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Analysis of laughter events and social status of children in classrooms

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Abstract

We analyzed the social interactions of children by collecting data in a science classroom of a Japanese elementary school using our developed system that can identify who is talking, when, and where in an environment, based on the integration of multiple microphone arrays and human tracking technologies. In the present work, among the sound activities in the classroom, we focused on laughter events, since laughter conveys important social functions in communication and might be a cue for identifying social status. Social status is often studied in educational and developmental research since it is importantly related to children's social and academic life. We extracted laughter events using the visual displays of spatial-temporal information provided by our developed system and quantified social status based on a sociometry questionnaire. Our analysis results revealed that the number of laughter events in children with high social status was significantly higher than in those with low social status. We also investigated the relationship between laughter type and social status.

Index terms: laughter, social status, children, natural conversation, real environment

1. Introduction

The background of the present study is the development of social robots that can suitably interact with humans. In the near future, such robots are expected to work with children in school classrooms [1-7]. In such cases, they must recognize and understand the social status of the children. Social status, which broadly refers to rank in a social structure, can be estimated from occupations and education [8]. More specific to the classroom context, social status is established through social acceptance and connections. Popular children rank high in the classroom social structure, while unpopular or overlooked children rank low [9]. Social status is often studied in educational and developmental research, since it is critically related to children's social and academic life. Social status is also related to such important phenomena in the lives of children as bullying. For instance, children with low social status are often the targets of bullying [10], and bullies tend to have high social status [11]. Two patterns of bullying have been reported; one involves a popular child bullying unpopular individuals of the same gender, and the other describes unpopular aggressive boys who bully popular girls [12].

Social status also influences children's academic outcomes. Children with low social status tend to have less successful academic performance [13]. The transformation of low social status into low academic performance probably reflects a reduced motivation to succeed [14].

To analyze children's behaviors in a classroom, we obtained permission to install a sensor network (RGB-D sensors and microphone arrays) in the science classroom of a Japanese elementary school. We collected data from actual science classes, including situations where children conducted group activities.

In our previous study, we used the spatial-temporal information extracted from a sensor network to localize and extract sound events [15]. Among several sound events in the classroom, we focused on laughter events because laughter commonly occurs in daily interactions and is not only simply related to amusing situations. It also expresses attitudes that have important social functions in communication [15-19]. In our previous study, we analyzed the relationship among laughter types, laughter functions, and their appropriateness to class contents [15].

We believe that laughter is a clue related to social status. Intuitively, extroverted children have more friends (i.e., higher social status), are more active, and laugh more frequently than introverted children. In this study, we extend our analysis on laughter events to investigate possible relationships with children's social status.

This paper is organized as follows. In Section 2, the data collection, contents, and annotation procedures are described. Section 3 presents our analysis results among laughter events, social status, and discussions. Finally, Section 4 presents a conclusion about our outcomes.

2. Data

2.1. Method of data collection in science classrooms

Microphone array processing technologies have been extensively applied for sound localization by intelligent rooms (e.g., [20-23]). To deal with situations where multiple speakers talk and move, we are developing a sensor network system that is able to identify who is talking, where, and when, based on the integration of multiple microphone arrays and human tracking technologies [15,23-25].

Figure 1 shows a science room where data were collected by our developed sensor network system. We used six of its eight desks for our science experiments. We installed a microphone array over each of the six desks about 2 meters directly over the desk's sink to avoid obstructing the student's field of view and potential collisions with the heads of the

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Fig. 1 *Science classroom where our developed system was installed*

teachers. For human-position detection, we attached multiple Kinect sensors on the ceilings and also collected video data by USB web cameras.

Each microphone array is composed of 16 omnidirectional microphones distributed in the 3D axes (approximately over a 30-cm diameter semi-sphere) for sound direction estimation in the 3D space to estimate the azimuth and elevation angles.

For sound direction estimation by each microphone array, we used our implemented system based on the MUltiple SIgnal Classification (MUSIC) method, which provides 1º-angle resolution in the 3D space and 0.1-second time resolution in real-time, by a 2GHz CPU [25].

For human tracking, we used particle filter-based 3D human localization using multiple depth (Kinect) sensor data [23]. The human position data were obtained in 33 ~ 66 ms and approximately 30-cm resolution. Although 2D human tracking based on Laser Range Finders (LRF) is another alternative [22], we opted to use depth sensors due to the large number of students and the appropriateness of attaching sensors on the ceiling. 24 depth sensors were attached to the ceiling to cover the entire classroom (~ 8 x 16 m).

2.2. Data contents

Multi-modal data were collected during a one-month period (in Feb. 2014) for 5th grade science classes. In our previous study, we analyzed laughter events for data collected in 2013 [15]. However, since social status data were available only for the 2014 data, we collected new laughter data. The roughly 120 5th graders were divided into four, 50 min. classes. The number of students per class was around 30 (five students per desk) and a class teacher and a science teacher. Since permission could not be obtained for one of the classes, the present study only contains analysis for three classes.

The global themes of the classes were "the birth of life" and "pendulums". Since laughs often occur simultaneously with other laughs or speech utterances, achieving adequate acoustic quality was difficult, even after sound separation that was based on microphone array processing. Thus, for the present analysis, laughter events were manually identified and segmented by research assistants.

We segmented the laughter events at each of the six desks with the spatial information provided by the sound direction estimation results. During the segmentation process, the annotators looked at the spatial and temporal displays as well as the spectrogram displays for each microphone array. By visually identifying the placements of the sound sources, the annotator selected the microphone array signal closest to the target sound source, listened to specified intervals, and segmented the laughter portions. Since children are the target of the present analysis, we excluded the laughter events of the teachers from our analysis.

We extracted 677 laughter events from the database and manually classified them based on individual (single) or group (multiple) laughs per desk. A group laugh means that multiple speakers around the same desk laughed at the same time. We also classified the laughter events based on whether they were related to class activity. Individual laughter syllables ("call") in a laughter sequence were counted by listening to and looking at the spectrograms.

2.3. Index of social status

We administrated a sociometry questionnaire before the study to quantify the social status measurements. In the questionnaire, the children listed five friends. From their answers we computed the social status of each child in each class using the following definition [26]:

$$\mathrm{ISSS} = \frac{1}{2}\left(\frac{N_{nominated}}{N_p - 1} + \frac{N_{mutual}}{N_{max}}\right),$$

where ISSS stands for the index of sociometric status scores, $N_{nominated}$ is the number of nominations (i.e., other children nominated this child as a friend), N_p is the number of children in the class, N_{mutual} is the number of mutual nominations (i.e., children who nominated each other), and N_{max} is the maximum number of nominations (i.e., five in our study). A child has higher social status if this value is closer to 1. Note that ISSS represents not an index of the extroverted/introverted nature of children but the richness of their friendships. Although a correlation may be found between them, we only used this sociometric status in this work.

Overall, we got 73 valid data samples; some children were absent when the questionnaires were administrated. We categorized their social statuses as high or low using the obtained ISSS scores. The median score was used as a cutoff point. The low social status group includes children whose scores were below the median, and the high group includes children whose scores were above. 38 children were categorized in the low group, and 35 were categorized in the high group.

Table 1 *Number of laugh events and children of each social status groups*

Social status group	Number of laughs		Number of children
	single	multiple	
High	275	167	29
Low	145	90	32

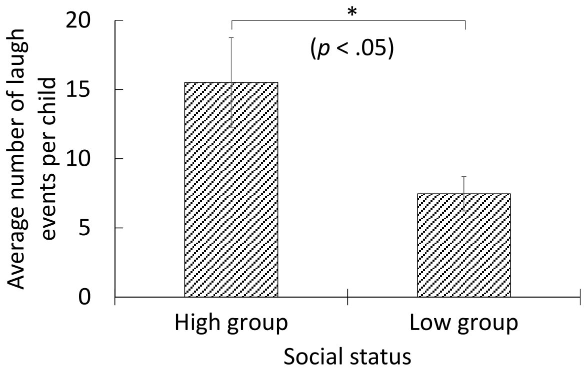

Fig. 2 A*verage number of laughs per child in different social groups*

3. Results and discussions

3.1. Number of laughter events and children's social status

Table 1 shows the number of single/multiple laugh events and the children of the social status groups (high or low). There are fewer children in both groups in Table 1 for the total amount in Section 2.3 because some children had no laugh events. The total number of laugh events is 442 in the high group and 235 in the low group. Fig. 2 indicates the average number of laugh events per child in both groups. A high-group child had about 15.5 laugh events in a class; a low group child had about 7.5. The average number of laughs per child was significantly higher in the high social status group than in the low social status group (Welch two sample t-test; t (36.1) = 2.32, $p < .05$). This result simply means that children with high social status tend to laugh more frequently.

For greater clarification of the specific influence of social status on the children's laugh events, we focus on the laughter environment. We calculated the ratio of single and multiple laugh events in every child and summarized it in groups (Fig. 3). The ratio of the two laughter types differs in both groups. The single and multiple laughter ratios are 59% and 41% in the high group and 68% and 32% in the low group. We conducted a one-way ANOVA within-subjects with a factor of laughing environment (single or multiple). The analysis reveals no significant difference between the single and multiple laughter ratios in the high group (F (1, 24) = 2.62 n.s.). On the other hand, the ratio of single laughs is significantly higher than the ratio of multiple laughs in the low group (F (1, 27) = 20.64, $p < .01$). This result suggests that the children with low social status generally laugh alone.

Figure 4 shows the distribution of the number of laughs and the social status values of the children in different groups

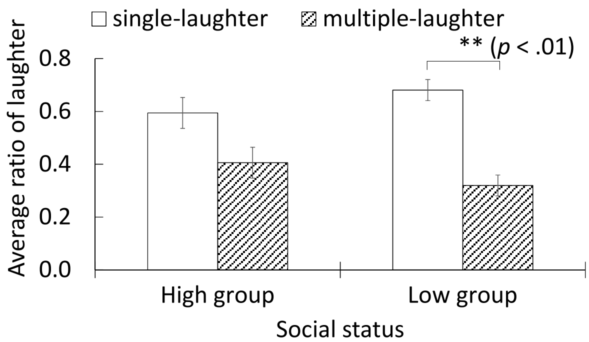

Fig. 3 *Average ratio of single/multiple-laughter in different social groups*

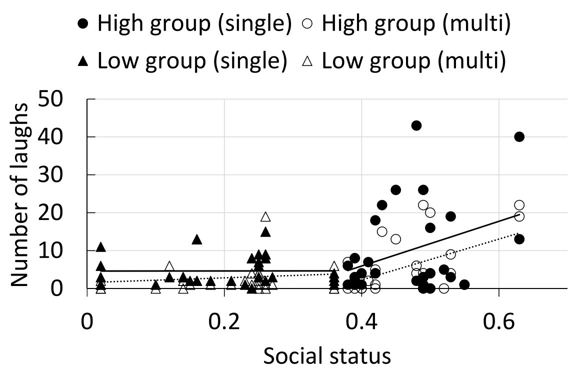

Fig. 4 *Distribution of number of laughs and value of social status of children in different groups and single/multiple laughter.*

and single/multiple laughter. To verify the relationships between the number of laughs and the social status values, we calculated the correlation coefficient among these factors. We found a significant weak and moderate positive correlation coefficient in the high group (single laughs: $r = .35$, F = 3.73, df1 = 1, df2 = 27, $p < .10$; multiple laughs: $r = .52$, F = 10.05, df1 = 1, df2 = 27, $p < .01$). But the distribution of the low group doesn't show a significant correlation coefficient (single laughs: $r = .002$, F = 0.00, df1 = 1, df2 = 30, n.s.; multiple laughs: $r = .15$, F = 0.69, df1 = 1, df2 = 30, n.s.).

From these results, we assume that the occurrence of the amount of laughter in the classroom reflects the richness of friendships. In other words, children with many friends tend to laugh more. They laugh with others. The children with few friends, however, are less likely to laugh. And when they laugh, they tend to laugh alone.

3.2. Style and prosody of laughter and children's social status

Figure 5 summarizes the average number of laughter calls (individual syllables in a laugh sequence) per child in different groups relative to gender. The numbers of boys and girls in the high group are 11 and 9. The numbers of boys and girls in the low group are 14 and 9. Because of bad audio conditions, some laughter couldn't be accurately counted. We omitted these samples from this analysis, and therefore the total

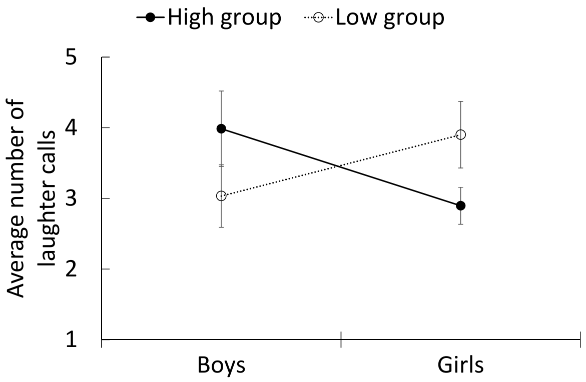

Fig. 5 *Average number of laughter calls per child in the different groups relative to children's*

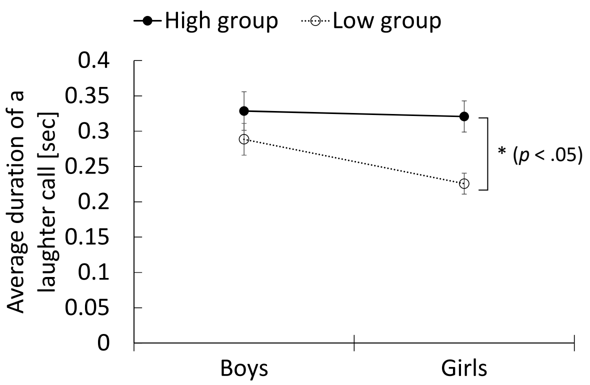

Fig. 6 *Average duration of laughter calls in different groups relative to gender*

number of children indicated above differs from the numbers in Section 2.3.

The average number of calls is 3~4 in all cases. These numbers are relatively few, probably because the laughter data were mostly acquired during class activities, where long laughter events are less likely to occur. Fig. 5 indicates an interesting tendency. In boys, high-group children have more calls than the low-group children. However, in girls, low-group children have more calls than high-group children. There is a significant interaction effect for these factors (F (1, 39) = 4.42, $p < .05$).

Interpreting this result is difficult. If the number of calls reflects the degree of fun, perhaps boys with many friends tend to find themselves in funny situations. Intuitively, such boys are aggressive about making funny situations. But girls with many friends don't create such behavior. Girls with few friends might be easily influenced by funny situations that are created by other children. Or they might show an assenting attitude for such circumstances. However, such discussion needs further analysis with more data.

We also analyzed the duration of each laughter call by dividing the duration of the laugh sequences by the number of laughter calls. Fig. 6 shows the average duration of a laughter call in different groups relative to gender. A two-way ANOVA revealed a significant main effect for social status groups (F (1, 213) = 6.68, $p < .05$). The main effect for gender (F (1, 213) =

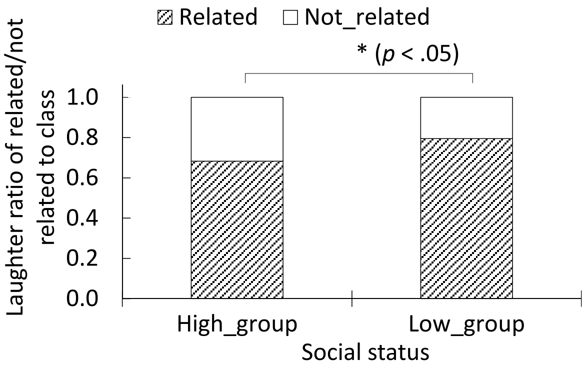

Fig. 7 *Laughter ratio of related/not related to class activities in the different groups.*

1.82, n.s.) and interaction effect (F (1, 213) = 1.11, n.s.) doesn't show any significance. The average duration of a laughter call was 325 msec in the high group children and 257 msec in the low group. This result means that the laugh sequences from high-group children consist of relatively long calls.

Relatively long calls create an impression of lightness and glee. Since the personality of children with many friends can be considered out-going and cheerful, the duration of the laughter calls might reflect such characteristics.

3.3. Relationship of laughter and class activity

Figure 7 shows the laughter ratio of related/not related to the class activities in different groups. Class-related laughter means laughter that evolved from such class activities as a teacher's funny story. Fisher's exact test indicates significant differences for the laughter ratios in the two groups ($p < .05$). The ratio of not-class-related laughter is relatively high in the high social status group.

This result suggests that laughs from children with many friends create funny situations, not only during class activities but also in not-class-activity situations and sharing laughs with other children.

4. Conclusions

We analyzed the relations between laughter events and the social status of children during actual science classes recorded in a Japanese elementary school. Children with high social status tend to laugh more frequently; their number of laughs correlates with their social status levels; the durations of each laughter call are relatively long; they also frequently laugh in out-of-class-activities. On the other hand, children with low social status tend to laugh alone and during class-activity situations. This suggests that their laughter is not shared with others. We also clarified gender differences.

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