Motivation for social bonding promotes high-stakes cooperative strategies

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Abstract

That humans belong to a highly social species is hardly debated and it is now well-established that being motivated to form solid social bonds enhances fitness across multiple mammal species. Yet, the proximate mechanisms by which such social motivation promotes success in the human ecological niche are mostly underspecified. Here, we demonstrate across five experiments that social motivation is robustly associated with a targeted increase in the weight granted to cooperation-related cues to produce approach-avoidance decisions. Modeling participants' decisions further revealed that motivation for social bonding results in a high-risk / high-reward cooperative strategy relying on a widening of the cooperation circle to include more powerful partners.

Keywords: social bonding, social motivation, cooperation, face evaluation, trustworthiness, dominance

Main text

While many non-human animals live in groups and interact with conspecifics, *Homo sapiens* are exceptional in the variety of social interactions they pursue (Kaplan, Hooper, & Gurven, 2009). For humans, social interactions are indeed frequent, diverse and rewarding (Chevallier, Kohls, Troiani, Brodkin, & Schultz, 2012; Hayden, Parikh, Deaner, & Platt, 2007; Izuma, Saito, & Sadato, 2008; O'Doherty et al., 2003; Pfeiffer et al., 2014; Rademacher et al., 2010; Ruff & Fehr, 2014). Individuals are biased to seek positive social interactions and maintain social bonds (Chevallier et al., 2016; Jones et al., 2011; A. Lin, Adolphs, & Rangel, 2012; Pizzagalli, Jahn, & O'Shea, 2005; Satow, 1975). There is now a consensus on the fact that the motivation to form social bonds plays a key role in human behaviour and enhances individual fitness (Chevallier et al., 2012; Platt, Seyfarth, & Cheney, 2016; Tomasello, Carpenter, Call, Behne, & Moll, 2005). However, beyond the fitness advantage conferred by successful and stable social bonds (Seyfarth & Cheney, 2011), the mechanisms by which social motivation ultimately promote success in the human ecological niche are still underspecified. In particular, all social interactions are not beneficial and individuals constantly face a trade-off between maximizing the number of cooperative interactions and minimizing exploitation risk. Therefore, motivation for social bonding should not operate indiscriminately but rather shape approach-avoidance decisions to maximize the number of *successful* interactions. According to this hypothesis then, social motivation should enhance responsiveness to cues

that are relevant to assess the success of cooperative interactions. Highly socially motivated individuals should thus grant more importance to cooperation-related signals - such as trustworthiness, than to power-related cues - such as dominance.

In the present paper, we tested this hypothesis by investigating the weight individuals grant to cooperation-related cues during social decision-making. More precisely, based on previous work showing that approach-avoidance decisions can be decomposed into cooperation and power evaluations (McAleer, Todorov, & Belin, 2014; Oosterhof & Todorov, 2008; Sutherland et al., 2013; Todorov, Said, Engell, & Oosterhof, 2008), we compared the weight granted to cooperation-related cues to that granted to power-related cues. Our analysis relied on face evaluations, a major determinant of social interactions (Todorov, Olivola, Dotsch, & Mende-Siedlecki, 2015). Face evaluations indeed predict who participants trust in economic games, who will be elected in political elections and who juries are most likely to condemn to death sentences (Bonnefon, Hopfensitz, & De Neys, 2013; Todorov, Mandisodza, Goren, & Hall, 2005; J. P. Wilson & Rule, 2015). Importantly, studies on face evaluations have shown that the weight granted to cooperation- and power-related cues, i.e. trustworthiness and dominance cues, varies across social contexts, which suggests that people adjust their social decisions flexibly according to the relevance of these cues. For instance, leader preferences are more driven by dominance in war-time, when physical strength is important, than in peace-time (Little, Burriss, Jones,

& Roberts, 2007; Spisak, Homan, Grabo, & Van Vugt, 2012). Going one step further, we hypothesized that this flexibility also operates across individuals and that motivation for social bonding is associated with an increase in the importance granted to trustworthiness to produce social decisions.

To test the hypothesis that the motivation to form social bonds is associated with a higher weight granted to cooperation-related cues, we first examined participants' reliance on cooperation- and power-related cues to produce judgments of threat, which are key to produce avoidance decisions. More precisely, we asked 60 participants to rate 40 faces on threat, trustworthiness and dominance (Figure 1A). We reconstructed their two-dimensional threat space, by modelling threat evaluations as a function of perceived dominance and perceived trustworthiness. Following the analysis plan used in Todorov et al.'s paper (2011), our model of threat evaluations included linear, quadratic and interaction effects of perceived trustworthiness and perceived dominance.

Material and methods - Social evaluations studies

All the presented studies received ethics approval from the local ethics committee and each participant received a description of the study and signed an informed consent before starting the experiment.

Experimental Procedure

Following Oosterhof and Todorov's methodology, the questions bearing on

the three traits of interest, trustworthiness, dominance and approachability (i.e., threat or likeability depending on the study), were presented in different blocks simultaneously with the face. Participants had to answer: “How [trait] is this person?” using a cursor on a 9-point scale ranging from 1 “not at all [trait]” to 9 “extremely [trait]” (recoded from -1 to +1 for the analyses). Depending on the block, [trait] was replaced with “trustworthy”, “dominant” or ‘threatening’/‘likeable’. Participants were instructed to answer following their first impression and they were told that there was no right or wrong answer. The cursor was initially set to the middle in order to reinforce the salience of the positive and the negative sides of the scale. If the participant wanted to select the middle of the scale, she still had to click on the scale to generate a valid response. The name of the dimension was displayed in each trial. At the end of the experiment, participants completed the Social Anhedonia Scale (Assouly-Besse, Dollfus, & Petit, 1995; Chapman, Chapman, & Raulin, 1976), a 40-item self-report questionnaire measuring lack of pleasure during social interactions The Social Anhedonia Scale has been widely used and is considered an adequate tool to measure individual differences in the motivation to form social bonds in the general population (Berthoz, Lalanne, Crane, & Hill, 2013; Chevallier et al., 2012).

We conducted this experiment three times: once online on ‘threat’ evaluations, once in the lab on ‘threat’ evaluations and once online on ‘likeability’ evaluations. The internal consistency of the Social Anhedonia Questionnaire was high for all the three studies (all αs > .81; Santos, 1999).

The entire procedure lasted approximately 20 minutes.

The online experiments were programmed on Qualtrics (http://www.qualtrics.com) and the experiment ran in the lab was programmed on ePrime (Psychology Software Tools, 2002). In the first threat evaluation experiment, participants rated 40 faces (20 woman faces) from the Karolinska database. 80 faces generated with FaceGen 3.1 replaced these photographs in the threat replication experiment. The number of faces was doubled in this experiment to obtain the same total number of trials as in the original threat evaluation experiment. 20 maximally distinct source identities were randomly selected from the face database available on Todorov's website (http://tlab.princeton.edu). Four variations of each identity were used: extremely dominant, extremely submissive, extremely trustworthy and extremely untrustworthy. Because we took advantage of an ongoing study, a memorization task using the same faces preceded this last evaluation experiment. Finally, 40 faces varying parametrically in dominance and trustworthiness generated using FaceGen 3.1 were used in the likeability evaluations experiment. Previous work has demonstrated that these faces elicit dominance and trustworthiness judgments both at the explicit and the implicit level (Stewart et al., 2012; Todorov, Dotsch, Porter, Oosterhof, & Falvello, 2013).

Analyses

To investigate the impact of social motivation on the composition of threat/likeability judgments, we ran a mixed linear regression on threat/likeability evaluations, taking social motivation, ratings of dominance and ratings of trustworthiness as predictors and participants' ID as a random factor. Following Todorov et al. (2011), this model included linear and quadratic interaction effects of perceived trustworthiness and perceived dominance as well as interaction terms between these two factors. The p-values reported for the social motivation effects are exact p-values were obtained via a permutation test ran over 1000 random reassignments of the motivation for social bonding scores. Finally, the three-way interaction between social motivation, trustworthiness and dominance was meta-analysed across the three studies using a fixed effect model (Berkey, Hoaglin, Mosteller, & Colditz, 1995).

Finally, as a post-hoc analysis, we estimated the influence of social motivation on the proportion of trustworthy faces rated as approachable (likeable or not threatening) using the parameter estimates of the meta-analytic model (Table S1). To take into account the uncertainty of the coefficients estimates, for each participant, the proportion of trustworthy faces rated as approachable was computed using coefficients randomly drawn from normal distributions around the model's coefficients estimates, with deviations equal to the coefficients estimates' standard deviations. The impact of social motivation on the proportion of trustworthy faces rated as approachable was then assessed using a beta regression. Because this simulation method may

produce different results depending on the coefficients used for computing the probabilities, we repeated this procedure 100 times to ensure that our overall results would not be influenced by the characteristics of each simulation. We averaged the results of the beta regressions (the impact of social motivation on the proportion of faces rated as approachable and the associated z statistic) across the 100 simulations.

Participants

Threat Evaluation Original Study: 60 American participants (28 women), aged 23 to 65 years old (34.92± 2.57 years), were recruited via Amazon Mechanical Turk (MTurk, http://www.mturk.com), which offers a large diversity of participants (Buhrmester, Kwang, & Gosling, 2011; Medin, Ojalehto, Marin, & Bang, 2017). The number of participants was fixed *a priori* based on our past experience with online and social cognition experiments. Each participant received 2$ for completing the 20-minute task (which corresponds to the prorated average 6$/hour compensation commonly used on MTurk). Reaction times inferior to 200 ms were discarded for not reflecting a complete processing of the faces (percentage of excluded trials: 0.58%; mean reaction time before data cleaning: 4.62 ± 0.46 s). Analyses were performed on at least 75% of the faces for all the participants. Finally, the motivation for social bonding scores were scaled between -1 and +1.

Threat Evaluation Replication Study: 30 French participants (18 women), aged 18 to 35 years old (25.43 ± 0.10 years) were recruited via an ad posted on a university mailing list. The number of participants was reduced for this study because of material constraints. Participants received 10€ for completing this study, which is the standard payment for studies conducted at the École Normale Supérieure. As in the original study, trials with a reaction time inferior to 200 ms were discarded (percentage of excluded trials: 0.01%; mean reaction time before data cleaning: 4.6 ± 0.59s). After data cleaning, all participants had analysable responses on at least 99% of the faces. Following the same procedure as for the original study, the motivation for social bonding scores were scaled between -1 and +1.

Likeability Evaluation Study: The number of subjects for this experiment was fixed *a priori* to 60, based on the online threat evaluations experiment. 60 American participants (25 women), aged 19 to 66 years old (34.52 ± 2.63 years), participated in this online study via Amazon Mechanical Turk. Each participant received 2$ for completing the 20-minute task. As in the threat evaluation studies, reaction times below 200 ms were discarded (percentage of excluded trials: 0.54%; mean reaction time before data cleaning: 5.05 ± 0.71 s). After data cleaning, all participants had analysable responses on at least 92% of the faces. As in the previous studies, the motivation for social bonding scores were scaled between -1 and +1.

Results - Social evaluations studies

As can be seen in Figure 1B, faces perceived as less trustworthy and more dominant were rated as more threatening (b_T = -0.35 ± 0.05, t (2316) = -15.25, p <.001; b_D = 0.35 ± 0.04, t (2316) = 17.32, p <.001; Figure 1B). In addition, a quadratic effect of dominance indicated that threat evaluations were more sensitive to higher than to lower levels of dominance ($b_{D\text{^}2}$ = 0.21 ± 0.07, t (2316) = 6.18, p <.001 =.024).

In line with our hypothesis, highly socially motivated participants granted more importance to perceived trustworthiness, but only to evaluate faces perceived as dominant ($b_{T*D*SocMot}$ = -0.17 ± 0.11, t (2316) = -2.97, p =.042; no other significant effect of social motivation was found: all ps >.119; Figure 1B). This result thus confirms and refines the hypothesized effect of the motivation for social bonding on approach-avoidance behaviour by revealing that the association between higher levels of social motivation and a higher weight granted to cooperation-related cues might be specific to the evaluation of powerful individuals.

We tested the robustness of this finding in two ways (2015). Firstly, by replicating the same experiment on 30 participants tested in the lab using avatar faces varying in dominance and trustworthiness, and then by extending this result to the opposite end of the approach-avoidance continuum through the investigation of likeability evaluations (60 participants).

As expected, the association between the motivation to form social bonds and an increased weight granted to trustworthiness to evaluate

dominant faces was confirmed in the experiment on threat evaluation conducted in lab ($b_{T*D*SocMot}$ = -0.31 ± 0.14, t (2359) = -4.26, p =.006). The reconstruction of the two-dimensional likeability space replicated the general approach-avoidance pattern found in the threat evaluation studies, with more trustworthy and less dominant faces perceived as more likeable (b_T = 0.38 ± 0.03, t (2317) = 21.87, p <.001 ; b_D = -0.34 ± 0.03, t (2317) = -22.22, p <.001) and likeability ratings being more sensitive to higher than to lower levels of dominance (b_{D^2} = -0.15 ± 0.08, t (2317) = -5.40, p <.001; Figure 1C). Even more importantly, the effect of the motivation for social bonding on the combination of perceived trustworthiness and perceived dominance was also evidenced in likeability evaluations ($b_{T*D*SocMot}$ = 0.19 ± 0.09, t (2317) = 3.93, p <.001; Figure 1C). Finally, a meta-analysis conducted on all three social evaluation experiments further confirmed the association between high levels of social motivation and a higher weight granted to trustworthiness for the evaluation of dominant faces ($b_{T*D*SocMot}$ = -0.21 ± 0.07, z = 6.33, p <.001).

In order to better understand the functional consequences of these weighting differences on approach-avoidance behaviour, we ran post-hoc analyses on the predictions of the meta-analytic model. We found that social motivation was associated with an increase in the range of trustworthy faces rated as approachable (b_{SocMot} = 0.78 ± 0.15, z = 10.12, p <.001), which was driven by a higher propensity to approach dominant and trustworthy individuals (b_{SocMot} = 0.95 ± 0.17, z = 11.01, p <.001; all the predicted

proportions of submissive and trustworthy faces rated as approachable were equal to one, model p-value: $p > .250$; Figure 1C).

To further examine these functional consequences, we directly measured participants' preference for dominant and trustworthy faces. To do so, we asked two independent samples of 60 and 200 participants to choose their preferred face in pairs of avatars parametrically varying in dominance and trustworthiness (Todorov et al., 2013) (Figure 1D). Using a logistic regression on participants' responses, we modelled the probability of choosing a more trustworthy and more dominant face over a more untrustworthy and more submissive one (McFadden, 1980; Safra et al., 2017).

Material and Methods - Social preferences studies

Experimental Procedure

The social preference experiments were programmed on Qualtrics. Avatar faces varying parametrically in dominance and trustworthiness similar to those used in the likeability evaluations studies were used for these experiments. 16 avatar faces corresponding to all the possible combinations of dominance and trustworthiness in a range of -3 to +3 points with an increment of 2 points were used in the original experiment ($N = 60$). The faces were regularly spaced on both the dominance and the trustworthiness dimensions. In each presented pair, the faces were 2 to 6 points different from each other on at least one dimension. This resulted in 120 pairs of faces. In the replication study ($N = 200$), only 8 avatar faces were used, corresponding

265 to all the possible combinations of dominance and trustworthiness in a range
266 of -2 to +2 points with an increment of 2 points, resulting in a total of 36 pairs
267 of faces.

268 Each trial began with a central fixation cross presented for 300 ms,
269 then the two faces were presented simultaneously. Participants had to select
270 their preferred face and had up to 2 seconds to answer by pressing “e” for the
271 face on the right and “p” for the face on the left (Figure 1D). Each trial was
272 followed by a blank page presented for about 500 ms. If they failed to answer
273 within 2 seconds, the next trial was automatically presented. All the possible
274 pairs of faces were presented in a random order. The presentation position
275 (right or left) of the faces was randomized between participants. In the original
276 experiment (N = 60), the trials were separated into three blocks of 40 trials
277 each.

278 As in the social evaluation studies, participants completed the Social
279 Anhedonia Scale (Chapman et al., 1976) at the end of the experiment (high
280 internal consistency: original study: α = .94; replication study: α = .94(Santos,
281 1999)).

282

283 *Analyses*

284 As recommended by McFadden (McFadden, 1980), choices were analysed
285 using a mixed logit logistic regression, taking subject ID, trial number and face
286 position as random factors. As each combination of dominance and
287 trustworthiness was presented only once, no quadratic effect of

trustworthiness and dominance and no interaction between trustworthiness and dominance was added to this model, such that the probability of choosing one face in a pair was equal to 1 minus the probability to choose the other face of the pair. Levels of trustworthiness and dominance as well as participants' social motivation were used as regressors in the logistic model (Table S2).

Based on these coefficients, we estimated the probability of choosing a more trustworthy but more dominant face for each level of social motivation (Long, 2009). As for the estimation of the proportion of trustworthy faces rated as approachable, we ran 100 simulations using, for each participant, coefficients randomly drawn from normal distributions around the model's coefficients estimates, with deviations equal to the coefficients estimates' standard deviations. For each simulation, the effect of social motivation on choice probability was assessed using a beta-regression. The presented results correspond to the coefficient estimate and the associated z-value averaged across the 100 simulations. Finally, a meta-analysis on the association between the motivation to form social bonds and the probability of choosing the more dominant and more trustworthy face was conducted using a weighted z test using squared roots of sample sizes as weights (Zaykin, 2011).

Participants

Original Study: 60 American participants (28 women) aged 19 to 67 years old

311 (31.80 ± 2.49 years), were recruited via Amazon Mechanical Turk. Each
312 participant received 2$ for completing the 20-minute task.
313 Two participants were removed from the analyses for pressing the same key
314 in more than 90% of the trials. As previously, reaction times below 200 ms
315 were discarded (percentage of excluded trials: 18.18%; mean reaction time of
316 the included participants before filtering: 1.07 ± 0.84 s; mean percentage of
317 analysed trials for the analysed participants: 83%). The analyses were
318 performed on 58 participants. Finally, the motivation for social bonding scores
319 were scaled to range between -1 and +1.
320
321 Replication Study: 200 American participants (95 women), aged 19 to 68
322 years old (34.27± 1.51 years), were recruited using Amazon Mechanical Turk.
323 This sample size was defined based on previous work on the stability of
324 behavioural differences associated with personality traits (Schönbrodt &
325 Perugini, 2013). Participants received 1.5$ for completing the 5-minute task.
326 Four participants were removed from the analyses for suspicion of
327 having already completed the original preference study based on their IP
328 address. Nine participants were removed from the analyses for pressing the
329 same key more than 90% of the trials. As in the original study, reaction times
330 were filtered to leave out reaction times shorter than 200 ms (percentage of
331 excluded trials: 18.03%; mean RT before filtering: 1.05 ± 0.39s) and the
332 motivation for social bonding scores were scaled to range between -1 and +1.
333 The analyses were performed on 187 participants.

334

335 **Results - Social preferences studies**

336 The first social preferences experiment (N = 60) confirmed that highly
337 socially motivated participants had a higher probability of preferring a more
338 dominant and more trustworthy face to a less dominant and less trustworthy
339 face (b_{SocMot} = 0.01 ± 0.01, z = 2.67, p =.001; Figure 1E). Motivation for social
340 bonding was also associated with a higher probability of preferring the more
341 trustworthy and more dominant face in the replication study conducted on a
342 larger sample (b_{SocMot} = 0.01 ± 0.01, z = 3.28, p <.001; N = 200) as well as in
343 the meta-analysis conducted on these two experiments (b_{SocMot} = 0.01 ± 0.01,
344 z = 4.11, p <.001; Figure 1E-F).

345

346 **Discussion**

347 Across five studies, we confirmed that motivation for social bonding is
348 associated with a higher weight granted to cooperation-related cues, i.e.,
349 trustworthiness cues, during social-decision making. Our results thus provide
350 support for the idea that social motivation is associated with specific
351 behavioural differences that favour successful cooperative interactions
352 (Chevallier et al., 2012).

353 Importantly, this weighting difference results in a specific distortion of
354 subjects' approach-avoidance two-dimensional space, such that highly
355 socially motivated participants are more likely to approach partners that are
356 perceived as both dominant and trustworthy. This implies that highly socially

357 motivated individuals are more likely to approach a larger range of trustworthy
358 partners (i.e. both submissive, lowly powerful, and dominant, highly powerful
359 ones). One interpretation of this finding is that in doing so, highly socially
360 motivated individuals maximize the number of successful cooperative
361 activities they engage in and, thereby, their fitness in cooperative
362 environments.

363 However, this widening of the cooperative circle to individuals who are
364 both dominant and trustworthy raises the question of the value of these
365 individuals as cooperative partners. Indeed, interactions with dominant
366 individuals, i.e., physically and socially powerful ones (Buss, 1995; Carmen
367 Emilia Lefevre et al., 2014; Lewis, Lefevre, & Bates, 2012; V. Wilson et al.,
368 2014), are not neutral compared to interactions with less dominant partners.
369 More precisely, interacting with socially powerful individuals can provide
370 immaterial benefits, such as social status (N. Lin, 1999; von Rueden, 2014),
371 and physical power sometimes constitutes an important lever for resource
372 acquisition (Kaufmann, 1983; Stockley & Bro-Jørgensen, 2011; von Rueden,
373 Gurven, & Kaplan, 2010). Crucially however, cooperation with dominant
374 individuals also brings about undeniable risks. For one thing, retaliation
375 against a highly powerful partner is more costly than retaliation against
376 someone who does not hold any power (Carré, McCormick, & Mondloch,
377 2009; Carmen E. Lefevre, Etchells, Howell, Clark, & Penton-Voak, 2014).
378 Importantly, unlike trustworthiness, dominance is not reliably associated with
379 particular cooperative tendencies (Boksem et al., 2013; Eisenegger, Naef,

380 Snozzi, Heinrichs, & Fehr, 2009; Stirrat & Perrett, 2010; van Honk, Montoya,
381 Bos, Vugt, & Terburg, 2012; Wibral, Dohmen, Klingmüller, Weber, & Falk,
382 2012). Therefore, interactions with dominant individuals bear higher stakes,
383 but not lower probabilities of success, than interactions with submissive
384 individuals.

385 The approach behaviour of highly socially motivated individuals
386 towards partners that are perceived as both cooperative and powerful may
387 thus be construed as a high-stake cooperation strategy. Importantly, this
388 strategy may be particularly successful to obtain larger amounts of resources
389 through cooperation. Precise investigations of this hypothesis would help to
390 further understand the adaptive value of the motivation to form social bonds in
391 cooperative environments. In particular, while we used a general measure of
392 motivation for social bonding in the present paper, it would be interesting to
393 tease apart the association between various components of social motivation
394 and social decisions (e.g., social attention, reputation management and social
395 reward responsiveness; Chevallier et al., 2012). In addition, it is worth
396 emphasizing that our results are correlational and that the direction of
397 causality should be clarified. Our assumption has been that increased social
398 motivation impacts approach behaviours but it is theoretically possible that,
399 approaching a larger range of trustworthy individuals enhances individuals'
400 motivation for social bonding. Further experiments investigating the influence
401 of previous social interactions on social motivation are thus needed in order to
402 reliably establish the causal relation between motivation for social bonding

and cooperation strategy.

Finally, and more generally, our results open the path to the analysis of the adaptive value of different social strategies, depending on the reliance on cooperation for resource acquisition in the environment as well as on the level of resources individuals can invest in cooperation. Indeed, while cooperation and cooperative tendencies have often been investigated as a trait (notably by self-reports of trust or economic games with unknown partners (McCullough, Pedersen, Schroder, Tabak, & Carver, 2013; Nettle, Colléony, & Cockerill, 2011; Petersen & Aarøe, 2015)), our results suggest that measuring cooperation strategies through partner choice as a combination of potential stakes, i.e., power-related cues, and probability of success, i.e., cooperation-related cues, can provide new insights into individuals' cooperative strategies.

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Figure

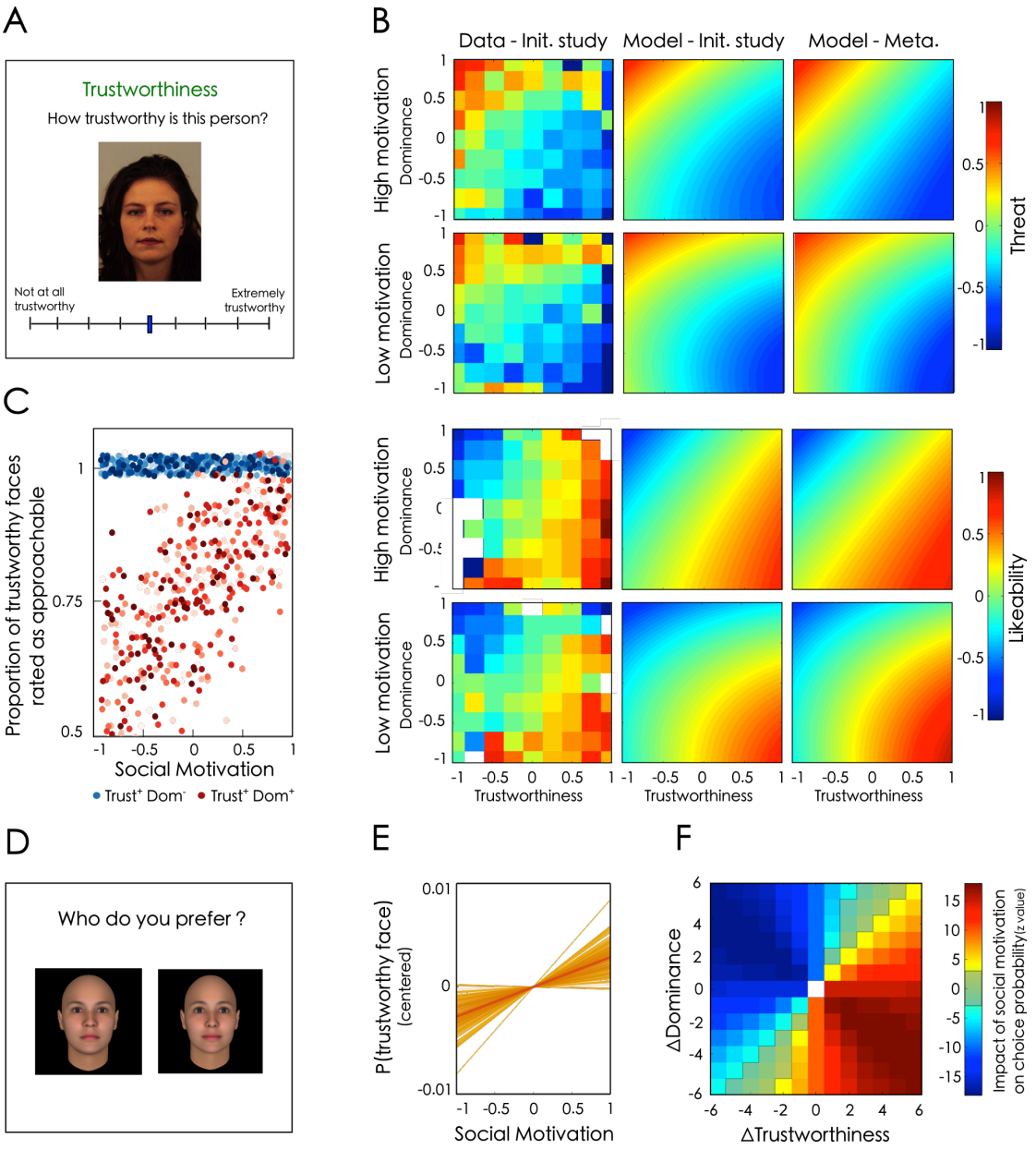

Figure 1 – Motivation for social bonding is associated with an increase in the relative weight granted to trustworthiness during social decisions

(A) Example of an evaluation trial. *Participants had to rate each face by moving a cursor, initially positioned in the middle of the scale.* ***(B) Threat (top) and Likeability ratings (bottom) as a function of trustworthiness (x axis) and dominance ratings (y axis).*** *Rating intensity is represented on a scale ranging from blue for lower ratings to red for higher ratings. Pixelized figures correspond to averaged data in the initial study for the most (upper*

row) and least (lower row) socially motivated participants (median split). Smoothed figures represent the predictions of the regression models obtained in the initial study (Model–Init study) and in the meta-analysis (Model–Meta.). Faces perceived as both dominant and trustworthy were rated as more approachable by highly socially motivated participants. ***(C) Effect of the motivation for social bonding on the evaluation of trustworthy faces.*** *Social motivation was associated with an increase in the proportion of dominant and trustworthy (Trust^{+}Dom*, in red) but not of submissive and trustworthy faces (Trust^{+}Dom^{-}, in blue) perceived as approachable.* ***(D) Example of a preference trial.*** *Both faces appeared simultaneously on the screen. Participants had up to 2 seconds to answer by pressing "e" to select the face on the left and "p" to select the face on the right.* ***(E) Computed probability of choosing a 1-point more trustworthy and 1-point more dominant face as a function of the motivation for social bonding.*** *100 simulations (light lines) revealed that the probability of choosing a more trustworthy but more dominant face increased with social motivation in both the original study and its replication (the bold regression line corresponds to the meta-analysis).* ***(F) Impact of the motivation for social bonding on choice probability for every combination of differences in trustworthiness (x axis) and dominance (y axis) in the meta-analysis.*** *Meta-analytic z values are represented on a scale ranging from blue for negative values to red for positive values. Shaded areas correspond to z-values below the 5% threshold of statistical significance after applying a Bonferroni correction for 169 comparisons. Social motivation is associated with a higher probability of preferring the most dominant and trustworthy faces.*

Supplementary analyses

Cues decoding:

In order to assess whether participants actually computed the presented stimuli, we checked whether their ratings were in accordance to the avatars' levels of trustworthiness and dominance (replication study on threat evaluations and the study on likeability evaluations). To measure participants' ability to decode trustworthiness and dominance cues, we ran mixed linear regressions on trustworthiness and dominance ratings, taking avatars' levels of trustworthiness / dominance as regressors and participants' ID as a random factor. As expected, intensity levels of both trustworthiness and dominance cues were successfully perceived in the two experiments (trustworthiness: all *p*s < .001; dominance: all ps < .001). In addition, highly socially motivated participants did not differ in their ability to detect these cues (meta-analytic effect across the two studies: both *p*s > .250; p-values obtained via a permutation test) and were not biased to rate faces as more trustworthy (meta-analytic effect across the two studies: both *p*s > .250).

Reaction times:

To check that differences in cue combination was not due to differences in cue processing, we measured the influence of social motivation on reaction times in the Preference studies. Reaction times were analysed to assess if social motivation affected the cognitive processes underlying the combination of social cues. This analysis was performed using a mixed linear regressions

on the population-level scaled reaction times, taking as regressors: social motivation, the absolute value of the difference in trustworthiness between the faces of each pair ($|\Delta Trustworthiness| = |\ Trustworthiness_{Left} - Trustworthiness_{Right}\ |$) and the absolute value of the difference in dominance between the faces of each pair ($|\Delta Dominance| = |\ Dominance_{Left} - Dominance_{Right}\ |$). This analysis revealed that social motivation was not associated with any difference in the speed at which social cues are processed (meta-analytic effect across the two studies: all *p*s > .192; p-values obtained via a permutation test), which suggests that the effect of social motivation was circumscribed to the way social cues are used to produce social judgments.

Supplementary figures

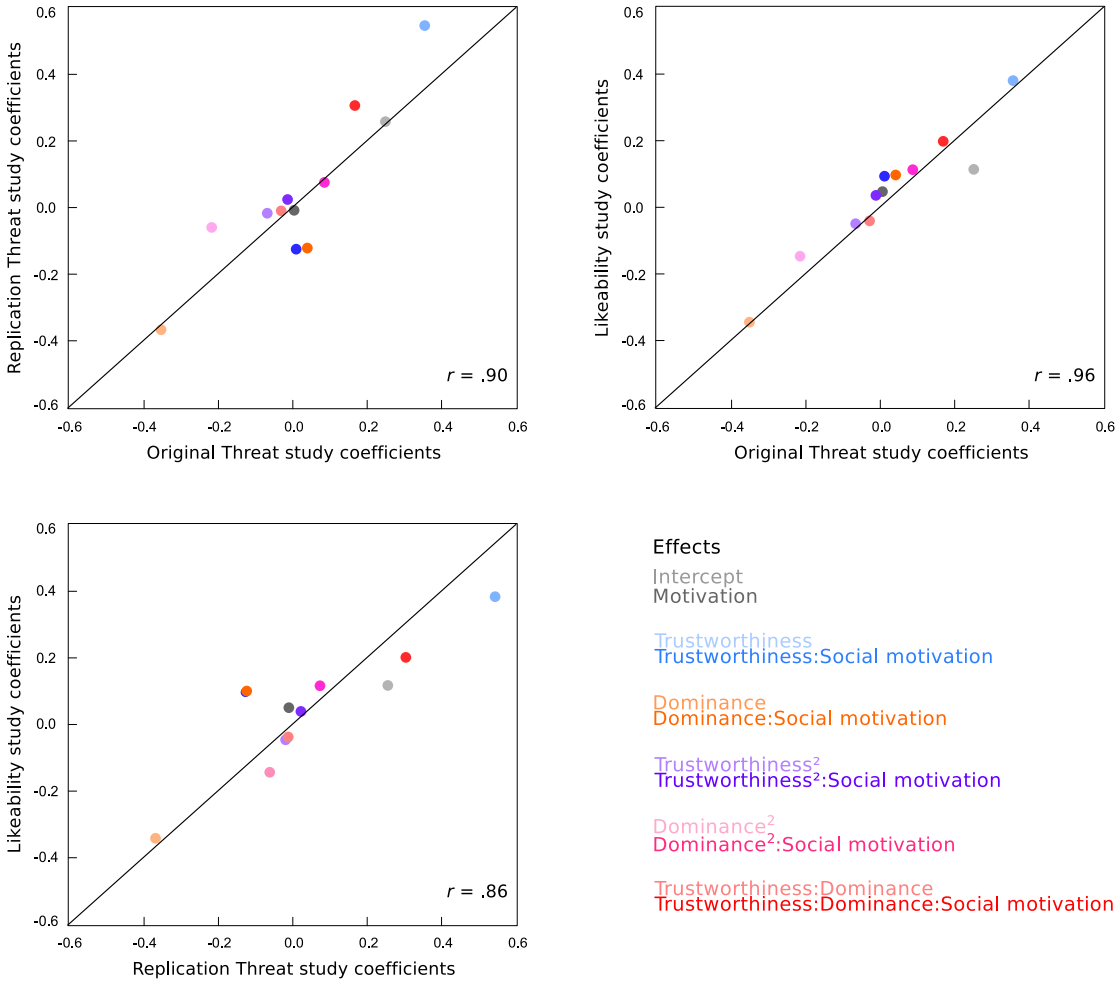

Figure S1 – Replication of the approachability evaluation models

Parameters from the different evaluation studies significantly correlate with each others (threat original – threat replication: r = .90, N = 12, p < .001; threat original - likeability: r = .96, N = 12, p < .001; threat replication – likeability: r = .86, N = 12, p < .001; the black line represents perfect equality between the two studies' coefficients), revealing the robustness of the results.

Supplementary Tables

Table S1 – Meta-analytic value of the coefficient parameters of the approachability evaluations models

Model parameters	**Coefficients estimates**
Intercept	0.20 ± 0.10
Trustworthiness	0.43 ± 0.12
Dominance	-0.35 ± 0.02
Trustworthiness^2	-0.05 ± 0.04
Domininance^2	-0.15 ± 0.08
Social Motivation	0.03 ± 0.06
Trustworthiness:Dominance	-0.03 ± 0.04
Trustworthiness:Social Motivation	-0.01 ± 0.13
Dominance:Social Motivation	0.01 ± 0.13
Trustworthiness^2:Social Motivation	0.02 ± 0.07
Dominance^2:Social Motivation	0.10 ± 0.06
Trustworthiness:Dominance:Social Motivation	0.21 ± 0.07

Meta-analytic value of the regression coefficients and their 95% confidence interval.

Table S2 – Logistic regression coefficients obtained in the preference studies

Parameter	**Original study (*N* = 58)**	**Replication study (*N* = 187)**
Trustworthiness	0.31 ± 0.02	0.38 ± 0.03
Dominance	-0.19 ± 0.02	-0.18 ± 0.03
Trustworthiness:Social motivation	-0.02 ± 0.04	0.05 ± 0.04
Dominance:Social motivation	0.03 ± 0.04	-0.04 ± 0.04

Coefficient estimates of the logistic regressions used to compute the probability of choosing a more dominant and more trustworthy face and their 95% confidence interval.