

Topic-Setting Program to Advance Cutting-Edge

Humanities and Social Sciences Research

(Area Cultivation program)

Progress Report

(Summary of Final Report)

[The wisdom of the crowd as emergent intelligence: the transformation of society
and individuals through collective decision-making]

Core-Researcher: Jun Saiki

Institution: Kyoto University

Academic Unit: Graduate School of Human and Environmental Studies

Position: Professor

Research Period: FY 2017 – FY 2020

1. Basic information of research project

Research Area	"Cognitive science turn" and transformation of identity		
Project Title	The wisdom of the crowd as emergent intelligence: the transformation of society and individuals through collective decision-making		
Institution	Kyoto University		
Core-Researcher (Name, Academic Unit & Position)	Jun Saiki, Graduate School of Human and Environmental Studies, Professor		
Project Period	FY2017 – FY2020		
Appropriations Plan (¥)	FY2017	JPY	2,600,000
	FY2018	JPY	5,167,500
	FY2019	JPY	4,095,000
	FY2020	JPY	1,300,000

2. Purpose of research

The decision-making style of a group or organization, including a state or company, is an important aspect of that organization's identity. For example, national systems such as democracy and dictatorship owe much to the decision-making style of a country. Group decision-making can be seen as a function of individual decision-making, but it is a complex process that depends on the nature of the group, decision problems, and circumstances. Group decision-making has been studied relatively independently in many research fields. For example, social psychology focuses on macroscopic characteristics such as the nature of groups, while cognitive science focuses on the psychological and neuroscientific processes of individual decision making. In mathematical ecology based on animal behavior, researchers try to understand the emergence of complex collective behavior from simple individual decision-making by analyzing herd behavior. In informatics, the field of people analytics, which measures and analyzes the communication of actual members of an organization, has emerged and is approaching the problem of group decision-making by making maximum use of ICT. Integration of all these outcomes is essential to elucidate more effective forms of collective decision-making and contribute to the development of society. For this purpose, it is essential for researchers in different fields to have deep discussions and to make complementary use of mutual research methods. In addition, a concrete research problem as a platform for researchers in different fields to collaborate is indispensable.

In this project, researchers in social psychology, cognitive science, mathematical ecology, and informatics collaborate on the phenomenon of "wisdom of crowds" in which collective decision-making of individuals with little knowledge surpasses that of experts. We aimed at elucidating the mechanism of creative group decision-making by the interaction between individuals and groups. The wisdom of crowds has received a lot of attention in recent years, and its psychological mechanism has been discussed. It has also been reported not only in human populations but also in various social animals including ants, bees, and birds, and its evolutionary and biological basis is being investigated. On the other hand, there are many unclear points about why, when, and under what circumstances "wisdom of crowds" occurs, and it has been pointed out in social psychology that social factors such as evaluation concerns hinder the promoting

effect.

Among the problems related to “wisdom of crowds,” this project set the main research goal of “creating smart groups and individuals through group decision-making.” We examined the algorithms and cognitive foundations of group decision-making in order to find ways to enhance the abilities of groups and individuals. At the same time, we sought ways to avoid social factors that impede individual and social “learning.” Furthermore, we explored the possibility of ICT utilization including people analytics to achieve these. By integrating these approaches, we aimed to provide an important foundation for realizing a smart society. The purpose of this project was to contribute to the positive transformation of social and individual identities by utilizing the knowledge and technology of cognitive science research.

3. Outline of research (Including study member)

Focusing on “the wisdom of crowds”, we carried out the main issue and sub-themes A to C to elucidate the mechanism of creative decision-making by the interaction of individuals in group decision-making, and to create smart groups/individuals by group decision-making.

Main issue: Creating smart groups/individuals through group decision-making

Empirical studies were conducted at two levels, group and individual, to examine the process of change in decision-making patterns in group decision-making. At the individual level, we examined decision-making styles in group decision-making situations using decision-making tasks with correct answers. At the group level, survey data were used to examine the characteristics of organizational groups in real-life situations where social factors were not controlled. Furthermore, we used people analytics to conduct multifaceted observations of actual network communication data, and have developed a method for improving the effectiveness of decision-making by appropriately controlling the method of providing information to members.

Sub-theme A: Examining the algorithm of wisdom of crowds

The wisdom of crowds strongly depends on the task situation, the nature of the group, etc., and its general principle remains unknown. There are also reports that deliberation decisions in small groups of 4–5 people are more effective than the wisdom of crowds, which aggregates independent individual decisions with an algorithm. However, the vast majority of studies use simple knowledge problems, and few studies use complex decision-making tasks of real-world importance. Therefore, in this study, we examined the characteristics of group decision-making with a small number of people in a complex task, using a task that requires ranking of value for survival in consideration of various conditions. In particular, we conducted an analysis focusing on the effect of confidence rating on the aggregation of answers. Specifically, we used a task known as the NASA task, which ranks a list of 15 items according to their importance in order to survive safely on the moon, assuming that the spacecraft broke down on the moon. After solving this problem individually, a group of five people deliberated and asked for a group response. In addition, for both individual rankings and group rankings, a confidence rating was requested for the evaluation of each rank. This task has a correct answer defined by NASA experts and can calculate an error score. We calculated the error score of the individual, the error score of the group judgment, the error score of the personal

data aggregated using the algorithm of the wisdom of the crowd, and the error score using the confidence rating at the time of aggregation, and compared them.

In the literature of group problem solving, the studies on collective intelligence reported that the important determinant of collective intelligence is not the intelligence of the members but the diversity of the members. In addition, the division of roles of members in solving group problems and the role of social network structures among members has been examined. However, many group problem-solving studies use time-limited deliberative problems, and few studies consider real-time solutions that occur in many real-life situations. Therefore, in this study, we investigated the mechanism of group decision-making in problem-solving with time constraints using a visual search task. The visual search task often used in cognitive psychology is a task in which decision-making plays an important role along with the perception and attention. In particular, in a task called a visual foraging task, which searches for as many targets as possible from a search screen containing an unknown number of targets, the performance is defined by when to switch the search screen based on available visual information. Therefore, it is suitable for examining the interaction between perception and decision making. While the visual foraging task is usually performed alone, by performing it in a group, we examined how the division of roles of multiple explorers affects the search results. In this research, a team was composed of players with two roles, a searcher to search for a target from the search screen and a decision-maker to switch the search screen. We set two team conditions, one in which roles were fixed so that players become proficient in their roles, and one in which roles were switched so that players experienced both roles, and examined which teams performed more efficient search.

Sub-theme B: Social and cultural psychological examination of social factors that hinder or promote the wisdom of the crowd

The organizational culture and the smooth interpersonal relationships it fosters are important for members of the organization to achieve better collective decision-making via productive interactions. In particular, in order to apply and generalize the current empirical findings to societal problems, it is necessary to specify the conditions for diverse organizational cultures in the real world and the various aspects of interpersonal relationships brought about by such cultural differences. Therefore, regarding the relationship between the organizational climate and interpersonal relationships, we analyzed the data from multiple perspectives, using a company survey conducted on about 30 companies, 60 departments, and 3000 people in Japan, through multi-level modeling.

Recent management studies have pointed out the importance of regulatory focus as an organizational culture (i.e., a culture that encourages taking risks and achieving success or a culture that prioritizes avoiding risks and failures). Therefore, it has been suggested that active communication within the group, including information exchange, becomes more prevalent in a promotion-focused culture. Furthermore, previous studies in cultural psychology suggest that promotion-focused cultures are more likely to form in environments with highly mobile interpersonal relationships. Therefore, in this study, we analyzed the three-way relationship of workplace relational mobility, promotion-focused organizational culture, and workplace trust. Our results show that workplaces with more interaction with people outside the company have a stronger culture that emphasizes success, and the strength of such a culture leads to a higher

relationship of trust within the organization.

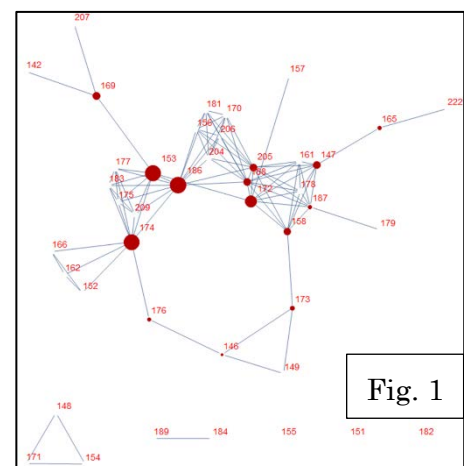
Additional analysis provided other insights into the organizational climate and cooperation within the organization. In cultural psychology, two subtypes of cultures, interdependent and independent, have been attracting attention and a huge amount of research findings have been accumulated. In this research, we examined the conditions when each type of culture supports cooperation. The results show that the culture which is more likely to promote cooperation depends on the mobility of the members of the organization. Specifically, in a mobile organization, independent cultures are more likely to lead to cooperation.

In addition, adopting a comparative perspective between Japanese culture and Western culture, we also conducted scenario-based experiments to see how performance-based evaluations operate in the two cultures. Japanese participants valued individual contribution more than the team's and company's contribution compared to American participants. Furthermore, in Japan, it was suggested that the motivation behind this decision could be due to individuals, who received excessive compensation, being afraid of being negatively evaluated by others. In other words, in Japan, it can be said that group decision-making is carried out in consideration of the reactions and evaluations of teams and others in the company even in performance-based systems.

Sub-theme C: Development of group decision-making research methods using people analytics

We have developed an experimental method using people analytics as a method for accurately collecting decision-making data in real-life situations. We collected the actual chat data using SLACK, which is a business SNS tool, as the original data for developing a method of people analytics in an actual human group. We have an NDA with the data provider company and are developing an analysis method as a joint research. In SLACK, there are channels for various businesses and topics, and users belonging to those channels communicate by chat. In this research,

we developed a basic analysis method for extracting the characteristics of the company from the chat data. Various important information can be obtained by performing an analysis that relies on the content of the utterance, but it is not easy from the viewpoint of information protection for companies and individuals. Therefore, in this research, we first tried to analyze the timing of each user's utterance. As will be explained in the research results, the typical development methods and results are shown in Fig. 1. When we formed an utterance graph that connects users who are speaking to each other on each channel and visualizes communication throughout the company, we can efficiently visualize the skeleton structure of corporate communication by setting a threshold based on the number of utterances per day and calculating the centrality of the network while raising the threshold. In FIG. 1, the mediation centrality of each user is calculated, and the user is represented by a circle having a size proportional to the value. We have developed several techniques for quantifying and visualizing the communication of the population as the basis of technology to evaluate and demonstrate the evidence of the wisdom of crowds expected to appear on SNS such as SLACK.



The research so far has been an analysis that does not go into the content of the utterance. Of course, from the viewpoint of personal information protection, it is impossible for the analysis system to directly access the utterance content. However, it is possible to extract specific keywords by natural language processing and numerically extract emotions and evaluations included in the utterances. This project aims to build a system for that purpose, and we conducted basic research on language development related to it and published it as a paper.

Research project structure

Role	Full name	Affiliation / department / job title	Research items
Principal Investigator	Jun Saiki	Kyoto University, Graduate School of Human and Environmental Studies, Kyoto University, Professor	Experimental research on individual transformation
Group Leader	Yukiko Uchida	Kyoto University, Kokoro Research Center, Professor	Experimental research on group transformation
Group Leader	Masaaki Sakagami	Kyoto University, Graduate School of Human and Environmental Studies, Professor	Mathematical ecology model for emergent algorithm
Member	Shoko Kanaya	Osaka University , Graduate School of Frontier Biosciences, Japan Society for the Promotion of Science Fellow (RPD)	Data collection and analysis related to individual transformation
Member	Kosuke Takemura	Shiga University, Faculty of Economics, Associate Professor	Data acquisition on group transformation
Member	Manabu Shikauchi	Cingular Co., Ltd. ▪ Director	Development of people analytics

4. Research results and outcomes produced

The outline of the research results on the three sub-themes and the research activities through collaboration between the teams are described below.

Sub-theme A: Examining the algorithm of the wisdom of crowds

(1) Examination of the mechanism of group decision-making and the wisdom of crowds in solving complex problems using NASA tasks: Obtaining individual ranking data and group decision-making data for groups of 5 people, we examined the wisdom of crowds and the mechanism of group decision-making with rank order data. We compared the average value of the individual error data with the following three aggregated data: Aggregation of group member decision data using the standard aggregation method of rank order data called Borda count, aggregated data (called CW-Borda) in which Borda count is weighted using confidence rating data for rank, and the group ranking data. The results of all three types of data were significantly improved over the individual error data. This result reproduces previous studies of the wisdom

of crowds and group decision-making. However, this result does not reproduce the results of previous studies that group decision-making performed better than the wisdom of crowds. Also, as a more important result, the aggregated data weighted with the confidence rating data is no different from the unweighted aggregated data, which is also different from previous studies. It has been repeatedly reported in previous studies that weighting with a confidence rating approaches the correct answer, and in order to examine the reason, we conducted a simulation in which the group size at the time of aggregation was changed using the data of all participants. The result clarified that although the weighting effect was not seen in the group size of about 5 people, the weighting effect became clear as the group size at the time of aggregation was increased. This result can be interpreted that the lack of weighting aggregation effect was not due to the unique characteristics of the NASA task, but to the small group size to be aggregated. However, the effect of weighting has been reported even for about 5 people in general knowledge problems, and the cause of this difference needs further investigation. This finding was published in the English academic journal *Cognitive Research: Principles and Implications*.

To further clarify why the effect of weighting aggregation was seen only with large group sizes in experiments using the NASA task, a ranking task using general knowledge problems, whose similarities were matched to the NASA task, is examined. If the results seen in the NASA task are based on the task format of ranking tasks, similar results can be expected in the ranking tasks of general knowledge problems. On the other hand, if the cause is the other unique characteristics of the NASA task, it is expected that the weighting effect will occur in the small group as in the previous study in the general knowledge problem. The study has now completed data collection and is now analyzed.

(2) Impact of division of roles in group visual search: Two searchers and one decision-maker perform a visual foraging task as a team to search for as many targets as possible while switching the search screen containing multiple target stimuli as necessary. At that time, two of the three people were two fixed pairs of experimenters and the performance of the remaining one was evaluated. This was to minimize the effect of differences among groups. The experiment consisted of two phases, and in the second phase, all the participants played the role of screen switching. Three conditions were set for the first phase. Under the fixed role condition, the participants were in charge of screen switching in both the first and second phases. Under the role change condition, the participant was in charge of the search role in the first phase, and was in charge of screen switching by switching roles in the second phase. Under the control conditions, the first phase was not performed and only the second phase was performed. Comparing the time required searching for the determined number of targets and complete the task under three conditions, no significant difference was found among the conditions, but the variance of the task execution time significantly decreased in the fixed role condition than in the role change condition. This result shows that the individual difference is larger in the role change condition than in the role fixed condition, and suggests that the effect of performing the visual search under the decision of others strongly depends on the characteristics of the decision-maker. However, since this effect is not uniformly promoting or suppressing, and may or may be inhibited by the decision maker, on average the role change does not produce differences in the average value with the fixed role condition. This result relates to the question of whether a specialist or generalist organization is more efficient when applied to a general organization. The role-fixing conditions in this study correspond to specialist-type organizations, and the role-switching

conditions correspond to generalist-type organizations. The results of this study cannot draw any clear conclusion about which is more efficient, and suggest that especially in generalist-type organizations, their performance is strongly dependent on the members' capacity or the mutual relationship between the members. On the other hand, in a specialist-type organization, the fluctuation of the performance as an organization is relatively small and stable. To what extent the results of this study can be generalized to real organizations is a topic for the future studies?

In addition to the comparison of role fixed and role change conditions, an analysis of the inter-reaction time interval, which is a method for evaluating the optimality of search in the foraging task, resulted in interesting results. When the optimality of the search as a group was evaluated for each of the two fixed pairs of experimenters, the search was performed optimally with the pair having similar search efficiencies, regardless of the role manipulation. However, the optimality in search is substantially reduced with the pair having greatly different efficiencies. This result shows the same tendency as the classical study of paired perceptual judgment, suggesting that a common mechanism may work in group decision making even in complex tasks such as visual search. The results of this research were presented at the symposium at the 84th Annual Meeting of the Japanese Psychological Association.

Sub-theme B: Social and cultural psychological examination of social factors that hinder or promote the wisdom of the crowd

The primary finding is that we elucidated the importance of environmental factors (e.g., high mobility) surrounding the group. Free-rider problems are more likely to occur during group decision-making, and therefore the establishment of mutual cooperation among group members is essential. This study showed that mutual cooperation within the group is strongly linked to the characteristics of the environment in which the group is located, such that the types of culture and climate that should be built within the group differ depending on the characteristics of the environment. In addition, a cross-cultural study between Japan and the United States suggests that the current environment and historical background of both countries influence the decision as to whether or not to introduce a performance-based system. It can be said that the group does not exist separately from the environment and history, but is embedded in its spatial and temporal context.

Secondly, we demonstrated the usefulness of cultural comparison as a research method (including the comparison between organizations with different organizational cultures). The traditional research method for group dynamics is through group experiments in the laboratory, and its usefulness and importance are undisputed. However, considering that group dynamics are dependent on environmental factors as described above, it is effective to compare groups within various environments which exist in the real world in order to understand the unique characteristics of the environment.

At the same time, the third point is the implication of the current research beyond a mere comparison of two dichotomous cultural groups. Although cross-cultural studies have made great progress in the field of social psychology, comparisons between the two countries (e.g., Japan and the United States) have been the main focus. While dichotomous comparison is a useful approach in that it shows the magnitude of the impact of culture, and thus has been adopted in research on the operation of performance-based systems, there are limits to this approach. One of the limitations is that the comparison between the two countries

cannot determine the cause of the differences revealed by the comparison.

For example, it is unclear which of the various differences between Japan and the United States is associated with the differences in decision-making style between Japan and the United States. For research areas with such limitations, the current corporate survey on the climate and interpersonal relationships reveals a new direction of research. In other words, it is a novel method of collecting data from many organizations and groups with different cultures and analyzing it by multi-level modeling. This allows us to empirically examine the mechanisms that occur at the cultural level. This combination of research method and analysis is an important contribution stemming from our research, which links the research theme of group decision-making with a cultural psychological perspective.

Sub-theme C: Development of group decision-making research methods using people analytics

As mentioned in the research content and method, we have developed several methods for quantifying and visualizing communication within the group as basic techniques for evaluating and demonstrating the evidence of the wisdom of crowds.

(1) Visualization of the hierarchical structure of communication within a company using an utterance graph: In SLACK, there are many channels by business, topic, department, etc. in the network. Since the utterances in each channel are sent to all channel members, it is not always known to whom the utterances are directed. Therefore, assuming that discussions have been established between users who are speaking within a certain period of time, we formed an utterance graph (discussion graph) that connects the speakers with links, and tried to visualize the state of the discussion within each channel. Since many users belong to multiple channels, this utterance graph has made it possible to visualize information transmission through discussions throughout the corporate network (Fig. 1). The skeletal structure of corporate communication could be efficiently visualized by setting a threshold value based on the number of utterances per day and calculating the centrality of the network while raising the threshold value. In FIG. 1, the mediation centrality of each user is calculated from the network structure, and the size thereof is illustrated. Mediation centrality is an indicator of the proportion of information that is located on the transmission path. Users represented by a large circle in FIG. 1 play an important role as a hub for communication across the network. Furthermore, by changing the threshold value, the skeletal network structure composed of more active and important users can be extracted, and the contribution of the skeletal structure to the wisdom of crowds in the entire corporate network and conversely the contribution of the surrounding users can now be analyzed.

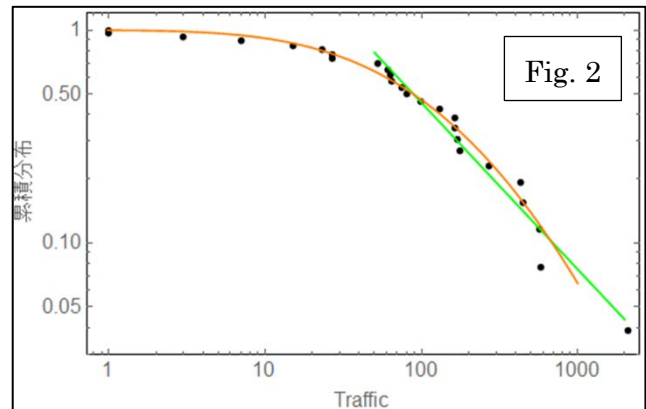
(2) **Leadership quantification:** The relationship between the presence or absence of the wisdom of crowds in corporate networks and the leadership of major users is also an interesting topic. However, it is not easy to quantify leaders and their leadership without referring to personnel information and the content of each utterance. Utterances on each channel are not spoken at similar paces or intervals. It gets excited and becomes quiet. Therefore, the utterances in the channel were divided into clusters based on the utterance time interval, and each cluster was assumed to be discussing a certain topic. Furthermore, the first speaker in each cluster was extracted from the traffic data as a silence breaker. Since the silence breaker has started or revived a certain topic, it was thought that the degree of leadership exerted in each user's channel can be measured from the frequency of silence breaks. We calculated the frequency of

silence breaks from traffic data for a company's SLACK network that can obtain personnel information, and confirmed that in that company key users such as the CEO and project manager are acting as a silence breaker on the relevant channel. This finding has made it possible to quantify the identification of key members and the degree of leadership of their users by analyzing traffic data in SLACK.

(3) Distribution of the number of utterances in the channel

There are various channels in SLACK, but there is a big difference in the number of utterances in each. FIG. 2 shows the distribution of the number of utterances of each channel of SLACK in a certain company. It is a cumulative distribution that plots the proportion of channels whose traffic is greater than a certain value over a period of time.

Orange is a fitting with a lognormal distribution. It is fairly well represented by a lognormal distribution, but the channel with the largest number of utterances deviates from the lognormal distribution. The green straight line is the one in which only the channels with a relatively large number of utterances are selected and fitted, which is the power distribution. It is also known from the income



distribution that the upper group has a power distribution in this way. In the case of income distribution, high-income earners over 20 million yen per year correspond to the green straight line above. In terms of the number of utterances in the SLACK channel, the green area extracts the main channels with the most utterances. The area around the right end of the green power distribution area is the main channel with very high activity. On the other hand, the left side of the green area is a channel that is not necessarily the main channel at present. However, the channels in this region are important channels in the sense that they have the potential to grow into major channels in the future. Based on the communication structure and the presence or absence of leadership obtained from the analysis of (1) and (2) of this study, it is possible to evaluate and intervene in these preliminary groups to increase the activity and sustainability of the entire network. It is uncertain whether this research result will immediately contribute to the wisdom of crowds. However, we expect that the reserve group identified in this study is highly responsive to external interventions. In that sense, in verifying the wisdom of crowds using traffic data, we would like to pay attention to the behavior of the channels that correspond to these preliminary groups, such as changes before and after the intervention.

Research activities between teams

In this research, in parallel with the research on sub-themes centered on cognitive science, social psychology, and informatics, research meetings of all project members are held regularly to confirm the progress and to plan an inter-team collaboration project. Many of the achievements of each of the above research themes were carried out with the advice and support of researchers in other fields through this research meeting, and some of them have changed significantly from the original plan.

As an opportunity to disseminate the results of this project to the outside, workshops of industry-academia collaboration were held in 2017 and 2018, and a workshop will be held at the Japanese Society

of Social Psychology in 2019. In the workshops in 2017 and 2018, fiscal year, researchers of this project introduced the findings about the wisdom of crowds in cognitive science and social psychology to the people in industry interested in the People Analytics, and participants discussed how to utilize them in actual situations.

At the Japanese Society of Social Psychology in 2019, a workshop “Thinking about ‘groups’ : Challenges in vision science, mathematical ecology, informatics, and social psychology” was held, and presented a group study by a team of social and cultural psychologists, as well as introducing approaches from vision science, mathematical ecology, and informatics. This workshop could appeal the effectiveness of methods (e.g., people analytics) that were not used in the conventional field of social psychology.

Future directions

Various collaborations have already been made through regular project member meetings. For example, the project of quantifying leadership in people analytics research (sub-theme C) was born out of discussions with the social psychology team (sub-theme B) and cognitive science research (sub-theme A). The project using the NASA task is currently starting a new project utilizing the know-how of collecting and analyzing survey data of the social psychology team as the next step. In addition, the People Analytics project has realized the use of communication data using slack in actual corporate activities, which provides a valuable field for cognitive science and social psychology projects centered on experiments and questionnaire surveys. Currently, experiments and surveys in the field of corporate activities in real situations are also planned within the research team, and it will be an effective means to verify the ecological validity of the findings of experiments and research studies using virtual settings.

This project raises the issue of “creating smart groups and individuals through group decision-making,” and has been conducting research through collaboration of different approaches such as cognitive science, social psychology, and informatics. This project, which started with only the platform of the wisdom of crowds, did not always proceed as planned, and was forced to change the plan based on realistic restrictions and the results of preliminary experiments and surveys. However, as a result of proceeding with the project while sharing those processes as well, after three years of research, it is becoming possible to build a more specific research platform that links cognitive science, social psychology, and informatics. Sub-theme B has shown a control focus of an organizational culture as an important macro characteristic that determines the effectiveness of group decision-making. Sub-theme A showed the importance of participant confidence and group division of roles as a way to analyze the effectiveness of group decision-making from a microscopic process. The network analysis of group communication advanced in sub-theme C works as an effective methodology for connecting these micros and macros. There is a large gap between the micro and macro perspectives, and it is difficult to directly connect them, so that the collaboration between conventional cognitive science and social psychology does not progress easily. However, the level of network analysis of communication can be expected to function as an intermediary term that connects the two.

In an attempt to achieve these initiatives, members of this project, composed of cognitive science, social psychology, informatics, are planning a research project to explore the mechanism of the emergence of cooperative behavior, by using the common pool resource management task as a common platform, and

applying for research funding. The common pool resource management task imitates the public resource management issues, such as forestry and fisheries resources, has the aspect of search for the optimal solution in real time, and requires communications as a key role. The common pool resource management task is drawing attention in the social sciences as a group cooperation task close to the actual situation. However, in many studies, individuals are treated as “abstract random variables”, and it is only possible to describe and predict the statistical characteristics and trends of cooperation. To understand the cooperative action of individuals with diverse feelings and preferences in the interaction with specific party in a specific environment, understanding the hierarchical state of individuals’ neural basis, nature of the interaction with others, and the external environment surrounding them is essential. This research proposal is based on conventional research that has elucidated cooperative behavior at the trait level, and aims to understand the state level at which collective behavior emerges through individual interaction. Elucidation of state-level psychological processes makes it possible to predict behavior in individual cases, which can lead to the proposal of concrete measures to promote cooperation in a small group of real organizations. In order to achieve this goal, it is essential to link the strengths of cognitive science, social psychology, and informatics, and we would like to promote research as a development of this project.

In addition, the research of this project has a new modern significance due to the recent corona pandemic. It is certain that coronaviruses will significantly change the way society is, especially communication, and how to make effective group decisions in new communication styles has become an urgent issue. This has not only the negative impact of restrictions on conventional communication styles, but also the positive side of utilizing new communication styles that make full use of ICT technology. Although new technologies are already appearing in the world, it is extremely important to empirically clarify how they should be utilized, and the results of this project will be able to greatly contribute to this point.

The team members of this project have decided to continue joint research and further develop their research. While seeking new research grants and industry-academia collaborative research with companies, we will proceed toward the achievement of the original research purpose of the creation of smart groups and individuals.