An Analysis of The Knowledge of Public Health Nurses Concerning Infants' Developmental Delays

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AN ANALYSIS OF THE KNOWLEDGE OF PUBLIC HEALTH NURSES CONCERNING INFANTS' DEVELOPMENTAL DELAYS

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The purpose of the present study was to analyze the knowledge of public health nurses (PHNs) concerning infants' developmental delays. It was a preliminary investigation for the improvement of our expert system to predict the developmental delays of infants on the basis of their mothers' information. Fifty-two PHNs with practical experience of five years or more served as subjects. They were asked to classify 35 signs of potential developmental delays in infants described as mothers' anxieties into several groups according to diagnostic features. The results by a multidimensional scaling technique showed that the diagnostic conception of PHNs to interpret abnormal signs of infants consists of the following four frames : (1) poor responsiveness to stimulation, (2) undergrowth, (3) disorders in the central nervous system, and (4) fragile health. These findings suggest that PHNs interpret mothers' concerns about development of their infants in these frames and thereby they predict the later developmental status of the infants.

Key words : expert systems, knowledge acquisition, developmental delays, public health nurses, infants, mothers, multidimensional scaling techniques.

Generally speaking, a mother's excessive anxiety about development of her infant negatively works for mother-infant interactions, but such anxiety may positively work as in the case where her anxiety eventually leads to early detection of developmental disorder of her infant (Nihei et al., 1986 ; Rogers, 1971).

We have an expert system developed to predict developmental delays on the basis of abnormal signs of infants which their mothers perceive during one year after birth. The main feature of this system is to use the mothers' concerns or anxieties about the development of their infants as the information source. The system succeeded in predicting the developmental status of individual infants with respect to being normal or below normal : The prediction was based on the mothers' information of 6-month-old babies who were reexamined one year later. The proportion of overall diagnostic-system agreement was over 80% (Murai et al., 1990).

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But our system is at a sprouting stage as an expert system since it merely predicts whether an infant will be delayed or not in its development. There are wide variations among the infants with developmental delays. They vary according to their developmental aspects and factors behind their delays. Treatment plans for them, therefore, should depend on the characteristics of their delays. If our system can make a diagnostic inference on the later developmental status of an infant, we should be able to make a meaningful treatment plan for the infant predicted to be delayed in an early period of development.

In the present study, we analyzed the knowledge of public health nurses (PHNs) concerning the developmental delays of infants, so that we can get the data which help us to improve the diagnostic inference of our expert system on the later developmental status of infants. We selected PHNs as subjects because: (1) PHNs have many opportunities of advising mothers who have anxieties about the growth and development of their infants, and (2) PHNs longitudinally observe infants with possible developmental delays, and have the knowledge of the relation between abnormal signs of infants and the later developmental status of infants. Because of their knowledge and experience, they are supposed to be able to interpret the developmental status of infants based on their mothers' information and also predict the future development of the infants. Such knowledge of PHNs is indispensable for the improvement of our system that takes up mothers' feelings toward their infants as the information source.

Buchanan et al. (1983) divided the stages of knowledge acquisition before producing an expert system into the following five stages: problem identification, conceptualization, formalization, implementation, and testing. According to their classification, this study corresponds to the conceptualization. That is to say, we would make clear the diagnostic conception to identify the characteristics of developmental delays through PHNs' knowledge.

For this purpose, multidimensional scaling (MDS) was used in this study. MDS was used as a way of describing the psychological representation which PHNs have concerning abnormal signs in infant development. Diagnostic frames by which PHNs understood those signs were shown through dimensional interpretation of the spatial model by MDS.

Method

Subjects: Subjects were 52 PHNs of seven districts in Niigata and Miyagi prefectures. The largest has live births over ten thousands a year and the smallest has under one hundred. Subjects had the practical experience of five years or more and the mean year of their experience was 13.4 years (range=5.0 to 34).

Stimuli: Stimuli were 35 items constructing EASY (Checklist for Early Atypical Signs of the Young) developed by Murai et al. (1986). These items consist of the abnormal signs of infants which their mothers would be able to perceive during

Table 1. List of the itmes of EASY used in the study

No.	Item	No.	Item
1.	Sleeping all day long	18.	Not looking around curiously
2.	Waking up at night	19.	Not following visually
3.	Sleeping little in daytime	20.	Not gazing at anything
4.	Irregular length of sleep	21.	No recognition when held up
5.	Crying little	22.	Scarcely smiling
6.	Crying always	23.	Hardly making voice
7.	Crying loud at night	24.	Flabby when held
8.	Crying in strange voice	25.	Stiff when held
9.	Sucking weakly	26.	Dislike for being held
10.	Taking milk too little	27.	Gaining little weight
11.	Vomiting frequently	28.	Easily falling ill
12.	No wish for milk	29.	Growing up slowly
13.	Not satisfied after sucking	30.	Slow limb movement
14.	No response to mother's call	31.	Convulsive fit
15.	Vacant look	32.	Too quiet
16.	Not reaching for anything	33.	Too nervous
17.	Slow eye movement	34.	Strange look in the eyes
		35.	Always in motion

one year after birth. Our system mentioned above has obtained the mothers' information by EASY. Table 1 shows a list of the items in shorted form. These items are classified into seven categories: sleeping (4 items), crying (4), feeding (5), social reactivity and exploratory behavior (10), behavior when held up (3), growth and health (5), and activity and general impression (4). Each of the items was printed on a card (length 1.5 cm $\times$ width 8.0 cm).

Procedure: PHNs were asked to do the sorting task by the method developed by Rosenberg, Nelson, and Vivekananthan (1968), as it is useful when subjects have too many stimuli to treat.

The subjects were shown the 35 cards in random order and instructed as follows: "Items of these cards are mothers' concerns or anxieties concerning the growth and development of their infants at about 6 months old. Please classify these items into several groups according to their diagnostic features. I leave it to you how many groups you will make. When you have finished the classification, please put the cards in the envelopes with the name of each group on."

After the task, the subjects were asked to report their strategies in sorting. They performed the task at their own paces and finished it in about 30 minutes.

Results and Discussion

The number of groups made by the subjects ranged from 3 to 11 with a mode of

5 groups. These groups were classified into 10 categories according to their contents. Table 2 shows these categories and the items classified by the subjects in each category from the first to the fifth.

To analyze the data by MDS, we need dissimilarity matrices of interstimulus distances. We got the dissimilarity matrices as the following procedure (Kruskal & Wish, 1978). Similarity matrices were first obtained by counting the number of subjects who classified each pair of the items into the same group. Then the similarity matrices were transformed into dissimilarity matrices by subtracting individual elements of the similarity matrices from the number of all subjects ($N=52$).

Table 2. Items classified by the subjects in each category from the first to the fifth.

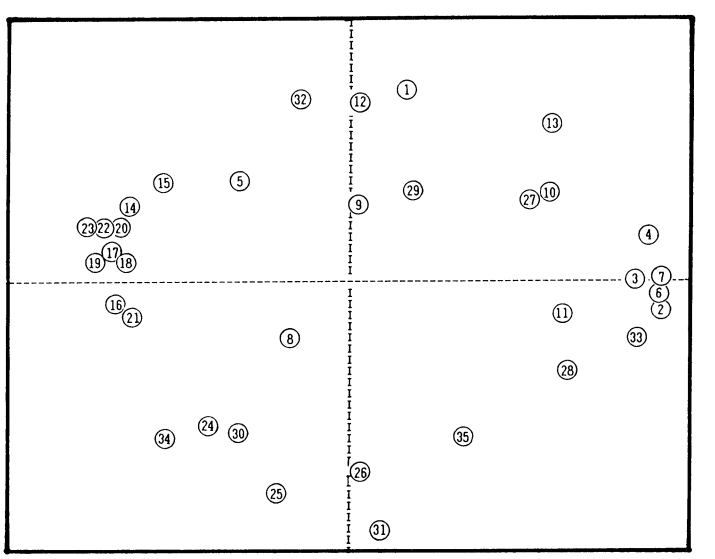
Category : item	Percentage[a] ($N=52$)	Category : Item	Percentage ($N=52$)
(1) Disorders in the CNS :		(6) Fragile health :	
Stiff when held	48.1	Easily falling ill	48.1
Flabby when held	36.5	Convulsive fit	38.5
Slow limb movement	34.6	Vomiting frequently	36.5
Convulsive fit	34.6	Gaining little weight	25.0
Dislike for being held	32.7	Crying in strange voice	21.2
(2) Undergrowth :		(7) Undernourishment :	
Growing up slowly	34.6	Not satisfied after sucking	36.5
Flabby when held	30.8	Taking milk too little	30.8
Stiff when held	30.8	Gaining little weight	25.0
Not reaching for anything	28.8	Sucking weakly	21.2
Sucking weakly	26.9	Growing up slowly	21.2
(3) Mental retardation :		(8) Environmental problems :	
Vacant look	23.1	Waking up at night	36.5
No response to mother's call	19.2	Sleeping little in daytime	36.5
Too quiet	19.2	Crying loud at night	36.5
Not reaching for anything	17.3	Irregular length of sleep	32.7
Scarcely smiling	17.3	Too nervous	30.8
(4) Emotional abnormality :		(9) Temperamental problems :	
No response to mother's call	17.3	Sleeping little in daytime	30.8
Vacant look	17.3	Crying always	28.8
Scarcely smiling	17.3	Crying loud at night	28.8
Not gazing anything	13.5	Too nervous	28.8
Crying little	11.5	Waking up at night	26.9
(5) Sensory abnormality :		(10) Environmental and temperamental problems :	
Slow eye movement	26.9	Waking up at night	11.5
Not following visually	26.9	Sleeping little in daytime	11.5
Not looking curiously	19.2	Crying lound at night	11.5
Not gazing at anything	19.2	Irregular length of sleep	9.6
Strange look in the eyes	19.2	Crying always	9.6

[a] Percentage of subjects who classified each item into each category.

The alternating least-squares scaling (ALSCAL) procedure in the statistical analysis system (SAS) package was used for analyzing the data. The data were analyzed with Euclidian model. Four-dimensional solutions were obtained with a 0.09 stress value. Kruskal (1964) has suggested that a 0.1 stress value indicates a fair fit.

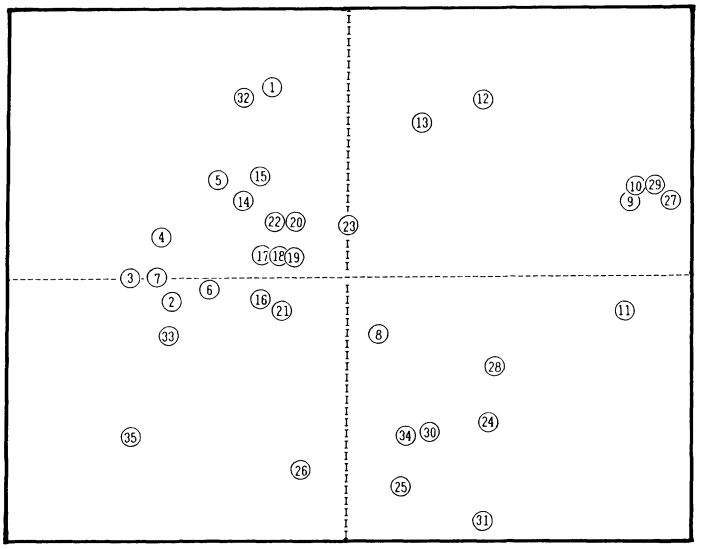
We did not use multiple regression analyses as a method to objectively interpret the dimensions of configurations described by MDS. Because our study was a preliminary investigation, we could not hypothesize the factors related to the configuration beforehand. Therefore, we want to interpret the dimensions of the configuration on the basis of meanings which the subjects gave to the items in classifying and of their introspection after the task.

Figure 1 shows 35 items in a plane of dimension 1 (horizontal) versus dimension 3 (vertical). The numbers correspond to the serial ones of the items in Table 1. Going from the left side to the right side, the items showing traits of poor responsiveness to stimulation appear to decrease. For example, the items such as "Hardly making voice (No. 23)", "Not following visually (No. 19)", "Scarcely smiling (No. 22)" and the like are plotted close together on the end of the left side. They correspond to the categories of "Mental retardation", "Emotional abnormality" and "Sensory abnormality" in Table 2. On the other hand, the items such as "Crying always (No. 6)", "Crying loud at night (No. 7)", "Waking up at night (No. 2)" and the like are plotted close together on the end of the right side. They correspond to the categories of "Environmental problems", "Temperamental problems" and "Environmental and temperamen-



Dimension 1 (Horizontal) vs Dimension 3 (Vertical)

Fig. 1. Configuration of 35 items derived in dimension 1 and dimension 3.



Dimension 2 (Horizontal) vs Dimension 3 (Vertical)

Fig. 2. Configuration of 35 items derived in dimension 2 and dimension 3.

tal problems" in Table 2. The subjects seem to interpret that these items indicate the behavioral traits of infants with difficult temperament and also the reactions of infants caused by inappropriate environment. The infants characterized by these items are relatively sensitive to changes in environmental stimuli. Therefore, dimension 1 is interpreted as the axis of poor responsiveness.

Figure 2 shows 35 items in a plane of dimension 2 (horizontal) versus dimension 3 (vertical). Going from the right side to the left side, the items showing traits of undergrowth and undernourishment appear to decrease. For example,the items such as "Growing up slowly (No. 29), "Gaining little weight (No. 27) and "Sucking weakly (No. 9)" are plotted on the right side. These items correspond to the categories of "Undergrowth" and "Undernourishment" in Table 2. On the other hand, the items such as "Sleeping little in daytime (No. 3)", "Always in motion (No. 35)" and the like are plotted on the left side. They correspond to the categories of "Environmental problems", "Temperamental problems" and "Environmental and temperamental problems " in Table 2. The infants with behavioral traits described in these items are supposed to be active and vigorous. In general, these behavioral traits are not related with undergrowth and undernourishment. Accordingly, dimension 2 is interpreted as the axis of undergrowth.

Next, Going from the lower side to the upper side, the items showing clear traits of disorders in the central nervous system (CNS) appear to decrease. For example, the items such as "Convulsive fit (No. 31)", "Stiff when held (No. 25)" and "Dislike for being held (No. 26)" are plotted on the lower side. These items exactly correspond to

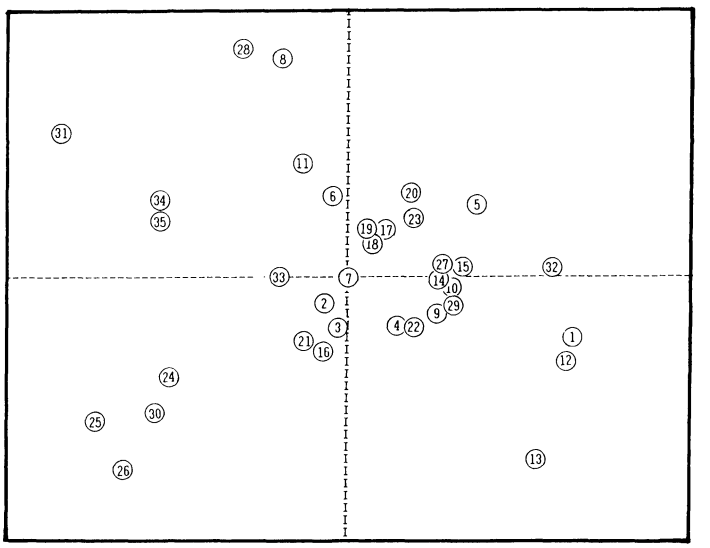


Fig. 3. Configuration of 35 items derived in dimension and dimension 4.

the category of "Disorders in the CNS" in Table 2. On the other hand, the items such as "Sleeping all day long (No. 1)", "Too quiet (No. 32)" and "No wish for milk (No.12)" are plotted on the upper side. These items are also considered to be slight signs of disorders in the CNS. But it is difficult to suppose that the infants characterized by these items would have disorders in the CNS unless they show other abnormal signs in development. Therefore, dimension 3 is interpreted as the axis of disorders in the CNS.

Finally, Figure 3 shows 35 items in a plane of dimension 3 (horizontal) versus dimension 4 (vertical). Going from the upper side to the lower side, the items showing traits of fragile health appear to decrease. For example, the items such as "Easily falling ill (No. 28)", "Crying in strange voice (No. 8)" and "Convulsive fit (No. 31)" are plotted on the upper side. These items correspond to the category of "Fragile health" in Table 2. "Convulsive fit (No. 31)" in dimension 3 was considered to indicate disorders in the CNS. On the basis of the subjects' introspection, however, the same item is also interpreted as a transient convulsion such as a febrile one. On the other hand, the items such as "Dislike for being held (No. 26)", "Stiff when held (No. 25)", "Not satisfied after sucking (No. 13)" and the like are plotted on the lower side. "Dislike for being held (No. 26)" and "Stiff when held (No. 25)" in dimension 3 were considered to indicate disorders in the CNS. But, according to the subjects' introspection, such reactions as described in these items are also considered to indicate the characteristics of infants with higher activity. Further those reactions are intepreted as ones caused by inexperienced mothers. In general, the behavioral traits described in these items are not related with fragile health. Therefore, dimension 4 is interpret-

ed as the axis of fragile health.

Conclusion

The results showed that the diagnostic conception of PHNs to interpret abnormal signs of infants consists of the following four frames: (1) poor responsiveness to stimulation, (2) undergrowth, (3) disorders in the CNS, and (4) fragile health. These findings suggest that PHNs interpret mothers' concerns about development of their infants in these frames and thereby they predict the later developmental status of the infant.

These findings will help us to reconstruct our expert system. However, the clinical validity of the system will not be established without testing it in our prospective study now in progress.

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