Role of Assigned Persona for Computer Supported Cooperative Work in Remote Control Environment

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Abstract. In the case of cooperative work through networks, non-verbal communication is obstructed. The purpose of this study is to examine the role of assigned persona for the computer supported cooperative work in remote control environment. This experiment scenario was the workplace and set the user scenario for the real subjects. The superior persona and the subordinate persona which affects the "psychological reward" and the "partner's evaluation" were assigned to the subjects. The experimental task that was the simulated chemical plant required to operate two subjects during 90 minutes. Results of primary and secondary task performances, the difference among the assigned persona was observed to execute the computer supported cooperative task. It is necessary to manage a basic design of the interaction between the person and the task concerned about the partner's honor information and the behavior information adequately.

Keywords: persona, nonverbal communication, cooperative behavior, organizational ergonomics, computer supported cooperative work.

1 Introduction

In the case of cooperative work through networks, non-verbal communication (e.g. exchanging the strategy, understanding of own role, synchronizing the timing for operation) is obstructed. Therefore, it is predicted that work performance of the computer supported cooperative work in remote control environment is deteriorated in comparison with normal cooperative work environment. In the study of the efficiency of the behavioral information, it was examined the process of inducing mutual cooperation among workers in a remote work environment (telework) experimentally. Subjects were not given information regarding their partners' reputations and knew only which buttons their partners pushed, i.e., their behavior in the remote work environment. The gambling task developed by Payne [1] was used, and cooperative behavior arose as subjects saw which buttons their partners pushed. Overall, the results suggest that an exchange of nonverbal behavioral information was necessary for inducing cooperative behavior [2].

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In general, the following are generally thought to be necessary for cooperative behavior to be induced: (1) an incentive for cooperation, (2) appropriate information about the reputations of cooperative partners, and (3) a clear role structure among partners. Moreover, in scenarios with two-participant decision making (e.g., Prisoner's Dilemma), research has indicated that participants would devote resources to gathering the information that they needed and accommodating the other participant's actions in their decision making [3].

It is considered that the "psychological reward" and the "partner's evaluation about own behavior or decision making" are the factors of an incentive for cooperation. Then, we examined experimentally the "partner's evaluation" concerned about the process of sharing strategy. This study was set at the communication style restricted environment. Because, it was thought that sharing correct strategy under the restricted communication situation was difficult. In this study, the subjects were made to play a game on the network with exchanging their environmental noise or partner's voice. As the results, it was suggested that subjects could achieve the cooperative behavior at the restricted communication situation using the "partner's evaluation" through the partner's environmental noise [4].

Meanwhile, it was suggested that the "psychological reward" was a function of the number of the cooperative behavior. In a social dilemma, participants are considered to show more reciprocal behavior as the game progresses, responding more sensitively to how much others cooperated in the previous round. That is, the frequency of cooperative behavior has an important role in the quality of decision making, which can foster the formation of a cooperative relationship [5].

Because the "psychological reward" depends on the participant's reputations, it is difficult to examine whether the "psychological reward" affects the work performance and the decision making quality. In addition, it is difficult to manage the structure of participant's role experimentally. Then, in this study, we focused on the structure of participant's role influencing the incentive for cooperation. The participants were assigned the persona. In this experiment, we assigned the persona to the task environment with the user scenario [6]. The assigned persona were the superior persona and the subordinate persona which affected the "psychological reward" and the "partner's evaluation about own behavior or decision making".

The purpose of this study is to examine the role of assigned persona for the computer supported cooperative work in remote control environment.

2 Method

2.1 Subjects

The subjects of this study were sixteen university students (male = 8, female = 8, 19-23 years; 20.9 ± 1.5 years). Before participation to this experiment, the informed consent was established with each subject. All subjects were paid for the participation of this experiment.

氏名	吉田　浩司		Photo Image
性別	男性	家族構成	妻，娘 1 人
年齢	40 歳	趣味	ゴルフ
役職	部長	性格	
	（入社 18 年目）	仕事には厳しいが，非常に部	
年収	約 800 万	下想い．正義感が強い．	

化学プラントの運転操作に関しては社内で 3 本の指に入る優秀なオペレーターである．同僚とは職場以外でもコミュニケーションを持ち，彼を慕う部下も多数存在する．会社では次期取締役候補とされている．また，非常に家族想いで，休日には家族 3 人で頻繁にレジャーに出かける．

普段は本社工場の化学プラント施設で働くとともに，オペレーター養成施設にて教官も務めているが，今回は会議への出席のため，東京に出張することとなった．しかし，本社の化学プラント施設の運転操作から外れるわけにはいかないため，東京の支社ビルのコントロールルームから遠隔操作でプラント施設のオペレーションを行うこととなった．

Fig. 1. Example of the user scenario (the “male” superior persona, written in Japanese)

2.2 Assigned Persona

Our experiment scenario supposed the workplace. We set the user scenario [6], the use case scenario [7] and persona core [8] for the real subjects. Subsequently, the superior persona and the subordinate persona which affects the “psychological reward” and the “partner’s evaluation about own behavior or decision making” were assigned to the subjects. All subjects were required to participating two experiments: the superior persona part and the subordinate persona part. He or she was required to play the assigned persona as described in the user scenario (e.g. Fig. 1).

2.3 Experimental Task

The experimental task (taking some sort of reference [9]) that is the simulated chemical plant is required to operate two subjects. This task is constructed in three tasks; the primary task is the mixture task of raw material, the goal operation is the heat treatment task, and the secondary task is the gauge reset task. The secondary task was prepared to examine the focus of attention and the influence of the assigned persona. Task screenshot is shown in Fig. 2. In this experiment, two participants were required for operating the task as a team during 90 minutes.

The trouble events were also set in the experimental scenario. The trouble events were inserted to induce the cooperative behavior. And the degree of difficulty was set in each 30 minutes; the first 30 minutes was easy phase, subsequently the mid 30 minutes was difficult phase, and the last 30 minutes was easy phase. The degree of difficulties was controlled by the failure probability in the trouble events and the frequency of the gauge reset demand. In this study, the subject played the two personas (the superior persona and the subordinate persona). To execute the primary task reliably, two subjects were required to the cooperative behavior controlling three valves each other (see Fig. 3).

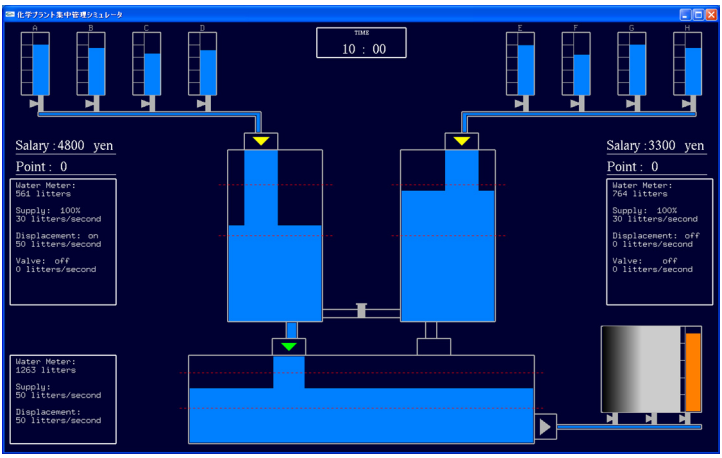

Fig. 2. Screen shot of experimental task

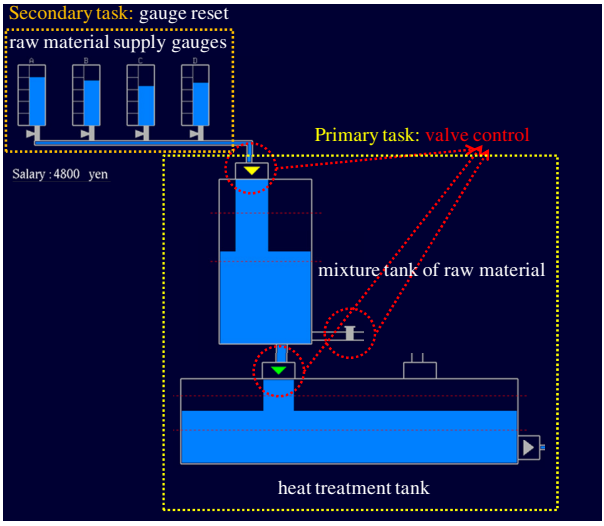

Fig. 3. Primary task control and secondary task control

2.4 Evaluation Indexes

The evaluation index for the primary task was the error rate of the mixture tank of raw material. Each subject was required to maintaining the material level from 50 % to 80 % by operating the three valves. The secondary task evaluation indexes were the success rate of the gauge reset, the reaction time to push the given buttons, and the error rate to find the reset demand. The evaluation index for the team's task performance was the ratio of the heat treatment tank of mixed material. The cooperative behavior was defined by two type of the observed behaviors: a) to use the valve for recovering

the partner's material shortage, b) to control the own valve for compensating the partner's material. Six experiment pairs were divided into the cooperative group and the other experiment pairs were divided into the non-cooperative group. And the evaluation indexes of the cooperative behavior were the rate of the cooperative behavior in the primary task, the assist rate of the partner's gauge reset and the reaction time to assist the partner's gauge reset.

3 Results

3.1 Primary Task Performance

The error rate of the mixture tank of raw material among the assigned persona as a function of experiment period was shown in Fig 4. Two-way ANOVA of the error rate of the mixture tank of raw material revealed two significant main effects: assigned persona ($F(1,11) = 6.24$, $p < 0.05$) and experiment period ($F(2,22) = 5.59$, $p < 0.05$). *Bonferroni's* multiple comparison method revealed significant differences among the assigned persona (superior > subordinate). During all experiment periods, the superior persona's error rate was higher than the subordinate persona's error rate.

3.2 Secondary Task Performance

The success rate of the gauge reset behavior among the assigned persona as a function of experiment period was shown in Fig 5. Two-way ANOVA of the success rate of the gauge reset task revealed significant main effect of the assigned persona ($F(1,11) = 9.80$, $p < 0.05$). *Bonferroni's* multiple comparison method revealed significant differences among the assigned persona (subordinate > superior). It was observed that the success rate on the subordinate persona was higher than the superior persona during all experiment periods.

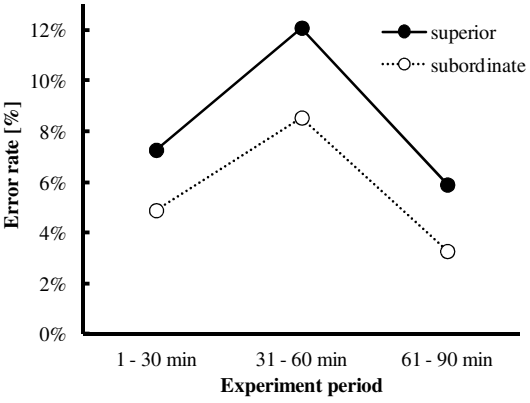

Fig. 4. Error rate of the primary task performance as a function of experiment period

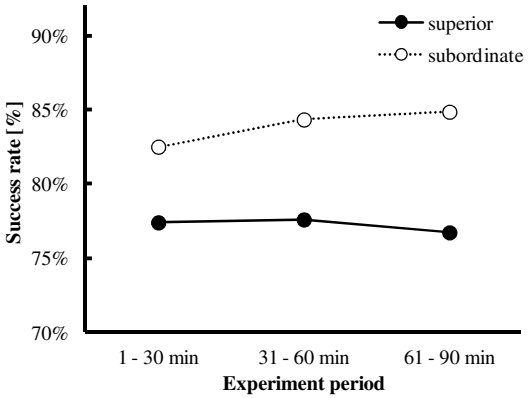

Fig. 5. Success rate of the gauge reset task behavior as a function of experiment period

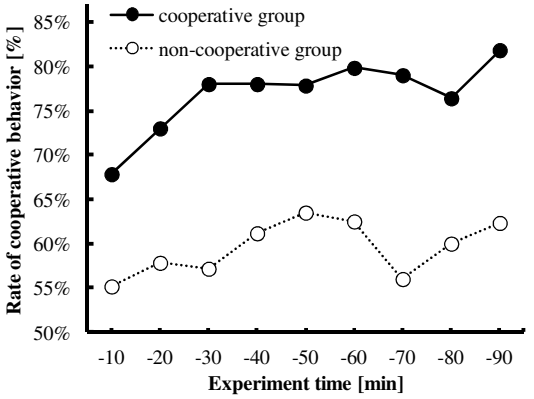

Fig. 6. Rate of the cooperative behavior as a function of experiment time

3.3 Effects of Cooperative Behavior

Rate of Cooperative Behavior. The rate of the cooperative behavior in each 10 minutes among the cooperative group and the non-cooperative group as a function of experiment time was shown in Fig. 6. Two-way ANOVA of the rate of the cooperative behavior revealed two significant main effects: observed behavior ($F(1,5) = 82.54$, $p < 0.0001$) and experiment time ($F(8,40) = 2.26$, $p < 0.05$). *Bonferroni's* multiple comparison method revealed significant differences among the observed behavior (cooperative group > non-cooperative group). It was observed that the rate of the cooperative behavior on the non-cooperative group was around 60 % during experiment. Meanwhile the rate of the cooperative behavior on the cooperative group was increased about 12 % or more with experiment progression.

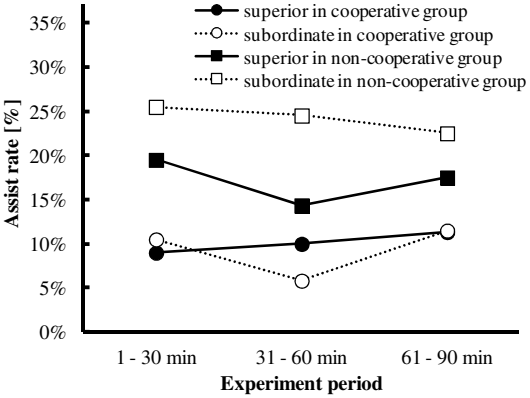

Fig. 7. Assist rate of the partner's gauge reset as a function of experiment period

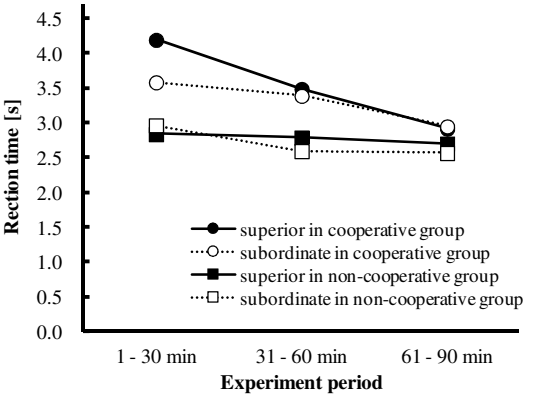

Fig. 8. Reaction time to assist the partner's gauge reset as a function of experiment period

Assist Rate for the Partner's Gauge Reset. The rate of cooperative behavior in the cooperative group had occurred higher than the non-cooperative group. Therefore it was examined the assist rate for the partner's gauge reset behavior. The assist rate for the partner's gauge reset among the assigned persona (the superior and the subordinate) and the observed behavior (the cooperative group and the non-cooperative group) as a function of experiment period was shown in Fig. 7. Three-way ANOVA of the assist rate for the partner's gauge reset revealed significant main effect of the observed behavior ($F(1,5) = 19.85$, $p < 0.01$). *Bonferroni's* multiple comparison method revealed significant differences among the observed behavior (non-cooperative group > cooperative group). The assist rate for the partner's gauge reset showed no significant difference between the assigned persona, but the assist rate of the subordinate in the non-cooperative group was higher than other group in all experiment periods.

Reaction Time to Assist the Partner's Gauge Reset. The same tendency was observed in the reaction time to assist the partner's gauge reset. The reaction time to assist the partner's gauge reset among the assigned persona (the superior and the subordinate) and the observed behavior (the cooperative group and the non-cooperative group) as a function of experiment period was shown in Fig. 8. Three-way ANOVA of the reaction time to assist the partner's gauge reset revealed significant main effect of the observed behavior ($F(1,5) = 7.94$, $p < 0.05$). In addition, the experiment period's main effect was revealed ($F(2,10) = 4.01$, $p < 0.05$). *Bonferroni's* multiple comparison method revealed significant differences among the observed behavior (cooperative group > non-cooperative group).

4 Discussion

The results of the primary task performance and the secondary task performance, the difference among the assigned persona were observed to execute the computer supported cooperative task through the network. During the first 30 minutes (period: 1 - 30 min), the error rate was increasing moderately. At the high difficult condition of mid 30 minutes (period: 31 - 60 min), the error rate was increased drastically. After the high difficult condition, the rate was recovered near the level of the first 30 minutes. And all experiment periods, the superior persona's error rate was higher than the subordinate persona's error rate. Similarly, the same tendency was observed in the success rate of the partner's gauge reset behavior at the secondary task. To summarize those results, if the person assigned the superior persona, the main task performance deteriorated because of the required follow-up behavior to the subordinate persona. But, it was also considered that the reason of the bad decision making to do the task was the expectation to the "psychological reward" from the subordinate persona for the assist behavior.

To examine the role of the assigned persona, twelve pairs divided two observed behavior groups. And all experiment periods, the assist performance to the partner of the subordinate in the non-cooperative group was higher than the other group. In this experiment, a subject executed two personas, the superior and the subordinate. Therefore, it was considered that the same subject selected different behavior to operate the task. That is, it was thought that the subordinate persona induced the subsidiarity attitude to the task. The subsidiarity attitude to the task diverted the focus of attention to the primary task and mistook the secondary task for the primary task. For the inappropriate attitude to the task, the assigned superior persona had to perform independent management to compensate low task performance in the assigned subordinate persona. In other words, it is able to say that the superior persona could understand the reward from the subordinate persona in their mind. Meanwhile, the subordinate persona could not understand the superior's overload from the result of their performance deficiency. That is, it is considered that the role of persona leads the operator into the misunderstanding state to infer the "partner's evaluation about own behavior or decision making" under the condition of inhibited the non-verbal communication.

5 Conclusions

In conclusion, these types of problem are not able to solve optimizing the interface design only. Therefore, it is necessary to manage a basic design of the interaction between the person and the task concerned about the partner's honor information and the behavior information adequately. This point of view may apply the ambient or the ecological interface design to manage the interaction.

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