

# Taking others for granted: Balancing personal and presentational goals in action selection

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## Abstract

This study investigates how individuals balance personal and presentational goals – how they want to be perceived by others – in social interactions where those are conflicting. We develop a computational model that construes presentational goals as minimising the divergence between the perceived and desired belief state of their partner. Based on the divergence between how much a person’s partner trusts them versus how much they want to be trusted, we predict complex decision-making patterns that cannot arise from solely focusing on maximising a partner’s utility. In accordance with our model, participants tended to forego signalling good intentions and prioritised their own goals when they perceived their partner to trust them. Participants were also less concerned about how they were perceived and acted more often in their own interest when their partner was unlikely to change their mind. We show that people are sensitive to the specific belief state of others and can dynamically adjust their decision strategy to trade off presentational and material gains.

**Keywords:** presentational goals; theory of mind; Bayesian models; social cognition

## Introduction

Who has never had to sit through another friend ranting about their life without concern about how we were feeling or had to wait for another while they were taking a “quick shower”? These puzzling tendencies raise the question: why are we sometimes careless about those we are close to and who value us? In this paper, we want to demonstrate that this pattern of behaviour is consistent with a relatively simple mathematical formulation for how people manage their material and social goals. The dialectic of pursuing goals which are misaligned with how we would want to be perceived are a fundamental aspect of life in a society. Managing those constant micro-conflicts requires that we can both evaluate the relative importance of a goal and weigh it against a potential cost in reputation. This necessitates holding a representation of how our choices will affect others’ beliefs about us and our goals and intentions. Put differently, we ought to be balancing local material gains with the changes in others’ beliefs about us that pursuing those gains would cause.

**Inverse planning and intervening on beliefs** Inverse planning uses probabilistic reasoning to infer an individual’s beliefs, goals, and preferences by observing their actions, working backward from behaviour to understand their intentions (Baker, Saxe, & Tenenbaum, 2009; Jara-Ettinger, Gweon, Schulz, & Tenenbaum, 2016). Social Markov Decision Pro-

cesses (MDPs) formalise how agents resolve conflicts between material and social goals through recursive inference of others’ value functions, integrating these into their own (Tejwani, Kuo, Shu, Katz, & Barbu, 2022). Agents can act strategically to signal specific intentions, knowing that their actions will be used by others to infer their goals (Baker, Jara-Ettinger, Saxe, & Tenenbaum, 2017; Ullman et al., 2009; S. A. Wu, Sridhar, & Gerstenberg, 2023). Evidence of this has been shown in social contexts such as teaching (Ho, Cushman, Littman, & Austerweil, 2021), storytelling (Chandra, Li, Tenenbaum, & Ragan-Kelley, 2024), or emotion expression in high-stakes social dilemmas (Houlihan, Kleiman-Weiner, Hewitt, Tenenbaum, & Saxe, 2023). People adeptly predict how their actions influence others’ beliefs and use these predictions to guide behaviour (Ho, Saxe, & Cushman, 2022; Oey, Schachner, & Vul, 2023).

**Communication and prosocial behaviour** Communication probably best exemplifies our ability to use inverse planning to cause intentional changes in our peers’ beliefs. People use communicative actions to transmit knowledge (Chandra, Chen, Li, Ragan-Kelley, & Tenenbaum, 2024; Ho et al., 2021), communicate about social norms (A. M. Chen & Saxe, 2024; Kleiman-Weiner, Shaw, & Tenenbaum, 2017; Radkani, Tenenbaum, & Saxe, 2022) or signal intimacy (Hung, Thomas, Radkani, Tenenbaum, & Saxe, 2022; Thomas, Woo, Nettle, Spelke, & Saxe, 2022). A specific case arises when one attempts to communicate about their character, say how prosocial one is. Prosocial behaviour, actions which benefit others (Y. E. Wu & Hong, 2022), is studied in economics as an intrinsic preference for fairer outcomes (Fehr & Schmidt, 1999) or as an aversion to negative emotions like guilt or frustration (Aina, Battigalli, & Gamba, 2020; Battigalli & Dufwenberg, 2007, 2022). It can stem from empathy, reciprocity (Saulin, Horn, Lotze, Kaiser, & Hein, 2022), or to build and maintain trust (Bicchieri, Xiao, & Muldoon, 2011; Jordan, Hoffman, Nowak, & Rand, 2016). Jordan et al. (2016) showed that uncalculating cooperation in economic games signals trustworthiness when decision processes are observable. However, such behaviour, while seemingly ignoring reward-based motives, may be driven by computations about one’s partner’s beliefs. By this we mean that people can hold intrinsic preferences about what others think of them (Gweon, 2021), which may then drive prosocial behaviour.

This type of social goal has been referred to as presentational or reputational goal (Kim, Colombatto, & Crockett, 2024; S. A. Wu et al., 2023; Yoon, Tessler, Goodman, & Frank, 2020).

Despite this recent progress, we have yet to consider some aspects of what a preference over beliefs entails. Beliefs, as represented by *probability distributions*, change in non-linear ways. This fact should be reflected in the behaviour of agents using inverse planning. For instance, the beliefs of highly uncertain agents should be more sensitive to new observations than those of agents who hold firmer positions. We argue that people are sensitive to the specific belief states of others as evidenced by how they trade off presentational and personal goals.

### Computational model

We present a computational model of how people manage situations where material goals compete with presentational goals. To do this, we propose an adapted version of the dictator game (Camerer & Thaler, 1995). Suppose two agents, Blue  $B$  and Green  $G$ , are interacting. Specifically,  $B$  can choose to take an action  $a$  from a set  $A$  which yields reward  $R_B(a)$  for  $B$  and  $R_G(a)$  for  $G$ , known to both agents. Crucially,  $G$  can only observe what  $B$  does: they cannot act. We assume that each agent evaluates their own gains as well as the other’s gains using the following utility function. For agent  $B$ :

$$U_B(a) = \alpha \cdot R_B(a) + \beta \cdot R_G(a) \quad (1)$$

where  $\alpha$  represents self-interest (how much  $B$  cares about their own reward) and  $\beta$  prosociality (how much they care about the other agent’s gain).

The key contribution of this paper is to suppose that social agents attempt to influence the belief others have of the values of their parameters  $\alpha$  and  $\beta$  (see also Yoon et al., 2020). That is, they assume that other agents attempt to infer the value of  $\alpha$  and  $\beta$  from their behaviour using Bayesian inference. Our approach is inspired by social MDPs (Tejwani et al., 2022) but instead of only using the outputs for optimising their gains and plan around other agents, they also use it to influence each other’s beliefs. Here, we consider that  $B$  wants to influence  $G$ ’s estimate of  $B$ ’s prosocial parameter  $\beta$  using a presentational term  $\text{Pres}(a, \beta_G)$  where  $\beta_G$  is  $G$ ’s estimate of  $\beta$ . The full utility function is thus

$$U_B(a) = \alpha \cdot R_B(a) + \beta \cdot R_G(a) + \delta \cdot \text{Pres}(a, \beta_G), \quad (2)$$

where  $\delta$  represents the contribution of the presentational goals of  $B$  in their decision making. The key challenge is thus to model  $\text{Pres}(a, \beta_G)$ . We propose that agent  $B$  attempts to bring a posterior distribution  $p(\beta_G|a)$ , i.e. what  $G$  would believe about them after taking action  $a$ , in line with a distribution  $\rho(\beta_G)$  representing their preference about what  $p(\beta_G|a)$  ought to be. As such, we write the social target as

$$\text{Pres}(a, \beta_G) = -D_{KL}[p(\beta_G|a)||\rho(\beta_G)], \quad (3)$$

which implies that  $B$  will be trying to find an action which minimises the Kullback-Leibler divergence between the estimated posterior  $p(\beta_G|a)$  conditional on taking action  $a$  and their preference  $\rho(\beta_G)$ . From there, agent  $B$  chooses an action  $a$  from the action set  $A$  by sampling from a softmax distribution, i.e.  $p(a) = \sigma(U_B(a))$ .

**Inference** In order to compute  $\text{Pres}(a, \beta_G)$ ,  $B$  must be able to anticipate how taking action  $a$  would influence  $G$ ’s estimate  $\beta_G$  of their prosocial parameter  $\beta$ . As such, agent  $B$  must be able to find or estimate  $p(\beta_G|a)$ . For simplicity,  $B$  assumes that  $G$  is not inferring their presentational goals parameter  $\delta$ . Focusing on  $\beta_G$ , it is straightforward to show that

$$p(\beta_G|a) \propto \exp(\beta_G R_G(a)) p(\beta_G) \quad (4)$$

Intuitively, this suggests that to infer what other people would believe their prosociality to be given some action  $a$ , agents use an average of their utility given the action weighted by their current estimate of what others think of them.

**Predictions** All predictions hinge on the fact that the behaviour of an agent with presentational goals is dependent on the current beliefs of other agents. These were not pre-registered. Suppose an agent  $B$  is not prosocial but wishes to be perceived as such, therefore  $\beta = 0$  and  $\delta > 0$  and both are assumed to be constant. Explicitly writing  $\text{Pres}(a, \beta_G)$  as  $-D_{KL}[p(\beta_G|a)||\rho(\beta_G)]$ , their utility is

$$U_B(a) = \alpha \cdot R_B(a) - \delta \cdot D_{KL}[p(\beta_G|a)||\rho(\beta_G)] \quad (5)$$

As  $p(\beta_G|a) \rightarrow \rho(\beta_G)$ , then  $D_{KL}[p(\beta_G|a)||\rho(\beta_G)] \rightarrow 0$  and so the contribution of the presentational terms decreases.

*Hypothesis 1:* When presentational goals are achieved or close to being achieved, agent  $B$  should be less incentivised to signal good intentions.

The contribution of  $D_{KL}[p(\beta_G|a)||\rho(\beta_G)]$  in selecting action  $a_i$  rather than action  $a_j$  depends on the magnitude of their respective changes in  $p(\beta_G|a)$ . That is, if all actions  $a$  have little influence (i.e. if  $p(\beta_G|a_i) \approx p(\beta_G|a_j)$  for all  $a_i, a_j$ ), then  $D_{KL}[p(\beta_G|a)||\rho(\beta_G)]$  becomes almost constant and hence no longer discriminates between actions. A trivial case occurs when the beliefs of  $G$  are independent from  $B$ ’s actions. A more interesting case is when  $G$  is so sure about  $B$ ’s intentions that any action  $B$  takes cannot meaningfully change their mind. Formally, when the entropy of their distribution over  $\beta_G$  gets very low:  $H(p(\beta_G)) \rightarrow 0$ . A third case occurs when  $G$  is unable to observe  $B$ ’s actions or their consequences, or at least when  $B$  believes this to be case. Then,  $B$ ’s actions cannot change  $G$ ’s beliefs.

*Hypothesis 2:* When  $B$  believes  $G$  to be certain in their beliefs, i.e. when they have low entropy, actions become less able to change them, and the weight of  $B$ ’s presentational goals should decrease.

*Hypothesis 3:* Agent  $B$  should pursue their own interests more when they are convinced that they cannot be observed.

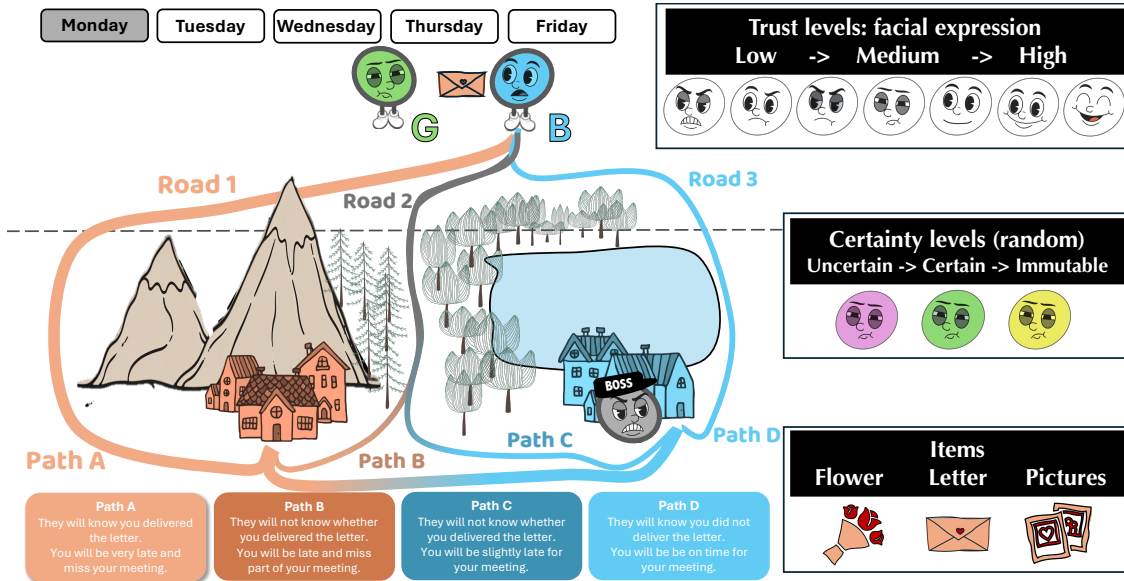


Figure 1: Materials used for the experiment. Each day, participants could choose a path from the four options. Each path is associated with a fixed outcome. Path A signalled to  $G$  that the item would be delivered. Path B and C would give no signal but only the former would deliver the item. Finally, path D would not deliver the item and signal it to  $G$ . Trust level was mapped onto facial expression as shown above, certainty was assigned randomly to a character colour/item pair which stay constant throughout the experiment.

## Methods

**Materials** To test our hypotheses, we introduce a version of the dictator game inspired by [Chandra, Li, Tenenbaum, and Ragan-Kelley \(2023\)](#), where an agent  $B$ , played by participants, is tasked by a *green, violet or yellow* agent, which we will always call  $G$ , played by a bot, to deliver an item to their friend in the Red village (see Figure 1).  $B$  must choose between three roads to reach Blue village for a work meeting. Road 1 is the longest and will anger their boss but involves passing through Red village and thus signals to  $G$  that the item will be delivered. Road 2 is ambiguous, potentially allowing  $B$  to deliver  $G$ 's item with less time cost but still angering their boss. Road 3 is the shortest, ensures  $B$  is on time, but clearly reveals that  $G$ 's item will not be delivered. Participants were explicitly told  $G$  would not know whether the item was delivered, making Road 2 potentially more desirable despite the trade-offs. Consequently, while  $R$  can only see which road  $B$  takes, i.e. 1, 2 or 3,  $B$  has four options (see Figure 1). This paradigm was built in Otree ([D. L. Chen, Schonger, & Wickens, 2016](#)).

**Representing agent  $G$**  Given that participants were playing as  $B$  and we needed to have a controllable behaviour for  $G$ , we used a bot. The bot updated their beliefs  $p(\beta_G|a)$  based on their prior, of which we manipulated the entropy, and on actions taken by participants. In order to perform those updates, we had to define a formal reward structure for the task but did not disclose it to participants. Paths  $A$ ,  $B$ ,  $C$  and  $D$  corresponded to a reward of 0, 1, 2 and 3 for  $B$ , representing how satisfied their boss would be based on when they arrive. For agent  $G$ , the payoffs were respectively 4, 4, 0, 0 corresponding to either delivering or not delivering the letter. Paths  $A$  and  $B$  always delivered the item, while  $C$  and  $D$  never

did. Crucially, as  $G$  could only tell which road  $B$  takes, i.e. 1, 2 or 3, their perceived payoffs had the two middle paths averaged. So the payoffs for  $B$  were 0, 1.5, 3 and 4, 2, 0 for  $G$ .  $G$  simply computed  $p(\beta_G|a) \propto \exp(\beta_G R_G(a)) p(\beta_G)$ , where  $\beta_G$  could take values 1 for prosocial,  $-1$  for adversarial and 0 for neither. The mean of the posterior distribution was then mapped onto 7 faces representing the following emotions *very unhappy, unhappy, slightly unhappy, unsure, slightly happy, happy, very happy* and displayed to participants (see Figure 1). Participants were told that each facial expression represented a level of trust for  $G$ : how much they believed that  $B$  cared about actually delivering the item.

**Design** We used a  $3 \times 3$  within subject design with  $9 + 1$  blocks of trials. The first condition, targeted at *hypothesis 1*, used facial expressions to manipulate the starting belief state of  $G$ . We had three cases where for  $\beta_G$  in  $[-1, 0, 1]$ , trust was *high* with  $p(\beta_G) = [0.1, 0.2, 0.7]$ , *moderate* with  $p(\beta_G) = [0.15, 0.7, 0.15]$  and *low* with  $p(\beta_G) = [0.7, 0.2, 0.1]$ . The second condition, targeted at *hypothesis 2*, used different character colours and item pairs to test whether participants were sensitive to how certain of their beliefs  $G$  was. Participants were explicitly told that all traits (other than trust) of each coloured agent were the same in all blocks with that same character. We set the entropy of  $G$ 's prior  $p(\beta_G)$  by passing it through a softmax with inverse temperature parameter  $\tau^{-1}$  to lead  $G$  to be *uncertain* with  $\tau_u^{-1} = 1$ , *certain* with  $\tau_c^{-1} = 10$  and *immutable* with  $\tau_i^{-1} = 100$ . The latter being an extreme case where  $G$  simply never updated their beliefs irrespective of  $B$ 's actions. To test *hypothesis 3*, we added an additional block where  $G$  was absent: that is where they will be not observe  $B$ 's actions at all. The game was organised in weeks, whereby participants were told that they would visit  $G$  on some business day of the week and that  $G$ 's mental states

would be reset each weekend. This way, we could change  $G$ 's beliefs between weeks and test the different combinations of conditions. Furthermore, having participants interact with  $G$  for more than a week was a way to train them on  $G$ 's certainty level, i.e. entropy of their prior.

**Participants** We recruited 99 British and American participants (51 male, 45 female, 2 non-binary, and 1 preferred not to say) aged  $34 \pm 13$  from Prolific. The task lasted about 30 minutes and participants were paid a £4.5 flat fee for taking part in the study. We did not provide any bonus to let people intuitively weigh each choice. To control for inattentive participants, we positioned attention checks before randomly chosen trials. We excluded one participant for failing more than three attention checks.

**Procedure** Following a consent form, participants were explicitly told that all their judgments should be intuitive and that their payment would not be affected by their decisions. They then followed an introduction to the game and the characters, going through the materials described above. To check their understanding, they had to complete a validation quiz before being able to proceed. The experiment was split in two parts. Part 1 involved visiting  $G$  every business day and was comprised of 10 blocks of 5 trials. Each block had participant interact with a different version of  $G$  corresponding to a certainty and trust level pair. For instance, if *uncertain* was associated with the green character and the letter, then in the *uncertain - low trust* block, a participant would be asked by a green character with an initially unhappy face to deliver their letter. Critically, after every trial within each week, participants saw how their path choice affected  $G$ 's state of mind, whether the item was delivered and the boss' reaction, allowing them to learn and plan subsequent decisions. Part 2 repeated the certainty-trust pairs of part one but only for a single day and had thus 10 blocks each with a single trial. Instead of displaying  $G$ 's updated state, we asked participants to predict how they thought their actions would change  $G$ 's state of mind. Following these, participants were asked to report how much they weighed being on time, and how much they valued pleasing  $G$ . They also provided a brief qualitative summary of how they approached situations given  $G$ 's initial state. Finally, participants completed a brief demographics questionnaire.

## Results

For all analyses below, we focused on the 10 blocks in part 2, which were one-shot judgements about which path to take under different certainty and trust conditions. The data, analyses scripts and modelling outputs for Stan can be found here: [https://github.com/Vbtresh/taking\\_for\\_granted](https://github.com/Vbtresh/taking_for_granted)

### Behavioural results

To establish whether the choice of path, i.e. how happy will  $B$ 's boss be, depended on the trust level of agent  $G$  and on their certainty level, i.e. how likely they are to change their mind, we run a mixed-effect regression predicting how

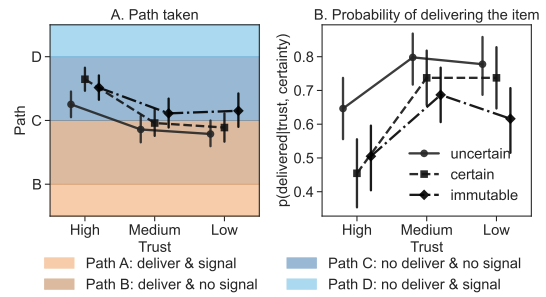
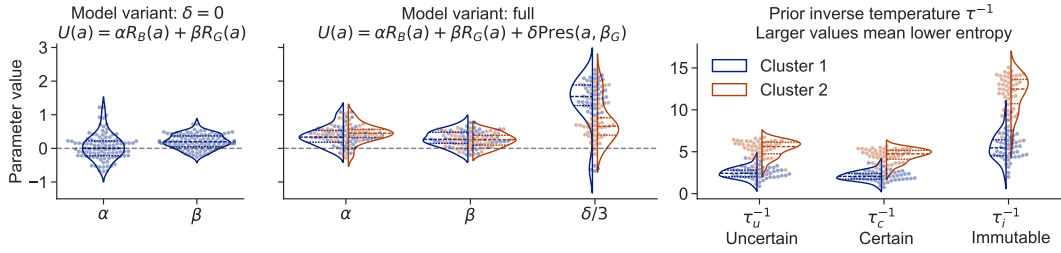


Figure 2: Path taken (A.) and probability of delivering the item (B.) given trust and certainty levels. Error bars are 95% confidence intervals.

late participants were to work and consequently how angry their boss was from the character's trust and certainty levels (Singmann et al., 2024) (see Figure 2). The reaction of the boss was measured on a scale 1 to 4, corresponding respectively to the shortest and longest paths. The trust of  $G$  had three levels: *high*, *medium* and *low*. Finally, certainty also had three levels: *uncertain*, *certain* and *immutable* corresponding in the task to the different character colours. We find a fixed effect of certainty ( $F(2, 104.81) = 7.09, p < .01$ ) and trust ( $F(2, 102.41) = 20.1, p < .001$ ) but no significant interaction. Trials where trust was *high* ( $\mu = 2.53 \pm .08$ ) had participants be significantly more timely than those where trust was *medium* ( $\mu = 3.02 \pm .08$ ),  $t(98) = -6.04, p < .001$ , or those when it was *low* ( $\mu = 3.06 \pm .08$ ),  $t(98) = -5.0, p < .001$ . In accordance with *Hypothesis 1*, this suggests that participants were more likely to favour their boss's reaction and be on time at work when characters already felt positively about them. Along the certainty dimension, we observe a significant difference between trials with the *uncertain* character ( $\mu = 3.03 \pm .07$ ) versus those with the *certain* ( $\mu = 2.84 \pm .07$ ),  $t(98) = 2.7, p = .022$  or the *immutable* ( $\mu = 2.74 \pm .07$ ),  $t(98) = 3.58, p < .001$  characters. Consistent with *Hypothesis 2*, this suggests that when the character was less likely to change their mind, participants tended to focus more on arriving early to please their boss.

We further wish to establish when participants were more likely to not deliver the item, i.e. taking advantage of the trust and certainty of  $G$  to not fulfil their request. We ran another mixed effect model, predicting the likelihood of actually delivering the item from the same predictors. We find a similar pattern of results with a stronger fixed effect of certainty ( $F(2, 98) = 19.93, p < .001$ ) and of trust ( $F(2, 98) = 27.7, p < .001$ ) with no significant interaction. The probability to deliver the item went from an estimated 79% with the *uncertain* down to 69% with the *certain* character ( $z = 2.784, p = .015$ ) and 63% with the *immutable* character ( $z = 4.1, p < .001$ ). This suggests that *uncertain* characters, those with a fluctuating mood, were more likely to get their item delivered than the other two. For trust, the probability of delivering the item went from an estimated 50% for the *high trust* trials up to 79% for *neutral* ( $z = -5.8, p < .001$ )

### A. Distribution of parameter estimates



### B. Cumulative frequencies of selecting each path in each condition for participants and model variants

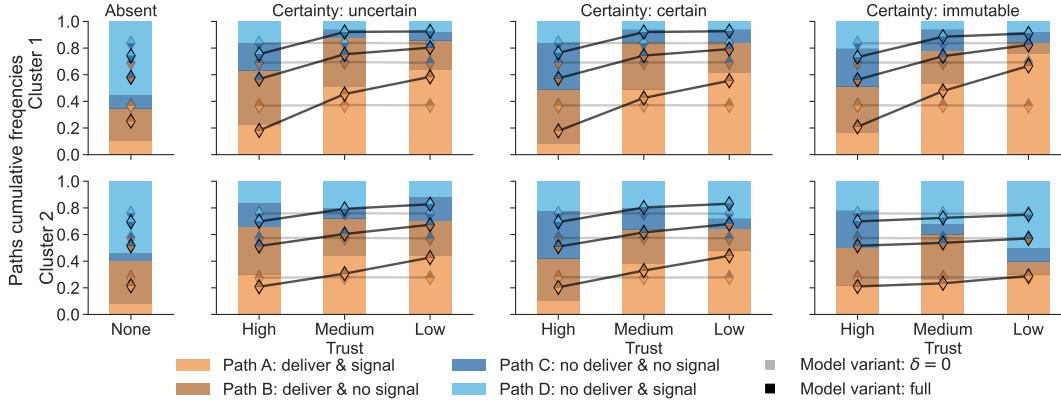


Figure 3: **A.** Distribution of parameter estimates for the  $\delta = 0$  and full models for each recovered cluster.  $\delta$  has been rescaled to be in a comparable unit to  $\alpha$  and  $\beta$  as its unit in KL divergence made the estimates much larger. The last plot provides the inverse temperatures controlling the entropy of the prior over the character’s beliefs. Larger values mean lower entropy and thus more certainty. **B.** Participants (stacked bars) and model variants (points) cumulative frequencies for each path for each cluster (rows) in all certainties (columns) and all trust conditions (x-axis).

and 77% in the *low* trust trials ( $z = -5.0, p < .001$ ). This shows that when characters were trusting, participants were much less likely to fulfil their request.

Finally, in accordance with *Hypothesis 3* we verified that without the presence of  $G$ , participants were significantly more likely to focus on arriving on time and making their boss happy rather than delivering the item ( $F(2, 98) = 75.23, p < .001$ ). Consistent with [Bicchieri et al. \(2011\)](#), participants were more timely when  $G$  was absent ( $\mu = 1.92 \pm .11$ ) than where they were present ( $\mu = 2.87 \pm .06$ ):  $t(98) = 8.673, p < .001$ .

### Modelling

To provide a more complete account of participants’ behaviour, we fitted variants of the model to the data in the 10 testing blocks using Stan using MCMC. Model variants had two families of parameters. First, the weights of the utility function:  $\alpha$ ,  $\beta$  and  $\delta$  (see Equation 2). Second, a set of in-

verse temperatures controlling the entropy of the estimated prior of the character, i.e. their level of certainty:  $\tau_u^{-1}$ ,  $\tau_c^{-1}$  and  $\tau_i^{-1}$ . For stability, we fitted  $\log \tau^{-1}$ .  $\rho(\beta_G, \tau^{-1})$  was discrete distribution over  $\{-1, 0, 1\}$ , for which the mode was 1 when trust was high, 0 for medium and  $-1$  for low. Each parameter had a group and participant level term which combined linearly. We fit a model with no presentational goals, i.e. one where  $\delta = 0$ , a model with no social goals, i.e.  $\beta = 0$  and a full model with social and presentational goals. An apparent bimodality in the distribution of the parameters for the full model motivated us to use a Gaussian mixture model on parameter values to observe whether we could recover two latent groups of participants. The clusters were evenly distributed with 49 participants in cluster 1 and 50 in cluster 2. Table 1 summarises model fits. We see that the full model performed better overall ( $r^2 = .62$ ). Importantly, across all variants, the model performed much better for participants in cluster 1 ( $r^2 = .76$ ) than cluster 2 ( $r^2 = .22$ ). Figure 3a shows the distribution of parameter estimates for each cluster of participants and Figure 3b shows participants’ judgments and the predictions for variant with no presentational goals and the full model.

Table 1: Model fits for all model variants and per cluster.  $r^2$  were computed from 400 bootstrapped samples

Model	Fit( $r^2$ )	cluster 1	cluster 2
$\delta = 0$	.25	.31	.07
$\beta = 0$	.54	.68	.16
full	<b>.62</b>	<b>.76</b>	<b>.22</b>

We can see from Figure 3b that the presentational  $\delta$  term was necessary for capturing the effect of *trust* on behaviour: only the variant with a non-zero  $\delta$  parameter captures the fact that participants tend to prioritise trusting  $G$  characters less than others. Note that parameter estimates for the full model

show that participants tend to behave as if they had baseline level of pro sociality, i.e.  $\beta > 0$ . We can see evidence of this by the large frequency of path *B*, i.e. the path which delivers the item but does not signal it. Crucially, we can see qualitatively different behaviours between the two clusters.

**Two strategies** Participants in cluster 1, seemed concerned with pleasing the other character ( $\delta = 4.15$ ) and seemed to act as if they had high prior entropy as shown by distribution of the lower inverse temperatures  $\tau^{-1}$  in Figure 3a. Behaviourally, this can be seen from the lack of observable differences between all certainty levels in Figure 3b. We can see that the full model recovers this pattern of behaviour pretty accurately. In contrast, participants in cluster 2 seemed less concerned with pleasing the other character overall ( $\delta = 1.98$ ), and seemed to be more sensitive to certainty of the other character as all  $\tau^{-1}$  tended to be higher than for participants in cluster 1. Behaviourally, we see that when the characters were *uncertain*, their behaviour was consistent with cluster 1. However, for *certain* and *immutable* characters, we see an increase in pursuing self-interest, reaching a maximum with the *immutable* character when their trust was *low*. While the model should theoretically accommodate this pattern, we clearly see a significant decrease in  $r^2$  for cluster 2 (see Table 1) and future work should seek to address this drop.

## Discussion

As predicted, interacting with a trusting character made participants less prosocial. They cared less about making a good impression or granting requests when the other character already held a positive opinion, even if that opinion could change quickly. This highlights how presentational social goals, i.e. focused on others’ beliefs about us rather than intrinsic concern for their well-being, can lead individuals to prioritize personal interests when social and personal goals conflict. Participants exhibited two distinct strategies. Cluster 1 members favoured their own interests more often when they perceived the other person to be trusting, showing little concern for how their actions influenced the other’s opinions. Interestingly, this behaviour seemed to interpolate between intrinsic social goals (valuing others’ rewards regardless of beliefs) and presentational goals (caring about others’ opinions only when they believe they can change them). In contrast, Cluster 2 members acted similarly with trusting characters but were highly sensitive to their ability to influence beliefs. They showed little interest in regaining trust when they believed their efforts would be ineffective, leading to more self-interested behaviour with distrustful, unyielding agents.

**Model extensions and limitations** While we chose to isolate the contribution of other’s beliefs to action selection by choosing a dictator game, the model can easily be extended to other economic games such as the ultimatum or trust game (Aina et al., 2020; Barnby et al., 2025; Oosterbeek, Sloof, & van de Kuilen, 2004). In those, dynamics become more com-

plex but also more realistic in that current changes in the belief states of others can lead to direct consequences on one’s future personal interests. Additionally, we currently do not let agents plan further than one step ahead, which greatly limits their flexibility. Letting agents plan should allow us to model more complex interactions which unfold over time, where short term losses can be weighed against long term gains (T. Chen, Houlihan, Chandra, Tenenbaum, & Saxe, 2024; Houlihan et al., 2023). This study has several limitations which caveat its findings. First, matching trust levels with facial expressions is imprecise: one could easily trust someone while being displeased with them. Second, the learning phase could have encouraged participants to learn a mapping between character features and path chosen, rather than using inverse planning.

## Conclusion

We presented a computational model of how individuals balance material and presentational goals in social interactions. Despite no direct cost on personal gains, participants prioritized others’ beliefs and the impact of their actions on those beliefs. By framing presentational goals, like maintaining trust, as minimizing the divergence between a desired and estimated belief state of the other agent, our model captures complex decision-making patterns, showing people are less likely to signal good intentions when they believe others already trust them. This approach advances understanding of social behaviour and may have potential applications in studying pathologies such as borderline personality disorder, which disrupt belief updating about others (Barnby et al., 2025).

## Appendix

We find expressions for the posterior distributions over  $\beta_G$  given actions  $a$ . Let us consider the following joint posterior:

$$p(\alpha_G, \beta_G | a) \propto p(a | \alpha_G, \beta_G) p(\alpha_G, \beta_G)$$

Using the utility function, note that  $p(a | \alpha_G, \beta_G) = \sigma(U_B(a, \alpha_G, \beta_G))$  (see Equation 1) where the utility of  $B$ ,  $U_B$  is also a function of  $\alpha$  and  $\beta$ . Replacing in Equation 1 yields:

$$\begin{aligned} p(\alpha_G, \beta_G | a) &\propto \sigma(U_B(a, \alpha_G, \beta_G)) p(\alpha_G, \beta_G) \\ &\propto \exp(U_B(a, \alpha_G, \beta_G)) p(\alpha_G, \beta_G) \end{aligned}$$

Taking the natural logarithm on both sides for clarity:

$$\begin{aligned} \log p(\alpha_G, \beta_G | a) &\propto \log \exp(U_B(a, \alpha_G, \beta_G)) + \log p(\alpha_G, \beta_G) \\ &= \alpha_G R_B(a) + \beta_G R_G(a) + \log p(\alpha_G, \beta_G) \end{aligned}$$

The likelihoods for  $\alpha_G$  and  $\beta_G$  are thus conditionally independent given  $a$  and by marginalising their respective priors, we get two separate equations for the posteriors:

$$\begin{aligned} \log p(\alpha_G | a) &\propto \alpha_G R_B(a) + \log p(\alpha_G) \\ \log p(\beta_G | a) &\propto \beta_G R_G(a) + \log p(\beta_G) \end{aligned}$$

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## References

- Aina, C., Battigalli, P., & Gamba, A. (2020). Frustration and anger in the Ultimatum Game: An experiment. *Games and Economic Behavior*, 122, 150–167. doi: 10.1016/j.geb.2020.04.006
- Baker, C. L., Jara-Ettinger, J., Saxe, R., & Tenenbaum, J. B. (2017). Rational quantitative attribution of beliefs, desires and percepts in human mentalizing. *Nature Human Behaviour*, 1(4), 0064. doi: 10.1038/s41562-017-0064
- Baker, C. L., Saxe, R., & Tenenbaum, J. B. (2009). Action understanding as inverse planning. *Cognition*, 113(3), 329–349. doi: 10.1016/j.cognition.2009.07.005
- Barnby, J. M., Nguyen, J., Griem, J., Wloszek, M., Burgess, H., Richards, L., ... Fonagy, P. (2025). Self-other generalisation shapes social interaction and is disrupted in borderline personality disorder. *eLife*, 14. (Publisher: eLife Sciences Publications Limited) doi: 10.7554/eLife.104008.1
- Battigalli, P., & Dufwenberg, M. (2007). Guilt in Games. *American Economic Review*, 97(2), 170–176. doi: 10.1257/aer.97.2.170
- Battigalli, P., & Dufwenberg, M. (2022). Belief-Dependent Motivations and Psychological Game Theory. *Journal of Economic Literature*, 60(3), 833–82. doi: 10.1257/jel.20201378
- Bicchieri, C., Xiao, E., & Muldoon, R. (2011). Trustworthiness is a Social Norm, but Trusting is Not. *Politics, Philosophy and Economics*, 10(2), 170–187. (Publisher: Sage) doi: 10.1177/1470594x10387260
- Camerer, C. F., & Thaler, R. H. (1995). Anomalies: Ultimatum, Dictators and Manners. *Journal of Economic Perspectives*, 9(2), 209–219. doi: 10.1257/jep.9.2.209
- Chandra, K., Chen, T., Li, T.-M., Ragan-Kelley, J., & Tenenbaum, J. (2024). Cooperative Explanation as Rational Communication. In *Proceedings of the Annual Meeting of the Cognitive Science Society* (Vol. 46). doi: 10.31234/osf.io/bmknu
- Chandra, K., Li, T.-M., Tenenbaum, J., & Ragan-Kelley, J. (2023). Acting as Inverse Inverse Planning. (arXiv:2305.16913 [cs]) doi: 10.1145/3588432.3591510
- Chandra, K., Li, T.-M., Tenenbaum, J. B., & Ragan-Kelley, J. (2024). Storytelling as Inverse Inverse Planning. *Topics in Cognitive Science*, 16(1), 54–70. doi: 10.1111/tops.12710
- Chen, A. M., & Saxe, R. (2024). How taking turns communicates desired equality in social relationships. *Proceedings of the Annual Meeting of the Cognitive Science Society*, 46(0).
- Chen, D. L., Schonger, M., & Wickens, C. (2016). oTree—An open-source platform for laboratory, online, and field experiments. *Journal of Behavioral and Experimental Finance*, 9(C), 88–97. (Publisher: Elsevier)
- Chen, T., Houlihan, S. D., Chandra, K., Tenenbaum, J., & Saxe, R. (2024). Intervening on Emotions by Planning Over a Theory of Mind. In *Proceedings of the Annual Meeting of the Cognitive Science Society* (Vol. 46).
- Fehr, E., & Schmidt, K. M. (1999). A Theory of Fairness, Competition, and Cooperation. *The Quarterly Journal of Economics*, 114(3), 817–868. (Publisher: Oxford University Press)
- Gweon, H. (2021). Inferential social learning: cognitive foundations of human social learning and teaching. *Trends in Cognitive Sciences*, 25(10), 896–910. (Publisher: Elsevier) doi: 10.1016/j.tics.2021.07.008
- Ho, M. K., Cushman, F., Littman, M. L., & Austerweil, J. L. (2021). Communication in action: Planning and interpreting communicative demonstrations. *Journal of Experimental Psychology: General*, 150(11), 2246–2272. doi: 10.1037/xge0001035
- Ho, M. K., Saxe, R., & Cushman, F. (2022). Planning with Theory of Mind. *Trends in Cognitive Sciences*, 26(11), 959–971. doi: 10.1016/j.tics.2022.08.003
- Houlihan, S. D., Kleiman-Weiner, M., Hewitt, L. B., Tenenbaum, J. B., & Saxe, R. (2023). Emotion prediction as computation over a generative theory of mind. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, 381(2251), 20220047. doi: 10.1098/rsta.2022.0047
- Hung, M. S., Thomas, A. J., Radkani, S., Tenenbaum, J., & Saxe, R. (2022). Modeling risky food sharing as rational communication about relationships. In *Proceedings of the Annual Meeting of the Cognitive Science Society* (Vol. 44).
- Jara-Ettinger, J., Gweon, H., Schulz, L. E., & Tenenbaum, J. B. (2016). The Naïve Utility Calculus: Computational Principles Underlying Commonsense Psychology. *Trends in Cognitive Sciences*, 20(8), 589–604. doi: 10.1016/j.tics.2016.05.011
- Jordan, J. J., Hoffman, M., Nowak, M. A., & Rand, D. G. (2016). Uncalculating cooperation is used to signal trustworthiness. *Proceedings of the National Academy of Sciences of the United States of America*, 113(31), 8658–8663. doi: 10.1073/pnas.1601280113
- Kim, J. S., Colombatto, C., & Crockett, M. J. (2024). Goal inference in moral narratives. *Cognition*, 251, 105865. doi: 10.1016/j.cognition.2024.105865
- Kleiman-Weiner, M., Shaw, A., & Tenenbaum, J. B. (2017). Constructing Social Preferences From Anticipated Judgments: When Impartial Inequity is Fair and Why? *Proceedings of the Annual Meeting of the Cognitive Science Society*, 46(0).

*Science Society*, 39(0).

- Oey, L. A., Schachner, A., & Vul, E. (2023). Designing and detecting lies by reasoning about other agents. *Journal of Experimental Psychology: General*, 152(2), 346–362. doi: 10.1037/xge0001277
- Oosterbeek, H., Sloof, R., & van de Kuilen, G. (2004). Cultural Differences in Ultimatum Game Experiments: Evidence from a Meta-Analysis. *Experimental Economics*, 7(2), 171–188. doi: 10.1023/B:EXEC.0000026978.14316.74
- Radkani, S., Tenenbaum, J. B., & Saxe, R. (2022). Modeling punishment as a rational communicative social action. In *Proceedings of the Annual Meeting of the Cognitive Science Society* (Vol. 40).
- Saulin, A., Horn, U., Lotze, M., Kaiser, J., & Hein, G. (2022). The neural computation of human prosocial choices in complex motivational states. *NeuroImage*, 247, 118827. doi: 10.1016/j.neuroimage.2021.118827
- Singmann, H., Bolker, B., Westfall, J., Aust, F., Ben-Shachar, M. S., Højsgaard, S., . . . Christensen, R. H. B. (2024). *afex: Analysis of Factorial Experiments*.
- Tejwani, R., Kuo, Y.-L., Shu, T., Katz, B., & Barbu, A. (2022). Social Interactions as Recursive MDPs. In A. Faust, D. Hsu, & G. Neumann (Eds.), *Proceedings of the 5th Conference on Robot Learning* (Vol. 164, pp. 949–958). PMLR.
- Thomas, A. J., Woo, B., Nettle, D., Spelke, E., & Saxe, R. (2022). Early concepts of intimacy: Young humans use saliva sharing to infer close relationships. *Science*, 375(6578), 311–315. doi: 10.1126/science.abh1054
- Ullman, T., Baker, C., Macindoe, O., Evans, O., Goodman, N., & Tenenbaum, J. (2009). Help or Hinder: Bayesian Models of Social Goal Inference. In *Advances in Neural Information Processing Systems* (Vol. 22). Curran Associates, Inc.
- Wu, S. A., Sridhar, S., & Gerstenberg, T. (2023). A computational model of responsibility judgments from counterfactual simulations and intention inferences. In *Proceedings of the Annual Meeting of the Cognitive Science Society* (Vol. 45, pp. 3375–3381).
- Wu, Y. E., & Hong, W. (2022). Neural basis of prosocial behavior. *Trends in Neurosciences*, 45(10), 749–762. doi: 10.1016/j.tins.2022.06.008
- Yoon, E. J., Tessler, M. H., Goodman, N. D., & Frank, M. C. (2020). Polite Speech Emerges From Competing Social Goals. *Open Mind: Discoveries in Cognitive Science*, 4, 71–87. doi: 10.1162/opmi\\_a\\_00035