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Direct reciprocity and reputation shape trust decisions similarly in blind and sighted individuals

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A R T I C L E I N F O

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A B S T R A C T

This study addresses the effects of blindness on trust. Using an auditory version of the multi-round Trust Game, we investigated the effect of reputation and reciprocity on trust decisions in early blind and sighted participants. During each round of the game, participants were endowed with a sum of money and had to decide how much they wanted to invest in their partners, who were manipulated as a function of their good or bad reputation and individualistic or cooperative behavior. The data showed that negative first impression about the partner (bad reputation and/or selfish behavior) impacted more blind participants than sighted ones. However, following repeated interactions with the partners, the overall mean investment aligned between the blind and sighted groups. We interpret these findings as suggesting that blindness may guide participants to a more cautionary behavior when dealing with partners with negative initial characteristics.

1. Introduction

Deciding to trust someone is an essential decision. However, it is even more relevant for blind individuals who need the help of others (including strangers) in various everyday situations, such as finding their way in unfamiliar places. Considering this, a critical question is whether blindness impacts how we perceive others' trustworthiness. Indeed, the extent to which someone is perceived as trustworthy seems to depend on three main factors: direct experience, reputation, and appearance (Ames et al., 2011). Individuals are more likely to trust people with whom they experienced positive reciprocal exchanges (people who reciprocated the trust) and are less likely to trust people with whom they had negative exchanges (people who dishonored the trust; Hoffman et al., 2015). Moreover, individuals trust people who are associated with a good (vs. bad) reputation, which consists of secondhand information about their past moral behaviors (Bellucci & Park, 2020). If direct experience and reputation, two key mechanisms for cooperation in human societies (for a recent review on reputation and reciprocity, see Xia et al., 2023), are available regardless of visual status, blindness may impact the role played by appearance (first impression) in driving trustworthiness decisions. Consistent with this view, previous studies have shown that the first impression individuals form about someone can powerfully influence trust decisions (Todorov et al., 2015), as demonstrated by Trust Game paradigms (Chang et al., 2010).

The Trust Game is a socioeconomic decision-making task in which the participant is endowed with an amount of money, and she/he

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can decide to invest (trust) a part of her/his money in another player (partner), which in turn, can honor or abuse that trust (Berg et al., 1995). Prior studies employing this task showed that participants tend to invest less in partners with untrustworthy faces than partners with trustworthy faces (Van't Wout & Sanfey, 2008). Trustworthy faces share *specific visual features*, such as higher inner eyebrows, smiling mouth, and pronounced cheekbones (Dotsch & Todorov, 2012). Importantly, participants think a trustworthy face is associated with a higher probability of reciprocation and prosocial behavior (Hassin & Trope, 2000), even when the partner's reputation information about previous behaviors is available (Rezlescu et al., 2012). This automatic tendency to strongly rely on facial appearance emerges early in childhood (Ewing et al., 2015). Overall, the data demonstrate the strength of the influence of facial appearance on social decisions (Todorov et al., 2015) and show that the decision to invest in a stranger strongly depends on the first *visual* impression (Li et al., 2021).

It is noteworthy that only a few studies have investigated trust decisions in blind individuals, and these experiments reported mixed results. For instance, Oleszkiewicz et al. (2017a) showed that blind individuals rated female lowered-pitch voices less trustworthy than sighted participants. However, when comparing the levels of "general" social trust statements ("people are exploitative or dishonest?") in blind and sighted individuals, the same authors (Oleszkiewicz et al., 2017b) found that both groups similarly tended to believe that people are more exploitative rather than dishonest. In a more recent study, Oleszkiewicz (2021) assessed trust level using the Balance of Social Exchanges Scale, which measures the perceived benefit of one's social interaction (e.g., agreement with "I benefit from most of my social contact") and the Interpersonal Trust Scale which assesses the proportion to trust (e.g., agreement with "most people can be trusted"), and found that blind show a slightly higher level of trust compared to sighted individuals. In a study by Ferrari et al. (2017), the authors showed that blind participants formed similar trustworthiness-based first impressions as sighted individuals when the evaluated behavior of the agent was verbally described. However, they were more prone, compared to sighted, to revise their initial trustworthiness impression when more information was provided, especially when impression updating was in the positive direction. Overall, these prior studies suggest that blindness may indeed affect trust decisions, but results are somehow inconsistent, possibly depending on the specific task used. Moreover, none of the prior studies directly explored whether visual experience influences trust decisions in realistic interactions (as in Trust Games). A prior study employed a social interaction game (Dictator Game, Kahneman et al., 1986) to assess the effect of visual impairment on altruistic behavior but not social trust (Oleszkiewicz & Kupczyk, 2020). Indeed, in the Dictator Game, a participant (dictator) has to decide to what extent she/he wants to split the money with the counterpart (recipient). Participants play only one round together, and the counterpart is totally passive and can only accept the division proposed by the dictator. Oleszkiewicz & Kupczyk (2020) reported that blind individuals offer less money compared to sighted controls, possibly reflecting an increased value of money in the setting of a lack of visual experience. It is important to note however, that the Dictator Game is not a "trust game" and does not allow for studying the effect of *social learning* during multiple exchanges (to contrast initial social evaluations vs. social evaluations after reiterated exchanges).

To study the possible impact of blindness on direct social interactions, we employed a multi-round Trust Game (MTG; Maurer et al., 2018) in which the reputation of the partners (good vs. bad) and their reciprocity behavior (cooperative vs. individualistic) were simultaneously manipulated. We decided to assess the impact of reputation and reciprocity since they are both key factors in

Table 1
Details of the blind participants tested in this study.

Subject	Gender	Age	Highest level of education (years)	Total blindness onset	Cause of blindness	Visual function
EB1	M	61	22	Birth	Neonatal glaucoma	Minimal light perception in right eye only
EB2	M	60	13	4 y/o	Buphthalmos	Light perception in left eye only
EB3	M	38	18	Birth	Retinopathy of prematury	No light perception
EB4	M	55	8	right eye: birth. left eye: 12 y/o	Uveitis	No light perception
EB5	M	60	22	Birth	Retinopathy of prematury	No light perception
EB6	M	36	16	Birth	Retinopathy of prematury	No light perception
EB7	M	45	8	Birth	Rubella during mother's pregnancy	Minimal light perception in left eye only
EB8	M	32	18	Birth	Genetic disorder	Minimal light perception
EB9	F	34	18	Birth	Genetic disorder	No light perception
EB10	F	48	8	Birth	Optic atrophy	Minimal light perception
EB11	F	26	18	Birth	Peter's anomaly	No light perception
EB12	M	34	18	Birth	Optic nerve hypoplasia	No light perception
EB13	F	31	18	Birth	Leber's congenital amaurosis	No light perception
EB14	F	46	22	Birth	Retinopathy of prematury	No light perception
EB15	M	57	13	3 months	Bilateral glaucoma	No light perception
EB16	M	38	16	Birth	Retinopathy of prematury	Minimal light perception in left eye only
EB17	M	57	13	10 y/o	Neonatal glaucoma	No light perception
EB18	M	51	16	Birth	Retinopathy of prematury	Minimal light perception
EB19	F	26	13	Birth	Glaucoma, corneal dystrophy	No light perception
EB20	F	32	18	Birth	Retinopathy	No light perception
EB21	M	20	13	Birth	Leber's congenital amaurosis	Minimal light perception

Abbreviations: EB: early blind; f: female; m: male; y/o: years old.

determining cooperative behavior (for a recent review, see Xia et al., 2023). This paradigm represents an ecological assessment of social trust. Specifically, participants do not evaluate other individuals on trustworthiness on a numerical scale (as in the previous experiment by Ferrari et al., 2017), but rather must decide to gamble on four different partners for ten consecutive rounds for each partner. Importantly, using this task, we can observe the possible effects of blindness over trust exchanges over time. We expected to find less trust investment by blind compared to sighted controls, consistent with what Oleszkiewicz & Kupczyk (2020) reported. Also, considering the results previously reported by Ferrari et al. (2017), we expected to find a greater tendency to revise the investment between the initial compared to final rounds in blind compared to sighted participants.

2. Materials and methods

2.1. Participants

Twenty-one profoundly blind individuals (7 females; age: M = 42.24, SD = 12.81 years, range: 20–61 years; education level: M = 15.67, SD = 4.30 years; Table 1) and twenty-one gender-matched sighted participants (7 females; age: M = 42.48, SD = 13.64 years, range: 23–61 years; education level: M = 16.24, SD = 3.47 years) took part in the experiment. Blind and sighted participants did not differ as a function of age ($t(40) = 0.058$, $p = .95$) and education ($t(40) = 0.47$, $p = .63$). Eighteen blind participants lost sight before the age of one, while three participants were severely visually impaired early on, and later became bilaterally totally blind. In particular, EB2 and EB4 reported functional visual loss from birth, while severe visual impairment for EB17 started at 6 months. Importantly, none of these participants could report visual memory. All blind participants were experienced braille readers, and they were independent travelers.

Informed consent was obtained from all participants. The study was approved by the local ethical committee and was carried out in accordance with the tenets of the Declaration of Helsinki. An *priori* power analysis conducted using G-Power 3.1 software indicated that for our experimental design, a sample size of 21 individuals in each group would be required to obtain 90 % statistical power at a significance threshold of alpha equal to 0.05. This would yield an expected large effect size of f(U) = 0.35 ($\eta^2_\rho = 0.11$) based on previous data (Ferrari et al., 2017).

2.2. The multi-round trust game task

Participants played an auditory version of the MTG. All auditory materials were in the participant's native language (Italian). The visual version of this task has been employed in a previous study investigating trust decisions in individuals with autism spectrum disorder (Maurer et al., 2018). In the present study, all the information provided to the participants was auditorily presented through headphones connected to a computer. In the MTG task, each participant played the role of the investor with four different virtual partners. At the beginning of the experiment, participants were informed that they would play an economic game with four different "virtual" partners (10 rounds of game for each partner) in the role of the investor via a personal computer interface. Participants were informed that these virtual partners were not real people but just like characters in videogames. They were asked to play according to their own goals and preferences, rather than optimize an experimenter-specified goal and they were free to decide the amount of money they wanted to invest in each partner (as in prior studies, see Hula et al., 2021). Participants were informed that the partner would have received the selected investment quadrupled by 4 (e.g., if 4 Experimental Monetary Units (EMUs) were invested, the partner would receive 16 EMUs) and could choose how many EMUs he wanted to return to the participant. Before each round, participants were endowed with 10 EMUs, regardless of how much EMUs had been earned from previous rounds. In so doing, each round stood alone, except that participants interacted with the same partner for 10 consecutive rounds. The number of each round for each partner was announced by the experimenter. In each round, participants verbally indicated the desired investment which was recorded by the experimenter using a computer keyboard. At the end of the investment phase, and before moving on to the next round, the experimenter reported to the participant: a) the amount of EMUs she/he earned in the round, c) the amount of EMUs the partner earned in the round, d) the amount of EMUs she/he earned in total (considering all the rounds played with that specific partner) and e) the amount of EMUs the partner earned in total (considering all the rounds played with the participant).

Partners differed as a function of Reputation and Reciprocity behavior. The Reputation of the partner was provided to the participant through a brief biographical story presented just before the game with each partner started. Two good and two bad reputation profiles were created. Reputation profiles emerged from the described person's lifestyle, habits, work, and social commitment. The two good biographies referred to a partner with a prosocial attitude (e.g., "Gabriele teaches disadvantaged children; he is an excellent teacher and uses innovative methods to facilitate children's learning"). In contrast, the two bad profiles were characterized by individualistic traits (e.g., "Andrea is the owner of a call center company, in which he exploits many young and underpaid individuals, and he thinks to use the money he earns to buy a luxury car"). The Reciprocity behavior of the partners was manipulated during trust exchanges with two partners acting cooperatively, by always returning a higher sum of EMUs compared to the amount initially invested by the participants. The other two partners acting in an individualistic manner always returned fewer EMUs than the participants invested. To improve the ecological validity of our task, partners varied their return number of EMUs randomly within predefined margins: cooperative partners returned between 37.5 % and 50 % of the quadrupled investment, while individualistic partners returned between 12.5 % and 25 % of it (see Lis et al., 2016; Maurer et al., 2018).

We created 4 different partners associated with the combinations of Reputation and Reciprocity behavior, a partner with: 1) good reputation and cooperative behavior; 2) bad reputation and cooperative behavior; 3) good reputation and individualistic behavior; 4) bad reputation and individualistic behavior.

The participant played 10 rounds with each partner before switching partners. The order of presentation of the partners was randomized across participants.

During the experiment, participants were seated comfortably in a quiet room and wore headphones. Sighted participants were blindfolded during the entire experiment (as in Ferrari et al., 2017). Stimuli presentation and data recording were implemented using E-prime 2.0 software. The experiment lasted approximately 40 min. At the end of the whole study, participants were thanked and were debriefed about the scope of the experiment. Importantly, they were also reminded about the nature of their 'partner', which was a computer algorithm that emulated the behavior of adult Trustees (as in prior studies, see Hula et al., 2021).

3. Results

The mean investment in Experimental Monetary Units (EMUs) in blind and sighted participants in the different experimental conditions is shown in Fig. 1.

As dependent variable, we first calculated the *mean overall investment* (i.e., across all rounds) for sighted and blind participants in the different experimental conditions. On this variable, we carried out a 2 × 2 × 2 repeated-measures ANOVA, with Reputation (good vs. bad) and Reciprocity behavior (cooperative vs. individualistic) as within-subject factors and Group (blind vs. sighted) as the between-subject factor. The ANOVA revealed a significant main effect of Reputation, $F(1,40) = 24.93$, $p < .001$, $\eta^2_\rho = 0.38$, and Reciprocity behavior, $F(1,40) = 40.80$, $p < .001$, $\eta^2_\rho = 0.50$ (Fig. 1**A**). These effects were due to participants investing significantly more in good-reputation than in bad-reputation partners, and significantly more in cooperative than in individualistic partners. None of the other main or interaction effects were significant: Group $F(1,40) = 0.93$, $p = .33$; Reputation × Reciprocity behavior, $F(1,40) = 0.001$, $p = .97$; Group × Reputation, $F(1,40) = 0.006$, $p = .93$; Group × Reciprocity behavior, $F(1,40) = 0.92$, $p = .34$; Group × Reputation × Reciprocity behavior, $F(1,40) = 0.007$, $p = .93$.

Despite the ANOVA on mean investment showed no group differences, visual experience may still affect how participants weigh the effects of reputation and reciprocity behavior over time, an aspect that cannot be captured by the first analysis that considered all rounds together. To assess this, following the statistical approach employed by Maurer et al. (2018), we considered the investment made by participants when the effects of reputation and reciprocity behavior were *first* at play (i.e., round 1 for reputation and round 2 for reciprocity), and after repeated exposition to the reciprocity behavior of the partners (final round).

Accordingly, to analyze participants' behavior at the beginning of the game, we implemented a 2 (Source of information *first impact*: Reputation of round 1 vs. Reciprocity behavior of round 2) × 2 (Valence: positive vs. negative) × 2 (Group: blind vs. sighted) repeated-measures ANOVA on mean investments across the different partners. The ANOVA revealed a significant main effect of Valence, $F(1,40) = 37.45$, $p < 0.001$, $\eta^2_\rho = 0.48$, indicating that positive partners (i.e., either for reputation or behavior) received higher investments than negative ones, and an almost significant main effect of Group, $F(1,40) = 4$, $p = .052$, $\eta^2_\rho = 0.09$, indicating that in general blind participants tended to invest less than sighted individuals. These effects were further qualified by the significant interaction Valence × Group, $F(1,40) = 4.48$, $p = .040$, $\eta^2_\rho = 0.0.10$, indicating that blind invested significantly less than sighted

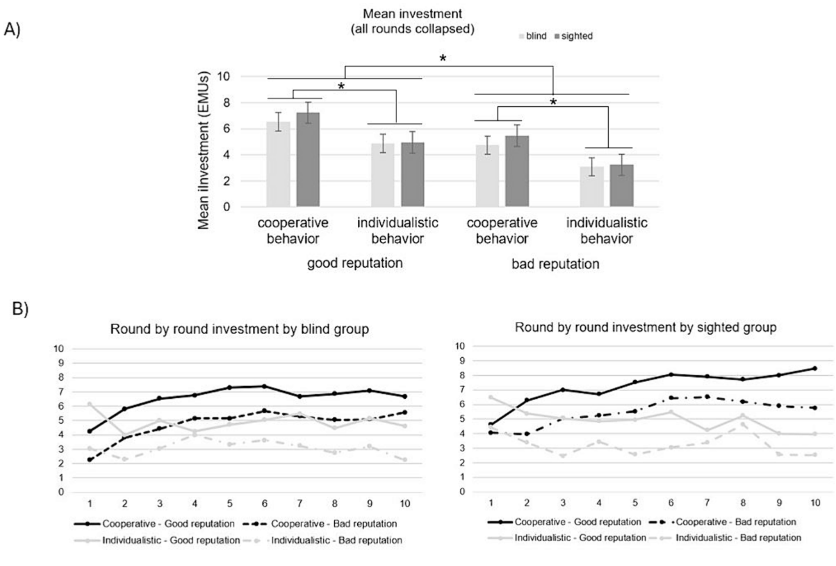

Fig. 1. A) Mean investment (across all rounds) in Experimental Monetary Units (EMUs) in blind and sighted participants as a function of Reputation (good vs. bad) and Reciprocity behavior (cooperative vs. individualistic). Participants invested significantly more in good-reputation partners and cooperative partners; visual experience did not affect mean investments. Error bar represents ± 1 standard error. **B)** Round by round investment by blind and sighted participants in the different game conditions. Asterisks indicate significant differences among conditions ($p < .05$).

participants in negative partners (i.e., either for reputation or behavior), $t(40) = 2.67$, $p = .02$ (Bonferroni corrected), but similarly in positive partners, $t(40) = 0.69$, $p = .49$ (Fig. 2**A**). None of the other main or interaction effects were significant: Source of information, $F(1,40) = 0.32$, $p = .57$; Source of information × Group, $F(1,40) = 0.34$, $p = .56$; Source of information × Valence, $F(1,40) = 1.16$, $p = .28$; Source of information × Valence × Group, $F(1,40) = 0.05$, $p = .81$.

To investigate the existence of potential differences between blind and sighted participants after multiple exchanges, we implemented an analysis focusing only on the *last round* of exchanges, again as in Maurer et al. (2018). For this purpose, we implemented a 2 (Source of information final round: Reputation vs. Reciprocity behavior) × 2 (Valence: positive vs. negative) × 2 (Group: blind vs. sighted) repeated-measures ANOVA considering only the tenth round for both the Reputation and Reciprocity factors (Fig. 2**B**). The ANOVA revealed only a significant main effect of Valence, $F(1,40) = 54.55$, $p < .001$, $\eta_p^2 = 0.57$, indicating that positive partners (i.e., either for reputation or behavior) received overall higher investments compared to negative ones. No other main or interaction effects were significant: Group, $F(1,40) = 0.42$, $p = .52$; Source of information, $F(1,40) < 0.01$, $p = 1$; Source of information × Group, $F(1,40) < 0.01$, $p = 1$; Valence × Group, $F(1,40) = 1.17$, $p = .28$; Source of information × Valence, $F(1,40) = 2.86$, $p = .09$; Source of information × Valence × Group, $F(1,40) = 0.27$, $p = .60$.

4. Discussion

Our study assessed whether blindness influences trust behaviors using an ecological social decision-making task. We found that both partners' reputation and reciprocity behavior were important sources of influence for trust decisions, regardless of visual experience. Indeed, for both blind and sighted participants, a good reputation led to greater investment than a bad reputation, and participants invested more in cooperative compared to individualistic partners. This finding is consistent with previous studies (Maurer et al., 2018), and supports the importance of reputation and reciprocity as key factors in social decisions (see Xia et al., 2023). However, when calculating the effect of counterparts' reputation and reciprocity on trust learning, separating positive from negative information and the initial from the last rounds, we found a stronger effect of the initial negative information in blind participants compared to sighted controls. Indeed, blind individuals invested less in negative partners (either for bad reputation and/or individualistic behavior) at the beginning of the game compared to sighted participants. This finding partially confirmed our expectation based on the results by Oleszkiewicz & Kupczyk (2020), who reported that in one-shot Dictator Game blind participants offered overall less money compared to sighted controls. However, in our paradigm, this was the case only at the beginning of the game and with negative partners.

Rather than considering our finding as reflecting an increased value of money in the blind, we suggest that when dealing with initial negative information about others, blind participants weigh this negative input more than sighted individuals and therefore invest less in these potentially disadvantageous partners. Moreover, while in our task participants knew that low investment in a cooperative partner would result in a limited final payoff for them (cooperative participants will always honor the investment, returning more money), in the Dictator Game used by Oleszkiewicz & Kupczyk (2020), an altruistic decision (equal division of money between the participant and the partner) will always result in a limited final payoff for the participants. Thus, in the Trust Game, prosocial behavior could result in a higher final payoff, which is not possible in the Dictator Game. These differences in task design may contribute to the discrepancies observed in the findings reported here (blindness reflected cautious behavior only after initial negative inputs) and those reported by Oleszkiewicz & Kupczyk (2020; blind participants always give less money to their partners).

The finding that blind participants initially weigh more negative information could be a protective behavior to prevent possible self-harm (unprofitable investments in people who dishonor the trust). The lack of visual experience may indeed make a blind person feel more vulnerable to possible external threats, with threatening signals becoming even more salient than in the setting of no visual deprivation. In this view, the stronger focus on initial negative information in deciding whether to trust the partner is consistent with previous studies showing that blind participants performed better than sighted controls in the discrimination of negative (fear, disgust, or anger) and neutral, compared to positive (happiness) emotions, expressed through both vocalizations (Klinge et al., 2010) and body odours (Iversen et al., 2015). Moreover, only the superior processing of *negative* emotions was reflected in stronger activity in the amygdala in the blind compared to sighted participants (Klinge et al., 2010). Since negative information may reflect possible

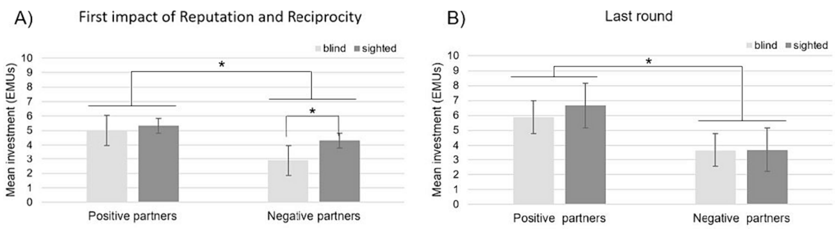

Fig. 2. A) Mean investment in blind and sighted participants when the effect of reputation and reciprocity behavior is first at play (round 1 for reputation and round 2 for reciprocity) and B) after repetitive exchanges (round 10). The investment is plotted for valence (positive vs. negative partners) across sources of information (i.e., positive partners because of good reputation or cooperative behavior and negative partners because of bad reputation or individualistic behavior). Blind invested significantly less than sighted participants in negative partners, but similarly in positive partners, at the beginning of the task, whereas visual experience did not affect investment in the last round. Error bar represents ± 1 standard error. Asterisks indicate significant differences among conditions ($p < .05$).

underlying danger, its evaluation has a critical survival value (Arioli et al., 2021a; Baumeister et al., 2001), a mechanism that may be potentiated by blindness due to the higher vulnerability associated with visual deprivation. However, this interpretation needs further investigation.

In line with Ferrari et al. (2017), we expected blind participants to be more prone to revise their first impression and consequently their investment in partners over repeated exchanges, the repeated rounds providing updated information about partner trustworthiness beyond the initial reputation. Visual inspection of Fig. 1b suggests that after the first exposure to the reciprocity behavior of the partner (in round 2) blind participants were indeed more affected by the incongruent behavior of the partners concerning their reputation and were more prone than the sighted to change their investment accordingly. No significant group differences were observed in round 10, suggesting that after the first revision of the trustworthiness behavior, the two groups tended to align in their investment (as also demonstrated by the comparable investment overall across rounds and partners). Moreover, while our study suggests that visual deprivation leads to more cautious social behavior in the face of initial negative stimuli, the study by Ferrari et al. (2017) seems to indicate an opposite social strategy in blind subjects, who evaluate other individuals more positively following positive information (during both impression formation and updating phases of the task). However, our task involved tractable economic consequences for the participants, probably enhancing their emotional responses associated with loss avoidance (Kahneman & Tversky, 1979). Moreover, our study assessed an implicit social evaluation (trust behavior) whereas Ferrari et al. (2017) asked for an explicit evaluation of trustworthiness, with implicit and explicit impressions relying on different mechanisms (Rydell et al., 2006). Further studies are needed to evaluate the effect of visual deprivation on implicit and explicit social processing.

In interpreting our results, some limitations should be acknowledged. Our sample size was overall small (although in line with several previous behavioral studies testing the effects of blindness on perceptual and cognitive functions), and the number of trials was overall limited, possibly weakening the statistical power. Future studies should provide further support to our results including larger samples, allowing also to consider the effects of other variables, like sex, age, or personality traits that are known to affect trust decisions (e.g., Horta et al., 2024; Akker et al., 2020). Moreover, although prior work shows that people invest similarly in humans and robots in a trust game where the participants knew their partner was a robot or human (Schniter et al., 2020), and several prior studies employed trust games with virtual partners, it may be that a more ecological situation in which blind participants play with real partners represents a more valid approach to approximate their trust decisions in real life. Future experiments may address this possibility, with more ecological contexts possibly allowing also to better disentangling the impact of reciprocity behavior and prior reputation on cooperative trust decisions. Notwithstanding these limitations, the present results critically add to our current knowledge about the effects of blindness on social interactions. While there is a vast amount of research focused on language (e.g., Handjaras et al., 2016) and spatial cognition (e.g., Bauer et al., 2015; Cattaneo et al., 2010, 2011; Ruggiero et al., 2018) in the blind, the study of social abilities has been neglected, with only a limited number of experiments specifically assessing the effect of visual deprivation on social functioning. Notably, although neuroimaging studies reported the recruitment of the typical social brain in blind participants during social processing (Arioli et al., 2021b), blind individuals often report social isolation and exclusion as well as difficulties with social exchanges (Sharkey & Stafford, 1990), especially in childhood (Pereira & Conti-Ramsden, 2019). Moreover, COVID-19 pandemic had a strong negative impact on the life of blind individuals, decreasing their sense of autonomy and increasing social exclusion (Boyle et al., 2020). Only by analyzing the real needs of blind individuals can we promote their well-being and inclusion. Thus, it appears essential to design ecological experiments that further characterize the social functioning of blind individuals in their everyday environments.

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CRediT authorship contribution statement

Maria Arioli: Writing – review & editing, Writing – original draft, Visualization, Software, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Chiara Ferrari:** Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Lotfi B. Merabet:** Writing – review & editing, Supervision, Conceptualization. **Zaira Cattaneo:** Writing – review & editing, Writing – original draft, Visualization, Supervision, Resources, Project administration, Investigation, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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References

Akker, O., Assen, M., Vugt, M., & Wicherts, J. (2020). Sex differences in trust and trustworthiness: A meta-analysis of the trust game and the gift-exchange game. *Journal of Economic Psychology., 81*, Article 102329.

Ames, D. L., Fiske, S. T., & Todorov, A. T. (2011). 28 impression formation: A focus on others' intents. *The Oxford handbook of social neuroscience, 419*.

Arioli, M., Basso, G., Carne, I., Poggi, P., & Canessa, N. (2021). Increased pSTS activity and decreased pSTS-mPFC connectivity when processing negative social interactions. *Behavioural Brain Research, 399*, Article 113027.

Arioli, M., Ricciardi, E., & Cattaneo, Z. (2021). Social cognition in the blind brain: A coordinate-based meta-analysis. *Human Brain Mapping, 42*(5), 1243–1256.

Bauer, C., Yazzolino, L., Hirsch, G., Cattaneo, Z., Vecchi, T., & Merabet, L. B. (2015). Neural correlates associated with superior tactile symmetry perception in the early blind. *Cortex, 63*, 104–117.

Baumeister, R. F., Bratslavsky, E., Finkenauer, C., & Vohs, K. D. (2001). Bad is stronger than good. *Review of General Psychology, 5*(4), 323.

Bellucci, G., & Park, S. Q. (2020). Honesty biases trustworthiness impressions. *Journal of Experimental Psychology: General, 149*(8), 1567.L.

Berg, J., Dickhaut, J., & McCabe, K. (1995). Trust, reciprocity, and social history. *Games and Economic Behavior, 10*, 122–142.

Boyle, C. A., Fox, M. H., Havercamp, S. M., & Zubler, J. (2020). The public health response to the COVID-19 pandemic for people with disabilities. *Disability and Health Journal, 13*(3), Article 100943.

Cattaneo, Z., Fantino, M., Tinti, C., Silvanto, J., & Vecchi, T. (2010). Crossmodal interaction between the mental number line and peripersonal haptic space representation in sighted and blind individuals. *Attention, Perception, & Psychophysics, 72*, 885–890.

Cattaneo, Z., Fantino, M., Tinti, C., Pascual-Leone, A., Silvanto, J., & Vecchi, T. (2011). Spatial biases in peripersonal space in sighted and blind individuals revealed by a haptic line bisection paradigm. *Journal of Experimental Psychology: Human Perception and Performance, 37*(4), 1110–1121.

Chang, L. J., Doll, B. B., van't Wout, M., Frank, M. J., & Sanfey, A. G. (2010). Seeing is believing: Trustworthiness as a dynamic belief. *Cognitive Psychology, 61*(2), 87–105.

Dotsch, R., & Todorov, A. (2012). Reverse correlating social face perception. *Social Psychological and Personality Science, 3*, 562–571.

Ewing, L., Caulfield, F., Read, A., & Rhodes, G. (2015). Perceived trustworthiness of faces drives trust behaviour in children. *Developmental science, 18*(2), 327–334.

Ferrari, C., Vecchi, T., Merabet, L. B., & Cattaneo, Z. (2017). Blindness and social trust: The effect of early visual deprivation on judgments of trustworthiness. *Consciousness and Cognition, 55*, 156–164.

Iversen, K. D., Ptito, M., Møller, P., & Kupers, R. (2015). Enhanced chemosensory detection of negative emotions in congenital blindness. Neural plasticity, 2015.

Handjaras, G., Ricciardi, E., Leo, A., Lenci, A., Cecchetti, L., Cosottini, M., & Pietrini, P. (2016). How concepts are encoded in the human brain: A modality independent, category-based cortical organization of semantic knowledge. *NeuroImage, 135*, 232–242.

Hassin, R., & Trope, Y. (2000). Facing faces: Studies on the cognitive aspects of physiognomy. *Journal of Personality and Social Psychology, 78*(5), 837.

Hoffman, M., Yoeli, E., & Nowak, M. A. (2015). Cooperate without looking: Why we care what people think and not just what they do. *Proceedings of the National Academy of Sciences, 112*(6), 1727–1732.

Horta, M., Shoenfelt, A., Lighthall, N. R., et al. (2024). Age-group differences in trust-related decision-making and learning. *Scientific Reports, 14*, 68.

Hula, A., Moutoussis, M., Will, G. J., Kokorikou, D., Reiter, A. M., Ziegler, G., ... & NSPN Consortium. (2021). Multi-round trust game quantifies inter-individual differences in social exchange from adolescence to adulthood. Computational Psychiatry (Cambridge, Mass.), 5(1), 102.

Kahneman, D., Knetsch, J. L., & Thaler, R. H. (1986). Fairness and the assumptions of economics. *Journal of business*, S285–S300.

Kahneman, D., & Tversky, A. (1979). Prospect theory: Ananalysis of decision under risk. *Econometrica: Journal of the Econometric Society., 47*, 263–291.

Klinge, C., Röder, B., & Büchel, C. (2010). Increased amygdala activation to emotional auditory stimuli in the blind. *Brain, 133*(6), 1729–1736.

Li, Y., Chen, Z., Liu, X., & Qi, Y. (2021). Perceiving the facial trustworthiness: Facial age, emotional expression, and attractiveness. Quarterly Journal of Experimental Psychology (Hove), 17470218211047176.

Lis, S., Baer, N., Franzen, N., Hagenhoff, M., Gerlach, M., Koppe, G., & Kirsch, P. (2016). Social interaction behavior in ADHD in adults in a virtual trust game. *Journal of Attention Disorders, 20*(4), 335–345.

Maurer, C., Chambon, V., Bourgeois-Gironde, S., Leboyer, M., & Zalla, T. (2018). The influence of prior reputation and reciprocity on dynamic trust-building in adults with and without autism spectrum disorder. *Cognition, 172*, 1–10.

Oleszkiewicz, A., Pisanski, K., Lachowicz-Tabaczek, K., & Sorokowska, A. (2017). Voice-based assessments of trustworthiness, competence, and warmth in blind and sighted adults. *Psychonomic Bulletin & Review, 24*, 856–862.

Oleszkiewicz, A., Pisanski, K., & Sorokowska, A. (2017). Does blindness influence trust? A comparative study on social trust among blind and sighted adults. *Personality and Individual Differences, 111*, 238–241.

Oleszkiewicz, A., & Kupczyk, T. (2020). Sensory impairment reduces money sharing in the dictator game regardless of the recipient's sensory status. *PLoS one, 15*(3), e0230637.

Oleszkiewicz, A. (2021). Blindness enhances interpersonal trust but deafness impedes social exchange balance. *Personality and Individual Differences, 170*, Article 110425.

Pereira, M. P., & Conti-Ramsden, G. (2019). *Language development and social interaction in blind children*. Routledge.

Rezlescu, C., Duchaine, B., Olivola, C. Y., & Chater, N. (2012). Unfakeable facial configurations affect strategic choices in trust games with or without information about past behavior. *PLoS one, 7*(3).

Ruggiero, G., Ruotolo, F., & Iachini, T. (2018). Congenital blindness limits allocentric to egocentric switching ability. *Experimental Brain Research, 236*, 813–820.

Rydell, R. J., McConnell, A. R., Mackie, D. M., & Strain, L. M. (2006). Of two minds: Forming and changing valence-inconsistent implicit and explicit attitudes. *Psychological Science, 17*(11), 954–958.

Schniter, E., Shields, T. W., & Sznycer, D. (2020). Trust in humans and robots: Economically similar but emotionally different. *Journal of Economic Psychology, 78*, Article 102253.

Sharkey, W. F., & Stafford, L. (1990). Turn-taking resources employed by congenitally blind conversers. *Communication Studies, 41*(2), 161–182.

Todorov, A., Olivola, C. Y., Dotsch, R., & Mende-Siedlecki, P. (2015). Social attributions from faces: Determinants, consequences, accuracy, and functional significance. *Annual Review of Psychology, 66*, 519–545.

Van't Wout, M., & Sanfey, A. G. (2008). Friend or foe: The effect of implicit trustworthiness judgments in social decision-making. *Cognition, 108*(3), 796–803.

Xia, C., Wang, J., Perc, M., & Wang, Z. (2023). Reputation and reciprocity. *Physics of Life Reviews*.