

# Relationship between Social Interaction and Mental Health

Eisuke Ono, Takayuki Nozawa, Taiki Ogata, Masanari Motohashi, Naoki Higo, Tetsuro Kobayashi, Kunihiro Ishikawa, Koji Ara, Kazuo Yano, and Yoshihiro Miyake

**Abstract**—In order to explore the relationship between human social interaction and mental health, we investigated the correlations between the amount of face-to-face contact time and quantified mental health. Social interaction data were obtained by wearable sensing system for two organizations in Japan. In this study, we regarded face-to-face contact between individuals as social interaction. The mental health of individuals was measured by psychological questionnaire. We found that the social behavioral property of individuals tended to reflect quantified stress in both organizations. The results suggest the possibility that people who experience large amounts of social interaction tend to have less stress.

## I. INTRODUCTION

Data on human social behavior are now readily available. Human behavior has been investigated statistically and dynamically, enabled by developments in sensing and information technologies [1]. Interevent time distributions of human activities such as communication, trade transactions, and library loans have been found to follow power-law [2], [3]. Although the statistical structure of human behavior has been partially revealed, the psychological or social meaning of the structure is not clear yet.

In social psychology, some previous studies have investigated the relation between social relationship and psychological state. It has been suggested that office layout arrangement encourages employee satisfaction and improves work satisfaction [4]. Social capital and mental illness were also found to relate to each other [5]. Social interaction and psychological state were indicated to be important for maintaining quality of life. However, previous studies had technical limitations to measure observable social interaction accurately [5].

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E. Ono, M. Motohashi, N. Higo and Y. Miyake are with the Department of Computational Intelligence and Systems Science, Tokyo Institute of Technology, Yokohama, Japan.

(e-mail: ono@myk.dis.titech.ac.jp, motohashi@myk.dis.titech.ac.jp, higo@myk.dis.titech.ac.jp, miyake@dis.titech.ac.jp)

T. Nozawa is with the Institute of Development, Aging and Cancer, Tohoku University, Sendai, Japan. (e-mail: nozawa@idac.tohoku.ac.jp)

T. Ogata is with the Intelligent Modeling Laboratory, the University of Tokyo, Tokyo, Japan and with the Department of Computational Intelligence and Systems Science, Interdisciplinary Graduate School of Science and Engineering, Tokyo Institute of Technology. (e-mail: ogata@iml.u-tokyo.ac.jp)

T. Kobayashi is with the National Institute of Informatics, Tokyo, Japan. (e-mail: k-tetsu@nii.ac.jp)

K. Ishikawa is with the Department of Human System Science, Graduate School of Decision Science and Technology, Tokyo Institute of Technology, Tokyo, Japan. (e-mail: ishikawa@hum.titech.ac.jp)

K. Ara and K. Yano are with the Central Research Laboratory, Hitachi, Ltd., Tokyo, Japan. (e-mail: koji.arah@hitachi.com, kazuo.yano.bb@hitachi.com)

Nakamura *et al.* found that the resting duration distribution of human physical activity obeyed power-law. [6], [7]. They also found that the scaling exponent of resting duration distribution of depressed patients was statistically lower than that of healthy people. These findings suggest that depressed patients tend to remain in their resting state more than healthy people.

Nozawa *et al.* investigated the relationship between the physical activity of individuals and their social interaction [8]. In their study, social interaction was defined as the amount of face-to-face contact time. Their results suggest the possibility that social context of individuals can be evaluated from their physical activity patterns. In other words, the effect of social relationship on individual physical activity state was indicated.

The statistical structure of human social behavior possibly reflects our qualitative states such as mental health and sociality. The effect of social interaction on mental health of individuals is not clear quantitatively yet. What does interacting with others mean for our psychological states? In this research, we focus on the relationship between observable social interaction and mental health. We used two sets of data measured in Japanese organizations. Our data are unique in that they are records of face-to-face interaction, measured by using a wearable sensing system. Simultaneously, we conducted a questionnaire to measure individual mental health. We propose a hypothesis that the amount of social interaction and mental health are related to each other. The purpose of this research is to verify the hypothesis by investigating the correlation between social interaction and mental health.

## II. METHODS

### A. Data

We analyzed two sets of face-to-face interaction data. The social interaction data were provided by the Central Research Laboratory, Hitachi, Ltd., Japan. The sets of data include two organizations in Japan. The first is a consulting firm (Org. A). In Org. A, 136 participants were objects of analysis. The data were measured from January 1, to February 22, 2011. The second is a nursing home (Org. B). In Org. B, 50 participants were objects of analysis. The data were measured from March 1, to March 31, 2011. People in Org. B were separated into two different groups: staff and elderly users. The data were collected anonymously and analyzed. The summary of organization is shown in Table I.

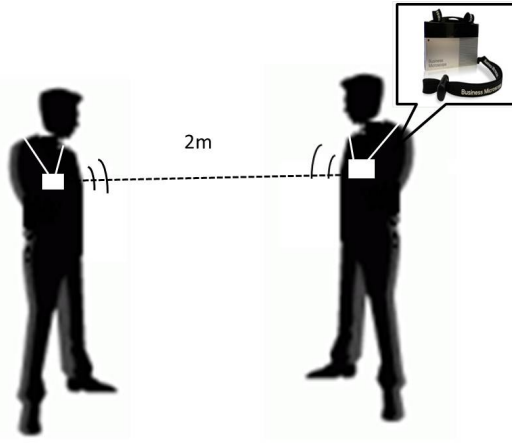


Fig. 1. Device used in the measurement of social interaction. The device contains an infrared sensor and detects face-to-face contact between participants only if they are within 2 (m) and facing each other.

TABLE I

ORGANIZATION SUMMARY. THE NUMBER IN PARENTHESES IS THE NUMBER OF ELDERLY USERS IN ORG. B.

	Number of participants	Number of valid answers	Observation period	Category of organization
Org. A	136	57	2011/1/5-2011/2/22	Consulting firm
Org. B	50(36)	49(35)	2011/3/1-2011/3/31	Nursing home for the elderly

## B. Social interaction

1) *Measurement method*: In order to measure social interaction as conversation events, we used the Business Microscope, which is a wearable sensing system developed by the Central Research Laboratory, Hitachi, Ltd [9]. The Business Microscope contains an infrared sensor, and its shape is similar to a name tag as shown in Fig. 1. Each participant wore the name tag around the neck and placed at the chest. The infrared sensor can detect face-to-face contact between participants if they are within 2 (m) of one another. The infrared sensor only senses the other within a 120° circular area in front of the name tag, and the system records face-to-face contact events cumulatively when two individuals are facing each other. We regard the amount of face-to-face contact as a feature of observable social interaction. It should be noted that the sensor records the face-to-face state as one minute even if a momentary contact was detected between participants. In other words, the time resolution of the system is equal to 1 (min). Face-to-face interaction logs were gathered through the whole measurement period. Then, the amount of face-to-face contact time between every pair of participants was obtained for the whole measurement period in each organization.

2) *Analysis method*: Nozawa *et al.* investigated social interaction in an office setting [8]. They analyzed social interaction using the social network analysis method. Inspired by their previous study, we regard the amount of social interaction between participants as connection weight in the

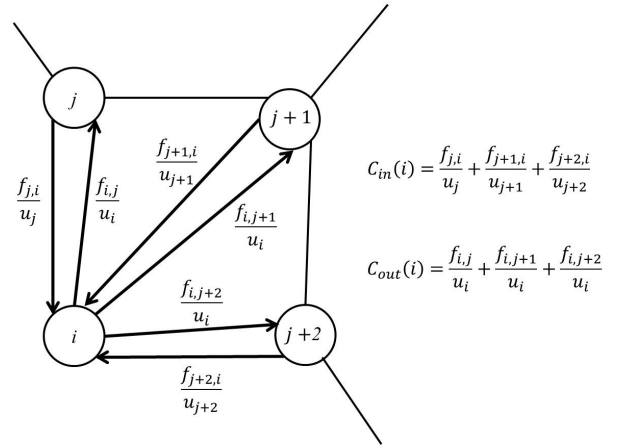


Fig. 2. Example of the calculation of social interaction characteristics

social network. For instance, if the total face-to-face contact time between  $i$  and  $j$  is 100 (min), the connection weight between  $i$  and  $j$  is 100, denoted as  $f_{ij}$  in (1). However, it was problematic to use face-to-face contact time as a weighted edge because the sensor-wearing time depended on the participants. To overcome individual differences, a normalized matrix  $G$  was adopted as an adjacency matrix for analysis.

$$G = [g_{ij}] = \left[ \left( \frac{f_{ij}}{u_i} \right) \right] \quad (1)$$

This matrix  $G$  was obtained by dividing each row of  $F = [f_{ij}]$  with  $u_i$ , where  $f_{ij}$  represents the total face-to-face contact time between participants  $i$  and  $j$  through the whole measurement period and  $u_i$  represents the total sensor-wearing time of participant  $i$ .

We calculated in-degree centrality  $C_{in}$  and out-degree centrality  $C_{out}$  to characterize the quality of each participant in the social network based on the method of [8]. In-degree centrality  $C_{in}$  was calculated using (2).

$$C_{in}(i; G) = \sum_j g_{ji} = \sum_j \frac{f_{ji}}{u_j} \quad (2)$$

$C_{in}$  quantifies the individual property that a person has been required to contact from other people. Out-degree centrality  $C_{out}$  was calculated using (3).

$$C_{out}(i; G) = \sum_j g_{ij} = \frac{1}{u_i} \sum_j f_{ij} \quad (3)$$

$C_{out}$  quantifies the individual property that the person has dedicated to social relationship. An example of calculation of  $C_{in}$  and  $C_{out}$  is shown in Fig. 2. These two centralities were the characteristics for social interaction analysis.

## C. Mental health

1) *Participants and measurement periods*: A questionnaire to measure mental health was conducted in each organization. In Org. A, 57 responses were obtained from

TABLE II  
EXAMPLES AND SUBSCALE FOR QOL AND SCL

Psychological Scale	Subscale	An Example of Statements
Stress Check List (SCL)	Psychological Stress	Obsession
		Inattention
	Social Stress	Interpersonal Avoidance
		Interpersonal Nervousness
	Physical Stress	Tired Feeling
		Sleep Disorder
Quality of Life (QOL)	Life Satisfaction	Satisfied with your life
	Motivational Life	Having dream for your future

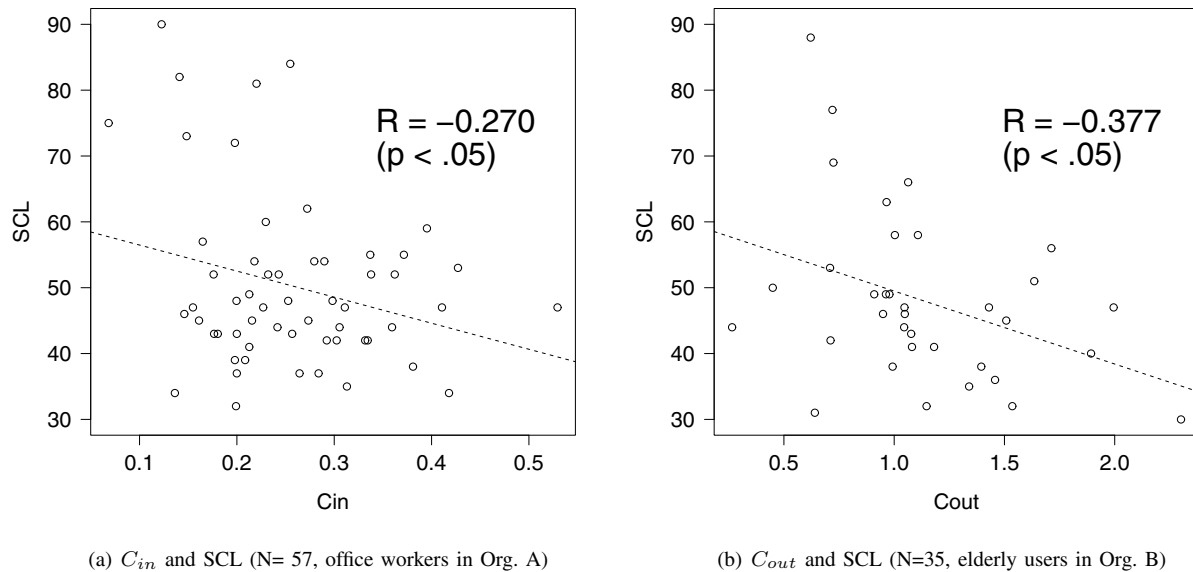


Fig. 3. Scatter diagrams showing the relationship between observable social interaction and degree of stress

136 participants. The answers were measured from February 7 to February 14, 2011. In Org. B, 49 responses were obtained from 50 participants. The responses were measured from March 4 to March 15, 2011. In Org. B, 35 answers were from elderly users, 14 were from staff.

2) *Measurement method:* In this research, the Mental Health Pattern (MHP) scale developed by Hashimoto *et al.* was adopted for the contents of questionnaire. Validity and reliability of the MHP scale have already been proven in their research [10], [11]. The MHP scale contains degree of stress and degree of life satisfaction. The Stress Checklist (SCL) scale and Quality of Life (QOL) scale were used to measure. The SCL scale has six subscales. QOL scale has two subscales. Examples of statements are shown in Table II. Each subscale had five questions. The total number of the questions was 40. During the procedure, the participant selected from four options: *strongly agree*, *agree*, *disagree* and *strongly disagree*. The answers were scored from four points (strongly agree) to one point (strongly disagree). Reversed question items were calculated by reversing the points.

### III. RESULTS

We found a statistically significant correlation between amount of social interaction and individual mental health. Pearson's correlation coefficients are presented in Table III. Notably, a significant negative correlation between  $C_{in}$  and SCL was observed in Org. A ( $p < .05$ ). In addition, a significant negative correlation between  $C_{out}$  and SCL was observed in the cluster of elderly users in Org. B ( $p < .05$ ). Slight positive correlations between social interaction and QOL were observed for both organizations.

Two diagrams and each correlation coefficient R are presented for precise observation of the correlations. Scatter diagrams describing the relation between social interaction and degree of stress are shown in Fig. 3. First, the result of Org. A is presented. The x-axis is  $C_{in}$  and the y-axis is SCL, as shown in Fig. 3(a). A negative correlation tendency is observed. Second, the result of the cluster of elderly users in Org. B is presented. The x-axis is  $C_{out}$  and the y-axis is SCL, as shown in Fig. 3(b). A negative correlation tendency is observed. Regression lines were drawn in each figure to aid understanding.

TABLE III  
CORRELATION COEFFICIENTS BETWEEN SOCIAL INTERACTION AND  
MENTAL HEALTH

Organization	Mental Scale	Cin	Cout
Org A	SCL	*-0.270	-0.069
	QOL	0.060	0.067
Org B(staff)	SCL	-0.089	0.184
	QOL	0.291	0.108
Org B(elderly users)	SCL	-0.058	*-0.377
	QOL	0.124	0.129

\* :  $p < .05$

#### IV. DISCUSSION

The results shows that the amount of social interaction is correlated to individual mental health. In particular, we found that the degree of stress (SCL) possibly reflects participants' behavioral property. These results support the hypothesis that there is a correlation between social interaction and mental health.

However, the degree of the correlation coefficient depends on the organization or cluster as shown in Table III. The correlation coefficient of the elderly users cluster in Org. B was larger than that of the staff cluster. In addition, the calculated centrality values of Org. B were higher than the those of Org. A. We assume that centrality value differences were caused by the organization's characteristics and shortness of the measurement period.

The results indicate that social supports were possibly exchanged through face-to-face social interaction. Social support means supports as help, advice that is exchanged through social relationships. Social support has been considered to be a buffer for stress generated in social life [12]. Allen *et al.* also reported that an open-space layout in an office setting encouraged communication and improved ease of communication [4]. The results in this research support the previous studies in social psychology.

Findings in this research are new because we investigated the relationship between social relation and psychological state quantitatively. The results suggest that not only physical activity, but also individual mental health possibly reflects the amount of social interaction. Nozawa *et al.* found significant positive correlations between the degree of physical resting state and network centralities, suggesting the effect of social relationship on individual physical activity [8]. Our results added psychological meaning on their previous study.

In this research, we did not consider individual attribute such as sex, age, and position. The experiment design also should be modified. There is still a possibility that the results occurred because of other causes such as home problems. Deeper investigations must be done in the future work.

#### V. CONCLUSION

In order to explore the relationship between observable social interaction and psychological state, we have conducted a correlation analysis of the amount of face-to-face contact time and quantified mental health. Significant negative correlations between the amount of social interaction and mental health were observed. These results suggest that people who interact with others relatively tended to have less stress.

There has not been a study of how the amount of observable social interaction is mutually related to psychological states. We have first partially clarified the relationship.

#### VI. ACKNOWLEDGMENTS

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