The Relationship between Seating Locations and Instructor-Student Entrainment in a Classroom

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Abstract: In face-to-face communication, the listener’s body movements are often observed to occur nearly simultaneously with changes in the speaker’s voice pattern. This synchronization between speaker and listener is called entrainment. The present study investigated the relationship between classroom seating positions and instructor-student entrainment. Four university instructors individually gave 60-minute lectures to classes of 36-64 students in classrooms. The body movements of the students were captured using a video camera, and the voices of instructors were recorded via a microphone. For each pixel, the covariance between the sound level changes of an instructor’s voice and the power of the brightness fluctuations of the pixel was calculated as an index of the entrainment level of each location in the classroom. The results suggested that students sitting in the middle row of the middle column in the classroom showed higher entrainment levels. Moreover, changes of entrainment level were found to reflect changes in student’s interest in the lecture.

Keywords: Classroom Seating Locations, Instructor-Student Entrainment, Student’s Interest

1. INTRODUCTION

Many researchers have studied the relationship between student’s seating position in the classroom and student’s performance or behavior. An early study [1] examined the association of course grades with assignments of classroom seating, and showed that students sitting in the front of the room performed at higher levels than those in the back of the room. Later studies (e.g., [2, 3]) showed a similar relationship between seating position and performance.

Several studies have focused on the relationship between student’s seating position and student’s behavior in the classroom. Koneya [4] found that students who were categorized as high verbalizers tended to choose seats in the center portion of the front row and angling toward the center of the middle of the room, which Koneya referred to as the action seats. Sommer [5] found that students sitting opposite the instructor were more likely to participate in discussions than students at the sides, because of greater eye contact with the instructor. However, few studies have investigated quantitatively the relationship between the student’s behavior and their seating location.

This study aims at visualizing the relationship between student’s behavior and the seating location in classrooms by focusing on the phenomenon of ‘entrainment.’ In face-to-face communication, the listener’s body movements are often observed to occur nearly simultaneously with changes in the speaker’s voice pattern [6-8]. This synchronization between speaker and listener, which is called entrainment [6, 7], has been considered to reflect the relationship between the speaker and the listener. In fact, our previous study [9] showed positive significant relationships between the levels of instructor-student entrainment and the students’ interest in the lecture, suggesting that entrainment level is related to the attitudes of the students toward the class. Our prior study [9] measured entrainment level using a video-based quantification method [10]. Since this method enabled objective evaluation of interactions between instructor and students over an extended period, it is an enhanced approach compared to methods of coding and psychological evaluations used in most previous studies. The present study adopted this technique to investigate the relationship between seating positions and attitudes towards the lecture.

2. METHOD

2.1 Participates

Four university instructors participated. Each gave one lecture (Case 1 – Case 4). Each lecture was a part of a different course. All participants were undergraduate students (Case 1: N = 43, Case 2: N = 36, Case 3: N = 63, Case 4: N = 36), and they had enrolled in the lecture courses beforehand.
2.1 Lectures
Each lecture lasted about one hour (Case 1: 58 min, Case 2: 60 min, Case 3: 62 min, Case 4: 51 min). The lectures of Case 1 and Case 4 were related to pedagogy. The lecture of Case 2 was on engineering. The lecture of Case 3 was on psychology. Each professor decided the content to be covered in the lecture and the order of the topics. For all lectures, each professor used presentation software and a projector.

2.2 Experimental settings and procedure
Each room in which a lecture took place was a regular classroom with a board and a screen located at the front of the room and with at least 150 fixed, unmovable seats for students (Figure 1). The window curtains of each classroom were closed to prevent adverse effects of outside light changes on video analysis. A video camera (SONY HXR-MC1) was located in the front of the lecture room to capture the body movements of the students, and another video camera was placed in the back of the room in order to record the behavior of the lecturer. The voices of the lecturers were recorded using a headset-microphone (Audiotechnica ATS-400), USB audio capture (EDIROL UA-25), and a personal computer (Panasonic CF-S8). The voices of the professors were presented via speakers at approximately 70 dB(A).

For Case 1, each student was assigned to a designated seat in kana order (i.e., Japanese alphabetical order). For Case 2, the students selected their seats arbitrarily. For Cases 3 and 4, the seating positions of the students were determined in the order of their entrance into the classroom, from the innermost column to outermost column. For all cases, students who did not wish to participate in the experiment were guided to sit in a designated area on the side of the room and they were excluded from the analysis. The participants were instructed not to change their seating positions during the lecture.

After each lecture, the students were asked to rate their interest in each topic on a seven-point scale, from 1 (not at all interesting) to 7 (very interesting).

2.3 Computational analysis of body movement and voice intensity
The intensities of the student’s body movements were evaluated through video analysis in order to examine the time-sequential relationship between student’s body movements and the lecturer’s voice. In this analysis method, the intensity of a participant’s body movement is defined by the power of the brightness level changes of the pixels in which the student is included.

For all cases, the intervals from the start to the end of each lecture were analyzed. The front-view movies were converted into low-resolution (64 × 48 pixels, frame rate 29.97 frame/s). The RGB values of each frame of each pixel were converted into 256 grey-level brightness. A wavelet transform was then performed on the time series of brightness values for each pixel. The power of each pixel of each frame was obtained by adding 0.5 - 2.5 Hz range power, and the time series of logarithms of the power was used as the index of body movement level. The bandwidth of 0.5 - 2.5 Hz was determined based on a preliminary investigation of the frequency of natural human movements [10], which revealed a strong correlation between this frequency range and the perceived intensity of human body movements.

The sound level (dB) of the lecturer’s voice was calculated at a sampling rate of 29.97 Hz, and the sound level was normalized for each lecture.

3. RESULTS
3.1 Relationship between seating locations and entrainment levels
In order to examine the relationship between student’s body movements and the lecturer’s voice, the covariance was calculated between the time series of the body movement level and the time series of the sound level of the instructor’s voice that preceded the brightness power for 1 s, for each pixel. The delay length of 1 s was determined based on a preliminary study [7]. A high covariance value on given pixel of a movie indicates that the body movement of the student included in the pixel was highly affected by the instructor’s voice; that is, the student showed a high level of entrainment.

The entrainment levels of each pixel from the beginning to the end of each lecture are shown in Figure 2 (left side). A red pixel indicates a higher positive covariance value.
for the pixel, and a blue pixel represents a negative covariance value.

The room used in Case 1 was divided into three blocks (left, center, and right), and the center and the right blocks are shown in Figure 2. For Case 1, the entrainment levels of students sitting in the right block seem to be smaller than the entrainment levels in the center block. Similarly, for Cases 3 and 4, the entrainment levels of the students in the center region were higher than those of the students in the sides and back of the room. As for Case 2, no systematic relationship between seating positions and entrainment levels was found. It should be noted that the result in the lower left region of Case 2 reflects the movements of the lecturer, who frequently moved around in the lower left region of the movie.

3.2 Relationship between student’s interest and entrainment level

Each lecture was divided into first and second halves at the temporal midpoint of each lecture, and the entrainment levels for each half of the lecture were calculated; these are shown in Figure 2 (center and right). It is clear from Figure 2 that the red areas of the images, representing the areas of high entrainment levels, are smaller for the second half than for the first half in Cases 1 and 4.

In order to assess whether entrainment levels are linked to the student’s subjective evaluations of the lectures, the averages of the student’s subjective interest in the first and the second halves of each lecture were calculated. The evaluations for the first half were calculated by averaging the evaluations for the topics in the first half, and the evaluations for the second half were also calculated by averaging the evaluations for the topics in the second half. These averages, shown in Figure 3, indicate that there

![Figure 2: Body movement entrainment levels for 60-min. (left), the first half (center), and second half (right). An image of entrainment levels is superimposed on a photograph of the lecture room.

![Figure 3: Student’s interest in the first half and second half of lectures. Vertical bars represent standard error.](image)
were strong decreases in student interest from the first to
the second half in Cases 1 and 4 (Case 1: \( t(42) = 5.19, p < .01 \); Case 2: \( t(35) = -.89, p = .37 \); Case 3: \( t(62) = 3.39, p < .01 \); Case 4: \( t(35) = 4.14, p < .01 \). These lectures showed
low entrainment levels in the second half. On the other
hand, for Cases 2 and 3, which did not show strong
decreases in interest level during the second half, there
was no clear distinction in entrainment levels between the
first and the second half of the lectures (Figure 2).

4. DISCUSSION

This study examined the spatial distribution of instructor-
student entrainment levels in a classroom. The entrainment
levels were relatively high in the middle row of the middle
column (i.e., center), compared to the peripheral area of
the lecture room, regardless of the seat assignment. The
finding that the students in center area showed the stron-
gest activity in the classroom is consistent with previous
studies which suggested a relationship between student’s
seating location and their attitudes toward the lecture.

Even in Cases 1 and 3, in which the students sat in
assigned seats, the students either in the back or in the side
of the room showed low entrainment levels. Thus, the
location difference in entrainment level is considered to
be caused by the seating location itself rather than by the
seat selection of the students.

The results of this study further suggest that entrainment
levels reflect student’s interest in the lecture, being consis-
tent with previous studies [5, 9]. This implies that seating
location could affect the student’s interest in the lecture
even if their seats are assigned by the instructor.

5. CONCLUSION

This study proposed a methodology for visualizing the
distribution of instructor-student entrainment levels and
examined the relationships between student’s seating
position and the entrainment level in actual university
lectures. It is possible that this methodology can be used
to examine student’s attitude toward a lecture quantita-
tively. However, it is necessary for future studies to
investigate whether the relationship found here is obtained
for other types of lectures.

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