ABSTRACT

The aim of this study was to propose and validate the new scaling method, fuzzy partial credit scaling (FPCS), which combines fuzzy set theory with the partial credit model (PCM) to score rating scales. To achieve this goal, the Chinese version of BDI (Beck Depression Inventory-II) was administrated to a depressed sample of patients and a non-depressed sample. The depressed sample consisted of 240 outpatients who were diagnosed as depressed by a psychiatric doctor, while 321 undergraduate students were recruited for the nondepressed sample.

In FPCS, triangular fuzzy numbers were generated by step parameters to characterize distributions of each alternative value. Next, the center of gravity (COG) method was applied to "de-fuzzify" the fuzzy number into a scalar. Then, the "observed fuzzy scores" defined in FPCS were calculated as the sums of fuzzy number values weighted by membership degrees for the following analysis.

Three studies were performed to compare the differences in reliability, validity and clustering precision between the raw score and FPCS.

In Study One, the reliability issue of FPCS was discussed. The results of confirmatory factor analysis demonstrate that the BDI reliability was higher in FCPS than in raw scoring. That is, compared with raw scoring, scoring via FPCS produced fewer measurement errors, meaning that more variances in an item of BDI were explained by depression.

In Study Two, the predictive validity issue of FPCS was investigated. First, logistic regression analysis was used to predict the odds of suffering depression based on FPCS and the raw scores. The analytical results showed that, via FPCS, the probability of correct classification of depressed and non-depressed was raised from 74.8% to 77.2%. Next, discrimination analysis was performed to classify the subjects according to the severity of depression into three categories: non-depression, depression with remission and depression without remission. The analytical results exhibited that, via FPCS, the probability of correct classification of severity of depression was raised from 71.2% to 80.7%. These two statistical analyses consistently show that FPCS exhibited higher predictive validity than did the raw score. That is, BDI scoring via FPCS makes more accuracy predictions for depression than raw score .

In Study Three, fuzzy c-means (FCM) clustering was applied to partition the sample according to severity of depression. To examine explore whether fuzzy-based clustering methods uncover the information inherent in the latent structure more

accurately than crisp clustering, FCM, Wald's method, and k-means method were performed. The analytical results reveal that the association between the original and classified membership generated by FCM was stronger than that of the Wald and k-means methods. Hence, FCM revealed the data structure most accurately.

Overall, FPCS has been consistently shown to be superior to raw scoring in terms of reliability, validity, and clustering accuracy. This study has empirically shown that fuzzy set theory is applicable to psychological research.