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# AN ERGONOMIC STUDY ON THE 'MORNINGNESS' AND 'EVENINGNESS' OF CALL CENTER AGENTS AND ITS EFFECT ON COGNITIVE PERFORMANCE

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## ABSTRACT

The increasing adaptation of shiftwork in the Philippines and its reported adverse effects had encouraged research studies among Filipino workers. This study aims to identify the circadian clock behavior of the shiftworker and its relationship together with the shift schedule against the level of performance. The subjects used in this study were call center agents. Subjects were initially asked to answer a compilation of survey from the Standard Shift work Index (SSI) and Swedish Occupational Fatigue Inventory (SOFI). During the experiment proper, three laptops with head microphones were used where each laptop contained the software and programs in measuring the speech ability, reaction time and memory of participants. Majority of the respondents belong to the morning type and only one belonged to the intermediate type. The General Health Score (SSI) of the agents was generally poor in the aspect of their psychological health. The Swedish Occupational Fatigue Inventory (SOFI) scores showed that the respondents did not experience excessive fatigue. Based on the two-way ANOVA, it was found that the three speech ability measures and reaction time were significant in terms of the performance deterioration at each schedule in relation to the body clock of the individual.

*Keywords:* Call center agent; Circadian clock; 'Eveningness'; 'Morningness'; Shift work

## 1. INTRODUCTION

Shiftwork has been prevalent around the globe, most especially in third world countries. Unlike the traditional working time, which is usually from 7:00 A.M. to 5:00 P.M., shiftwork schedules are often not fixed. According Muckenhuber (2009), shiftwork is defined as a method of designing a work schedule that goes beyond any worker's normal working time to allow continuity in the operating hours of the company. Härmä (1993) further defined it as a work setup made up of two or more teams that help each other to cover the workload in a given schedule. While for Gabud et al., (2015) shiftwork is an employment practice that involves irregular working hours that can be further categorized as follows: morning, midday, and night shift. In this study, the standard definition of shiftwork was defined as any work schedule that deviated from the traditional working hours that allowed continuous flow of operations, which in return helped the organization meet workload and customer demand from time to time (Mikalauskas et al., 1994; Ognianova et al., 1998; Wright et al., 2013).

Due to the shiftwork's effectiveness, other sectors in several countries, including the Philippines, followed and had also adapted this practice over the years. Among these sectors adapting shiftwork are the Healthcare and Business Process Outsourcing. Adapting the practice

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has helped these sectors to be more productive and be able to meet the increasing demands of the society. Furthermore, shiftwork contributes in minimizing operation costs in a way organizations invest on labor force rather than spending too much on infrastructure.

Despite the effectiveness of shiftwork, it had been reported to have underlying effects on its employees. Since work schedule is outside the normal working hours and is often during extreme times of the day, employees are said to experience negative effects related to health, sleep, and deterioration in performance. Additionally, they were also said to experience difficulties in terms of having a work-life balance (Saijo et al., 2008; Ferguson et al., 2008).

At present, call centers are considered to be one of the leading BPO (Business Process Outsourcing) industries locally, where they usually provide technical and customer support. As they serve as the third party of companies, they are engaged in adapting shiftwork, especially since clients are usually from other countries. Depending on the organization's needs, the schedules of employees may vary from time to time, leading to workers having extreme schedules and workloads.

Being identified as one of the several organizations adapting to shiftwork, the BPO agents from a call center will be considered as a subject of this study. In line with this, the study aims to identify the circadian clock behavior of the shift worker and its relationship, together with the shift schedule, against the level of performance and to investigate the different levels of performance through consistency and job deterioration per circadian clock type.

## 2. METHODOLOGY

### 2.1. Participants

The subjects used in the study were from the Business Process Outsourcing (BPO) sector, in particular the call center industry. In coordination with the company, all participants considered in the study belonged to one group in order to minimize disrupting the entirety of operations.

### 2.2. Materials

The initial survey compilation distributed had sections from the Standard Shiftwork Index (SSI), which were the Composite 'Morningness' Questionnaire and the General Health, and Social and Domestic Situation. The Composite 'Morningness' Questionnaire aims to identify if the individual was a 'morning' type, 'intermediate', or 'evening' type. The General Health was used to assess the psychological or mental health of the shiftworker. In addition, the Swedish Occupational Fatigue Inventory (SOFI) was also included in the compiled survey, which aimed to assess the fatigue experienced by the subjects.

During experiment proper, three laptops with head microphones were used where each laptop contained the necessary software and programs in measuring the speech ability, reaction time, and memory.

#### *2.2.1. Praat software*

The Praat software was used to measure the speech ability of each respondent. The software is capable of recording the voice of individuals and analyzing the voice according to its level of pitch, intensity, and harmonics-to-noise. The audio records the manner of speaking of agents and identifies the emotion and stress in the speaker's voice.

#### *2.2.2. Reaction time test*

The program used to assess the reaction time of respondents was a program online (Online Reaction Time Test, 2002), which is widely used to measure how fast an individual reacts to a signal. The reaction time program was used to test whether the circadian rhythm or the body clock of an individual and the shift schedule where an individual was assigned had significant effects on the speed of reaction time.

*2.2.3. Working memory capacity*

The Working Memory Capacity is a program developed by GoCognitive (2008) which primarily focuses on measuring short-term memory of an individual. The chosen test was an audio-memory where respondents will hear the numbers and will have to remember the sequence before entering the numbers. Each respondent used a headset microphone to be able to hear the numbers clearly. At the same time, this represents an incoming call interaction during actual operations.

## 2.3. Experimental Design and Procedure

The design procedure for the study was divided into two, which are the screening stage and pre-experimental design methodology. The first phase was the stage for determining which among the agents were qualified for the setting, while the second phase was for the experiment proper where the different tests will be performed for a single group of respondents.

Respondents were initially assessed from the survey, wherein they were grouped according to what body clock type they belonged to. For this study only three 'morning' types and three 'evening' types will be included in the experiment. These three of each type were those who obtained the highest general health score in their specific group. To be able to determine the experiment setting, Design Expert 9 software was used for the combinations of the experiment setting. A split-plot, multi-level categoric design was chosen, since there were different levels of factors in the study. Additionally, the circadian clock was a hard-to-change factor, which is very applicable for this model. In this study, agents were assigned to a shift schedule for two weeks. They were asked to perform the cognitive tests at the start and end of their shift. After two weeks, they were reassigned to another schedule and the same procedures were performed for the cognitive tests. After another two weeks, they were reassigned to the last schedule and performed that test again during the start and end of their shifts. All in all, they were scheduled for three shifts to be able to assess the performance of the 'morning' and 'evening' types at each schedule. The schedules that were followed were the current shift schedule of the account of the agents. The changing of schedule follows a forward rotation, wherein respondents were assigned first to the 12:00 A.M. shift for two weeks, 3:00 P.M. shift for the next two weeks, and 8:00 P.M. for the last two weeks. The experiment had two replicates, which mean that respondents performed the cognitive tests twice within the two-week schedule of each shift.

## 2.4. Experimental Variables

*2.4.1. Shiftwork schedule*

A shiftwork schedule is outside the normal working hours of 8:00 A.M. to 5:00 P.M. and goes beyond the morning-until-afternoon schedule and it has a night to morning schedule. Call centers are one of those industries that are engaged in shiftwork, having their operation hours outside the normal, especially the ones that handle foreign accounts. Since there are different time zones, the schedule would usually have time differences with the local time, especially when the implemented schedule depends on the account that the call center handles. At the same time, their schedules are subjected to management's decision.

Table 1 shows the summary of the schedule used by the researchers during the duration of the study. Agents were assigned to work on the first schedule (12:00 A.M.–8:00 A.M) for the first two weeks, then they were transferred to the next schedule (3:00 P.M.–11:00 P.M.) for another two weeks, and then to the third schedule (8:00 P.M.–4:00 A.M.) for the last two weeks.

Table 1 Shiftwork schedule of host company

| |
|---|
| 12:00 A.M. – 8:00 A.M. |
| 3:00 P.M. – 11:00 P.M. |
| 8:00 P.M – 4:00 A.M. |

For this study, the performance of each employee at the start and end time across all shifts was obtained. Since the study considered speed of rotation and time start of shift, the experiments were performed every start and end time during the two-week shift rotation, which is categorized as a slow speed of rotation. Since the schedule was changed to test if there were performance differences and deterioration on subjects, the schedule was considered as an independent variable.

*2.4.2. Circadian rhythm of individuals*

Circadian rhythm is divided into two periods, specificially, a 'morning' and an 'evening' type, wherein an individual can be assigned to either of the two. Morning types are related to 'morningness' or individuals who would usually wake up early in the morning and prefer to sleep early at night, while 'evening' types are related to 'eveningness'. These are individuals who prefer to wake up late and sleep late during the night as well. In this study, both types were assigned on the same shift schedules to be able to compare their performances at a given shift. This was to assess which between the two categories performs better at a given time, in terms of the difference in the scores of cognitive performance at the start and end of each shift. Since the study wanted to test whether the circadian rhythm of individuals in different shift schedules have an effect on their performance, it was assigned as an independent variable.

*2.4.3. Cognitive performance*

The study wanted to investigate the relationship between the circadian rhythm with the level of performance of the participants in each shift schedule implemented. There can be several performance measures that can be used in a call center set-up, such as handling time of calls and number of successful calls made, which are quantitative. However, these two depend on the complexity of calls, which may be difficult to determine. Another factor that can be looked into in measuring performance of agents is how an agent can handle the call in terms of communicating with the caller, speed of answer when trunk line is available, and his capability to memorize details given by the callers. These three were translated to three cognitive measures, which were speech ability, reaction time, and short-term memory. Overall, there are five dependent variables in this study, which is summarized in Table 2.

Table 2 Summary of cognitive measure variables

| Cognitive Performance | Description | Unit |
|---|---|---|
| Reaction Time | The time it takes agent presses the button when green light appears | Seconds |
| Memory | The number of correct sequence of numbers entered by agent | 1 or 0 (1 for correct and 0 for incorrect) |
| Pitch | The rate of vibration of focal cords while speaking | Hz |
| Intensity | The volume of the voice while speaking | Db |
| Mean harmonics-to-noise ratio | How high or low the voice is while speaking | Db |

*2.4.4. Fatigue*

As fatigue has its different kinds, one type of the fatigue that was looked into was the vocal fatigue. It is common for call center agents to experience vocal fatigue after talking consistently for eight hours a day. Due to this, they can develop throat strains and irritations that can further lead to loss of voice and effects on their voice quality. According to Work Cover Queensland (2013) symptoms of voice strain may include rough quality of voice, change in pitch, and

decrease in volume. In one study teachers were used as subjects, and their respective voices were recorded during their work in school. The results showed that the more time the teachers talk during class, the more fatigued their voice gets. In relation to their study, the researchers used the Praat software as the tool to measure the quality of the participants' voice during the start and at the end of their shift at different schedules. The differences in the voice quality characteristics between the times the test was taken were assessed to check if the voice quality was still acceptable or the agent was already experiencing vocal fatigue. Since voice was measured at different times, vocal fatigue was determined to be a dependent variable.

## 3. RESULTS AND DISCUSSION

### 3.1. Pre-test Results

The screening stage of the experiment enabled the researchers to identify the circadian clock of the participants through the initial survey distributed. Table 3 shows the overall summary of the individuals and their classification according to their circadian rhythm or body clock. This is divided into three groups - the 'morning' type, 'intermediate' and 'evening' type. It can be observed that majority of the respondents belong to the 'morning' type group, and there is only one individual who was classified as an 'intermediate' type. In this study, the 'intermediate' type would not be considered and the study would just include the comparison between the morning and evening types.

Table 3 Summary of agent's body clock

| Body Clock Type | Legend | Agents | No. of Agents |
|---|---|---|---|
| 'Morning' Type | M | B,D,G,I,J,K,M | 7 |
| 'Intermediate' Type | I | N | 1 |
| 'Evening' Type | E | A,C,E,F,H,L | 6 |

As the body clock types were assessed, the agent's psychological health, fatigue, and social and domestic situation were also evaluated through the other sections of the survey questionnaire. Other portions of the survey were comprised of the General Health Questionnaire (section of SSI), Swedish Occupational Fatigue Inventory (SOFI), and the Social and Domestic Situation Questionnaire (section of SSI), all of which were used to assess the current level or score of the agents in their psychological health, physical fatigue, and social and domestic situation in relation with their work.

#### *3.1.1. General health score*

The general health scores of the fourteen agents were normally distributed. By using one-sample t-test, the target mean for GHQ score was 4. This was the limit score for an individual to be considered psychologically healthy. Scores above it means an individual feels distress and had poor health in terms of psychological aspects. Figure 1 shows that the agent's scores were generally poor in the aspect of their psychological health.

#### *3.1.2. Physical fatigue*

The fatigue scores of the eighteen agents were normally distributed. By using one-sample t-test, the target mean for fatigue score was 12. This was the limit score for an individual before he/she experiences excessive fatigue. Scores above 12 mean an individual experiences more fatigue while performing work.

The p-value obtained from the test was 1.000 which means there was not enough evidence to conclude that mean fatigue score was greater than 12, thus rejecting the hypothesis. Figure 2 shows a summary describing the SOFI score obtained from the respondents.

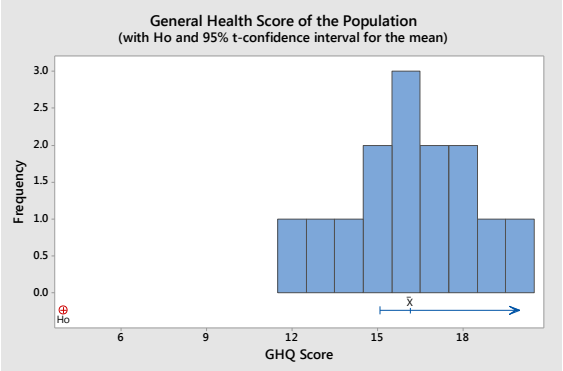


Figure 1 General health scores of the population

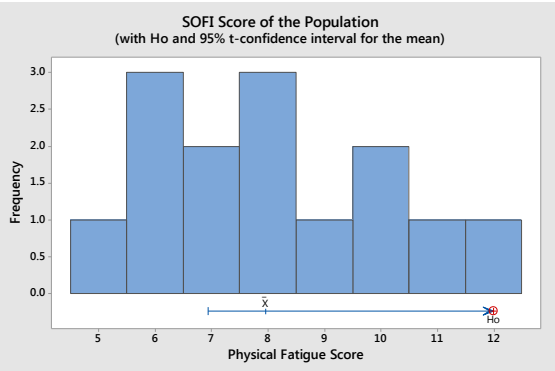


Figure 2 SOFI scores of the population

The p-value obtained from the test was 1.000 which means there was not enough evidence to conclude that mean fatigue score was greater than 12, thus rejecting the hypothesis. Figure 2 shows a summary describing the SOFI score obtained from the respondents.

### *3.1.3. Work-life balance*

The social and domestic situation scores of the fourteen agents were normally distributed. By using the one-sample t-test, the target mean for social and domestic situation score was 3. This was the score where respondents were very much involved in social and domestic activities despite their work schedule. The p-value obtained after the test was 0.003, indicating that the mean score of the population were significantly greater than 3, thus accepting the hypothesis. It can be seen that majority of the scores were more than the target limit of 3, which is an indication that most of them were socially involved in social activities outside work like having hobbies, spending time with family, and time alone.

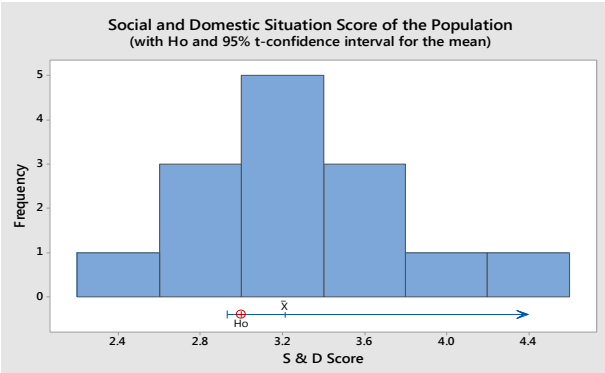


Figure 3 Social and domestic scores of the population

## 3.2. Experimental Results

### *3.2.1. Speech ability*

There were three speech ability measures considered in this study which were pitch, intensity, and harmonics-to-noise. The deterioration of 'morning' types and 'evening' types at these three aspects were investigated. All in all, each respondent took the speech test twice for each schedule (12:00 A.M., 3:00 P.M., and 8:00 P.M.) and results were obtained. Figure 4 shows the interaction of both types in terms of pitch deterioration across all shifts.

Similar to pitch, the Praat software was used to be able to obtain the voice intensity of the agents as the researchers wanted to investigate the intensity deterioration of the 'morning' types and 'evening' types on three different schedules. Figure 5 shows the interaction of both types in terms of intensity deterioration across all shifts.

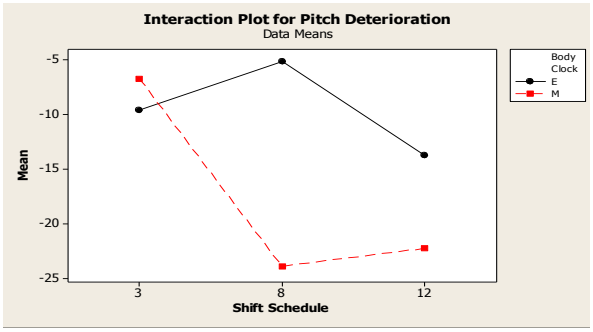


Figure 4 Pitch deterioration of 'Morning' and 'Evening' types

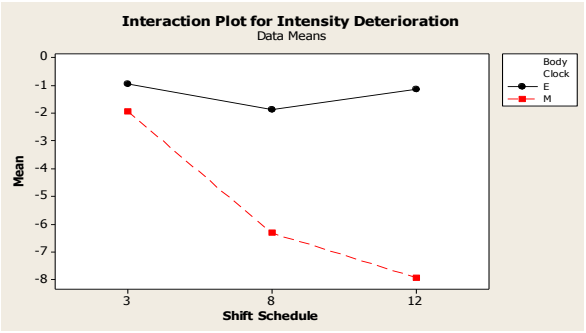


Figure 5 Intensity deterioration of 'Morning' and 'Evening' types

Harmonics-to-noise is defined as the degree of hoarseness of the voice quality of an individual while speaking, which is the abnormal change in voice commonly caused by the misuse and overuse of voice. In this study, the harmonics-to-noise at the start of shift and at the end of shift were obtained to see if there were changes between the two times across all the shift schedules. Figure 6 shows the interaction of both types in terms of harmonics-to-noise deterioration across all shifts.

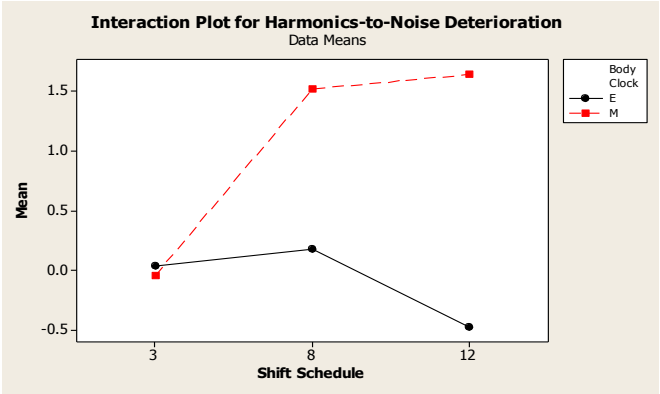


Figure 6 Harmonics-to-noise deterioration of 'Morning' and 'Evening' types

### *3.2.2. Reaction time performance*

In this study, the reaction time at the start and at the end were obtained to see if there was deterioration in terms of reaction time performance across all shifts for both 'morning' and 'evening' types. Figure 7 shows the interaction of both types in terms of reaction time deterioration across all shifts.

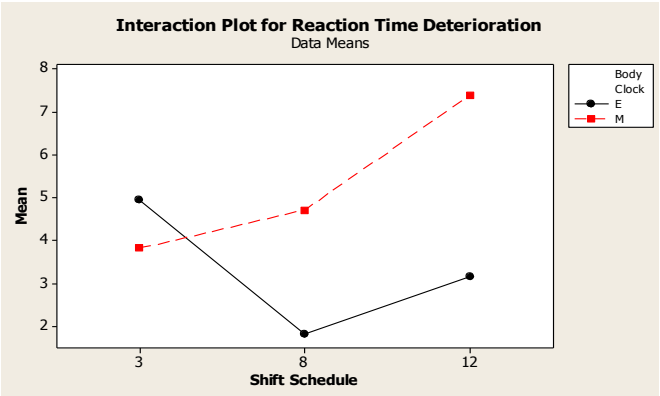


Figure 7 Reaction time deterioration of 'Morning' and 'Evening' types

*3.2.3. Memory performance*

In this test, the memory performance for the start and end shift per shift schedule were obtained. The measure used was in terms of correct items that were obtained. The memory score difference between the start and end per shift schedule were obtained to assess their memory performance of 'morning' and 'evening' types. Figure 8 shows the interaction of both types in terms of memory performance across all shifts.

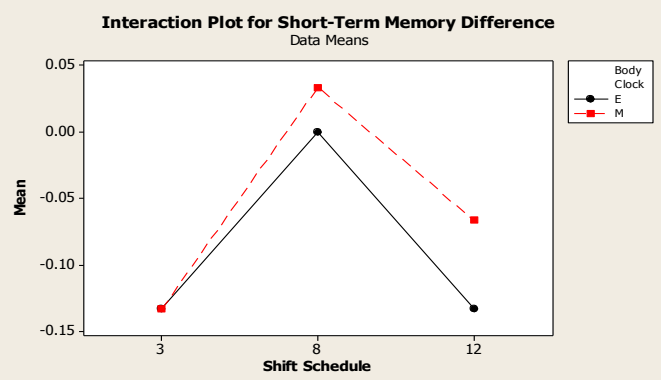


Figure 8 Memory difference of 'Morning' and 'Evening' types

## 4. CONCLUSION

Based on the two-way ANOVA, the cognitive performances were measured. It was found that the three speech ability measures and reaction time were significant in terms of the performance deterioration in each schedule in relation to the body clock of the individual. However, short-term memory did not have enough evidence to conclude that shift schedule and the body clock of an individual was related to short-term memory difference or deterioration from start to end. These results showed that shift schedule, body clock, and interaction between these two were related to the deterioration of performance results. Despite these responses being significant, it is still unclear as to what extent the body clock and shift affects the particular response.

Performance deterioration was shown to be very evident between 'morning' types and 'evening' types across different shifts in the context of this study. The speech ability in particular served as the highlight as speaking is the main tool of the considered subjects.

With the growth of different industries that are engaged on shiftwork, this could be a relevant study as 'morningness'-'eveningness' was shown in this study to have a relationship with different schedules.

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