Supporting Information

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SI Text

SI1. Behavioral experiments of the Beauty Contest game have been widely studied [see e.g., lab experiments (1–3) or newspaper competitions announcing the rules of the game and inviting readers of *Financial Times*, *Die Zeit*, and others to participate (4)]. These studies successfully identify high vs. low level of reasoning according to the chosen numbers at or near 33 (level 1), 22 (level 2), and 0 (equilibrium), the theoretical numbers according to the above discussed process for M = 2/3.

SI2. The finite step of iterated elimination of weakly dominated strategies (Fig. 1*B*) is not a good descriptive model as shown in other studies (1–4). Furthermore, for $M < 1$ only 8% of all numbers were above 50 of which most were chosen by one subject. Only 2 choices out of 120 were 0, the equilibrium reached also by L4 or higher levels. For $M > 1$, numbers below 50 were 28%. 9 choices of 120 were 100, the equilibrium reached also by L2 or higher levels.

SI3. Moreover, there was a significant difference between the high- and low-level reasoners in terms of the numbers of choices classified as level 1 or level 2 (or higher) (for 12 different M-parameters, thus without M = 1, because this case does not distinguish between L1 and L2) in the human condition [Kruskal-Wallis equality-of-populations rank test, Chi (2) = 11.67 d.f. = 1, $P < 0.001$].

SI4. Examples of answers to the questionnaire (translated from French). Low level of reasoning subject ID 1: (*i*) Please comment on your first choice. M = 2/3 in the human condition. "I considered average of 50 and then I multiply 50*2/3, and rounded to the closest integer." (*ii*) Please comment on your choice when M = 1/4 in the computer condition. "Same reasoning, average equal to 50, thus I multiplied 50 by 1/4." (*iii*) Did you have a general rule for the trials in the human condition? "I always used an average of 50 multiplied by the coefficient." (*iv*) Did you have a general rule for the trials in the computer condition? "Same as for the human but with more accurate calculation". High level of reasoning subject ID11: (*i*) "50 multiplied by 2/3 with a reduction to take into account others' responses." (*ii*) "Average of the responses of the computer equal to 50, then I multiplied 50*1/4." (*iii*) "I used the same rule as for the computer, but with a reduction if the coefficient was <1 and an increase if the coefficient was larger than 1." (*iv*) "I considered an average of 50, which I multiplied by the coefficient. Sometimes I tried to take into account my own response." Random player ID 19: (*i*) "I chose a number >50". (*ii*) "I chose a number between 50 and 100: the smaller the coefficient the highest the number I chose." (*iii*) "I was thinking more in general for the human condition than for the computer." (*iv*) "I did not use any rule and I was thinking less than for the human condition."

1. Costa-Gomes M, Crawford VP (2006) Cognition and behavior in two-person guessing games: An experimental study. *Am Econ Rev* 96:1737–1768.
2. Ho T-H, Camerer CF, Weigelt K (1998) Iterated dominance and iterated best response in experimental "p-Beauty contests". *Am Econ Rev* 88:947–969.
3. Nagel R (1995) Unraveling in guessing games: An experimental study. *Am Econ Rev* 85:1313–1326.
4. Bosch-Domenech A, Montalvo JG, Nagel R, Satorra A (2002) One, two, (three), infinity: Newspaper and lab beauty-contest experiments. *Am Econ Rev* 92:1687–1701.

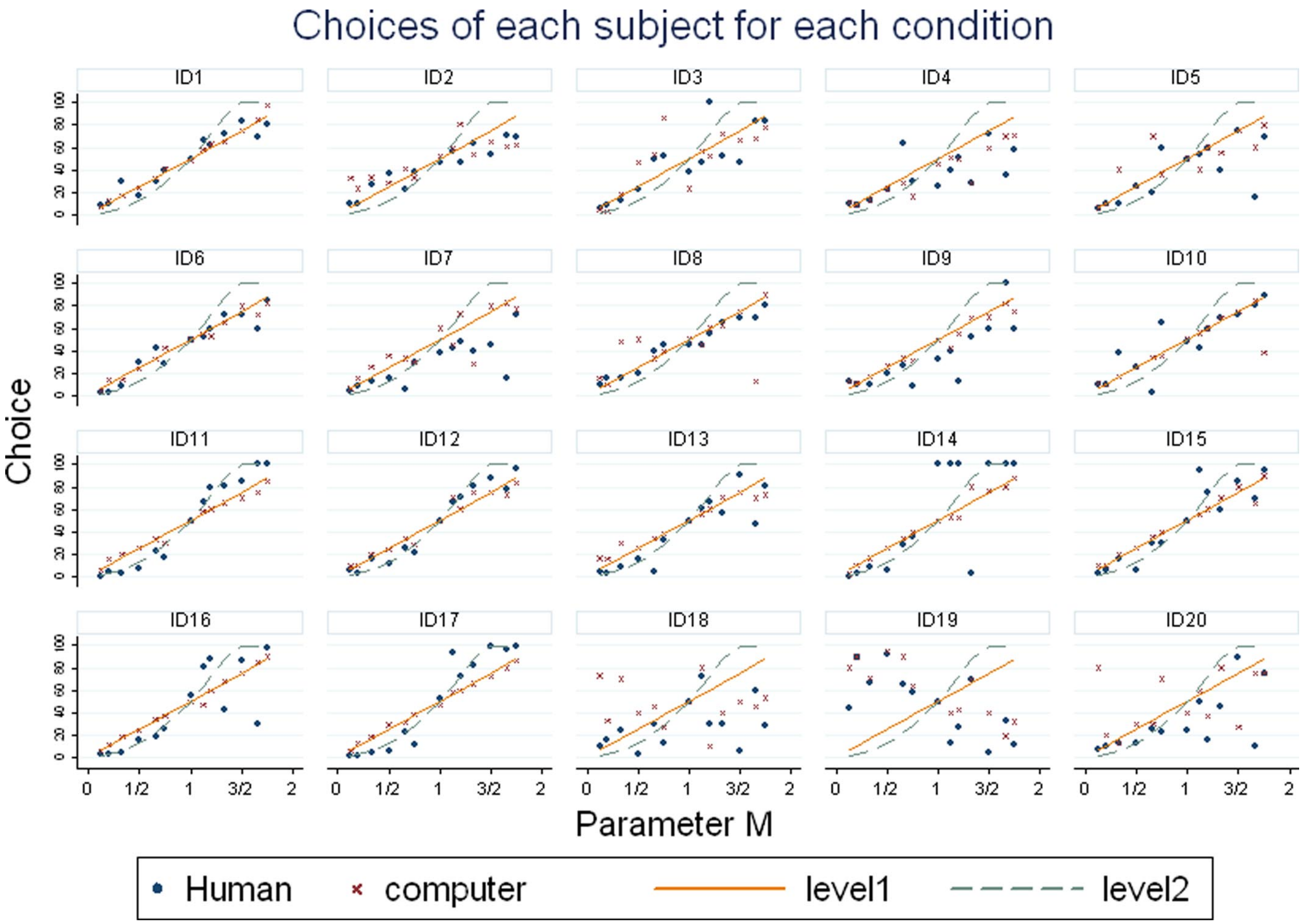


Fig. S1. Individual choice patterns in the beauty contest game, $n = 20$. Here, we present the choices for each parameter value M [M $<$ 1 (1/8, 1/5, 1/3, 1/2, 2/3, 3/4), M $>$ 1 (9/8, 6/5, 4/3, 3/2, 5/3, 7/4), and M = 1] in the human and computer condition, separately. We depict the theoretical (Cognitive Hierarchy Model) level 1 line (brown line with choices equal to 50*M) and the level 2 line (blue line with choices equal to 50*M^2). We classified 10 participants (ID: 1–10) according to level 1 (low level) and 7 (ID: 11–17) to greater than level 1 (high level). Three participants (ID: 18–20) played in a random manner.

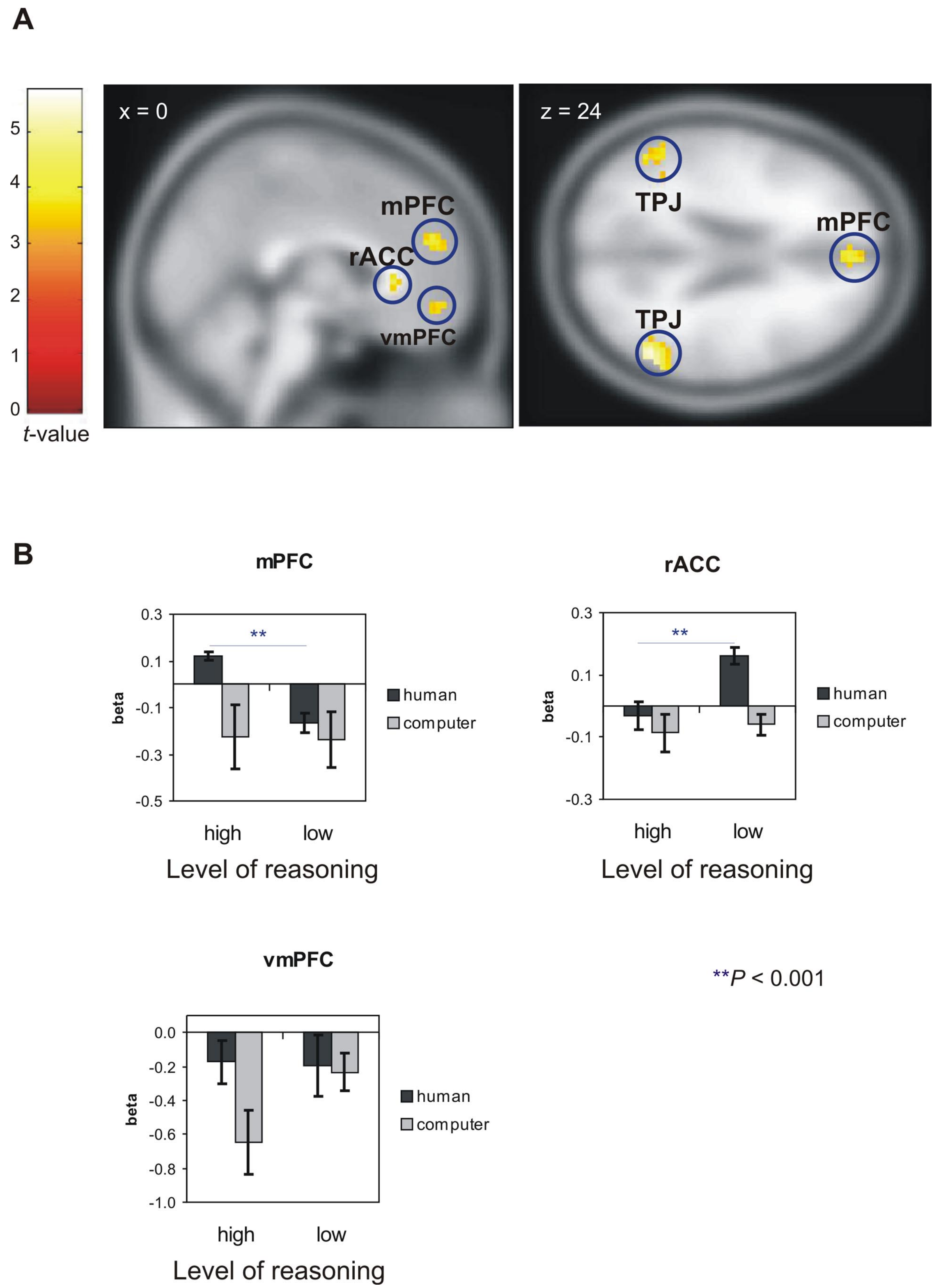


Fig. S2. The mentalizing network. Random effect analysis, $n = 20$ subjects. We found enhanced activity in the dorsal portion of the medial prefrontal cortex [mPFC, (0, 48, 24)], ventral mPFC (relatively less deactivated, 9, 48, −6), rostral anterior cingulate cortex [rACC, (−9, 36, 3)], superior temporal sulcus [STS, (−51, −60, 27)], and bilateral temporo-parietal junction [TPJ, (−51, −60, 21)] and [51, −60, 27]) in the human vs. computer conditions. (*A*) Group data thresholded at $P < 0.001$, uncorrected, is plotted on sagittal and axial sections of a normalized canonical template brain. (*B*) We plot the average parameter estimates (+/− S.E.M.) for relative difference in BOLD activity in the human and computer conditions for high- and low-level reasoning subjects in mPFC (0, 48, 24), rACC (−9, 36, 3) and vmPFC (9, 48, −6).

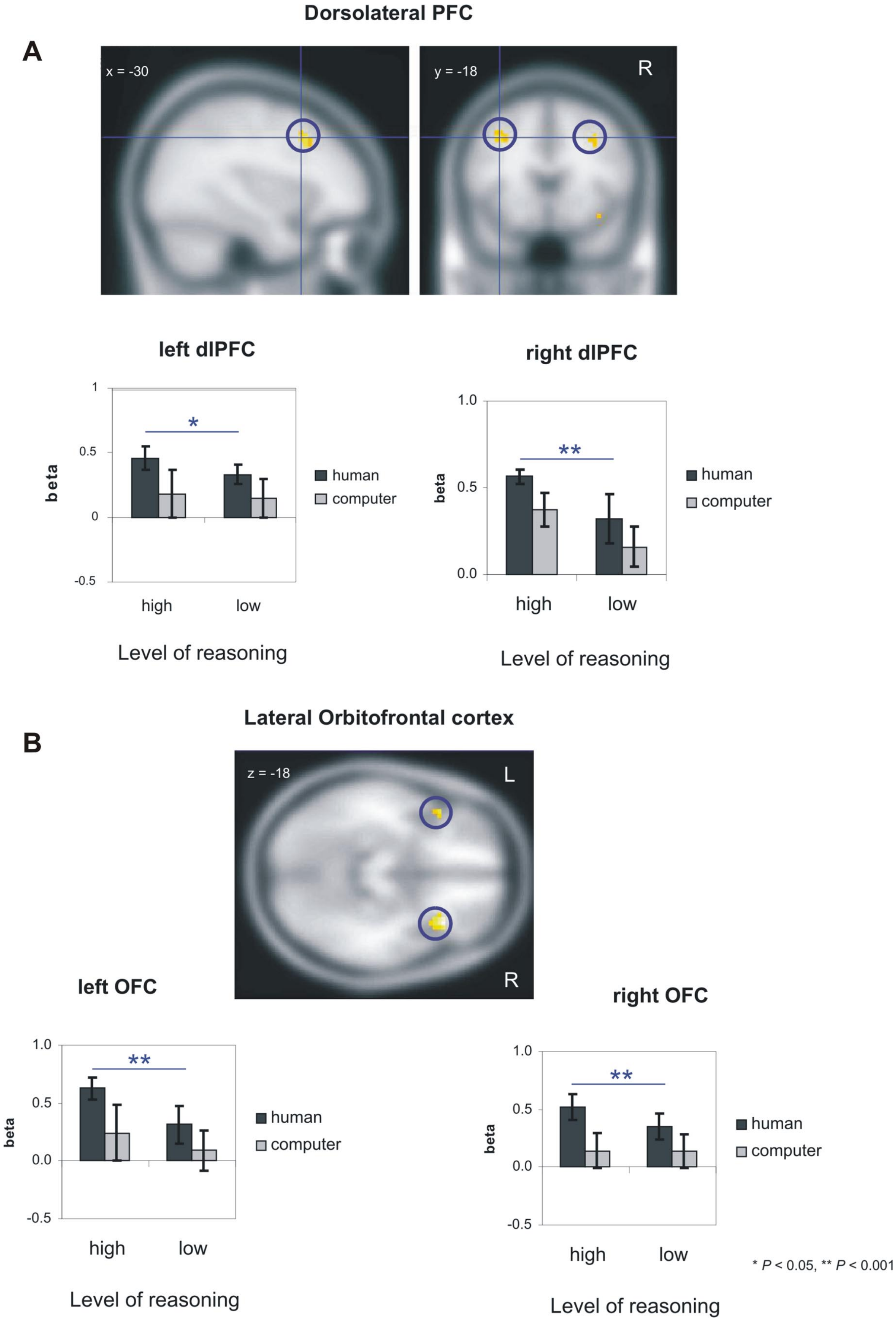


Fig. S3. Activity specific to high-level reasoning subjects. We found enhanced activity in the (*A*) dorsolateral prefrontal cortex [dlPFC; left (−30, 18, 36) and right (33, 15, 42)], and (*B*) caudolateral orbitofrontal cortex [OFC, BA47; left (45, 21, −18) and right (36, 24, −18)] in the human vs. computer conditions. This activity is significant only for the high-level reasoning subjects (see the pattern of the parameter estimates); and in the human condition these areas were significantly more active for high than low reasoners. We plot the average parameter estimates (+/− S.E.M.) for relative difference in BOLD activity in the human and computer conditions for high- and low-level reasoning subjects.

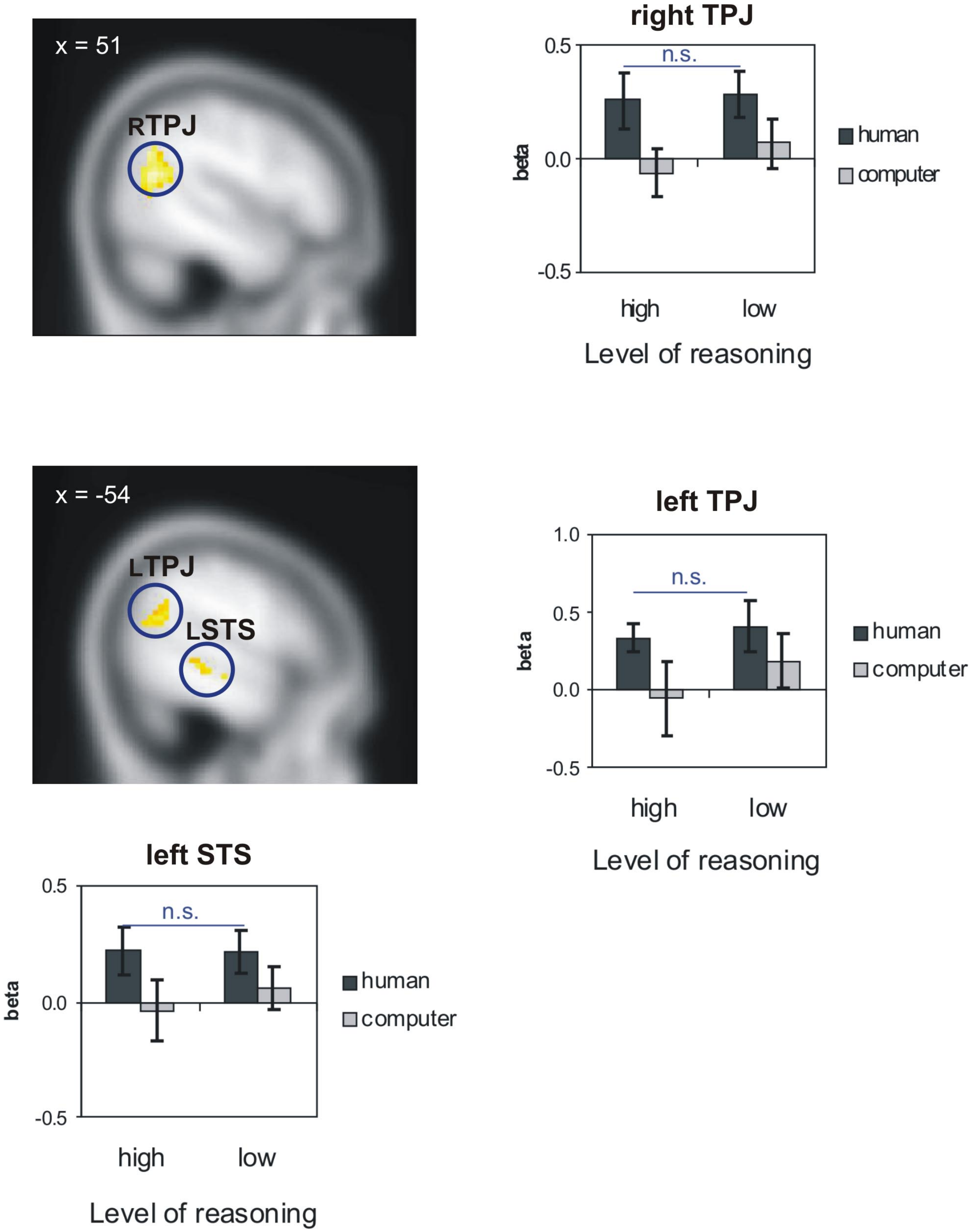
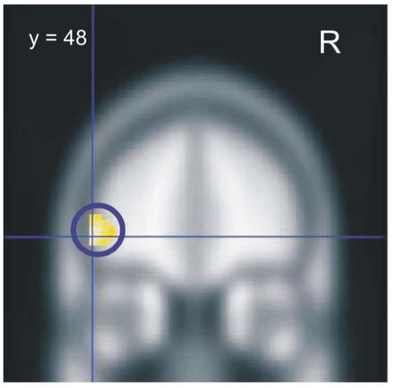


Fig. S4. Patterns of activity related to high and low levels of reasoning. Plot of the average parameter estimates (+/− S.E.M.) for relative difference in BOLD activity in the human and computer conditions for high- and low-level reasoning subjects. The activity of the TPJ [*Left* (−51, −60, 21) and *Right* (51, −60, 27)] and STS (−51, −60, 27) were related to playing against humans independently of the level of reasoning. Random effect analysis, $n = 20$ subjects. Group data thresholded at $P < 0.001$, uncorrected, are plotted on sagittal sections of a normalized canonical template brain.

Frontal activity related to calculation



Calculation task

Fig. S5. Frontal activity related to calculation. Results from our calculation task show enhanced activity in the angular gyrus and inferior parietal lobule when the subjects were requested to mentally multiply a factor times a number (c1 condition), and when they were asked to multiply twice the same factor times a number (c2 condition). Additional activity related to calculation (both c1 and c2 condition) was found in the lateral prefrontal cortex (peak MNI coordinates, $x = -48$, $y = 48$, $z = -3$). Notably, no activity of the medial prefrontal cortex was related to any kind of calculation (as shown in the figure). Random effect analysis, $n = 20$ subjects. Group data thresholded at $P < 0.001$, uncorrected, is plotted on a coronal section of a normalized canonical template brain.

Activity related to the comparison between Human and Computer conditions, N = 20

Location	Side	MNI Coordinates	*z*-score
Dorsal mPFC (BA10/32)	---	0, 48, 24	4.04
Rostral anterior cingulate cortex (BA24)	---	-9, 36, 3	4.56
Ventral mPFC (BA10)	---	9, 48, -6	3.78
Temporo parietal junction	L	-51, -60, 21	4.13
	R	51, -60, 27	5.08
Superior temporal sulcus	L	-51, -18, 12	3.91
Posterior cingulate cortex	---	-12, -42, 27	3.41
Dorsolateral prefrontal cortex	L	-30, 18, 36	4.13
	R	33, 15, 42	3.56
Caudolateral OFC (BA47)	R	36, 24, -18	5.37
	L	-45, 21, -18	4.62

Note: BA indicates Brodmann Area; L = left, R = right; MNI coordinates x, y, z mm