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Multivariate Analysis of the Spanish Version of the FMI-14: Contributions From the Item Response Theory and Biplot Methods

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ABSTRACT

The concept of mindfulness is increasingly frequent in academic literature about positive psychology and subjective well-being. Although there are several tests to measure this construct, most of them have been applied to people accustomed to meditation. Furthermore, in Spanish, there are very few alternatives to evaluate mindfulness. In this paper, we analyze the psychometric properties of the FMI-14. Specifically, we use Item Response Theory (IRT) and Biplot methods. We found that some items could be remove from the scale and it would have practically the same information capacity. In addition, the study found that the items have low discriminative power. It is concluded that combined application of TRI and Biplot methods, can contribute significantly to multivariate analysis of psychometric tests.

KEYWORDS mindfulness, item response theory, biplot methods, FMI-14.

Introduction

Currently, in the field of psychology welfare, *mindfulness* is one of the most researched topics.

This concept refers to the ability of an individual to be fully in present, and to respond flexibly to environment pressures (Argote, 2006). Studies on mindfulness are becoming frequent in health sciences because it has been found that it can greatly regulate emotions (Baer, 2003), helps reduce depression (Hayes & Feldman, 2004; Jimenez, Niles, & Park, 2010; Segal, Williams & Teasdale, 2002), and affects the perception of stress and the quality of life (Astin, 1997; Grossman, Schmidt, Niemann & Walach, 2004; Kabat-Zinn, 2013; Nyklíček & Kuijpers, 2008).

In order to measure the level of mindfulness in an individual, some researchers have developed many instruments: Mindfulness Attention Awareness Scale - MAAS (Brown & Ryan, 2003); Friburg Mindfulness Inventory - FMI (Walach, Buchheld, Buttenmüller, Kleinknecht, & Schmidt, 2006); Toronto Mindfulness Scale - TMS (Lau et al., 2006); Philadelphia Mindfulness Scale - PMS (Cardaciotto, Herbert, Forman, Moitra, & Farrow, 2008); among others. However, despite the wide variety of studies that exist in this regard, the literature still discusses the dimensionality of the construct (Soler, 2014). For example, Lau et al. (2006) suggest that mindfulness should be considered a two-dimensional concept, they found an attentional factor (consciousness) and an attitudinal factor (acceptance), an approach which is also defended by Cardaciotto et al. (2008). On the other hand, there are researchers who believe that mindfulness refers primarily to care what happens in the present moment. In this line are Brown and Ryan (2003) and Wallach et al (2006).

The above-mentioned instruments have something in common: they have been used mostly in people who practice meditation. This situation could cause the results have little validity in subjects that do not usually meditate. That is unfortunate if we think that these people are the majority of the population, and they are precisely who most likely to benefit from mindfulness. In this regard, it is pertinent to mention that tests used in this context would be closer to a measurement of willingness to mindfulness (Jimenez et al., 2010), as they are evaluating the levels of mindfulness that arise spontaneously, and not intentionally sought as in practice of meditation.

One of the few scales that exist to evaluate mindfulness in people unfamiliar with meditation is the FMI-14, abbreviated version of Friburg Mindfulness Inventory (Wallach et al., 2006). This questionnaire has already been translated and validated into English (Leigh, Bowen, & Marlatt, 2005), German (Heidenreich, Ströhle, & Michalak, 2006) and French (Trousselard et al., 2010). The aim of this study is to perform a multivariate analysis of the Spanish version of the FMI-14, in order to better understand its psychometric characteristics. For this, some statistical analysis techniques were applied to a data array composed of 200 rows (individuals) and 14 columns (items). Specifically, analyzes were performed with Item Response Theory and Biplot methods.

Method

Item Response Theory (IRT)

The IRT represents a new perspective in psychometrics and multivariate statistics. More than a theory, IRT consists of a diverse range of measurement models that try to incorporate information about cognitive processes that influence when responding to an item (Rupp, 2003). This approach, also called Latent Trait Theory assumes that skill or trait between the individual and the answer given to the item, there is a nonlinear relationship that can be expressed in probabilistic terms. Thus, this kind of analysis relates the characteristics of the test questions and features of individuals, with the probability of choosing each response category (Chernyshenko, Stark, Chan, Drasgow, & Williams, 2001).

The IRT allows to obtain a pair of measures from an item: its level of difficulty and its discriminatory capacity. Such properties belong to the characteristic curve of Item (CCI), equivalent to a nonlinear regression on the probability of correctly answering each of the questionnaire items (McGrory, Doherty, Austin, Starr, & Shenkin, 2014). There are several models in the IRT, and these can be defined depending on the number of response alternatives of the items (dichotomous/polytomous) or according to the amount of estimated parameters.

To analyze the characteristics of FMI-14, a two-parameter logistic model was used. Thereby, difficulty (b) and discriminative power (a) of the items were estimated.

a = discrimination index

$$P(\theta) = \frac{e^{Da(\theta-b)}}{1 + e^{Da(\theta-b)}}$$

P (č) = probability of guessing right.

č = skill level of the subject.

b = difficulty index.

e = base of natural logarithms (2.718).

D = constant = 1.7 (value entered for the logistics function to be adjusted to normal ogive with an accuracy of 0.01).

The parameter "a" indicates the slope of the ICC when č = b; the values of this parameter can be from 0.3 to 2.5, considering as discriminative items that are above the unit.

Biplot methods

Within the wide range of multivariate analysis methods, researchers have given great importance to the implementation of Biplot methods in several fields of knowledge due to the reliability of its results. The origin of these techniques dating back to the seventies, when Gabriel (1971) introduces with the main objective to describe approximately a rectangular array using a graphical representation in small size, which allows visualizing the relationships between individuals and variables. In other words, to jointly represent rows and columns of a matrix (Galindo, 1986). Thus, a biplot is a graph of a matrix XI×J with row and column markers a1,…,aI and b1,…, bJ, respectively, chosen in such a way that the inner product $a_i^T b_j$ is the element xij of X. The rows and columns of this marker matrix are the coordinate points in a Euclidean space related to the same orthogonal axes (Nieto, Galindo, Leiva & Vicente-Galindo, 2014). So, the factorization Biplot ensures approximate graphical representation of the matrix, as each xij can be reconstructed as follows: $Xij = a_i^T b_j$ (i = 1, 2,…..I; j = 1, 2,…..J).

There are various types of Biplot, because according to the factorization performed different markers are generated. To graph the FMI-14 GH-Biplot was used, this type of graph preserves the usual Euclidean metric between the columns, obtaining a high-quality rendering for them. Regarding the interpretation of GH-Biplot should be noted that the rows (individuals) are represented as points and columns (variables) as vectors. Direction of vectors reflects the direction in which the values of the variable increase, and projections of all points on a row vector in particular breed about the ordering of individuals with respect to that variable. The distance between individuals indicates dissimilarities, i.e. the proximity between points reflects the similarity between individuals regarding the different variables.

The GH-Biplot also allows to interpret the variability of the variables and correlation between them. The longer a vector, the greater the variability of that variable. Therefore, it is also greater information that this variable contributes to the study. On the other hand, to know the degree of association between variables is necessary to look at the angles among vectors: the smaller they are the greater the degree of correlation. Plains angles indicate inverse correlation between variables, and right angles indicate independence between them.

Software

The analysis of the TRI were carried out with the R-Project program (R Development Core Team, 2012) and ltm package (Rizopoulos, 2006). The GH-Biplot representations were made with the MultBiplot (Vicente-Villardón, 2010), and factor analysis with SPSS 22 (IBM, 2013).

Results

When analyzing data from the perspective of traditional factor analysis (based on the correlation matrix), it is observed that all items meet the minimum recommended saturation (0.30). Although we must say that with a stricter cutoff point, namely 0.40, item 2 would be out of the unifactorial solution. Shifting the factorial model to IRT parameters, it is seen that none of the items has much difficulty. This indicates that very little trait level (mindfulness) is required to be measured by the instrument (Table 1).

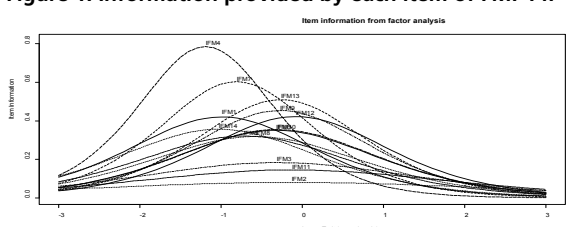
Table 1. Difficulty and discrimination parameters.

Item	Difficulty	Discrimination
1	-1.238	1.420
2*	-0.422	0.507
3*	-0.619	0.840
4	-1.105	1.974
5	-1.054	1.168
6	-0.468	1.192
7	-0.880	1.617
8	-0.862	1.142
9	-0.357	1.333
10	-0.444	1.202
11*	-0.263	0.798
12	-0.113	1.300
13	-0.338	1.316
14	-1.374	1.326

Note: Less discriminative items (*).

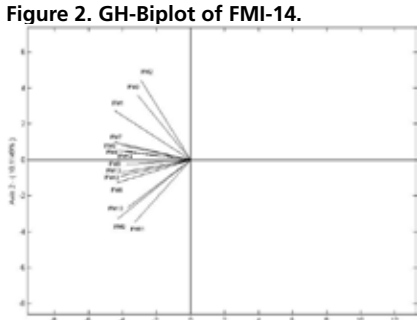
It was also found that items 2 (I feel my body when I cook, clean or talk to other people), 3 (When I realize that my mind is distracted, gently return to the experience of the here and now) and 11 (In situations difficult, I can pause without reacting immediately), they are not useful to discriminate between different levels of Mindfulness, so these are the ones that provide less information (Figure 1).

Figure 1. Information provided by each item of FMI-14.



The Figure 2 shows the 1-2 plane of GH-Biplot, where the accumulated inertia amounts to 39.2%. There it can be seen that there is a high positive correlation between items 4 (I am able to appreciate me myself), and 14 (I'm able to smile when I realize how I sometimes make life difficult) as the angle generated between these vectors is the smallest among all. This pair of items also have a very strong relationship with items 5 (I pay attention to what's behind my actions) and 7 (I feel connected to my experience here and now). Other associated items are 8 (I accept the unpleasant experiences), 13 (I am patient with myself and others), 12 (I experience moments of peace and quiet even when things get agitated and stressful) and 6 (I see my mistakes and difficulties without judgment).

Figure 2. GH-Biplot of FMI-14.



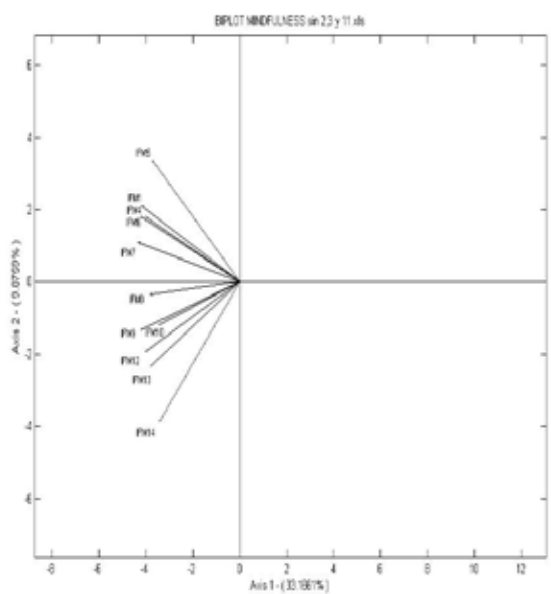
In summary, there is a high association between the above-mention items (4, 5, 6, 7, 8, 12, 13, 14), since these are which have more homogeneous behavior. Moreover, there seems to be two sets of interrelated elements: on one hand, items 2 and 3, and on the other, items 9, 10 and 11.

Discussion

This paper has studied the behavior of the items in the Spanish version of FMI-14 with different statistical techniques. First, from the viewpoint of classical test theory, the solution generated by the Factorial Analysis found that, except for the number 2, all items saturated enough on a single factor. However, in the analysis from the IRT it was obtained that the latter and items 3 and 11, were contributing less information to the instrument. These results suggest that such items are dispensable and could be removed from the scale, resulting in a shorter and consistent instrument, and which would get practically the same information.

By using the GH-Biplot again to graph the FMI-14 without such items, it is seen that the remaining structure is more uniform (Figure 3). Even with only these 11 items a higher percentage of inertia is absorbed, then it would explain up to 43.0% of it, when previously we could only explain 39.2%. This is important if we remember that the main objective of any multivariate analysis is to explain and describe as much information as possible with the least amount of variables, that is to say more with less (Frías-Navarro & Pascual, 2012; Peña, 2002).

Figure 3. GH-Biplot of FMI-14 without items 2, 3, and 11.



Another important finding from the IRT is the low discriminative power of the items, showing that the instrument has a limited capacity to discriminate between different levels of mindfulness, although it may be useful to identify whether or not people have this trait. This is interesting if one considers that the analysis was done with ordinal data, not binary. Future research could compare the results obtained with both types of data and examine whether there are significant differences in response patterns provided by individuals depending on the nature of the data or the way they are treated.

Finally, the GH-Biplot proved to be a useful tool for analyzing data derived from the application of an instrument of psychological assessment tool, in this case the FMI-14 in its Spanish version. It has become clear the advantage of using methods of graphic representation, as opposed to mere descriptions of models and their analysis presenting only numerical aspects.

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