  - Alignment between actions and values of the cultural group.


**8 Dimension Model**



**Financial Dimension**

- Subjective evaluation of financial status.
- Generally characterizes:
  - Ability to live within means
  - Financial resilience
  - Social displays of wealth
  - Sense of security

**8 Dimension Model**



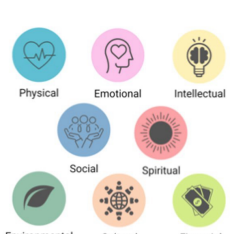
Some groups will adapt this 8 Dimension Model to include Occupational wellbeing as a 9<sup>th</sup> dimension.

- The State of Michigan high-school curriculum uses this 9 Dimension Model.

The evidence supporting Occupational wellbeing as an independent latent variable is poor.

- Usually reflects subdomains of Financial wellbeing.
- Factor loading splits Occupational questions with Environmental, Social, and Intellectual latent variables as well.

**8 Dimension Model**



Some fields use the 8 Dimension Model but ignore the presence of some domains.

- Usually removing either Spiritual, Environmental, Cultural, or Financial (or some combination).

Usually reflects that those domains do not have particular relevance to that field.

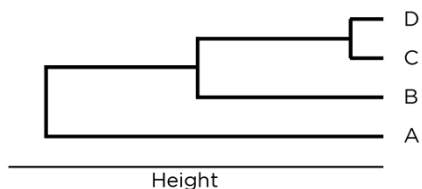
- i.e., not a focus to intervene in/with

**8 Dimension Model**

### Dimensions of Wellness Worksheet

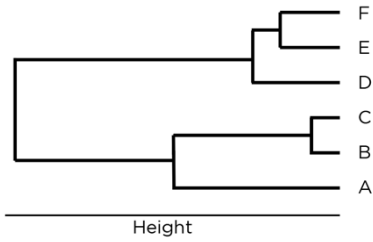
1. Two factors (A and B) have a correlation near +1. What would that correlation indicate?
2. Two factors (A and C) have a correlation near -1. What would that correlation indicate?
3. What are the typical strength of correlation labels for correlations of 0.2, 0.4, and 0.8?
4. What are the typical strength of correlation labels for correlations of -0.2, -0.4, and -0.8?
5. Correlations between factors in physiology-based fields are typically \_\_\_\_\_ than in psychology-based fields.

**Data:**



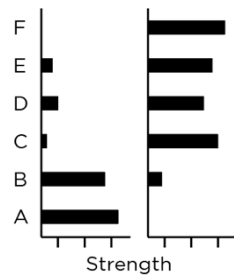
6. Using the cluster analysis plot above, which two factors are most similar?
7. Using the cluster analysis plot above, which factor is the most unique?

Data:



- Using the cluster analysis plot above, if you had to break the variables into two groups which variables would you group together?
- Using the cluster analysis plot above, if you had to break the variables into three groups which variables would you group together?

Data:



- Using the factor weighting plot above, if you had to break the variables into two groups which variables would you group together?
- What dimensions make up the 2 Dimension model of wellness?
- What dimensions make up the 5 Dimension model of wellness?
- What dimensions make up the 8 Dimension model of wellness?