Analysis of Fuzzy Cluster for Mental Health

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SUMMARY Recently, there are many Japanese citizens living abroad in Asia, including developing countries. However, not many studies have been conducted regarding their mental health. The purpose of this study was to see what kinds of stress people experience when living abroad. Japanese workers living abroad, including some who are married to foreign nationals, and their families were asked seven questions in a survey, and they provided answers to questions in agreement with the intent and purpose of this study. Morphological analysis of the results and category classification by word class was carried out. This category was arranged by word classes. Additionally, the tendencies of responses were categorized according to the KJ method. In response to the question, “Do you have any trouble because of cultural differences?” these responses were classified according to common features. A fuzzy cluster analysis was carried out based on this information. Meaningful clusters were obtained by fuzzy cluster analysis. Differences in the values of stress and family culture can best be described by fuzzy cluster analysis.

key words: mental health, questionnaire, living abroad, fuzzy cluster analysis

1. Introduction

The number of Japanese people living abroad has surpassed one million. There are many different types of living and working situations for these people. Some of them are living alone, having left their families in Japan. Others are living in small towns or remote areas. This could be for people living in China or Thailand. People living in cities, as well as these people, suffer from a lot of stress.

According to the Statistics Bureau, based on the Annual Report of Statistics on Japanese Nationals Overseas by the Ministry of Foreign Affairs of Japan in 2011 [1], the number of Japanese currently living abroad totaled 758,788. Asia had the most with 299,868.

The total number of Japanese workers living abroad is 480,072, including foreign students but excluding family. In all, 192,618 people are working in and across Asia. The breakdown is: China 91,102, Thailand 29,433, Taiwan 12,333, Singapore 11,769, Philippines 9,249, Korea 8,340, Indonesia 7,130, Vietnam 6,134, and so on. This is the number of people who have turned in notice of residence; it does not include people who repeatedly take business trips for one or two months at a time.

Along with the economic growth of Asia, especially China and Taiwan, more and more people are being assigned to work abroad. This was not the case before, but now it is quite common for Japanese workers to be sent to work in these Asian countries.

Japanese people living abroad have to get used to working in a new place, a new life style, a different culture and language. Their colleagues are not Japanese in many cases. For example, they have difficulty communicating, and when they have a problem, they do not have anyone they can really confide in, so they become isolated. They become stressed, but it is a different kind of stress from that which might be experienced in Japan. They feel a lot more stress. The purpose of this study was to see the difference in the kinds of stress people experience when living abroad regarding both psychological and social conditions. China and Taiwan were selected for this survey because recently the number of Japanese people living there has been increasing.

In this study Japanese people living in China and Taiwan were asked seven survey questions, and a fuzzy cluster analysis was carried out.

Cluster analysis is a class of methods that can be applied to objects that exhibit groupings. Cluster analysis identifies similar objects to each other and groups them into clusters. There are lots of studies on cluster analysis in various fields such as statics, pattern analysis, data-mining and fuzzy theory [2]–[4]. A number of cluster analysis methods have been presented thus far. Among them fuzzy cluster analysis methods have the characteristics of easily dealing with ambiguous objects. For example, they were applied to classify articles and documents written in natural languages. Therefore fuzzy cluster analysis was adopted. In this study fuzzy cluster analysis was carried out according to keywords concerned with mental health. Meanings of these keywords are ambiguous and similarities among these keywords contain subjective factors. So in this study, psychology experts selected important keywords concerned with mental health and defined degree of similarity among the keywords. A morphological analysis of results of a questionnaire was carried out and categories were constructed according to the definitions of those keywords.

Research related to this study is divided into two major themes. One is concerned with the mental health of students overseas, such as international students on American college campuses [5]. The other is concerned with the adjustments of company employees to overseas assignments [6].
In the latter research, correlations between aspects of employees’ adjustment, such as job level, education level, language skills, outcome expectancy and so on are focused on, but relatively little attention is paid to mental health. Some research concerns employees’ adjustment to overseas assignments from the perspective of their mental health, but results are obtained through statistical analysis of answers from general questionnaires. This study focuses on the mental state of Japanese people living abroad, and the results are obtained through fuzzy cluster analysis of freely descriptive answers.”

2. Methods

2.1 Participants

There were 40 participants (17 men, 22 women and 1 unknown), age and name of company omitted due to protection of privacy.

The survey sites were urban areas in China and Taiwan, where it was comparatively easy to come into contact with Japanese language and culture.

2.2 Date of Survey

Date of survey: Aug., 2009 and Mar., 2010.

2.3 Procedure

i) Survey questionnaire

The respondents were asked 7 survey questions for which they provided answers.

1) How do you cope with stress?
2) Have you experienced any problems in your work due to cultural differences?
3) Have you experienced any problems in your private life due to cultural differences?
4) Have you ever thought things turned out better for you in your work because of cultural differences?
5) Have you ever thought things turned out better for you in your private life because of cultural differences?
6) Were there differences in stress before moving to a foreign country?
7) What changes did you experience before and after moving to a foreign country?

ii) Analysis

A) Creating word class category and context category

Morphological analysis of answers to the above survey questionnaire and category classification by word class was carried out. Table 1 shows part of the classification results for word level. According to Table 1, the words “rough”, “bad” and “cruel” belong to the same word class “Negative image (adjective)”. As for response level, tendencies of responses to questions were categorized using the KJ method [7]. For example, the response to the question “Do you have any trouble because of cultural differences?” was categorized with part of the classification result presented in Table 2. Word class category was based on morphological analysis. Context category was based on responses to questions.

B) Calculations for the degree of similarity of the category by word classes

The degree of similarity among texts was calculated, from all responses obtained from our questionnaire and defined using $tf \times idf$ (term frequency) and Vector-Space methods. Here $tf$ means the value which shows how many keywords are used in an identical text and $idf$ means the value which shows how many keywords are used in all responses. The degree of similarity places weight by multiplying them. The Vector-Space method was used for obtaining the degree of similarity among texts. Degree is decided by the number of valid categories. The product of $tf$ and $idf$ was used as the weight of a category. If two vectors are decided from responses to P1 and P2, the value of $\cos \theta$ can be obtained. A matrix of the degree of similarity among respondents was created based on normalization of the category by word classes. For example, Table 3 shows the calculated result of the degree of similarity for three respondents, with the value 0 to 100. Where the degree of similarity ranges from 100*costheta (0 $\leq$ costheta $\leq$ 1, that is, between 0% and 100 %). The degree of similarity between P1 and P3 is 60% and the degree of similarity between P2 and P3 is 80%. Therefore P2 is more similar to P3 than P1.
C) Placing weight using the category by KJ method

The degree of similarity using the category of word classes represents tendencies of how similar responses are. In addition, weights are added using the category KJ method to the degree of similarity. The following is the computation method of placing weights.

(Case 1) In the case of two respondents belonging to the same category by KJ method:

\[ \text{new weight} = \alpha + (100 - \alpha) \times \beta \]

Where \( \alpha \) is a degree of similarity using the category by word classes, while \( \beta \) is used when specialists want to show how much weight is given to specific values.

(Case 2) In the case of two respondents belonging to different categories by KJ method:

\[ \text{new weight} = \alpha - \alpha \times \beta \]

Note that since \( \alpha = 100 \cos \theta \) (\( \theta \) is an angle between vectors \( P_i \) and \( P_j \)) and \( 0 \leq \beta \leq 1 \), \( 0 \leq \text{new weight} \leq 100 \).

The computation is illustrated using Tables 2, 3 and 4. The degree of similarity between \( P_1 \) and \( P_2 \) is 60% in word level. However, \( P_1 \) and \( P_2 \) belong to different categories by the KJ method. Therefore the degree of similarity is reduced by 12 and becomes 48. The calculating formula is \( 60 \times 0.2 = 60 - 12 = 48 \), where we give 0.2 as a proper value of \( \beta \). On the other hand, \( P_2 \) and \( P_3 \) belong to the same category by the KJ method. Then 4 is added to the degree of similarity and it becomes 84. The calculating formula is \( 80 + (100 - 80) \times 0.2 = 80 + 4 = 84 \). Table 4 is constructed by multiplying weights using this method of calculation.

D) A normalized adjustment fuzzy matrix and reachability matrix

The normalized adjustment fuzzy matrix is obtained by Table 4. Each value of the normalized adjustment fuzzy matrix is equal to a value divided by a corresponding value in Table 4 multiplied by 100. A reachability matrix is obtained by repeating multiplication of the fuzzy matrices.

Note that a reachability matrix can be obtained in the following way.

Let \( F \) be a fuzzy matrix and \( R_1 = F \). Repeat the following multiple until \( R_{n+1} = R_n \).

\[ R_2 = R_1 \times F, \quad R_3 = R_2 \times F, \ldots, \quad R_{n+1} = R_n \times F \]

Then \( R_n \) is a required reachability matrix.

E) A construction of partition trees

A partition tree was made by referring to the reachability matrix, which obtained the resulting calculations.

3. Results and Discussion

In this study, as participants are particularly scarce and samples are rare, it is considered that 40 participants are enough. After combining all data regarding every respondent, the following results were obtained (Fig. 1). This data was complied and the names were given to each cluster. In Fig. 1, figures of boxes on the left side indicate degree of

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Table 4  Adjustment Fuzzy Matrix.

|     | P1 | P2 | P3 |
|-----|----|----|----|
| P1  | 100| 48 | 68 |
| P2  | 48 | 100| 84 |
| P3  | 68 | 84 | 100|

Fig. 1  Obtained partition tree.
similarity. Clusters with one element are omitted. For example, there are three clusters (F1, F2 and D3) in which more than one element exists. All elements are similar to each other, being more than or equal to 80% degree of similarity. Cluster F1 has 28 elements. Cluster F2 has 2 elements and cluster D3 has 3 elements. Under the constraint of more than or equal to 80% degree of similarity, the other 17 clusters with one element each were constructed from among 40 people. These 17 clusters with one element are omitted in Fig. 1.

In the upper cluster of Fig. 1, it was found that there are two clusters “F1: stress experienced from differences in the values” and “F2: stress experienced from differences in family culture” from the view point of mental health. It implies that there are two overall causes, “differences in values” and “differences in family culture” in the mental health of Japanese workers living abroad.

“F2: stress experienced from differences in family culture”, causes some people to dislike it, others merely to keep their distance, and still others not to go along with it at all. Cluster F2 included descriptions such as “the range of family is too large” and “people have higher regard for parents and grandparents than in Japan”.

“F1: stress experienced from differences in the values” was divided into two clusters if the degree of similarity is changed from more than or equal to 80% into more than or equal to 83%. The first was “E1: work related stress” and the second was “E2: the boundary of cultural differences between one’s own country and the foreign country where he/she is working”. “F1: stress experienced from differences in the values” included descriptions of differences in the way people think and act between Japan and foreign countries. “E1: work related stress” came from prior negotiating and quality control, that is, over how it is done and people’s way of thinking. This causes people to experience conflicts. The way to alleviate this kind of stress was by playing golf with colleagues. “E2: the boundary of cultural differences between one’s own country and the foreign country where he/she is working” as sub-structures. This represents new knowledge derived from fuzzy cluster analysis.

Meaningful clusters in mental health could be obtained from this study. By applying fuzzy cluster analysis to free description responses, potential causes, which would not be obtained by popular selection type questionnaires, could be found in the mental health of Japanese workers living abroad.

In the future, the causes of stress of Japanese workers living abroad will be drawn from the clusters obtained. There also remains a need to compare this work with other approaches.

4. Conclusion

In previous research, results were obtained by statistical analysis of answers to survey questionnaires. These results show degrees of specific items or correlation among items. They are related to hypotheses assumed in advance. The results of this study were obtained by applying fuzzy cluster analysis to answers to survey questionnaires. The results show the hierarchical structure in the matter of answers to survey questionnaires. This hierarchical structure was not predicted in advance. For example “F1: stress experienced from differences in the values” has “E1: work related stress” and “E2: the boundary of cultural differences between one’s own country and the foreign country where he/she is working” as sub-structures. This represents new knowledge derived from fuzzy cluster analysis.

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