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Supplementary Information for

Neural Mechanisms underlying Pupil Mimicry in Trust Formation

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Behavioral results

Table S1. The effect of partner's pupil on participants' trust

Fixed Factors*	**F**	**Df1**	**Df2**	***p*-value**
Corrected Model	38.00	2	5,933	**0.000**
Pupil Partner	38.00	2	5,213	**0.000**
Random Factors	**Estimate**	**SE**	**Z**	***p*-value**
Variance	2.955	0.055	53.930	**0.000**
Var(intercept)	1.048	0.244	4.288	**0.000**

Table S2: The effect of partner's pupil on participants' pupil size

Fixed Factors	**F**	**Df1**	**Df2**	***p*-value**
Intercept	14.201	11	153,986	**0.000**
Pupil Partner	1.274	2	153,986	0.280
lin	19.504	1	153,986	**0.000**
quadr	82.079	1	153,986	**0.000**
cub	15.234	1	153,986	**0.000**
Pupil Partner * lin	8.276	2	153,986	**0.000**
Pupil Partner * quadr	1.923	2	153,986	0.146
Pupil Partner * cub	15.783	2	153,986	**0.000**

					***p*-value**	**95% Confidence Interval**	
Random Factors	**Res. Eff.**	**Estimat**	**SE**	**Z**		**Lower**	**Upper Bound**
Repeated Measures	AR1 diagonal	0.2̂55	0.004	64.219	0.000	0.247	0.263
	AR1 rho	0.986	0.000	4,316.792	0.000	0.985	0.986
Intercept [subject = ID]	Variance	0.015	0.004	3.906	0.000	0.009	0.0026

Table S3: The effect of partner's pupil on participants' trust

Fixed Factors	**F**	**Df1**	**Df2**	***p*-value**
Intercept	15.229	5	5,750	**0.000**
Pupil Partner	32.00	2	5,750	**0.000**
Mimicry (yes/no)	19,504	1	5,750	0.312
Pupil Partner*Mimicry	6	2	5,750	**0.003**

					p-value	95% Confidence Interval	
Random Factors	**Res. Eff.**	**Estimat**	**SE**	**Z**		**Lower**	**Upper Bound**
Intercept	Variance	2.954	0.056	53.099	0.000	2.847	3.066
Intercept [subject = ID]	Variance	1.038	4.243	4.276	0.000	0.565	1.641
Int. [subject=ID*Run]	Variance	0.0054	0.001	3.297	0.001	0.0029	0.0098

FMRI results

Table S4. Brain regions that show heightened activation for mimicry > no mimicry

Region	BA	Side	Cluster size	x	y	z	Z-Max
1. Occipital pole	18	L	39,834	-6	-92	14	5.32
1. Middle Temporal Cortex	37	L		-58	-54	0	5.14
1. Supramarginal Gyrus (TPJp)	39	L		-54	-44	36	5.13
1. Lateral Occipital Cortex	19	L		-38	-74	26	5.13
1. Occipital pole	18	L		-10	-90	16	5.09
1. Lingual Gyrus	18	L		-8	-76	-6	5.08
2. Angular Gyrus (TPJp)	39	R	1,184	54	-48	32	5.07
2. Middle Temporal Gyrus	22	R		64	-26	-4	4.86
2. Angular Gyrus (TPJp)	39	R		50	-48	28	4.81
2. Angular Gyrus (TPJp)	39	R		56	-48	26	4.75
2. Parietal Operculum (TPJa)	22	R		52	-34	20	4.74
2. Superior Temporal Gyrus (STS)	22	R		48	-30	-2	4.67

*The activation survives whole-brain correction ($P < 0.05$) for multiple comparisons at the cluster level 2.3. (N = 34). Locations coordinates are in stereotactic MNI space with 2x2x2 voxel size. The source of anatomical labels: FSL Atlas tools. Subpeaks of the clusters= Z-score; R= right; L = left; BA = Brodmann area. TPJp = TPJ posterior.

Table S5. Brain regions that show heightened activation for mimicry with constricting pupils

Region	BA	Side	Cluster Size	x	y	z	Z-Max
1. Lateral Occipital Gyrus – V5	19	L	13,971	-36	-82	-10	6.46
1. Precentral Gyrus	4	L		-34	-18	56	5.74
1. Lateral Occipital Sulcus–V5	19	L		-38	-78	-10	5.62
1. Lateral Occipital Gyrus-V5	19	L		-42	-80	-4	5.59
2. Lateral Occipital Gyrus-V5	19	R	7,948	36	-84	-2	6.4
2. Lateral Occipital gyrus	19	R		36	-66	62	6.4
2. Fusiform Gyrus	20	R		40	-38	-22	5.69
3. Precentral Gyrus	44	R	3,020	44	8	30	5.76

3. a. Insula	47	R		32	28	0	5.76
3. Precentral Gyrus	44	R		44	10	30	5.57
3. Middle Frontal Sulcus	6	R		32	-2	50	4.62
4. Insula	48	L	768	-36	18	2	5.71
4. a. Insula	47	L		-32	26	-2	5.12

*The activation survives whole-brain correction ($P < 0.05$) for multiple comparisons at the cluster level 2.3. (n = 34). Locations coordinates are in stereotactic MNI space with 2x2x2 voxel size. The source of anatomical labels: FSL Atlas tools. Subpeaks of the clusters= Z-score; R= right; L = left; BA = Brodmann area; a = anterior.

Table S6. Brain regions that show heightened activation for mimicry with dilating pupils

Region	BA	Side	Cluster Size	x	y	z	Z-Max
1. Occipital temporal Gyrus	37	R	763	50	-62	-14	6.46
1. Lateral Occipital Gyrus–V5	19	R		46	-76	-2	5.74
1. Lateral Occipital Gyrus–V5	19	R		44	-82	-14	5.62
1. Precentral Gyrus	3	L		-36	-18	62	5.59
1. Paracingulate Gyrus	32	R		8	26	36	6.4

*The activation survives whole-brain correction ($P < 0.05$) for multiple comparisons at the cluster level 2.3. (n = 34). Locations coordinates are in stereotactic MNI space with 2x2x2 voxel size. The source of anatomical labels: FSL Atlas tools. Subpeaks of the clusters= Z-score; R= right; L = left; BA = Brodmann area.

Table S7. ToM and Threat masks' links for download

Network	Studies	Date of	Link to download
ToM	140	10/03/2015	http://neurosynth.org/analyses/terms/theory%20mind
Threat	170	15/03/2015	http://neurosynth.org/analyses/terms/threat/

Table S8. Partners' pupils constricting > static

Region	BA	Side	Cluster Size	x	y	z	Z-Max
1. Lateral Occipital Gyrus –V5	37	R	868	50	-62	2	4.56
1. Lateral Occipital Gyrus –V5	37	R		52	-70	0	4.12
1. Lateral Occipital Gyrus –V5	37	R		58	-70	0	4.1
1. Inferior Temporal Gyrus (ITG)	37	R		48	-46	-18	3.65
1. Middle Temporal Gyrus	37	R		52	-44	-6	3.26
1. Middle Temporal Gyrus	37	R		46	-60	14	3.17

*The activation survives whole-brain correction ($P < 0.05$) for multiple comparisons at the cluster level 2.3. (n=34). Locations coordinates are in stereotactic MNI space with 2x2x2 voxel size. The source of anatomical labels: FSL Atlas tools. Subpeaks of the clusters= Z-score; R= right; L = left; BA = Brodmann area.

Table S9. Partners' pupils dilating > static

Region	BA	Side	Cluster Size	x	y	z	Z-Max
1. Lateral Occipital Gyrus –V5	37	R	1,152	50	-62	2	2
1. Lateral Occipital Gyrus –V5	37	R		52	-70	0	-16
1. Lateral Occipital Gyrus –V5	37	R		58	-70	0	8
1. Lateral Occipital Gyrus –V5	37	R		48	-46	-18	12
1. Lateral Occipital Gyrus –V5	37	R		52	-44	-6	2
2. Temporal Occipital Gyrus (Fusiform Gyrus)	37	L	556	42	-50	-14	-14
2. Lateral Occipital Sulcus	19	L		-40	-68	8	3.68
2. Lateral Occipital Gyrus –V5	19	L		-40	-70	-6	3.16
2. Lateral Occipital Gyrus –V5	19	L		-42	-58	8	3.15
2. Lateral Occipital Gyrus –V5	19	L		-52	-66	12	2.89
2. Lateral Occipital Gyrus –V5	37	L		-44	-62	-10	2.88

*The activation survives whole-brain correction ($P < 0.05$) for multiple comparisons at the cluster level 2.3. (n = 34). Locations coordinates are in stereotactic MNI space with 2x2x2 voxel size. The source of anatomical labels: FSL Atlas tools. Subpeaks of the clusters= Z-score; R= right; L = left; BA = Brodmann area.

Table S10. Partners' pupil size changing > static

Region	BA	Side	Cluster Size	x	y	z	Z-Max
1. Lateral Occipital Gyrus –V5	37	R	1,419	50	-62	2	4.75
1. Inferior Temoral Gyrus (ITG)	37	R		48	-46	-18	4.22
1. Lateral Occipital Cortex	37	R		60	-70	0	3.99
1. Lateral Occipital Gyrus –V5	39	R		46	-60	14	3.63
1. Temporal Occipital (Fusiform Gyrus)	37	R		42	-50	-14	3.54
1. Middle Temoral Gyrus	37	R		52	-44	-6	3.36

*The activation survives whole-brain correction ($P < 0.05$) for multiple comparisons at the cluster level 2.3. (n = 34). Locations coordinates are in stereotactic MNI space with 2x2x2 voxel size. The source of anatomical labels: FSL Atlas tools. Subpeaks of the clusters= Z-score; R= right; L = left; BA = Brodmann area.

Methods

Table S11: The subjects' sex, age and questionnaire scores

Participant characteristics	N	Min	Max	Mean	Std.
BDI	36	0	18	4.080	3.988
State	27	36	57	46.30	4.445
Trait	35	43	56	48.66	3.412
EC	40	0	7	4.686	1.275

PT	40	0	7	4.814	1.203
LSAS Fear	40	0	1	0.519	0.334
LSAS Avoid	40	0	1	0.486	0.308

Characteristics of subjects. The average score of the BDI questionnaire was 4.08 which means that our participants had some minimal depression symptoms (Beck, Guth, Steer, & Ball, 1997). The average STAI score was 46.30 and 48.66 while the cut-off score for anxiety is 54-55 (Kvaal, Ulstein, Nordhus, & Engedal, 2005), therefore, we can conclude that the group is not anxious. For the Interpersonal Reactivity Index (IRI), the average score per question is among 3.5 (the half of the seven subscales). This group has an average of 4.68 per empathic concern (EC) and 4.81 for perspective taking (PT), suggesting that participants were empathetic towards other people. The average score for the LSAS is 0.5, concluding that the group does not have any abnormal fear or avoidance behaviors. BDI = Beck Depression Inventory, State & Trait = two subscales of State-Trait Anxiety Inventory, LSAS = Liebowitz Social Anxiety Scale.

Table S12. Localizers

TOM-Localizer		**Threat-Localizer**	
1. ToM story	**1. Photography story**	**1. Threatening story**	**1. Non-threatening story**
Larry chose a debated topic for his class paper due on Friday. The news on Thursday indicated that the debate had been solved but Larry never read it.	A large oak tree stood in front of City Hall from the time the building was built. Last year the tree fell down and was replaced by a stone fountain.	Imagine the following situation: At night on the way home, you decide to take a shortcut through the dark park. From the middle of the park, a man with a knife approaches you. You run for your life.	Imagine the following situation: You are watching an animal documentary on TV. The doorbell rings. Your neighbour is at the door and asks whether you have some sugar for her. You go to kitchen to get it for her.
2. Question	**2. Question**	**2. Question**	**2. Question**
When Larry writes his paper he thinks the debate has been solved.	An antique drawing of City Hall shows a fountain in front.	The situation is threatening	The situation is threatening
3. Answer	**3. Answer**	**3. Answer**	**3. Answer**
True/False	True/False	True/False	True/False

Localizer tasks. Two localizer tasks were performed to map ToM and threat-related networks. The inclusion masks derived from the localizers consisted thus of voxels that showed a significant difference between conditions where participants had to use ToM or had to think about a threatening event as compared to a control condition. Scan settings were the same as for the trust-game task **(Methods, fMRI data acquisition**). The threat and ToM localizers were matched in terms of the number of words they contained. Both localizers lasted 8 minutes and their order was counter-balanced across participants.

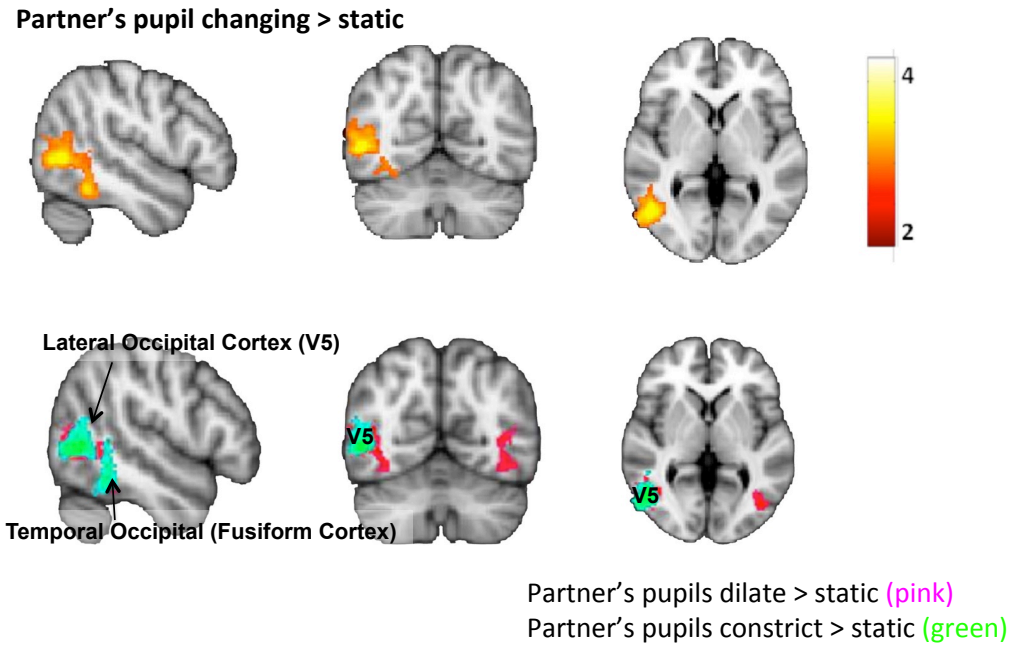

Figure S1. Neural correlates of partners' pupil change To determine the effect of observed pupillary changes on neural activity, irrespective of whether subjects mimicked or not, we evaluated the fMRI data acquired during the encoding of partner pupils: constricting, static and dilating conditions. We created the following contrasts: constrict versus static, dilate versus static, and changing versus static (combination of partner dilating and constricting conditions). This analysis revealed that compared to static pupils both partner pupil dilation and constriction was associated with enhanced activity in spatially overlapping areas including the right lateral occipital gyrus [50, -62, 2] and the temporal occipital fusiform gyrus [52, -44, -6]. The contrast between dilating versus constricting pupils did not yield significant differences. This analysis depicts that the processing of partner's dilating and constricting pupil sizes share common neural underpinnings in the lateral occipital and temporal areas. Top figure: The whole-brain analysis contrast compares partner's changing (dilating and constricting) versus static pupils (thresholded at $P < 0.05$ (cluster-level FWE correction with multiple comparisons at 2.3. (n = 34)). For visualization purposes, the threshold was set at z = 2 – 4. Bottom figure: shows the overlap between partner's dilating and partner's constricting pupils.