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**Social Gaze in Team Cooperation:
A Multiparty Eye Tracking Study**

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Abstract

Team work is an essential aspect of modern organizations, as it enables individuals to collaborate and achieve common goals. However, free riding behavior can pose a significant challenge to team productivity and success. Understanding potential drivers that contribute to team dynamics is crucial in mitigating this issue. Previous research has primarily focused on the verbal content of team interactions, neglecting the non-verbal cues such as eye contact and gaze patterns. In this paper, we aim to shed light on the relationship between interdependent gaze dynamics and free riding behavior in teams.

An empirical study was conducted in which teams of three participants cooperated on a real effort task. Eye movements were recorded using mobile eye tracking glasses during the team meeting. Our results reveal a correlation between dynamic gaze patterns during social interaction and team output and team cohesion. A negative correlation was found between gaze aversion and team output, whereas a positive correlation was found between mutual gaze and self-reported team cohesion.

This paper adds to the literature studying the impact of communication on team work and the role of non-verbal cues, especially gaze patterns, in economic decision making. Our findings provide insights that can help organizations create more productive and effective teams.

1 – Introduction

Team work is a vital aspect of many modern organizations, as it enables individuals to collaborate and pool their resources in order to achieve a common goal. The success of an organization often depends on the ability of team members to work together efficiently and effectively. However, free riding behavior can pose a significant challenge to the productivity and success of a team (Balliet & Van Lange, 2013; Delfgaauw et al., 2021; Fischbacher & Gächter, 2010; Van Lange et al., 2013). In order to mitigate this issue, it is important to understand potential drivers that contribute to the dynamics of team work. Previous research in this field has largely focused on the verbal content of team interactions, neglecting the importance of non-verbal cues such as eye contact and gaze patterns (Balliet, 2010; Sally, 1995). Eye contact and gaze patterns might play a critical role in fostering trust and cooperation among team members, providing important information about an individual's intentions, motivations, and level of engagement, and impacting the overall success of the team (see, e.g., Fischbacher et al., 2022; Hausfeld et al., 2021; Kurzban, 2001; Lahey & Oxley, 2016). Given the importance of team work for organizational success and the potential impact of non-verbal cues on cooperation and decision making, this paper aims to shed light on the relationship between interdependent gaze dynamics and free riding behavior in teams. By doing so, we aim to address the gap in previous research and provide insights that can help organizations to create more productive and effective teams.

Specifically, we conducted an empirical study in which teams of three participants had to cooperate on a real effort task. First, the teams had time to discuss their individual contribution to the joint task in a face-to-face setting. In a second step, each team member decided on their individual contribution in private. Given that the individuals' payoff depended on their team's output, the incentive structure represented the typical social dilemma of free riding. To measure the impact of eye contact and gaze, we recorded each team member's eye movements during the team meeting using mobile eye tracking glasses. In the present paper, we are particularly interested in measuring the correlation between gaze patterns and team output. Through examination of the team members' decisions, we aim to understand the effects of mutual gaze

and gaze aversion on (non-)cooperative behavior within teams. In addition, this paper is a first step toward a better understanding of the interplay between gaze patterns and self-reported team cohesion. Our results reveal that dynamic gaze patterns during social interaction correlate with team output and team cohesion. More specifically, gaze aversion and team output correlate negatively, whereas mutual gaze and self-reported team cohesion show a positive correlation.

Overall, this paper is related to the literature studying the impact of communication on team work as well as to the small but growing economic literature studying non-verbal cues, and especially gaze patterns, in economic decision making. In addition, our paper adds to the literature strands studying the role of eye contact and gaze in social interaction.

2 – Related Work

2.1 – Cooperation in Teams

Team performance strongly depends on the willingness of its individual members to cooperate. However, cooperation usually comes with certain costs. For example, these can be in terms of the disutility of effort or time. Whereas a team's output is typically shared equally among all team members, each individual has to bear the costs alone (Nalbantian & Schotter, 1997; Thielmann et al., 2020). Given that each team member decides individually to what extent they will incur these costs, teams often fail to achieve the socially optimal level of cooperation due to conflicting personal and collective interests (see, e.g., Kollock, 1998; Van Lange et al., 2013).

Numerous studies have demonstrated that communication, especially in natural face-to-face interaction, mitigates free riding behavior by encouraging cooperative behavior in teams (Balliet, 2010; Sally, 1995). In an attempt to identify the key mechanisms of the communication effect, He et al. (2017) found that cooperative intentions are primarily driven by type detection, as most individuals are willing to cooperate when they assume that their counterpart will reciprocate. However, a large body of literature

also demonstrates a close link between team cohesion and collective performance (see, e.g., Balliet et al., 2014; Simpson, 2006).

Team cohesion is a multifaceted construct that is generally assumed to increase cooperative behavior by fostering communication between team members (Casey-Campbell & Martens, 2009). According to Salas et al. (2015), it includes several subdimensions of which the most pertinent are belongingness (i.e., “the degree to which members of a group are attracted to each other”), social cohesion (i.e., “a closeness and attraction within the group that is based on social relationships”), and task cohesion (i.e., “an attraction or bonding between group members that is based on a shared commitment to achieving the group’s goals and objectives”). Overall, team cohesion and team performance show a positive correlation, which is influenced to some degree by the method of assessing these constructs (Casey-Campbell & Martens, 2009). In working teams, for example, a strong relationship was found between self-reported team cohesion and implicit outcome measures (Chiocchio & Essiembre, 2009). Recently, Delfgaauw et al. (2021) investigated the interplay between team cohesion, team performance, and team incentives. While team cohesion was not influenced by tournament-related incentives, it amplified their positive effect on team performance. Accordingly, the authors concluded that higher team cohesion ultimately results in less free riding behavior by emphasizing the collective impact of individual decisions.

Overall, these findings suggest that both type detection and team cohesion play a crucial role in team cooperation. However, it remains unclear to what extent these mechanisms of the communication effect are attributable to verbal or nonverbal communication signals.

2.2 – Eye Movements and Economic Decision Making

The study of eye movements in relation to decision making has gained popularity in behavioral economics, because eye movements can provide insights into decision making processes (Lahey & Oxley,

2016).¹ In particular, eye tracking has been used to understand how eye movements improve economic decisions. For instance, certain eye movements during information acquisition were found to be indicative of cooperative decisions in both a money allocation task and a public goods dilemma (Fiedler et al., 2013). Similarly, Wang et al. (2010) claim that participants could increase their payoff in a sender-receiver game by incorporating information about their counterparts' eye movements. These results indicate that the ability to observe, understand and evaluate the gaze of others in strategic situations improves economic decision making.

Recently, eye tracking has also been implemented as an interactive tool in computer-mediated interaction, allowing participants to exchange gaze information and evaluate their counterpart's intentions. Hausfeld et al. (2021) investigated if participants are able to evaluate gaze information transmitted in real-time to determine their counterpart's hidden choice in four simple coordination games. The results indicate that participants were generally capable of incorporating gaze information to maximize their earnings. Moreover, participants who made the first choice successfully adjusted their gaze to become more predictable in three box-choice coordination games with common interests and to conceal their intentions in a competitive hide-and-seek variant. In another interactive eye tracking study, Fischbacher et al. (2022) investigated if participants are able to identify prosocial motives by observing their counterpart's gaze in a money allocation task. Participants who were presented the allocators' gaze location in real-time performed better in judging their prosociality. However, when allocators received an incentive to appear more prosocial, they adjusted their gaze, making it more difficult for observers to identify their actual social type. Thus, what people look at conveys information about their intentions and motives, but can be strategically adapted to maximize personal gains. However, the findings are limited to the strategic use of gaze information visualized in computer-mediated interaction. Our work builds up on these findings to

¹ As the feeling of being observed can influence a person's behavior, one might worry that the usage of eye trackers alters economic decision making. However, Kee et al. (2021) found no considerable changes in economic behavior

address the open question “whether gaze can also signal things other than intentions” (Hausfeld et al., 2021). More specifically, we examine its communicative function for cooperativeness in working teams.

2.3 – Social Gaze Dynamics in Face-to-Face Communication

Given that natural gaze in face-to-face interaction conveys more information than the object currently being looked at, we extended the paradigm to include interdependent attentional processes between individuals, conceptualized as social gaze (Emery, 2000). Its three components are *mutual gaze* (i.e., individuals are looking at each other), *gaze aversion* (i.e., an individual looks at another who looks away), and *joint attention* (i.e., individuals are looking at the same object or aspect; Pfeiffer et al., 2013). Previous research on social gaze revealed that human faces and eyes automatically attract visual attention (Laidlaw et al., 2012; Langton et al., 2000). However, attentional shifts to these stimuli are not only attributable to their inherent salience, but involve strategic considerations following a cognitive top-down mechanism, since others can observe one’s gaze in face-to-face interaction (see, e.g., Kuhn et al., 2016). Accordingly, eye movements have both a perceptual as well as communicative purpose, known as the dual function of social gaze (Gobel et al., 2015). Recently, Hessels (2020) provided a comprehensive literature review on the role of social gaze in face-to-face interaction. Primarily, social gaze dynamics have been identified as a key factor for effective communication (Ho et al., 2015; Kleinke, 1986). In addition, prolonged episodes of mutual gaze are positively correlated with a variety of desirable characteristics, such as trust, rapport building, and common grounding between individuals (see, e.g., Broz et al., 2012; Foddy, 1978). In contrast, avoiding mutual gaze during social interactions is associated with unfavorable outcomes. For example, Vrzakova et al. (2021) observed a negative correlation between gaze aversion and the quality of agreements in dyadic negotiations. The authors suggest that individuals are able to understand their counterpart’s averted gaze as a signal of socio-emotional discomfort and thereby incorporate it into their decisions. Consequently, social gaze plays an important regulating role in face-to-face communication and shapes our behavior when working together. In the present study, we sought to

further disentangle the effects of mutual gaze and gaze aversion by examining their differential correlation with cooperative behavior in teams.

3 – Study Design and Methods

3.1 – Team Task

We conducted a controlled empirical study to examine the relationship between social gaze and subsequent (non-)cooperative behavior. Each team consisted of three members who had to jointly work on a team task. In the following, we describe the team task and the set-up in detail.

The team's task was to create a tangram together. A tangram is a Chinese puzzle based on geometric pieces that can be arranged to create various shapes reminiscent of animals or objects. In eye tracking studies, tangrams are frequently employed as a collaborative problem-solving task, because they require close cooperation as well as visual coordination between participants (see, e.g., Carletta et al., 2010; Dale et al., 2011). In our set-up, teams had to coordinate on a unique shape. Each team member had twelve pieces they could contribute to build it. Accordingly, teams had to pool their resources to coordinate on a solution making it a highly interdependent task. In the first stage of the team task, team members were allowed to discuss the task and their individual contributions in a ten-minute face-to-face interaction, which is henceforth referred to as the non-binding communication stage.

In the non-binding communication stage, participants were seated at a round table divided into three parts by partitions. The partitions contained rectangular cut-outs so that the participants were able to see and communicate with their team members despite being spatially separated. We decided to measure eye movements during natural face-to-face communication, because “gaze should not be treated as an isolated phenomenon, but as one aspect of the interaction, which is multimodal by nature” (Hessels, 2020). After completing the non-binding communication stage, in the second stage, each participant decided on their actual contribution to the team task individually while sitting in an isolated cubicle without any contact to the others (see Figure 1).

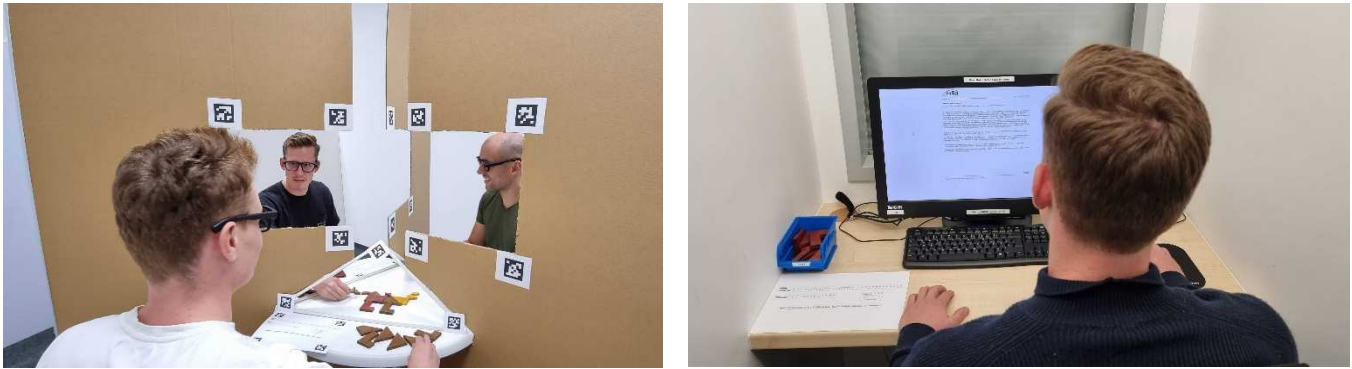


Figure 1. First non-binding communication stage in group room (left) and second stage in isolated cubicle (right).

To induce the typical social dilemma in teams, we based our incentive structure on a stylized model following Nalbantian and Schotter (1997). Each team member's payoff was determined by the total pieces contributed to the team task. Given that each contributed piece was costly for a team member, this set-up created incentives to free ride. In the following, we present our stylized model to illustrate the incentive structure.

Assume the team consists of three risk-neutral and money maximizing players, $i = 1, 2, 3$. Each player's contribution to the team task is denoted by $x_i \in \{0, \dots, 12\}$ with costs, $c_i = c(x_i) = \frac{1}{2}x_i^2$. The team's output is then given by $X = \sum_{i=1}^3 x_i$. In order to capture the leveraging effects in team cooperation, the team's revenue is determined by multiplying the team's output, $R = 12X$. The revenue is split equally between the team members.

This leads to a payoff $\pi_i = \frac{1}{3}R - c_i$. Each player solves the following maximization problem:

$$\max_{x_i \in \{0, \dots, 12\}} \pi_i = \frac{1}{3}R - c_i = 4 \sum_{i=1}^3 x_i - \frac{1}{2}x_i^2$$

$$x_i^* = 4$$

The team surplus TS is given by the following maximization problem:

$$\max_{x_i \in \{0, \dots, 12\} \forall i \in \{1, 2, 3\}} TS = R - \sum_{i=1}^3 c_i = 12 \sum_{i=1}^3 x_i - \frac{1}{2} \sum_{i=1}^3 x_i^2$$

$$x_i^{SO} = 12$$

If the team members would behave as money maximizing selfish players, we would expect a contribution of four pieces to the team output. If the players could coordinate on the socially optimal contribution, each team member would contribute twelve pieces. These output levels will serve as our benchmark values to measure the degree of team cooperation. If a team member contributes more than four pieces, this signals cooperation. The higher the deviation from the individually optimal contribution, the higher is the cooperation.

3.2 – Sample

Participation in the 40-minute study required German language skills at native-speaker level and unrestricted or appropriately corrected vision and hearing. Furthermore, wearing glasses was defined as an exclusion criterion, because head-mounted eye tracking devices had to be worn during the study. All 33 participants were students from the Karlsruhe Institute of Technology, as we recruited them from the Karlsruhe Decision & Design Lab (KD2Lab)² subject pool using hroot (Bock et al., 2014). Due to technical issues during one session, data of three participants had to be excluded from the analysis, resulting in a final sample of 30 participants aged between 20 and 28 years ($M = 23.23$, $SD = 2.25$, 50% female). Participants were randomly assigned to ten teams, consisting of either women or men only, and received earnings (EUR) according to the final decisions they and their team members made in the team task ($M = 14.78$).

² The KD2Lab was funded by the Deutsche Forschungsgemeinschaft and the Karlsruhe Institute of Technology (INST-12138411-1FUGG)

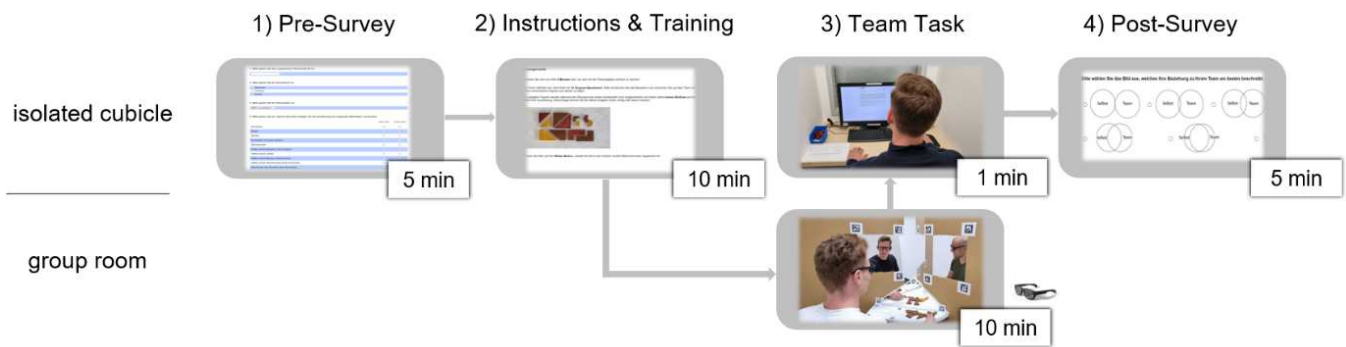


Figure 2. An overview of the different phases and stages of the study, which were conducted either in the individual cubicles or the group room.

3.3 – Procedure

We conducted the study at the KD2Lab.³ First, the participants had to give their informed consent. Next, they went through four distinct phases of the study (see Figure 2). In the first phase, they were seated in individual cubicles to complete a pre-survey.⁴ In the second phase, the participants received detailed instructions on the team task, answered five comprehension questions (e.g., “Please select the option that correctly reflects the team task’s payoff principle”), and practiced the upcoming task on their own for five minutes (see Appendix: Instructions). In the third phase, they were equipped with eye tracking glasses and then led into a group room to perform the team task’s first non-binding communication stage. Afterwards, the eye trackers were removed and the participants were guided back to their cubicles for the second stage of the team task, in which they made the private decisions about their individual contributions. In the final fourth phase, the participants completed a post-survey before providing their bank details for disbursement within the privacy compliant infrastructure of the KD2Lab. After the study, participants were led out of the lab separately to avoid any contact between them.

³ The study was preregistered at AsPredicted (#105022) and approved by the ethics committee of the Karlsruhe Institute of Technology

⁴ Instructions and scales of the study were implemented using SoSci-Survey (v3.4.00; Leiner, 2022)



Figure 3. Illustrated is a Pupil Invisible connected to the Pupil Labs Companion Device (left) and a participant equipped with both devices (right). During the non-binding communication stage, the mobile phone was stored in a small pocket (yellow circle) attached to the chair so that it would not interfere with the real effort task.

Eye-Tracking Equipment. Eye movements were recorded during the team task's first non-binding communication stage using three Pupil Invisible eye tracking glasses (Pupil Labs, 2023). The head-mounted devices do not restrict the participants' freedom of movement and feature an unobtrusive, lightweight design (see Figure 3). While recording, the eye tracking glasses were connected to mobile phones (Pupil Labs Companion Device; OnePlus 8) via a single USB-C cord to calculate gaze data in real-time at a sampling rate of 200 Hz (Pupil Labs Companion App; v1.4.23).

Pre-Survey. At the beginning of the study, participants completed a pre-survey including a demographic questionnaire, a German translation of the Edinburgh Handedness Inventory (Oldfield, 1971) and three German scales to control for dispositional collective orientation (Hagemann, 2017; 2020), interpersonal trust (Beierlein et al., 2014), and personality traits (Rammstedt et al., 2014).

The Edinburgh Handedness Inventory (EHI) is a screening tool to assess a person's dominant handedness (Oldfield, 1971). More specifically, participants are asked to indicate what side they prefer to perform ten everyday activities (e.g., "Writing"). The EHI was included to control for a laterality bias of visual attention toward one of the team members located on the participant's left- and right-hand side.

The Instrument for the Assessment of Collective Orientation (CO) measures a person's tendency to cooperate in a goal-oriented manner, to seek input from others, and to contribute to achieving a team's objective (Hagemann, 2017). It comprises two dimensions assessed by 16 items rated on a five-point

Likert scale (“disagree” to “strongly agree”). Ten items load on the factor belongingness (e.g., “For most tasks, I would rather work alone than as part of a group”) and six items on dominance (e.g., “When I’m convinced of something, I stick to my opinion, whatever other team members say”). The CO shows good reliability (Cronbach $\alpha = .84$; McDonald $\omega = .85$) and evidence of convergent, discriminant, and predictive validity (Hagemann, 2020). We controlled for collective orientation, because it has been found to positively affect coordination and performance in teams (Hagemann et al., 2021).

The Short Scale for Measuring Interpersonal Trust (KUSIV3) includes three items (e.g., “In general, people can be trusted”) rated on a five-point Likert scale (“disagree” to “strongly agree”) to measure a person’s disposition to trust and rely on other people (Beierlein et al., 2014). An investigation of its psychometric properties indicates good reliability (McDonald $\omega = .85$) as well as content and construct validity. As the final decision in the team task partially depends on whether participants trust other members to adhere to the mutually agreed-upon solution, we included the KUSIV3 (see, e.g., Balliet & Van Lange, 2013).

The Big Five Inventory 10 (BFI-10) is a short version of the original 44-item scale to measure personality traits according to the five-factor-model (Rammstedt & John, 2007). For each of the personality dimensions, two items (e.g., “I see myself as someone who is outgoing, sociable”) are rated on a bipolar five-point Likert scale (“strongly disagree” to “strongly agree”). With regard to the subscales, adequate to good reliability coefficients were obtained ($r_{tt} = .58$ to $.84$). Furthermore, several studies demonstrated its content, factorial, convergent, discriminant and predictive validity (Rammstedt et al., 2014). We included the BFI-10 to test for confounding effects of personality traits on social gaze dynamics and team cooperation (see, e.g., Broz et al., 2012; Thielmann et al., 2020).

Post-Survey. As suggested by Salas et al. (2015), we operationalized team cohesion as a multifaceted construct including both task and social dimensions (see Section 2.1). However, there is no comprehensive scale for assessing team cohesion according to this multidimensional conceptualization. Thus, we adopted appropriate items from three validated scales to measure belongingness, social cohesion,

and task cohesion respectively. Similarly, Delfgaauw et al. (2021) measured social cohesion by including the dimension's items from the Group Environment Questionnaire by Carless and De Paola (2000).

Belongingness was measured using the Inclusion of Other in the Self Scale (IOS; Aron et al., 1992). By selecting one of seven pictograms depicting increasingly overlapping circles, participants subjectively rate their relational closeness to the team (Cronbach $\alpha = .66$). An extensive examination of the IOS' psychometric properties has proven it to be a highly reliable and valid tool for capturing the construct (Gächter et al., 2015). For instance, it correlates strongly with a battery of related questionnaires and a principal component analysis-based index of relationship closeness (Spearman's $p = .85, p < .001$).

In order to measure social cohesion, we adopted the subdimension for cohesiveness from the Group Cohesiveness Scale (GCS; Wongpakaran et al., 2013). The subdimension consists of two items ("I feel accepted by the group"; "In my group we trust each other") rated on a five-point Likert scale ("disagree" to "strongly agree"). The GCS shows a very good internal consistency (Cronbach $\alpha = .87$) and evidence for construct and convergent validity. Despite being evaluated with psychiatric inpatients ($n = 96$), we decided to include the items due to their high face validity for assessing a team's social cohesion.

We measured task cohesion by including three items of the subdimension for task cohesion (Cronbach $\alpha = .74$) of the Group Environment Questionnaire adapted for work teams (GEQ; Carless & De Paola, 2000). The items (e.g., "Our team is united in trying to reach its goals") are rated on a five-point Likert scale ("disagree" to "strongly agree"). The authors investigated the revised scale's construct and criterion validity with a sample of employees ($n = 120$) working in teams. Strong correlations were found between task cohesion and team effectiveness ($r = .67, p < .01$) as well as three subscales of the Work-Group Characteristics questionnaire by Campion et al. (1993): team spirit ($r = .72, p < .01$), social support ($r = .68, p < .01$), and communication/cooperation within the team ($r = .62, p < .01$).

Finally, we asked participants to indicate whether they have known any team member before taking part in the study to control for familiarity effects on social gaze and outlined constructs.

3.4 – Main Hypotheses

As natural communication is spontaneous and dynamic, we decided to study social gaze in unconstrained face-to-face interaction. Specifically, we investigated the correlation between social gaze dynamics (X) and the participants' subsequent contribution to the team output (A) as well as self-rated team cohesion (B). In particular, we focus on the two dynamics of social gaze that occur directly between team members (i.e., at least one person looks at another): mutual gaze (X1) and gaze aversion (X2). Moreover, we examined the aforementioned relationship while controlling for collective orientation (CO) and interpersonal trust (KUSIV3), since these individual dispositions have been shown to affect both cooperativeness and social gaze behavior in teams (see, e.g., Balliet & Van Lange, 2013; Broz et al., 2012; Hagemann et al., 2021). Based on the previously presented literature, we hypothesized following correlations⁵:

H1A. The level of mutual gaze (X1) within a team positively correlates with the participants' individual contribution to the team task (A)

H1B. The level of mutual gaze (X1) within a team positively correlates with the participants' self-reported team cohesion (B)

H2A. The level of gaze aversion within a team (X2) negatively correlates with the participants' individual contribution to the team task (A)

H2B. The level of gaze aversion within a team (X2) negatively correlates with the participants' self-reported team cohesion (B)

⁵ While controlling for dispositional collective orientation (CO; see AsPredicted#105022: Section 2) and interpersonal trust (KUSIV3; see AsPredicted#105022: Section 8)

3.5 – Data Preparation and Estimation Strategy

As outlined above, our key variables are the participants' individual contribution and self-reported team cohesion, as well as the teams' level of mutual gaze and gaze aversion. In the following, we describe the steps that were required to prepare the data for statistical testing of our hypotheses.

First, scores of the scales and corresponding subdimensions – CO, KUSIV3, BFI-10, IOS, GCS, and GEQ – were calculated according to the manuals by taking the unweighted mean of their recoded items. The EHI required the calculation of a laterality quotient ($100 * \frac{R-L}{R+L}$) to infer dominant handedness (right ≥ 40 ; left < 40). In order to reduce the dimensionality of the BFI-10, we also performed a principal component analysis with the five personality traits – extraversion, agreeableness, openness, conscientiousness, and neuroticism – and determined the principal components (BFI-10_A; BFI-10_B) that explain more variance than each of the variables individually (eigenvalue > 1 ; Abdi & Williams, 2010; see Appendix: Table 1).

Contribution and Team Cohesion. Individual contribution (A) was measured as number of tangram pieces a participant allocated to the team task during the second stage, in which each team member could decide about their contribution in private. In order to compute team cohesion (B) according to the conceptualization introduced earlier, we combined our scales for belongingness (IOS), social cohesion (GCS), and task cohesion (GEQ) by taking the unweighted mean of their z-standardized values.

Social Gaze Dynamics. The quantification of mutual gaze (X1) and gaze aversion (X2) included several steps. We used the open-source software Pupil Player (v3.5.1; Pupil Labs, 2023) to define the following areas of interest (AOIs) and assign each collected gaze point to one these: Member_Left, Member_Right, Task, Payoff, and Else (see Figure 4). As necessary for further analysis of recurrent states within teams, we also computed the AOI Members representing gaze toward other team members in general by aggregating the gaze points assigned to Member_Left and Member_Right.



Figure 4. Displayed is the participants' field of view during the non-binding communication stage (left) as well as the defined AOIs Member_Left, Member_Right, Task, Payoff, and Else (right).

Further computations were conducted in R (R Core Team, 2023). First, each participant's time series of gaze points to the defined AOIs was cut into a ten-minute sequence representing the exact duration of the non-binding communication stage. To be precise, we chose a duration of 601 seconds, which was synchronized between team members using an annotation cue at the beginning and end of the non-binding communication stage. Next, we cut each participant's time series into one-second slices. We then assigned the AOI to each slice, which included the majority of gaze points during each period (see Figure 5A). Due to the high sampling rate of 200 gaze points per second, the procedure is very robust against missing values. Nevertheless, missing values were assigned to the AOI Else to avoid a systematic overestimation of social gaze dynamics.

In a subsequent step, we used each team's synchronized time series to perform multidimensional recurrence quantification analysis (MdRQA). This is a novel computation method that can be used to quantify and visualize behavioral dynamics between multiple participants (Wallot et al., 2016; 2018). More specifically, MdRQA is a multivariate extension of recurrence-based analysis that has been used in eye tracking research to investigate visual coupling between two participants (e.g., joint attention) by shifting one participant's temporal series in time and thus, identifying convergent states of gaze at various time lags (see, e.g., Richardson & Dale, 2005; Dale et al., 2011). Instead of measuring the similarity between two time series, MdRQA computes the degree of systematic regularity between an unlimited

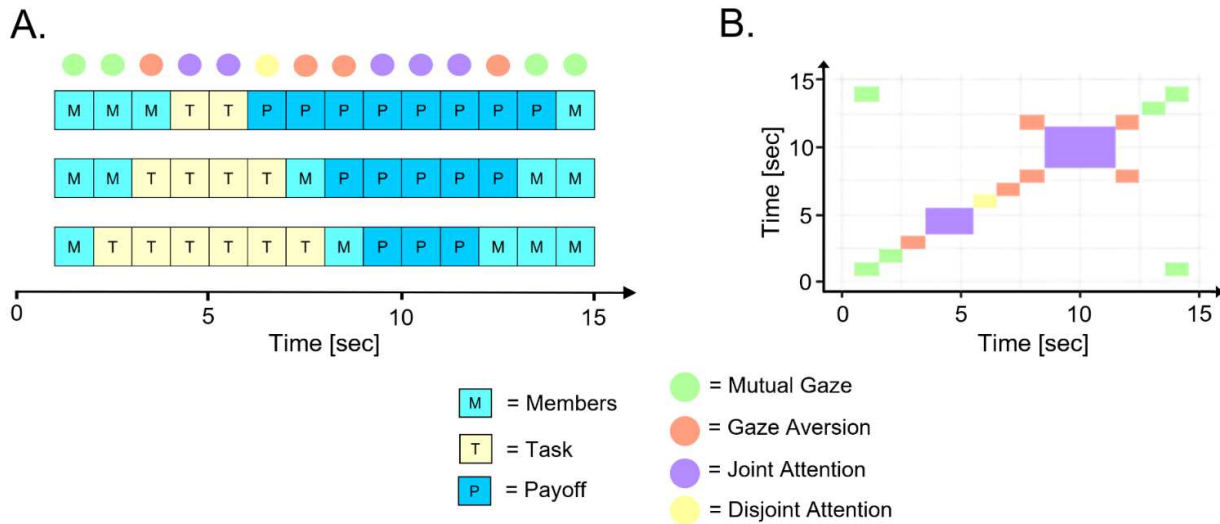


Figure 5. Adapted from Vrzakova et al. (2021): Exemplary time series of three team members with assigned AOI (Members; Task; Payoff; Else) per one-second period (A) and corresponding recurrence plot as generated by MdrQA (B) displaying the social gaze dynamics (Mutual Gaze; Gaze Aversion, Joint Attention, Disjoint Attention) based on respective AOI combinations per second (e.g., Mutual Gaze = $AOI_{Members} \wedge AOI_{Members} \wedge AOI_{Members}$).

number of synchronized data streams. This allows to identify the extent to which multiple participants are looking at corresponding AOIs (e.g., mutual gaze), but also, to which degree a systematic division occurs (e.g., gaze aversion). Thus, MdrQA can be used to investigate complex interdependent processes, such as social gaze. Following the paradigm introduced by Vrzakova et al. (2021), we assigned each possible combination of AOIs (e.g., $A_{Members} \wedge B_{Members} \wedge C_{Task}$) to one of the conceptualized social gaze dynamics: mutual gaze, gaze aversion, joint attention, and disjoint attention (see Figure 5B).

We thus define:

- Mutual Gaze: At least two participants are looking at other team members (e.g., $A_{Members} \wedge B_{Members} \wedge C_{Members}$)
- Gaze Aversion: Only one participant is looking at another team member who is looking elsewhere (e.g., $A_{Members} \wedge B_{Task} \wedge C_{Task}$)
- Joint Attention: All participants are looking at either the task or payoff sheet ($A_{Task} \wedge B_{Task} \wedge C_{Task}$; $A_{Payoff} \wedge B_{Payoff} \wedge C_{Payoff}$)
- Disjoint Attention: Remaining AOI combinations are defined as disjoint attention (e.g., $A_{Task} \wedge B_{Payoff} \wedge C_{Else}$)

We performed MdrQA with standard parameters for categorical data (emb = 1, del = 1, norm = euclidean distance, rad = 0.0001) in order to visualize and calculate the recurrence for each social gaze dynamic respectively. Instead of computing overall recurrence rates including all possible time lags, we calculated recurrence rates for each dynamic at a lag of zero seconds (RR_0) to test our hypotheses, because mutual gaze and gaze aversion are defined by temporal synchrony (e.g., the exact point in time, two participants are looking at each other). Overall recurrence rates would misrepresent these dynamics, because they include all recurrences of assigned AOI combinations at various time lags (Vrzakova et al., 2021). In contrast, the RR_0 of mutual gaze (X1) and gaze aversion (X2) reflects the percentage of time, the respective dynamic occurred during the non-binding communication stage.

Estimation Strategy. After pre-processing the data, we conducted an initial descriptive analysis to report the sample's characteristics, pairwise correlations, and aggregated gaze behaviors including the distribution of gaze between AOIs (Members; Task; Payoff; Else) and RR_0 of each social gaze dynamic.⁶

We tested our main hypotheses (H1A; H1B; H2A; H2B) using partial correlation analyses with CO and KUSIV3 as covariates. In order to test if our main hypotheses are robust to adding further covariates, we performed OLS regression analyses with individual contribution (A) and self-reported team cohesion (B) as dependent variables. In the first model, we included both social gaze dynamics (X1; X2) as explanatory variables. Next, we added the examined dispositions to work collectively and trust other individuals (CO; KUSIV3). The third model further contained the personality traits' first and second principal component (BFI-10_A; BFI_B).⁷ Finally, we included demographics (age; female).

Furthermore, we conducted tobit regressions with individual contribution (A) as an additional robustness check since the variable's outcome could only vary between zero and twelve.

⁶ An α -level of .05 was used for all statistical calculations

⁷ Since we were testing whether our main results are robust to adding personality traits in general, we did not include each dimension of the BFI-10 individually

4 – Results

4.1 – Descriptive Statistics

For a comprehensive overview of the descriptive results see Appendix: Table 2. None of the participants reported knowing a team member before taking part in the study. Moreover, no outliers exceeding the first and third quartiles by more than three interquartile ranges were identified.

Contribution. Overall, we observed a high level of cooperation with an average individual contribution of 11.20 pieces. Three out of ten teams failed to maximize the team surplus, as a total of seven participants deviated from the socially optimal contribution ($x_i^{SO} = 12$). However, none of the participants showed purely selfish behavior, since the lowest contribution of eight pieces was considerably higher than the Nash equilibrium ($x_i^* = 4$).

Team Cohesion. Similarly, participants reported high levels of team cohesion. Compared to belongingness ($M = 5.50$; $SD = 1.43$) and social cohesion ($M = 4.32$, $SD = 0.59$), we observed the highest scores for task cohesion ($M = 4.72$, $SD = 0.33$), with 14 out of 30 participants selecting the maximal rating of five.

Social Gaze. During the 601-second non-binding communication stage, most of the participants' ($n = 30$) gaze points were allocated to the AOI Task ($M = 0.56$, $SD = 0.15$), succeeded by Members ($M = 0.18$, $SD = 0.10$), Else ($M = 0.15$, $SD = 0.05$), and Payoff ($M = 0.11$, $SD = 0.10$). No considerable difference between gaze to Member_Left ($M = 0.09$, $SD = 0.05$) and Member_Right ($M = 0.09$, $SD = 0.06$) was found. Among social gaze dynamics in teams ($n = 10$), joint attention ($M = 0.43$, $SD = 0.14$) occurred most prominently. Mutual gaze ($M = 0.15$, $SD = 0.10$) and gaze aversion ($M = 0.14$, $SD = 0.04$) were approximately equally frequent.

Furthermore, a qualitative examination of the recurrence plots generated using MdRQA showed that episodes of mutual gaze occurred predominantly at the beginning and, especially, the end of the non-binding communication stage, whereas gaze aversion and joint attention emerged throughout its entire period (see Appendix: Figure 6).

4.2 – Testing the Main Hypotheses

H1: Mutual Gaze. Two-sided partial correlation analysis ($n = 30$) with CO and KUSIV3 as covariates showed no significant correlation between mutual gaze (X1) and individual contribution (A), $r(26) = .157, p = .424$. Thus, hypothesis H1A was not supported.

Consistent with H1B, however, we found a moderate, positive correlation between mutual gaze (X1) and team cohesion (B), $r(26) = .345, p = .072$.

H2: Gaze Aversion. The partial correlation analysis revealed a strong, negative correlation between gaze aversion (X2) and individual contribution (A), which supports hypothesis H2A, $r(26) = -.526, p = .004$.

In contrast, we observed no significant correlation between gaze aversion (X2) and team cohesion (B) undermining hypothesis H2B, $r(26) = .098, p = .621$.

4.3 – Robustness Checks

OLS Regressions. We observed (marginally) significant positive correlations between mutual gaze and individual contribution when considering the influence of both social gaze dynamics together ($p = .001$) and adding social dispositions ($p = .001$) as well as personality traits ($p = .078$). Whereas the size of the coefficient remained rather similar, adding demographics rendered the result insignificant ($p = .341$; see Table 3).

Similar to the partial correlation analysis, OLS regressions showed positive correlations between mutual gaze and team cohesion, which were (marginally) significant in the first ($p = .067$), second ($p = .028$), and third model ($p = .027$). However, we observed a drop in the coefficient and no significant correlation in the fourth model ($p = .502$) challenging our main results for hypothesis H1B (see Table 4).

In support of our previous finding regarding the relationship between gaze aversion and contribution (H2A), we observed (marginally) significant negative correlations when controlling for the influence of mutual gaze ($p = .001$), dispositions ($p < .001$), personality traits ($p = .002$), and demographics ($p = .059$; see Table 3).

A. Contribution				
	(1)	(2)	(3)	(4)
X1	4.478*** (1.173)	4.734*** (1.239)	3.060* (1.657)	3.426 (3.517)
X2	-18.875*** (5.182)	-20.523*** (4.441)	-17.366*** (5.023)	-18.020* (9.018)
CO		1.074* (0.615)	0.859 (0.723)	0.859 (0.741)
KUSIV3		0.278 (0.443)	0.535 (0.465)	0.500 (0.634)
BFI-10_A			-0.005 (0.156)	-0.009 (0.183)
BFI-10_B			0.514* (0.288)	0.503 (0.293)
Age				0.008 (0.140)
Female				-0.084 (0.894)
Constant	13.183*** (0.766)	9.099*** (2.045)	8.567*** (2.136)	8.672** (3.752)
R ²	0.310	0.378	0.488	0.489
Observations	30	30	30	30

Robust standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3. Results of the OLS regressions with individual contribution (A) as the dependent variable.

Finally, consistent with our main results, neither the first ($p = .706$), second ($p = .891$), third ($p = .943$), nor fourth ($p = .497$) model revealed a significant correlation between gaze aversion and team cohesion (see Table 4).

Tobit Regressions. The results of the tobit regressions with individual contribution (A) as the dependent variable were qualitatively in line with the results obtained from estimating OLS models (see Appendix: Table 5).

B. Team Cohesion				
	(1)	(2)	(3)	(4)
X1	2.041*	3.193**	3.235**	1.576
	(1.071)	(1.372)	(1.368)	(2.309)
X2	1.438	0.579	0.318	3.592
	(3.777)	(4.192)	(4.388)	(5.201)
CO		0.586	0.668	0.702
		(0.424)	(0.521)	(0.481)
KUSIV3		-0.652	-0.676	-0.511
		(0.391)	(0.420)	(0.506)
BFI-10_A			-0.080	-0.066
			(0.086)	(0.110)
BFI-10_B			0.047	0.099
			(0.214)	(0.229)
Age				-0.069
				(0.093)
Female				0.331
				(0.407)
Constant	-0.518	0.173	0.050	0.209
	(0.598)	(1.579)	(1.650)	(1.740)
R ²	0.063	0.156	0.175	0.211
Observations	30	30	30	30

Robust standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4. Results of the OLS regressions with self-reported team cohesion (B) as the dependent variable.

5 – Discussion

5.1 – Communication and Cooperation

In order to answer the research question, whether there is a relationship between social gaze in teams and their members' subsequent willingness to cooperate, we executed an empirical study. In particular, we introduced a real effort tangram task constituting a typical social dilemma in team cooperation. Consistent with findings on the communication effect in social dilemmas, we observed very high cooperation rates, since the team task's first non-binding communication stage was performed in face-to-face interaction (Balliet, 2010; Sally, 1995). The participants also reported high levels of team

cohesion. For instance, the feeling of belongingness was rated on a level comparable to close friends, even though none of the participants knew their team members before participating in the study (Gächter et al., 2015). Further, the descriptive results do not imply that the sample exhibits exceptionally altruistic characteristics, as the scores for personality traits, interpersonal trust, and collective orientation are similar to the reference values for young adults aged between 20 and 28 (Beierlein et al., 2014; Hagemann, 2020; Rammstedt et al., 2014). Overall, these findings indicate that the team task successfully introduced the formation of team identity, which eventually led to high individual levels of cooperation.

5.2 – Gaze Patterns in Face-to-Face Interaction

During the non-binding communication stage, participants spent more than half of the ten-minute period looking at the shared area for creating the tangram. However, they also looked at their team members for almost 20% of the time they were given to complete the task. These findings are consistent with the results of similar eye tracking studies in which the average proportion of gaze to team members ranged from 17% to 46% (see, e.g., Broz et al. 2012; Vrzakova et al., 2021).

According to the gaze-cueing paradigm, looking at the face of others enables individuals to infer their attentional focus by triggering reflexive gaze shifts to the same location (Frischen et al., 2007). Consistent with this, we observed very similar gaze distributions within teams, whereas the allocation of gaze to the AOIs varied greatly between teams. This was particularly evident in the proportion of gaze to the payoff table, indicating that some teams paid much more attention to the monetary gains and costs of individual contributions than others during the non-binding communication stage. Our findings demonstrate that the real effort task required team members not only to focus on arranging their tangram pieces, but also to pool their resources by attending to each other. In doing so, teams coordinated their gaze, which ultimately resulted in substantial levels of social gaze.

In previous studies, the proportion of mutual gaze in dyadic conversations ranged from 46% to 60% (Broz et al., 2012; Rogers et al., 2018). With about 15% to 41%, lower levels of mutual gaze were observed during interactions involving more than two people (Capozzi et al., 2019). Given that the teams

in our study had to complete a demanding real effort task, our findings line up well with these results. By analyzing the recurrence plots generated using MdRQA, we were also able to determine when exactly participants engaged in mutual gaze, gaze aversion, and joint attention respectively. In support of the gaze-cueing paradigm, sustained periods of joint attention were interspersed by very short episodes of gaze aversion, indicating that team members aligned their visual attention by frequently monitoring each other's gaze (Frischen et al., 2007). In contrast, episodes of mutual gaze occurred mainly at the beginning and the end of the non-binding communication stage. Similarly, Haensel et al. (2022) observed a significant decrease in mutual gaze after participants introduced themselves to each other. Overall, the descriptive results support the assumption that the ability to perceive others' gaze direction – whether directed at oneself or averted – plays a crucial role in social interaction by facilitating the coordination of attentional processes.

5.3 – Social Gaze in Teams

Mutual Gaze. In accordance to He et al. (2017), who suggested reduced social distance as one mechanism of the communication effect, we found a positive correlation between the level of mutual gaze in teams and their members' self-reported team cohesion. Thus, the proportion of time at least two team members are looking at each other simultaneously appears to influence their social cognition. In support of this finding, Mason et al. (2005) found that the perception of mutual gaze made individuals feel more attracted to others than gaze aversion (Pfeiffer et al., 2013). Mutual gaze has also shown to increase the probability of memorizing others (Frischen et al., 2007). Consequently, the observed relationship between mutual gaze and team cohesion is consistent with previous findings and supports the assumption that it “signals communicative intent and ‘opens the channel’ for social interaction” (Pfeiffer et al., 2013). However, our results did not reveal a robust correlation between mutual gaze and participants' individual contribution. This indicates that different levels were not taken into account when making strategic considerations regarding the trade-off between purely self and social-welfare maximizing decisions.

Hence, the level of mutual gaze might not affect economic decision making in teams, yet positively influences their team members' subsequent evaluation of social- and task-related aspects.

Gaze Aversion. Given that gaze aversion has previously been associated with competitive behavior and also naturally counteracts the dynamic of mutual gaze, we expected it to negatively impact cooperation in teams (Foddy, 1978; Vrzakova et al., 2021). As predicted, our statistical analysis revealed a robust negative correlation between gaze aversion and the participants' individual contribution, whereas no relation with the explicit rating of team cohesion was found. Accordingly, teams in which the members were less responsive to each other's direct gaze – and thus exhibited greater levels of gaze aversion – generated lower outputs overall. This suggests that the perception of averted gaze not only allows team members to align their visual attention, as suggested by the gaze-cueing paradigm, but also to obtain additional information that eventually shapes their economic decisions. Consistent with this, recent findings from behavioral economics have shown that the ability to observe others' (visualized) gaze direction in remote interaction enabled participants to maximize their payoff in simple coordination games and to judge the prosociality of their counterpart in social dilemmas (Fischbacher et al., 2022; Hausfeld et al., 2021). Similarly, Bayliss and Tipper (2006) have previously demonstrated that individuals make inferences about the trustworthiness of others by observing their averted gaze. Overall, our results provide first evidence that team members adjust their own economic behavior according to the level of gaze aversion experienced during face-to-face communication.

5.4 – Limitations

As in other eye tracking studies, the validity of our results is limited by the rather small number of observations. For this reason, we focussed on statistically testing four main hypotheses using partial correlation analyses and challenging the robustness of their results in a further step. In addition, individual contributions to the team task were very heterogeneous converging at the upper boundary, which limited the detectable correlation with mutual gaze and gaze aversion. Although the high level of cooperation is attributable to the communication in a face-to-face setting, we expected more variance (Balliet, 2010). As

the tendency to free ride becomes more pronounced in larger teams, one solution would be to include more members per team (see, e.g., Nosenzo et al., 2015). However, this would also increase the complexity of an adequate definition and measurement of social gaze dynamics, as these mainly involve two individuals at a time. Therefore, a more appropriate solution would be to increase the stylized conflict between individual and collective interests by altering the cost function. Moreover, our design cannot explain how exactly mutual gaze and gaze aversion effect (non-)cooperative behavior and cohesion in teams. Therefore, further studies are needed to investigate the underlying mechanisms.

5.5 – Conclusion

In summary, our findings reveal that eye contact and gaze patterns play a decisive role in team work. More specifically, we found that the willingness to cooperate as well as the feeling of cohesion within teams is influenced by the dynamics of social gaze between its members. What matters is not the mere frequency with which team members look at each other during collaboration, but the extent to which these episodes result in mutual or averted gaze. Whereas the level of mutual gaze positively correlates with self-reported team cohesion, gaze aversion shows a negative correlation with team output. Thus, the results of our paper underline the importance of non-verbal cues and signals for economic behavior and team interactions. Managers and organizations should not only pay attention to the content of the communication but also take into account the power of non-verbal signals and especially social gaze when being confronted with team cooperation. Further research is needed to gain a broader understanding of the impact of social gaze in different work situations as well as in remote settings, in which almost no information about the gaze direction of others is available.

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Appendix

Table 1

Principal component analysis

Component	Eigenvalue	Explained Variance
BFI-10_A	1.798*	0.360 (0.360)
BFI-10_B	1.122*	0.224 (0.584)
BFI-10_C	0.964	0.193 (0.777)
BFI-10_D	0.799	0.160 (0.937)
BFI-10_E	0.317	0.064 (1.000)

Cumulative explained variance in parentheses

* Eigenvalue > 1

Note. Listed are the principal components of the BFI-10's five dimensions – extraversion, agreeableness, openness, conscientiousness, and neuroticism – as well as their eigenvalues and explained variances.

Table 2

Descriptive statistics and pair-wise correlations

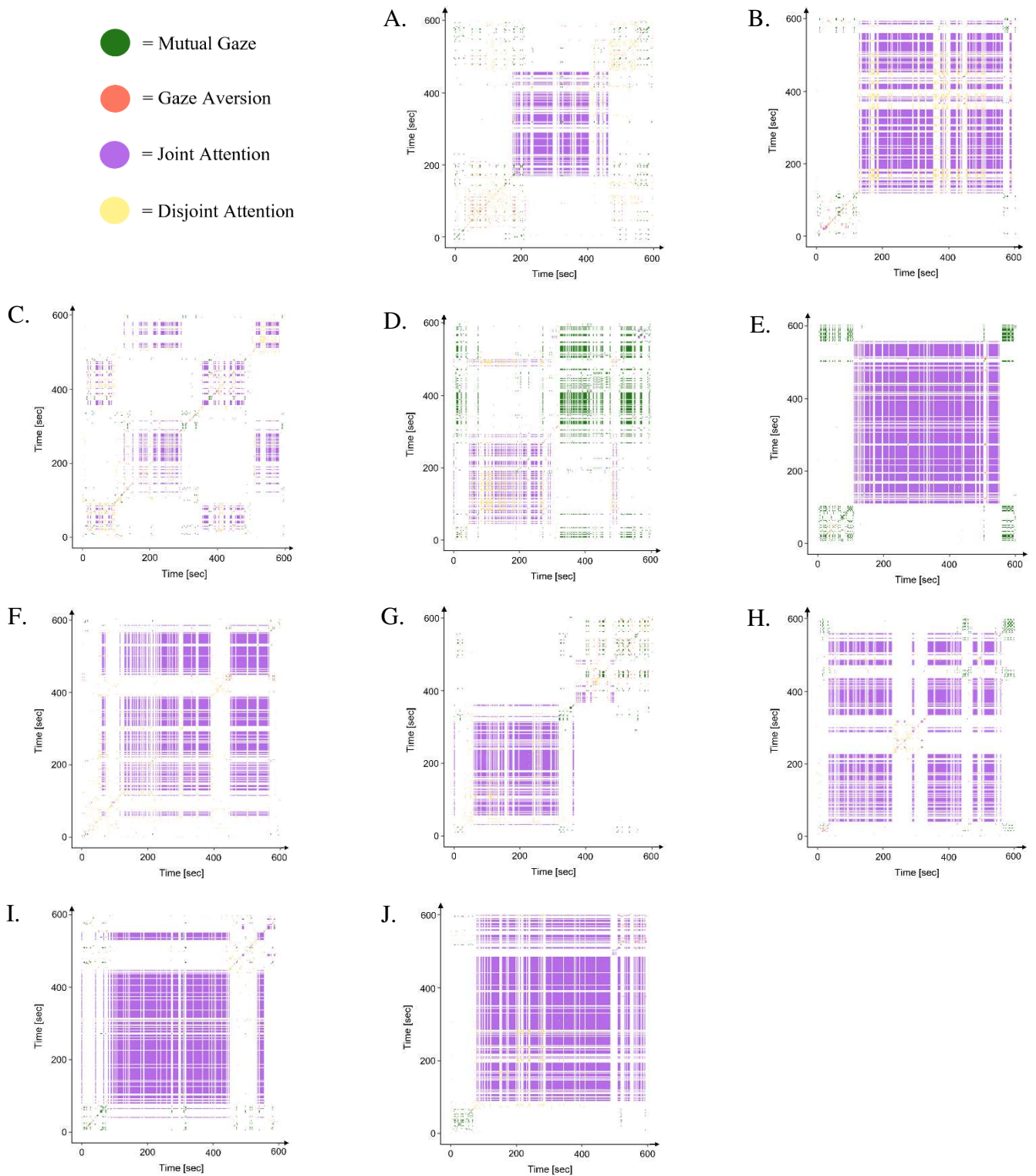
Variable	Mean	SD	Min	Max	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	
(1) Female	1.50	0.51	1.00	2.00																	
(2) Age	23.23	2.25	20.00	28.00	-0.14																
(3) Contribution	11.20	1.54	8.00	12.00	0.18	-0.14															
(4) Team Cohesion	0.00	0.83	-2.05	1.01	0.21	-0.13	0.36														
(5) Belongingness	5.50	1.43	2.00	7.00	0.21	-0.10	0.13	0.81**													
(6) Social Cohesion	4.32	0.59	3.00	5.00	0.20	0.05	0.40*	0.91**	0.68**												
(7) Task Cohesion	4.72	0.33	4.00	5.00	0.10	-0.27	0.36*	0.78**	0.35	0.58**											
(8) Mutual Gaze	0.15	0.09	0.04	0.39	0.47**	-0.16	0.19	0.24	0.08	0.36*	0.16										
(9) Gaze Aversion	0.14	0.04	0.09	0.24	-0.33	0.35	-0.49**	0.11	0.14	0.18	-0.05	0.15									
(10) Joint Attention	0.43	0.14	0.23	0.60	0.12	-0.30	0.08	-0.31	-0.19	-0.45*	-0.14	-0.53**	-0.83**								
(11) Collective Orientation	2.99	0.33	2.25	3.69	-0.25	0.27	0.12	0.07	-0.06	0.15	0.08	-0.13	0.18	-0.25							
(12) Interpersonal Trust	3.83	0.43	3.00	4.67	-0.08	0.13	0.21	-0.15	-0.29	0.03	-0.12	0.28	0.05	-0.21	0.36						
(13) Extraversion	3.17	0.80	2.00	5.00	0.17	-0.19	0.42*	0.12	-0.02	0.07	0.25	0.30*	-0.23	0.05	-0.02	-0.10					
(14) Agreeableness	3.30	0.68	2.00	4.50	0.10	-0.13	0.24	0.08	0.00	0.06	0.16	0.12	-0.24	0.11	0.24	0.14	0.35				
(15) Conscientiousness	3.65	0.88	2.00	5.00	0.13	0.31	-0.32	-0.22	-0.13	-0.19	-0.23	-0.20	0.07	0.04	-0.12	-0.22	0.10	0.07			
(16) Neuroticism	2.78	0.99	1.00	5.00	0.36	0.02	-0.03	0.13	0.23	0.18	-0.09	0.16	0.07	-0.13	-0.26	0.06	-0.45*	-0.14	-0.09		
(17) Openness	3.37	1.04	1.50	5.00	0.07	0.10	0.38*	0.17	-0.01	0.18	0.24	0.10	-0.16	-0.04	-0.05	-0.01	0.07	-0.37*	-0.11	0.24	

* $p < 0.05$, ** $p < 0.01$

Note. Results of the descriptive analysis ($n = 30$); Female was coded 1 = male and 2 = female.

Figure 6

Social gaze dynamics visualized by multidimensional recurrence quantification analysis (MdrQA)



Note. Recurrence plots (MdrQA) visualizing the social gaze dynamics – mutual gaze, gaze aversion, joint attention, and disjoint attention – of each team along the 600-second non-binding communication stage. Colored areas represent the defined combinations of AOIs at various time lags (see Section 3.5).

Table 5*Tobit regressions*

	Contribution			
	(1)	(2)	(3)	(4)
X1	29.853** (13.382)	25.107** (10.544)	11.956 (8.316)	14.203 (12.784)
X2	-52.289*** (12.384)	-48.620*** (11.210)	-31.324** (12.325)	-32.406 (23.839)
CO		2.308 (2.335)	0.773 (2.029)	0.994 (2.161)
KUSIV3		1.020 (1.777)	2.755 (1.701)	2.700 (2.002)
BFI-10_A			0.434 (0.572)	0.426 (0.759)
BFI-10_B			1.999** (0.734)	1.965** (0.845)
Age				-0.153 (0.453)
Female				-0.455 (2.695)
Constant	17.992*** (3.114)	7.122 (8.546)	4.485 (7.272)	8.131 (9.956)
rc_Contribution	13.078** (5.800)	12.063* (5.953)	8.069* (4.391)	7.906* (4.062)
Pseudo R ²	0.134	0.151	0.241	0.244
Observations	30	30	30	30

Robust standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note. Results of the tobit regressions with individual contribution (A) as the right censored dependent variable (rc_Contribution; upper limit = 12).

Instructions

Translated version of the instructions

Welcome,

before we start, we would like to give you some essential information about our study.

Participation in the study is voluntary. The survey is anonymous. Socio-demographic data such as gender is collected for the purpose of evaluating the statements heterogeneously across groups. No attempt will be made to draw conclusions about specific individuals from the information you provide. The results of the evaluation will be published exclusively in anonymous form (in tables and/or graphs), so that it is not possible to draw conclusions about individuals. Please do not enter any personal data*, not even from third parties, in the free text fields.

*According to Art. 4 No. 1 of the General Data Protection Regulation (GDPR), “personal data” means “any information relating to an identified or identifiable natural person; an identifiable natural person is one who can be identified, directly or indirectly, in particular by reference to an identifier such as a name, an identification number, location data, an online identifier or to one or more factors specific to the physical, physiological, genetic, mental, economic, cultural or social identity of that natural person”.

In the context of the experiment, we use the currency “ECU”. This will be converted into Euros for your compensation at the end of the study. Thereby, 1.00 € equals 9.60 ECU.

At the beginning of the study, you will receive an endowment of 72 ECU. The amount of your payoff depends on your decision as well as the decisions of your team members in the experimental team task. After the study, you will receive a minimum payoff of 48 ECU for your participation.

The study consists of a main part (about 30 minutes) and two short surveys (5 minutes each) at the beginning and at the end. Please take your time when answering the questions.

Please click on the continue button to start. There is no possibility to return to a previous page. Therefore, please answer all questions in the given order.

Thank you for completing the pre-survey,

before we continue, we would like to describe the procedure of the main part of this study.

In the main part, you will work with two other participants to solve a team task. The goal of the team task is to create shapes based on geometric pieces. To do this, you will receive a tangram puzzle, which we will describe in more detail below.



The main part is divided into two phases.

1) Practice phase (15 minutes): First, we want to make sure that you gain a basic understanding of how to work on the team task. For this purpose, you will receive a detailed explanation about the objective and the rules of the team task. We will also describe in detail what will affect the amount of your payoff.

2) Team task (10 minutes): After the practice phase, you will be equipped with eye-tracking glasses and guided to the room where the team task will be performed. After completing the team task with your team members, you will be guided back to the individual cubicle you are currently in.

Tangram puzzle

The team task is based on a tangram puzzle. A tangram is a set of building blocks in geometric shapes. These building blocks can be used to create various shapes reminiscent of animals or objects.

The tangram puzzle has no particular rules. For example, the building blocks do not necessarily have to touch each other. Thus, figures can also include distinct components.



Instructions

Below you will receive detailed information about the team task as well as the payoff principle. Please take your time to understand the objective and the rules of the game.

Team task

Once the team task begins, you will be equipped with eye-tracking glasses and led to a group room. In this room, you will be asked to take a seat at a round table, which is divided by partitions. The partitions contain rectangular cut outs so that you can see and communicate with your team members despite being spatially separated.

You will have 10 minutes to complete the team task. At the end of the 10 minutes, you will be guided back to your individual cubicle.

The team task is based on the tangram puzzle, which was introduced on the previous page. In the team task, you will be given your own set of 12 tangram building blocks. Together with your team members, you will have a total of 36 building blocks to complete the task.

The objective of the team task is to work together with your team members to create a shape from the available building blocks. You can talk with your team members during the 10 minutes and place as many building blocks as you like on the table. You can also take your own blocks off the table at any time. To make it easier to assign the building blocks to the individual team members, they have different colours.

Within the 10 minutes, you and your team members need to agree on a figure as well as the building blocks required for it.

Afterwards, you will be escorted back to your individual cubicle to make a final decision about how many of your 12 building blocks you would like to contribute to the team task.

Your individual decision and the decisions of your two team members will determine the amount of your payoff.

Payoff

To complete the team task, each team member receives a set of 12 tangram blocks. Thus, a total of 36 blocks will be available to create a shape. Each team member decides individually on the number of pieces they want to contribute to the team task.

The amount of your payoff depends on two factors.

1) Individual revenue: First, the sum of the building blocks contributed by all three team members is calculated. This sum can be between 0 and 36, since all three participants can contribute between 0 and 12 building blocks. The sum of the building blocks is then multiplied by 12 to determine the team’s overall revenue. In the second step, the team revenue is divided equally between the team members, so that each participant receives one third as individual revenue.

The following table shows your individual revenue based on the sum of contributed building blocks.

Building blocks (sum)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Individual revenue	0	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96	100	104	108	112	116	120	124	128	132	136	140	144

2) Individual costs: Each building block you contribute to the team task incurs a cost to yourself. These individual costs increase with each block you have already contributed and are deducted from your individual revenue.

Building blocks	0	1	2	3	4	5	6	7	8	9	10	11	12
Individual costs	0	0,5	2	4,5	8	12,5	18	24,5	32	40,5	50	60,5	72

Consequently:

Payoff = 72 + (R - C)

72: Endowment	<u>Examples:</u>	R (10) = 40; C (6) = 18	R (20) = 80; C (12) = 72
R: Individual Revenue		Payoff = 72 + (40 - 18)	Payoff = 72 + (80 - 72)
C: Individual Costs		Payoff = 94 ECU	Payoff = 80 ECU

Comprehension tasks

Before we continue with the practice phase, we would like to ask you to complete the following comprehension tasks. For this purpose, please use the auxiliary materials provided at your workplace.

1) Please indicate the maximum number of building blocks you can personally contribute to the team task.

__ building blocks

Unfortunately, your answer to the question was not correct.

To complete the team task, each participant receives a set of 12 tangram building blocks.

2) Please indicate the maximum number of building blocks that your entire team can contribute to the team task.

__ building blocks

Unfortunately, your answer to the question was not correct.

To complete the team task, each participant receives a set of 12 tangram building blocks. Thus, each team receives a total of 36 building blocks to complete the task.

3) Please select all decisions that influence your individual revenue.

Your individual decision

Decisions of the other two participants

Unfortunately, your answer to the question was not correct.

Both your individual decision and the decisions of the other two participants influence your individual revenue, since it is based on the total number of building blocks contributed (0 to 36).

4) Please select all decisions that influence your individual costs.

Your individual decision

Decisions of the other two participants

Unfortunately, your answer to the question was not correct.

Only your individual decision influences your individual costs, as it is based on your individual contribution (0 to 12).

5) Please select the option that correctly reflects the payoff principle of the team task.

Payoff = Individual Costs - Individual Revenue + 72

Payoff = (Individual Costs - 72) + Individual Costs

Payoff = (Individual Revenue + 72) + Individual Costs

Payoff = 72 + (Individual Revenue - Individual Costs)

Unfortunately, your answer to the question was not correct.

The payoff principle is: Payoff = 72 + (Individual Revenue - Individual Costs)

Practice phase

Please take 5 minutes to get familiar with the team task.

You will find a box with 12 tangram blocks in front of you. Please take out all the building blocks and try to create different shapes on the table in front of you.

The number of building blocks used is neither observed nor recorded during the practice phase and thus has no influence on the payoff.

To continue, please click on the button at the bottom right corner of the screen as soon as the time on it has expired.

Thank you for completing the practice phase,

you have successfully completed the first part of the study. Next, the team task begins.

Reminder

The team task is divided into two phases.

- 1) During the 10 minutes, you and your team members need to agree on a shape to build as well as the building blocks required to achieve it. You can talk with each other during the 10 minutes and place as many building blocks as you like on the table. You can also remove your own building blocks from the table at any time.
- 2) After the 10 minutes, you will be guided back to your individual cubicle. Next, you need to indicate how many of your 12 building blocks you would like to contribute to the team task.

The first stage is to agree on a solution the team task. In the second stage, you decide on how many building blocks you want to contribute to the agreed upon solution. This individual decision is not disclosed to the other participants.

Your individual decision and the decisions of your two team members in the second stage determine your payoff.

Please remain seated until you will be guided to the group room to complete the team task.

Decision stage

Please indicate how many of your building blocks you would like to contribute to the agreed upon solution.

Payoff principle: **Payoff = 72 + (R - C)**

72: Endowment

R: Individual Revenue

C: Individual Costs

___ building blocks

Thank you for completing the team task,

now please take your time to answer the questions included in the post-survey.

Please click on the continue button to start. There is no possibility to return to a previous page. Therefore, please answer the questions in the given order.