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Examining the Antecedents of Creative Collaboration with an AI Teammate

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Short Paper

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Abstract

With the advent of artificial intelligence (AI), individuals are increasingly teaming up with AI-based systems to enhance their creative collaborative performance. When working with AI-based systems, several aspects of team dynamics need to be considered, which raises the question how humans' approach and perceive their new teammates. In an experimental setting, we investigate the influence of social presence in a group ideation process with an AI-based teammate and examine its effects on the motivation to contribute. Our results show a multi-mediation model in which social presence indirectly influences whether human team members are motivated to contribute to a team with AI-based teammates, which is mediated by willingness to depend and team-oriented commitment.

Keywords: artificial intelligence, team, creativity, brainstorming, human-AI collaboration

Introduction

People often form teams to make complex decisions, create innovative solutions, and depend on each other to complete intricate tasks (Randrup et al. 2016; Siemon et al. 2019). With the advent of artificial intelligence (AI), individuals working together are increasingly teaming up with AI-based systems to enhance their joint performance and collaborative outcomes (Seeber et al. 2020). Combining complementary strengths of human intelligence (e.g., flexibility, empathy, creativity, and common sense) with AI (e.g., pattern recognition, speed, and efficiency) has led to the emergence of hybrid intelligence (Dellermann et al. 2019). Hybrid intelligence allows human teammates to overcome gaps and biases in their decision-making, creativity, and collaboration (Jarrahi 2018). Possible applications of AI-based systems in collaborative scenarios range from systems that are used as facilitators (Derrick et al. 2013; Elshan et al. 2022; Strohmann et al. 2017) to systems that evaluate the creative ideas of other people (Siemon 2022). Thus, AI can take on roles where it actively interacts with humans and roles where it is an equal collaboration partner, serving as a mediator or arbitrator to resolve disputes or problems (Larson 2010). When employing and working with AI teammates, several aspects of team dynamics need to be considered

(Elshan and Ebel 2020; Siemon et al. 2020), which raises questions about how humans approach and perceive their new teammates.

When humans collaborate to complete tasks and exchange information and perspectives, they learn from each other thereby enhancing their co-creating efforts (Bunderson and Sutcliffe 2002; Chae et al. 2015). To this end, team members need to be placed in the right environment to fully realize the potential of collaborative co-creation. The absence of the right relationships between the team members may thwart their collaboration even if the team composition and the technology are appropriate for the situation (Fabriek et al. 2008; Mohammed and Angell 2003). This essential relationship may not be present between humans and AI-based teammates, potentially creating dissonance among human team members (Shaikh and Cruz 2022; Zhang et al. 2021). Therefore, to design and facilitate productive human-AI collaboration it is critical to identify the implicit assumptions that guide human-human collaboration and affect their motivation to contribute to the task. There is early research on how people behave in collaborative scenarios working with AI-based teammates (Bittner et al. 2021; Poser et al. 2022; Shaikh and Cruz 2022; Siemon 2022; Stieglitz et al. 2021). Research on a specific type of AI-based system, conversational agents, shows that the social presence of the AI influences the behavior of the humans interacting with it. Social presence describes the extent to which humans perceive the presence of another entity (human or AI-based system). Social presence is a key phenomenon related to the interaction with AI-based systems (Mozafari et al. 2021), as well as in computer-mediated collaboration and has been one of the most frequently analyzed variables (Elshan et al. 2022). However, interaction differs from collaboration in various aspects, especially around the joint value creation (Siemon et al. 2019), willingness to depend on teammates, commitment to the team and the motivation to contribute to the common task. Therefore, a critical aspect of human-AI team collaboration remains unexplored: how does social presence influence people to be less or more motivated to contribute to a team when working with AI-based team members?

Theoretical Background

Human-AI Collaboration

Advancements in AI are allowing AI-based systems to take on more active roles in collaboration (Anderson et al. 2018). While AI-based systems of the past were meant to adapt to humans or perform activities in a reactive manner, they now operate proactively and generate value on their own (Russell and Norvig 2021). Current AI-based systems offer the potential for task automation as well as augmentation. In terms of task augmentation, humans and AI are combined to form a hybrid intelligence that forms the basis for collaboration (Dellermann et al. 2019). In this study, we define collaboration as the combined effort individuals that is purposefully organized to achieve a common objective (Leimeister 2014). In a collaboration context, and in this case human-AI collaboration, there are various mechanisms and phenomena (Siemon et al. 2019) that do not or only partially exist in a human-computer interaction context. Such phenomena include, for example, social loafing and evaluation apprehension (Siemon 2022; Siemon and Wank 2021; Stieglitz et al. 2021). Early research in the context of AI-based team members found that such phenomena in 'traditional' contexts differ when human team members are augmented with AI-based team members (Siemon 2022; Stieglitz et al. 2021). For example, Stieglitz et al. (2021) show that people tend to exert less effort when collaborating with AI-based teammates and tend to cede responsibility to the AI-based teammate. Consequently, the augmentation of human team members with AI-based ones changes team dynamics and team member behaviors (Siemon 2022). The computational and analytical capabilities of AI can be leveraged to deal with the complexity of decision-making processes, with the goal of augmenting human intelligence and decision-making tasks rather than replacing humans from the process (Jarrahi 2018). This symbiosis is particularly effective in augmentation tasks because machines can consistently and accurately complete repetitive tasks requiring large amount of data to be processed while humans are superior in empathetic or intuitive tasks. When the complementary strengths of human intelligence and artificial intelligence are combined, both will behave more intelligently than each of them individually (Kamar 2016). Such enhancement in any job environment will improve employees' decision-making abilities, increase time allocated to non-trivial activities, increased creativity, and improved productivity for both employee and business (Daugherty and Wilson 2018). However, the integration of human input into AI implies challenges, as human intelligence can only be integrated if certain organizational constraints are adequately considered. For instance, many hybrid intelligence systems fail due to a lack of participation from human contributors, or due to the fact that human contributors are

submitting random or erroneous contributions on different tasks to gain rewards without making useful contributions (Kamar 2016). Consequently, the value of human-AI collaboration generated through a symbiotic partnership may only be fully realized in practice (and beyond the theoretical narratives) provided humans comprehend, trust, and adopt AI (Dubey et al. 2020; Wamba-Taguimdje et al. 2020) during their collaborative efforts. Studies have found various concerns that threaten human comprehension of and trust in AI: concerns regarding the negative impact of AI, such as poor decision-making, discrimination, bias, and inaccurate recommendations on human/AI collaborations (Davenport et al. 2020) or the fear and skepticism among human workers towards working with AI (Rampersad 2020). Humans frequently reject and disregard new technology if they feel threatened by it (i.e., if it impacts their financial well-being), regardless of their (initial) enthusiasm for it (Elkins et al. 2013). This is mainly because humans are less able to understand an AI-based team member, are not familiar with it, and do not feel social presence, unlike with human team members that they may even know only through technology-mediated collaboration (Mozafari et al. 2021). Unfamiliar team members, especially non-humans, can consequently lead to discomfort, which can affect collaborative behaviors.

Social Presence Theory

Social presence refers to "the extent to which other beings in the world appear to exist and react to the user" (Heeter 1992). In communication, this refers to the degree to which an individual is viewed as an approachable real person. The core of social presence theory is that the social impact of a communication medium is largely determined by the level of social presence (e.g., human contact, personalness, human warmth, etc.) that it provides to its users (Short et al. 1976). This presence is essential for people to learn about and interact with other people (Short et al. 1976). Accordingly, whenever there is a contact between two people, both parties engage in acting out specific roles as well as developing or maintaining some type of personal relationship. These two aspects of a connection are referred to as interparty and interpersonal exchanges. A proper level of social presence should improve interaction, and collaboration, and subsequently enhance the related motivation to contribute (Wei et al. 2017). Haines (2021) state that “feelings of social presence had a significant impact on willingness to work” in virtual teams. Further research in computer-mediated collaboration also shows that social presence is essential for effective collaboration and influences engagement and motivation to perform in teams. Therefore, we hypothesize a positive relationship between social presence and motivation to contribute.

H1: Social presence positively influences motivation to contribute.

Furthermore, social presence has been demonstrated to be an experiential phenomenon, implying that different collaborators may experience varying amounts of social presence when interacting with the same collaboration system (Wei et al. 2017). Previous studies examined the antecedents and characteristics of social presence and discovered aspects such as psychological participation and engagement or commitment (Biocca and Harms 2002). Psychological participation is defined as an observer being aware of another person's intention or idea through focusing on the other person's emotional state (Kim et al. 2013). Similar, Haines (2021) define this as the perceived awareness of the activities of other team members, which shows that others are putting forth their effort within the team. Commitment can be characterized as the other person's perceived reliance, connection, and responsiveness to the observer's activities (Kim et al. 2013). Only if one is aware of another person's intention, idea, and activities, then one develops trusting beliefs and is willing to depend on that person (Qiu and Benbasat 2009). Consequently, we hypothesize that social presence also has a positive influence on willingness to depend.

H2: Social presence positively influences willingness to depend.

For a team to function and for everyone to pull together, willingness to depend is essential to establish team-oriented commitment (Peters and Manz 2007; Sheng et al. 2010). Willingness to depend shows that one can rely on the actions, such as decision making, of one's team members or that tasks are completed as coordinated and distributed, thus creating a commitment to the team. Haines (2021) further state that a higher willingness to work is associated with higher feelings of loyalty to the team. Therefore, we hypothesize a positive relationship between willingness to depend and team-oriented commitment.

H3: Willingness to depend positively influences team-oriented commitment.

Commitment to the team is essential to be motivated to deliver effort. This motivation comes from being able to rely on other team members (i.e. willingness to depend) and build on their completion of tasks and

knowing that all team members are pulling in the same direction (Siemon et al. 20219). Although motivation to contribute depends on other factors, team-oriented commitment is a critical factor (Chang et al. 2010; Haines 2021). If a team member shows commitment to the team, this can also indirectly mean that he or she is motivated to contribute to the team. "When team members are willing to do additional work for their team, they are likely to feel that other team members likewise feel obligated to do the same" (Haines 2021). Team-oriented commitment, therefore, leads to increased motivation to contribute, which we hypothesize.

H4: Team-oriented commitment positively influences motivation to contribute.

Consequently, we investigate two basic theoretical derivations. The direct influence of social presence on motivation to contribute and the indirect, mediated connection between social presence and motivation to contribute via the mediators willingness to depend and team-oriented commitment. We define the indirect multi-mediation as our last hypothesis.

H5: Social presence influences motivation to contribute mediated by willingness to depend and team-oriented commitment.

In figure 1 we show our theoretical research model with H1-H5.

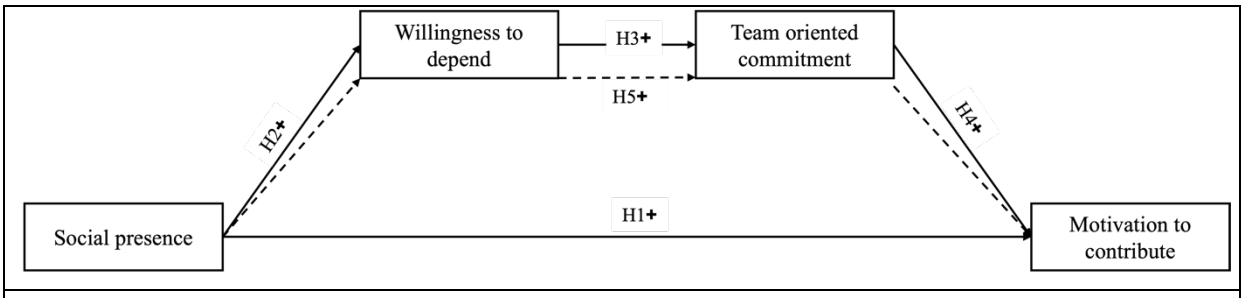

Figure 1. Theoretical model

Consequently, we aim to investigate what role social presence plays in digital collaboration and, more importantly, how different actors (AI-based team members versus human team members) influence this mechanism.

Methodology

To test whether and how social presence influences motivation to contribute, we designed a between-subjects simulation based online experiment. Our objective was to analyze whether creating the perception of an AI-based teammate being a collaboration partner (keeping all other aspects of collaboration and team contributions in a brainstorming session the same), makes a difference on individuals' motivation to contribute. The experiment had two conditions. Subjects were randomly assigned either to the experimental or to the control group. A special website called *collaborationspace* was developed for the experiment. On the website, each participant was guided through a simulated brainstorming session. The website simulated the presence of six geographically dispersed participants in a synchronous brainstorming session. Apart from the subject, each participant was a rule-based script that was played to simulate a conversation.

In the experimental group, the participant was added to a group with five actor scripts. Three scripts represented teammates and one script represented the facilitator. All scripts represented human beings. One actor script was represented as an AI-based system. All human actors had unisex names (Kim, Taylor, Sam, Alex), while the AI-based system was named GenBo. In the control group, the participants were also added to a group with five actor scripts. In this condition, all teammates and the facilitator actor scripts were presented as humans. All human actors had unisex names (Kim, Taylor, Sam, Alex). The AI-based teammate, GenBo, was replaced by the name of a human actor with the unisex name Taylor.

Experimental Procedure

The collaborative activity in the experiment followed three steps and took on average 15 minutes to complete:

(1) Introduction: The process started with a short introduction of the task and a declaration of consent implemented on Unipark. Participants were informed that the purpose of the activity was to test a newly developed collaboration system that enabled users to synchronously brainstorm on a given task. In addition, the participants were told that the collaboration system will automatically form a team for the brainstorming task. At this point the participants were randomly divided into the experimental and control groups and were forwarded to *collaborationspace*.

(2) Team Composition and Brainstorming Session on Collaborationspace: The team composition process was simulated and the "group formation" took around one minute in which all actors joined the session. After the team composition process was complete, the participants went through a short introduction session. Each actor introduced him/her/itself briefly with one or two sentences. In the experimental group, GenBo introduced itself as an AI-based system (*"Hey, I am GenBo. I may interact with you like a human, but I am an Artificial Intelligence Bot."*). In the control group, Taylor introduced him/herself (*"Hey, I am Taylor. Nice to meet you guys. Looking forward to our brainstorming session."*). After all participants had introduced themselves, the facilitator initiated the brainstorming session and introduced the brainstorming task: Helping a local zoo to gain more visitors[1]. The facilitator then informed the participants that they could not build upon each other's ideas. This resulted in a brainstorming session that lasted six minutes and had 21 messages (ideas). For example, the actor script 'Kim' contributed with the idea, "Another idea could be sky walks. Walking on bridges over them or between them". In both the experiment and control conditions, the brainstorming task and brainstorming contributions that were provided remained identical. Only the names of one of the teammates (GenBo [treatment group], Taylor [control group]) differed. After six minutes of brainstorming, the facilitator ended the session.

(3) Survey: After the brainstorming session was concluded, the participants were automatically directed to a survey on Unipark.

Measures

The survey questionnaire consisted of 35 items, including demographics. We used adaptations of the five-item social presence scale by Qiu & Benbasat (2009), four-item *willingness to depend* scale based on McKnight et al. (2002), seven-item *team-oriented commitment* scale (Van den Heuvel 1995), and five-item *motivation to contribute* scale (Lin 2006). All measures were on a 5-point Likert-type scale. As our experiment required high attention, we took several measures to ensure that participants thoughtfully participated in the experiment. First, we ensured that the participants stayed in the browser the entire time by automatically canceling the experiment whenever participants closed or switched the browser window. We also included some attention check questions in the survey. Furthermore, in the post-experiment survey, we asked participants to provide the name of the AI-based teammate or facilitator, depending on which condition they were in. Finally, following Driskell et al. (2010), we included a suspicion check (also serves as manipulation check) by asking whether the participants thought that GenBo was indeed an AI-based teammate (vice versa for the control group) and a general suspicion check reflecting on the nature of the experiment.

Participants

We recruited 180 participants from Amazon Mechanical Turk (MTurk). We choose MTurk, as it offers an integrated compensation system and access to a large pool of participants. All participants were required to have the Master Qualification as defined by MTurk. Due to the implementation of several attention checks and suspicion checks, 80 participants were removed from our analysis (11 failed the basic attention check, 31 failed to provide the name of GenBo, 17 failed to provide the facilitator name, are 21 were suspicious that the brainstorming was simulated). This resulted in a dataset of 100 participants with 54 in the experimental group and 46 in the control group. The average age of the participants was 42 years. 42 participants were female, 57 were male, and one preferred not to disclose. Eleven participants had a high school degree or

[1] The entire brainstorming session, including the participants' ideas and responses, is based on a brainstorming session conducted and filmed by Ideo in 2017. The original interaction was transcribed, and the answers were slightly adjusted (e.g., partially shortened, expressions used mainly in spoken language removed etc.). The entire video/transcript can be seen here: https://www.youtube.com/watch?v=VvdJzeO9yN8

equivalent (e.g., GED), 10 had some college but no degree, 6 had an associate degree (e.g., AA, AS), 55 had a bachelor's degree (e.g., BA, BS), 17 had a master's degree (e.g., MA, MS, Med), and one had a professional degree (e.g., MD, DDS, DVM).

Results

We performed an analysis of reliability, where all scales met the minimum required Cronbach's alpha value of 0.700 (Social presence = 0.941; willingness to depend = 0.897; team-oriented commitment = 0.796; motivation to contribute = 0.744). We used confirmatory factor analysis to test our measures, which showed that all items have significant (significance level of $p \leq .001$) positive factor loadings higher than .700. Furthermore, we calculated composite reliability (CR) and average variance extracted (AVE), both indicating reliable factors (Urbach et al. 2010). To test the hypotheses, we performed a mediation analysis. We tested the research model using structural equation modeling with partial least squares analysis, using SmartPLS3. We incorporated bootstrapping re-sampling to assess the significance of the paths with 1000 samples. The research model is a multiple mediation model with the outcome variable motivation to contribute. The predictor variable is social presence. The mediator variables are willingness to depend and team-oriented commitment. The direct effect of social presence on motivation to contribute is not significant (β=0.29), rejecting H1. The direct effect of social presence on willingness to depend is significant (β=0.80**) supporting H2, as well as the direct path from willingness to depend on team-oriented commitment (β=0.42*) supporting H3. Furthermore, the direct path from team-oriented commitment on motivation to contribute is significant (β=0.86**) supporting H4. The indirect effect of social presence on motivation to contribute is significant (β=0.30*), mediated by willingness to depend and team-oriented commitment supporting H5. Figure 1 shows the multiple mediation model including the significant direct and indirect paths.

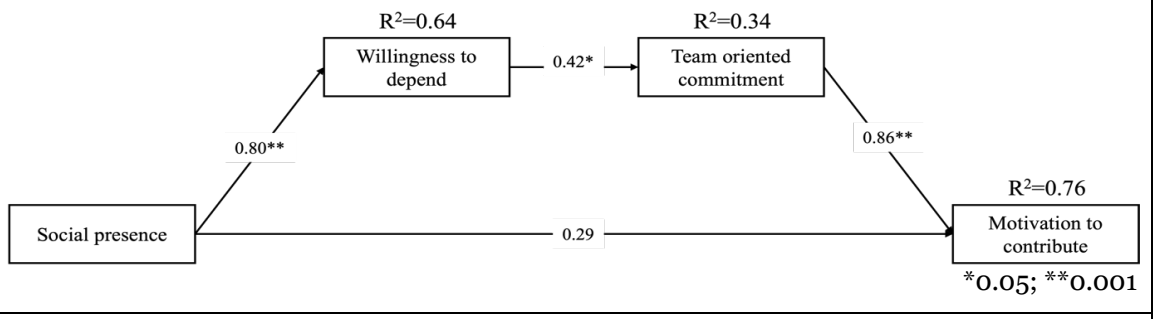

Figure 2. Multiple Mediation Analysis

Discussion and Outlook

The multi mediation model shows that social presence is an essential aspect of collaboration between human and AI-based teammates. It indirectly influences whether human team members are motivated to contribute to a team with AI-based teammates. However, this influence is not direct (rejecting H1), and is mediated by willingness to depend and team-oriented commitment (supporting H5). The perceived social presence, which was significantly lower in the AI-based teammate GenBo (M=3.32, SD=1.05) compared to the human teammate (M=4.01, SD=0.67, $p<0.001$) had a strong effect on the willingness to depend (β=0.80**). Our results confirm that people are less willing to depend on each other if no social presence is felt. Although this has already been confirmed by various studies within the realm of computer-mediated communication (Rourke et al. 1999; Tu and McIsaac 2002) or human-AI interaction (Elshan et al. 2022), our results show that simply creating the perception of the collaboration partner as AI as opposed to naming it as a human makes a significant difference: people feel a different social presence between these two situations. This shows that people are less willing to depend on an AI-based teammate as they would depend on a human. This is particularly interesting since the content of the contributions from the GenBo and Taylor teammate were identical. Furthermore, willingness to depend has a strong direct effect on team-oriented commitment (β=0.42*). That shows that if participants in a team are less willing to rely on someone in the team, team-oriented commitment also decreases, since only a coherent team with reliable

team members generates commitment (Sheng et al. 2010). If there is less commitment to the team, the motivation to contribute decreases, which can affect overall team performance (Chang et al. 2010; Sheng et al. 2010). It is therefore not surprising that motivation to contribute is lower in the experimental group (M=4.07, SD=0.65) than in the control group (M=4.29, SD=0.48), which however is not a significant difference (p=1.92). The direct effect of team-oriented commitment on motivation to contribute shows this relationship (β=0.86**). Subsequently, social presence has an influence on the motivation to contribute, only mediated by willingness to depend and team-oriented commitment, but no significant direct effect. Social presence has therefore no significant power to directly influence the motivation to contribute.

Our results are in line with existing studies that show that social presence is an essential part of the interaction with AI-based systems. Research on conversational agents also highlights the importance of social presence for communication satisfaction and successful service encounters (Diederich et al. 2022; Elshan et al. 2022). Furthermore, there is an emphasis on the design of AI-based interaction partners to enhance social presence and ensure a pleasant interaction (van Doorn et al. 2017; Qiu and Benbasat 2009). However, these studies do not evaluate the basic conditions that need to be present for effective collaboration with AI-based systems. This study fills that gap and expands the body of knowledge. Our findings suggest that before evaluating the design and implications of AI-based systems like conversational agents one should consider investigating insights about human behavior and expectations for collaboration with AI-based systems. These insights form an essential foundation for further design choices. Our findings also contribute to the understanding of team collaboration and the effect of social presence on motivation to contribute. We show that social presence is not only important in one-to-one interaction scenarios, as demonstrated by Qiu and Benbasat (2009) who show the direct effect of social presence on trusting beliefs (which is similar to willingness to depend) in human-AI interaction, but also its importance for human-AI collaboration by showing the mediated effect on team-oriented commitment and motivation to contribute.

We assume that people might have reservations, anxiety, and concerns about working with an AI teammate and are therefore less willing to depend on the AI teammate (Thiebes et al. 2021) due to not being familiar or not understanding the AI-based teammate. Future research on AI-based systems must address these concerns in a meaningful way. Willingness to depend is a factor that is related to trust and people tend not to trust collaboration partners who they do not understand or are not familiar with (Thiebes et al. 2021). While contributing to the foundational body of AI-human research, this study has several limitations that provide opportunities for future research. One limitation is the short duration of the experimental task during which the actual collaboration takes place. Although creativity sessions often take place with ad-hoc teams, collaboration with all its dynamics and social facets is difficult to achieve over such a short period of time. The nature of our simulation experiment is another limitation that needs to be considered. While only responses of participants who passed the suspicion check were used, it cannot be ruled out that participants suspected that the actors were in fact rule-based scripts. Our results show that social presence is an important mechanism influencing expected team performance regarding the willingness to depend, which calls for further research to investigate how social presence can be increased in AI-based teammates. While research on conversational agents mostly focuses on the design of such systems (e.g., incorporating anthropomorphic features), we aim to elaborate on whether the familiarity with AI or the understandability of AI may influence factors that affect social presence. Further research can also pursue a qualitative evaluation of the participants ideas, as they collectively produced 5815 words during the brainstorming session (an average of 581 words per person). This could shed light on the extent to which the presence of an AI-based teammate may have influenced the quantity as well as the quality of the ideas and on whether the motivation to contribute influenced the nature and quality of the actual contributions.

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