

Characteristics of Practical Nursing Knowledge from Biological Data – Analyses of EEG in Performing Blood Collection –

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Abstract. Nursing skills include many “Proficient skills” and “knacks”, it is said that the handing down them to new nurses is difficult because of their “tacit nature”. In this study, we devoted attention to biological data, such as the electroencephalographic (EEG) data, and their changes as a method for converting tacit knowledge into formal knowledge. We analyzed the characteristics, including the differences in the changing state of tension or concentration between nurses and beginners from the EEG data. In the experiment the participants were 2 nurses and 11 beginners who had no knowledge or experience of blood collecting skills. We divided the 11 beginners into two groups randomly to ascertain differences between Group 1 and Group 2. Group 1 comprised six beginners without a time limit for blood collection, whereas Group 2 comprised five beginners with a specific time limit (60 s). They performed blood collection skills 11 times each using an infusion and blood collection trainer (Adam, Rouilly Ltd.). We measured their EEG (in the prefrontal cortex area) at the time for comparison. For the analysis we used the β/α value as an indicator of tension and the θ/α value as an indicator of concentration of this time from the brain waves, and compared the β/α values with the θ/α values in each group (Group 1, Group 2, and nurses). Results revealed that nurses were in a state of concentration with calm during the performance with the predominant θ/α value. The β/α values were predominant with most beginners from Group 1. In contrast, θ/α values were predominant with most beginners from Group 2. Therefore, when beginners were given a time limit, they were able to concentrate on the sensitive task rather than become tense. Consequently, when beginners learn tense skills that demand physical aggression such as blood collection, some moderate limits are effective for beginners, especially in overly tense circumstances. We plan to analyze the differences between more nurses and more beginners and the processes by which beginners come to acquire proficiency, and to clarify characteristics of practical nursing knowledge.

Keywords. Nursing skills, Tacit Knowledge, Electroencephalographic (EEG), Learning Support, Blood Collection Skills

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investigated whether the difference between the three groups can be applied to the learning support of nursing skills.

1. Experimental Methods

1.1. Experimental Participants

We conducted an experiment with two nurses (female), and 11 beginners (8 male and 3 female, average age 22.1 ± 2.9) who had no knowledge or experience of blood collecting skill.

We divided the 11 beginners into two groups. The first group comprised six beginners, who were given no time limit for blood collection. We call this Group 1. The second group, which included the other five beginners, was given a specific time limit (60 s) for blood collection (Group 2). The grouping of beginners was conducted randomly. We obtained prior consent from them for participation in our study.

1.2. Experimental Procedure

Using the following procedure, we collected data of nurses' and beginners' brain waves and video images during performing blood collection, and interviews after the experiment.

1. Watching the video educational materials of blood collection skills produced before the experiment, the beginners practiced the procedure 2–3 times under the guidance of nurses, using intravenous and blood collection trainers (Adam, Rouilly Ltd.).
2. After preparing the participants with leads for EEG (Brain Pro FM-929; Selsyne Aim Institutes), we first measured brain waves (prefrontal area) for 60 seconds at rest. Beforehand, the region used for the sensor (forehead) was wiped sufficiently to prevent the human body's sebum and perspiration from creating noisy data in the results.
3. They performed blood collection skills with trainers. We measured brain waves of members of the three groups. Each participant repeated measurements 11 times. Video recordings were taken throughout the experiments (Figure 1).
4. After the experiments were completed, we offered beginners semi-structured interviews related to their understanding of guidance before conducting blood collection skills, acquisition or knack of the skills, and tension during the experiment.



Figure 1 Measurement of EEG data in performing blood collection skills.

Table 1 Average values of the β/α and θ/α values of Group 1, Group 2, and nurses (one-way layout analysis of variance and non-parametric multiple comparison (Bonferroni method))

Average values β/α (tension)	
Group 1: Beginners (unlimited)	1.29 ± 0.41
Group 2: Beginners (for 60 s)	1.44 ± 0.41
Nurses (for 60 s)	1.41 ± 0.26
Average values θ/α (concentration)	
Group 1: Beginners (unlimited)	1.22 ± 0.48
Group 2: Beginners (for 60 s)	2.00 ± 0.72
Nurses (for 60 s)	2.35 ± 0.20

(* $p < 0.05$, *** $p < 0.001$)

Table 2 Average values of the β/α and θ/α values of Group 1 and Group 2 (two-sample t -test)

With Figure 2, we present the results of a comparison of the changes of β/α values with θ/α values of two nurses (nurse M and nurse N). When they performed blood collection procedures, the θ/α values were always predominant over the β/α values.

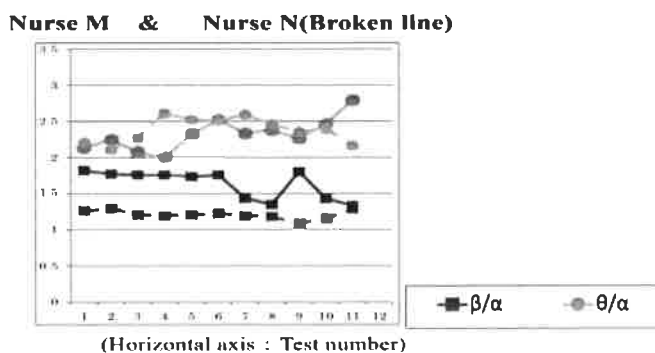


Figure 2 Comparison between changes of β/α values with θ/α values for each performance of nurse M and nurse N in blood collection skills.

With Figure 3, we present the results of a comparison of the changes of β/α values with θ/α values between nurse N and each beginner from Group 1, which consists of beginners without the time limit for blood collection. For three out of the six beginners {beginners 2, 3, 4}, the β/α values were always predominant over the θ/α values. For the other two beginners {beginner 1, 5}, θ/α values were predominant over the β/α values. For beginner {6}, the predominance of the β/α values and the θ/α values was reversed in experiments.

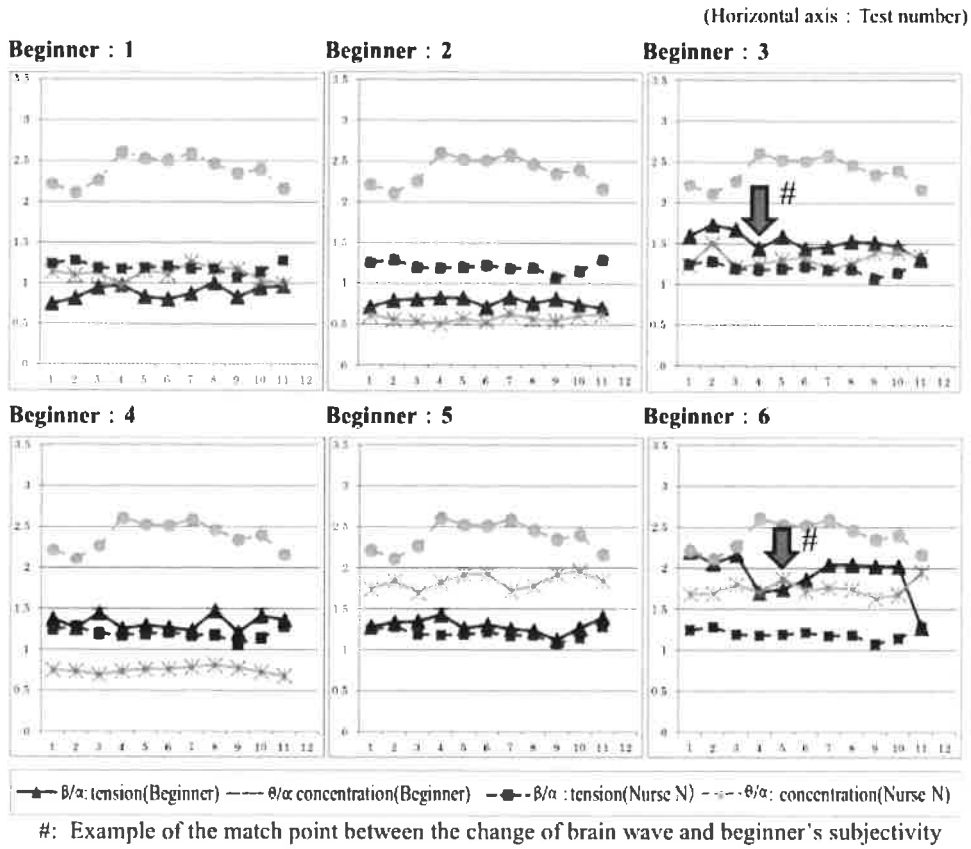


Figure 3 Comparison of changes of β/α values with θ/α values for each performance between each beginner in Group 1 and nurse N

Figure 4 presents the results of a comparison of the changes of β/α values with θ/α values between nurse N and each beginner from Group 2, which comprised beginners with the specific time limit (60 s) for blood collection skills. For four out of the five beginners {beginners 7, 8, 9, 10}, θ/α values were predominant over the β/α values, and differences between θ/α values and β/α values of Group 2 were greater than differences between those of Group 1. The β/α values of beginner {11} were predominant over the θ/α values alone in Group 2, but the differences between β/α values and θ/α values were small. Their predominance was reversed in the experiments.

(Horizontal axis : Test number)

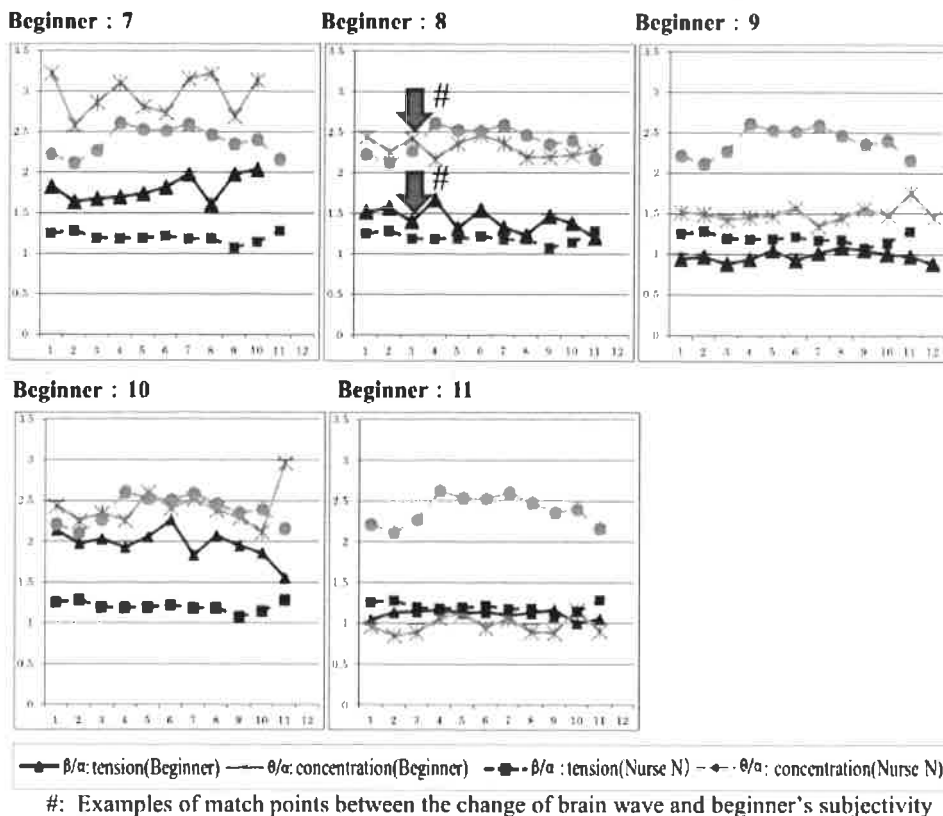


Figure 4 Comparison of the changes of β/α values with θ/α values for each performing between each beginner in Group 2 and nurse N

Table 3 presents results of a post-test interview related to tension felt by the beginners. All beginners were able to understand the procedures of blood collection, and four of them felt that they were able to acquire the blood collection skills at the fourth or fifth opportunity in the experiments.

Eight beginners felt tense at first, and four beginners felt that they were relieved of stress at the third or fourth opportunity in the experiments.

Table 3 Results of the post-test interview of beginners

Understanding of explained skills (knowledge level) (n = 11)	Understandable	11
	Not understandable	0
The performed times of acquisition the skills (n = 11)	First to second	1
	4 th to 5 th	4
	6 th to 7 th	2
	8 th	1
	I could not acquire the skills.	3
About tension (n = 11)	Nervous	8
	Not feel so tense	3
The performed times of being relieved of stress (n = 8)	Second	1
	3 rd - 4 th	3
	5 th	2
	Gradually	1
	Remained tense	1

5. Discussion

The results of analyzing brain waves in this study, as shown in Figure 2 suggested that, with nurses who experienced blood collection, the θ/α values were always dominant in the experiments, meaning that they performed the procedure with countenance. The θ wave is said to be more deeply relaxed and concentrated on the task than the α wave, appearing when the right brain is being used intensively [10]. One knack of the skills of inserting needles in blood collection and intravenous injection is to ascertain the site and circumstances of a patient's blood vessel [12]. If one can do it well, then the skills themselves are usually not perceived as difficult. Therefore, for nurses who have already realized the procedure related to the skills, the performance with blood collection trainers is not a situation in which they do not feel especially tense. They might be able to do it nearly automatically. Therefore, a significant difference was found between the θ/α values of nurses and the beginners (Table 1)

However, most beginners, who had not acquired the procedure and the image of the whole action yet, said they felt "tense" when performing the unusual action of inserting the needle into the blood vessel of the arm model to collect blood. Among the eight beginners {1,2,3,4,6,7,8,10} who answered that they felt "tense" in the interview, it was beginners {2,3,4,6,11} whose tension index for the β/α value was dominant. Among beginners {5, 9} whose θ/α value was dominant, the result of the figure corresponded with the result of subjectivity. Among beginners {1, 11} whose figures of tension and concentration did not correspond with their subjectivity, but the differences between both indexes were small. And for beginners {7,8,10}, their subjectivity and brain waves' characteristics were contradictory. Thus, for most participants, 10 of 13 participants including nurses, it is inferred that their subjectivity might correspond with their brain waves' characteristics. If we will consider the uncertainty and arbitrariness of subjectivity in evaluation of blood collecting skills, brain waves can be used as objective indexes.

Here, all beginners {7, 8, 10} for whom subjectivity and brain wave characteristics did not match were from Group 2. Generally, it is said that one's concentration rises when one is given a time limit. These results suggest that even if they subjectively believe that they are tense, they are sufficiently concentrated on the task in terms of brain waves by focusing on performing the skill within the limited time. Based on that result, when beginners learn tense skills that entail physical aggression such as blood collection, it is readily apparent that some moderate limits are effective for beginners, especially in overly tense circumstances, to concentrate on it rather than become tense.

The change of the β/α value and θ/α value each performance was confirmed by asking the beginners "In which performance did you become unaware of tension?" One beginner {3} showed a decreased β/α value in the fourth performance (arrow in Figure 3). With beginner {6}, the predominance of the β/α value and θ/α value were reversed in the fifth performance (arrow in Figure 3). For beginner {8}, the β/α value decreased and the θ/α value increased in the third performance (arrow in Figure 4): their subjectivity corresponded to their brain waves' characteristics. However, even if the change did not necessarily continue, because some participants showed distinctive negative correlation between the β/α value and θ/α value, as shown above, it is expected that the analysis of brain waves might enable high-precision measurements including those related to success and failure of each blood collection.

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