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学 位 論 文 題 目　Influence　of　empathy　on　human-agent　coexistence
　　　　　　　　　relationship

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博士論文の要旨

氏　　　名　　　津村　賢宏

論文題目　Influence of empathy on human-agent coexistence relationship

Many technologies are being used in numerous situations, including ChatGPT, generative AI, factory robots, cleaning robots, nursing robots, and anthropomorphic agents for customer service and chatbot support. In addition, the global environment is becoming more accepting of anthropomorphic agents with the development of businesses using 3D avatars and VR technology. On the other hand, as the use of AI technology and anthropomorphic agents in society becomes more widespread, people may feel distrust and rejection toward these technologies, which may lead to negative behaviors. Therefore, it is an important issue to establish a coexistence relationship with AI technologies and anthropomorphic agents used in future society. As a way to solve this problem, an appropriate relationship can be established when people feel empathy and trust toward anthropomorphic agents. It has been discussed in the fields of psychology and philosophy that these are important factors in human relationships, and we believe that they have a significant impact on the construction of relationships between people and anthropomorphic agents. Therefore, we focused on empathy between people and anthropomorphic agents. In particular, we investigated the factors that make people empathize with anthropomorphic agents. Below is a summary of the three experiments.

In the first study, we focused on self-disclosure from agents to humans to increase human empathy toward anthropomorphic agents. We experimentally investigated the possibility that self-disclosure from agents promotes human empathy. Two hypotheses were formulated, and the conditions under which humans are more empathetic toward agents were experimentally analyzed and discussed. The experiment was conducted in a three-way mixed design, and the factors were agent appearance (human, robot), self-disclosure (highly relevant self-disclosure, less relevant self-disclosure, no self-disclosure), and empathy before and after video stimuli. An ANOVA was conducted using data from 918 participants. The results showed that there was no main effect for the emergent factor and that self-disclosure, which was highly relevant to the scenario used, promoted more human empathy by a statistically significant margin. We also found that self-disclosure did not suppress empathy. These results support our hypothesis. This study reveals that agents' self-disclosure represents an important feature of anthropomorphic agents that helps humans accept them.

The next study focused on tasks between agents and humans. In particular, we experimentally examined the hypothesis that task difficulty and task content promote

human empathy. The experiment was a two-way ANOVA with four conditions: task difficulty (high, low) and task content (conflict, cooperation). An analysis of variance (ANOVA) was conducted with data from 578 participants. Results showed no main effect of the task content factor and a significant main effect of the task difficulty factor. In addition, pre-task empathy for the agent decreased after the task. ANOVAs showed that one category of empathy for the agent increased more when the task difficulty was higher than when the task difficulty was lower. This indicated that this category of empathy was likely to be affected by the task. The task used itself was likely to be an important factor when manipulating each category of empathy.

As a final study, we focused on tasks in which humans and agents interacted in a variety of ways to investigate agent characteristics that significantly influence human empathy toward the agent. Experiments were conducted to examine the effects of task completion conditions (success, failure) and agent representation (yes, no) on human empathy. An ANOVA was conducted using data from 363 participants. The results of the experiment showed that human empathy toward the agent is difficult to maintain in the task completion condition alone, and that agent representation can maintain human empathy. These results indicate that the characteristics of AI agents play an important role in helping people accept anthropomorphic agents.

Based on the results of the above three studies, this paper discusses an empathic approach to help anthropomorphic agents gain acceptance from people and proposes the design of a relationship in which agents working with people can coexist and co-prosper with people through empathic agents in the future. As a general discussion, we discussed the design of empathy agents that can be considered from the results of the three studies, and the questionnaire validity for empathy agents was also discussed from the Cronbach's alpha coefficient. In addition, we discussed how affective and cognitive empathy affected empathy toward the agent from the three studies. The behavioral changes of people toward empathy agents were also discussed with a focus on empathic responses.

Throughout all of our studies, our investigation of the factors necessary for agents to be empathetic to people showed that when empathy agents were empathetic to people, their altruistic behavior and their awareness of task continuation increased. In addition, we created a modified version of the IRI, which investigates human empathy characteristics in psychology, as a questionnaire for agents who are empathetic to others in the study of empathy agents. While maintaining the reliability of this questionnaire, it helps to solve the problem of previous studies of empathy agents in which the definitions of empathy were disparate and difficult to compare. Future research will extend the study of empathy agents in an online environment to investigate the effects of empathy agents on people in the real world.

Results of the doctoral thesis defense

博士論文審査結果

Name in Full
氏 名　　津村　賢宏

Title
論文題目　　Influence of empathy on human-agent coexistence relationship

　本学位論文は，「Influence of empathy on human-agent coexistence relationship」と題し，全7章から構成されている．

　第 1 章「Introduction」では，研究の動機，目的，背景について説明されている．ここで本研究の目的が，「人間に共感される擬人化エージェント開発のための共感に効果的な要因の実験的調査」であることが述べられている．次に，第 2 章「Related Work」では，一般的な共感の 2 分類（感情的共感，認知的共感），共感エージェントの定義（共感されるエージェント，共感するエージェント），共感エージェントと人間の関係などの関連研究について説明されている．続いて，第 3 章「Influence of agent's self-disclosure on human empathy」では，「エージェントの外見」要因とエージェントが自分のことを語る「自己開示」要因が人間の共感に与える影響の実験的解明について述べられている．実験の結果，エージェントの背景に関連した自己開示の有効性が支持され，外見の影響は支持されなかった．そして，第 4 章「Facilitate empathy for agent through task difficulty」では，エージェントのタスクの難易度要因，タスクの性質要因（競争的，協調的）が人間の共感に与える影響を実験的に調べる研究について説明がされている．実験の結果，「競争タスクでは，難易度が高いほど人間の共感が抑制される」，「協調タスクでは，難易度が高いほど人間の共感が促進される」という仮説は支持されなかったが，タスク難易度には主効果が認められた．続いて，第 5 章「Maintain empathy for agent through agent's expression」では，タスク達成時のエージェントの表出要因，タスク実行の成否要因が共感に与える影響を実験的に検証する研究について述べられている．実験の結果，共感エージェントが表出をする場合，タスクの成否にかかわらず共感に影響することがわかった．最後に，第 6 章「General discussion」において研究全体の考察，第 7 章「Conclusion」で本研究の結論が述べられている．

　公開発表会では博士論文の章立てに沿って発表が行われ，その後に行われた論文審査会及び口述試験では，審査員からの質疑に対して出願者は適切に回答した．

　質疑応答後に審査委員会を開催し，審査委員で議論を行った．審査委員会では，出願者の博士研究が「人間の共感を促進するエージェントの開発に貢献できる様々な要因を実験的に調査，確認するオリジナリティの高い研究」であることが評価された．

　以上を要するに本学位論文は，仮説・検証アプローチによって人間の共感に影響する要因を広く実験的に調査した優れた研究であり，共感エージェントの開発，HAI ヒューマンエージェントインタラクション，人工知能の研究分野の発展に貢献するという点で学術的価値が大きい．また，本学位論文の成果は，学術雑誌論文 2 編，査読付き国際会議論文 2 編として発表され，社会的な評価も得ている．以上の理由により，審査委員会は，本学位論文が学位の授与に値すると判断した．