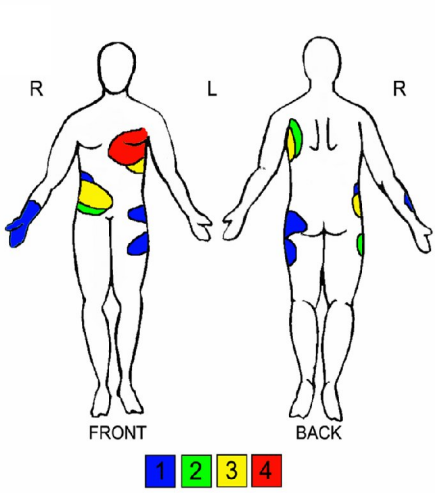
Supplementary Material

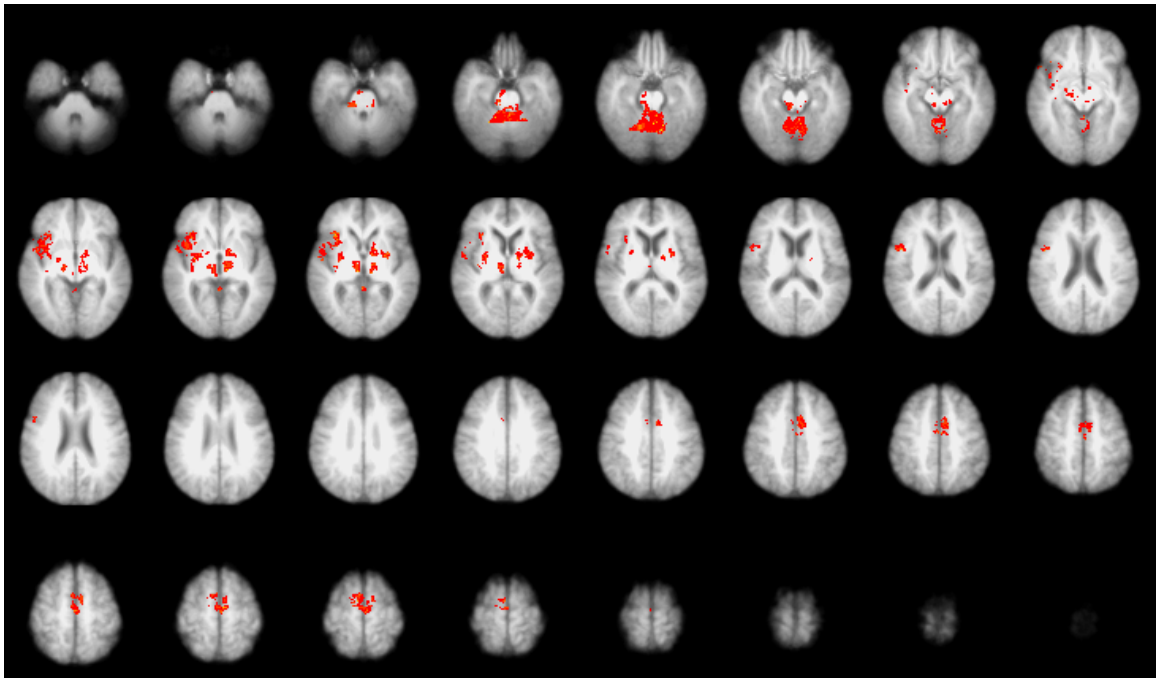
Distribution of PHN sites in the group studied:



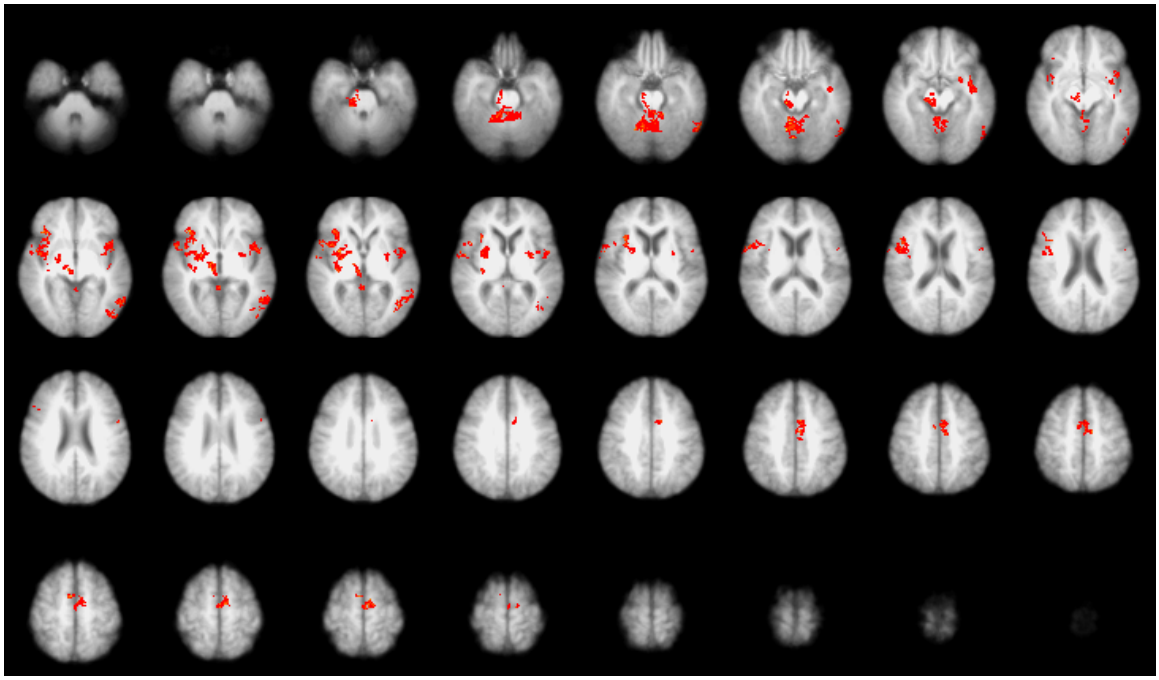
Figure, adapted from (Geha et al. 2007), indicates body locations for PHN pain. The outlined areas are the sites where stroking the skin with a foam pad evoked pain. Color code represents number of subjects for a given body region. Note that we screened over 400 potential PHN patients, and could only enter 14 into the study, as the large majority of PHN patients had a long list of confounding other conditions.

Summary of supplementary figures:
Supplementary figure 1 shows the unflipped contrast between touch evoked allodynia and non-painful touch (*(Sa-St)all,* random-effects). We observe many of the same activations seen after flipping. However, thalamic activity becomes bilateral, while insular, basal ganglia, and amygdala activity become less extensive and MT activity disappears. Thus, the differences between these maps imply that flipping the data results in a more appropriate representation.

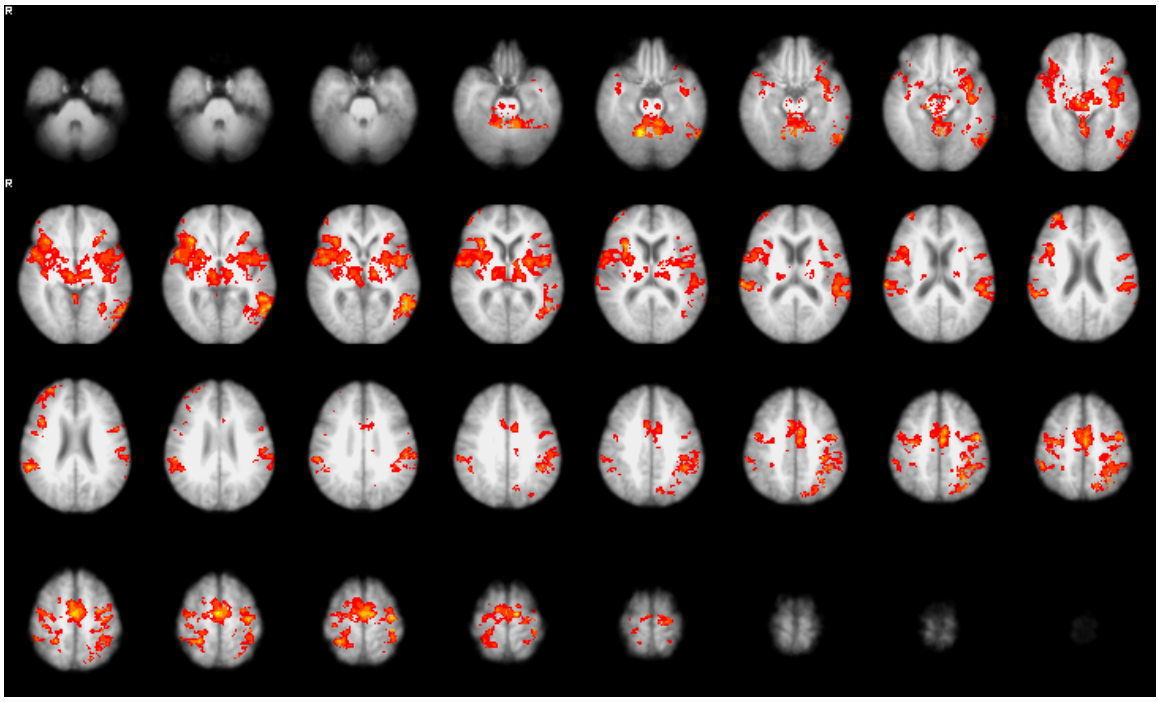
The remaining supplementary figures show the complete maps for activations shown in Figs. 2 & 3 (Supplementary Figs. 2-8), whole-brain covariate map for allodynia (Supplementary Fig. 9) and the complete maps for correlation based network analysis (Supplementary Figs. 10-11). Supplementary tables 1, 2, and 4 are the complete lists of brain region identified for contrasts from Figs. 2 & 3. Supplementary table 3 shows the statistical differences regarding correlation strengths in the regional analyses for areas studied in Figs. 4-6. Supplementary table 5 is the list of brain regions identified in correlation based network analysis, and the regions showing significant differences in connectivity strength between the two networks.



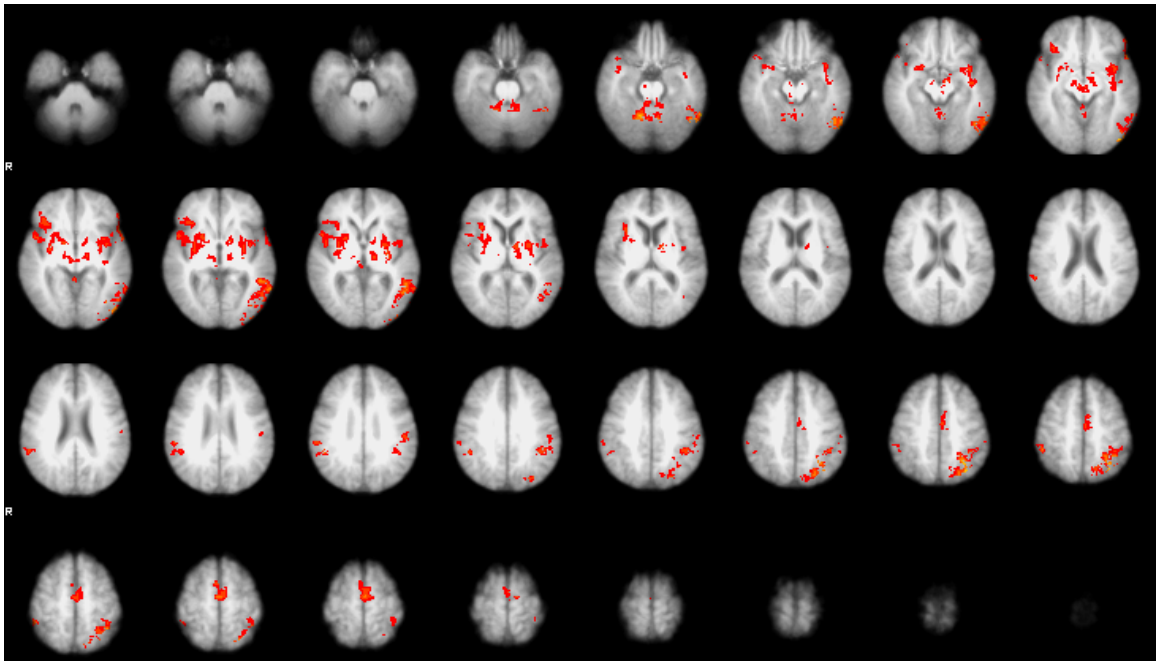
Supplementary figure 1. Brain activity map for the comparison between allodynia-evoking touch stimuli vs. non-painful touch stimuli across all treatment sessions; random-effects contrast without flipping.*(Sa - St)all* (n = 11 patients; z > 2.3, P <0.01).



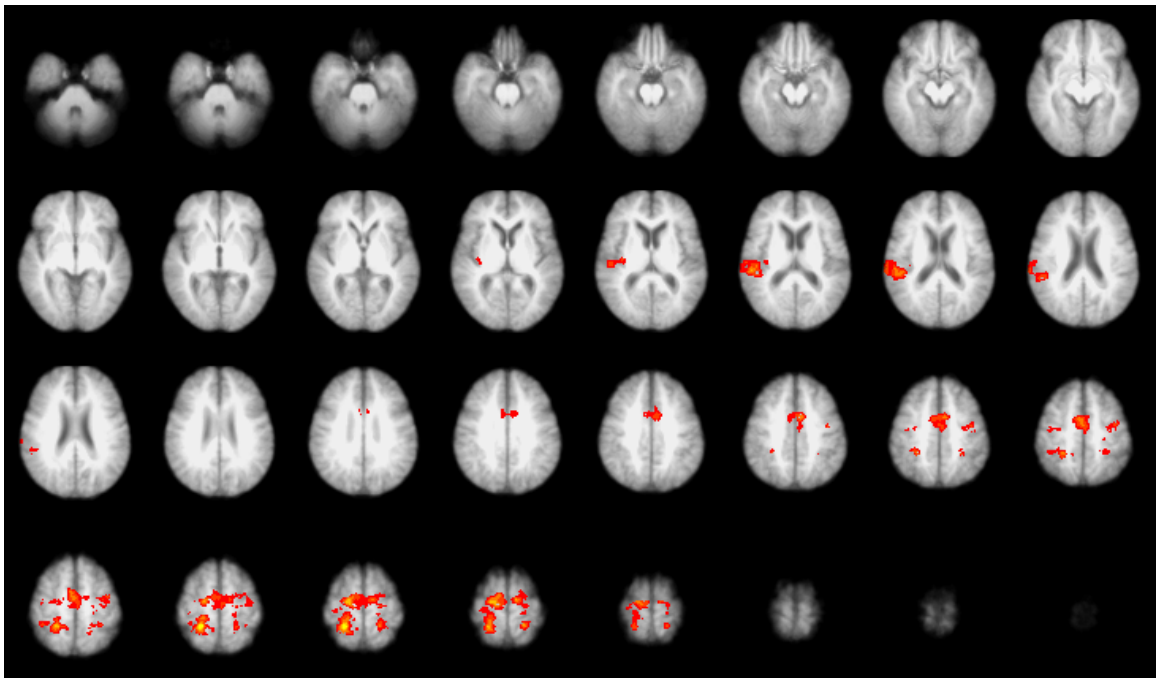
Supplementary figure 2. Brain activity map for the comparison between allodynia-evoking touch stimuli vs. non-painful touch stimuli across all treatment sessions; random-effects contrast after flipping *(Sa - St)all* (n = 11 patients; z > 2.3, P <0.01).



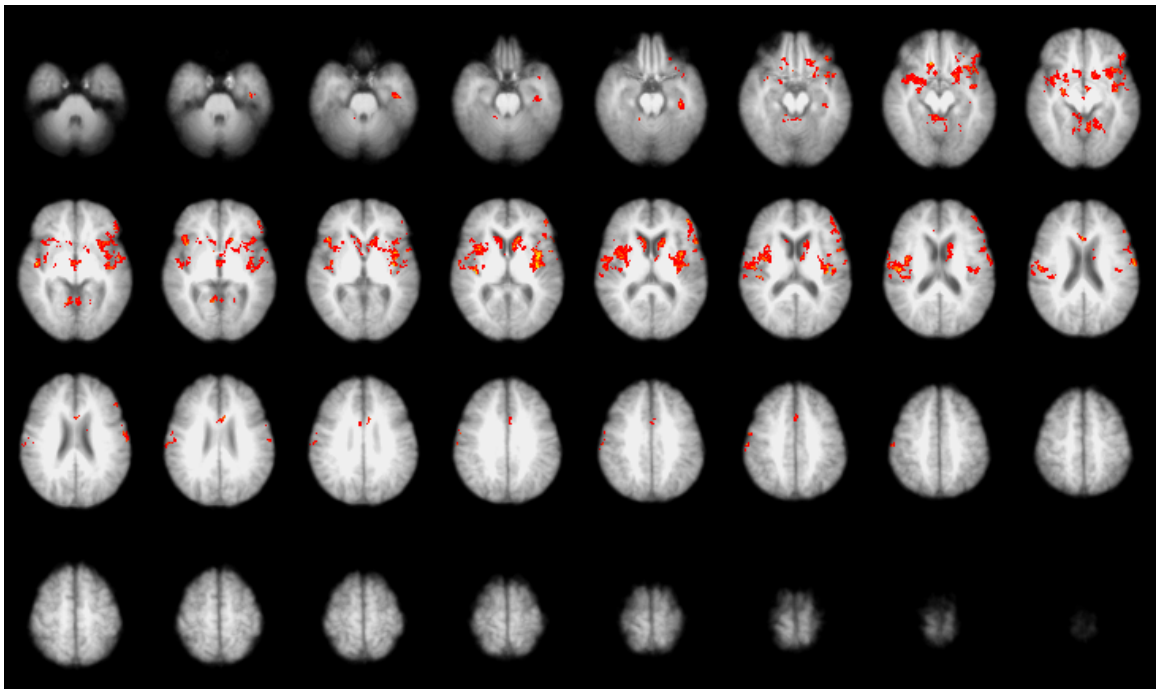
Supplementary figure 3. Brain activity map for the comparison between allodynia-evoking touch stimuli based on stimulus timings vs. non-painful touch stimuli across all treatment sessions; fixed-effects contrast *(Sa - St)all* ($z > 2.3$, cluster $P < 0.01$).



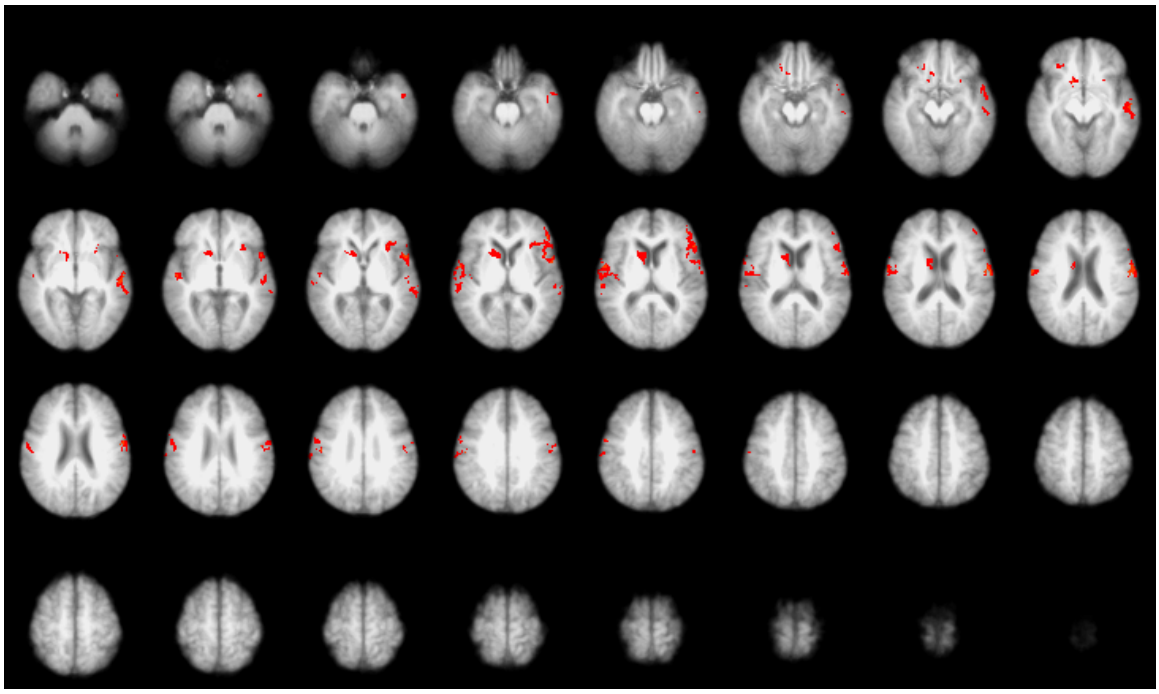
Supplementary figure 4. Brain activity map for the comparison between allodynia-evoking touch stimuli based on ratings vs. non-painful touch stimuli across all treatment sessions; fixed-effects contrast *(Ra - St)all* (n = 11 patients ; z > 2.3, cluster P <0.01).



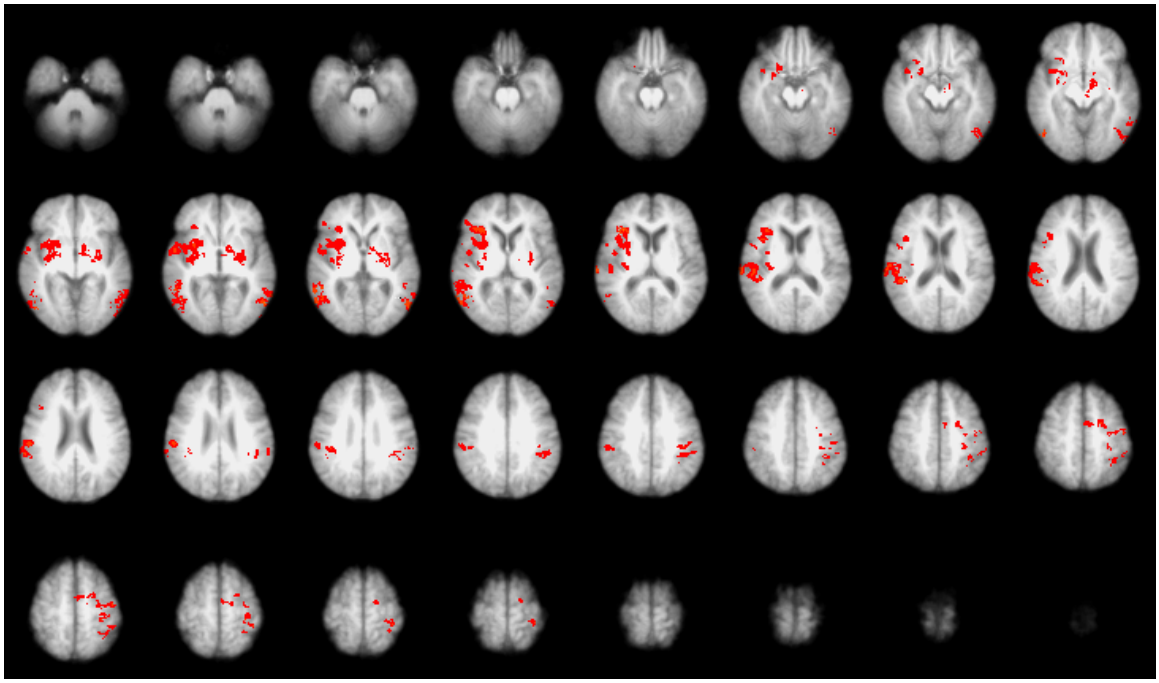
Supplementary figure 5. Contrast results between brain activity obtained using stimulus timings and the one obtained from ratings *{(Sa-St)-(Ra-Rt)}all*; fixed-effects (n = 11 patients; z >2.3; cluster P < 0.01).



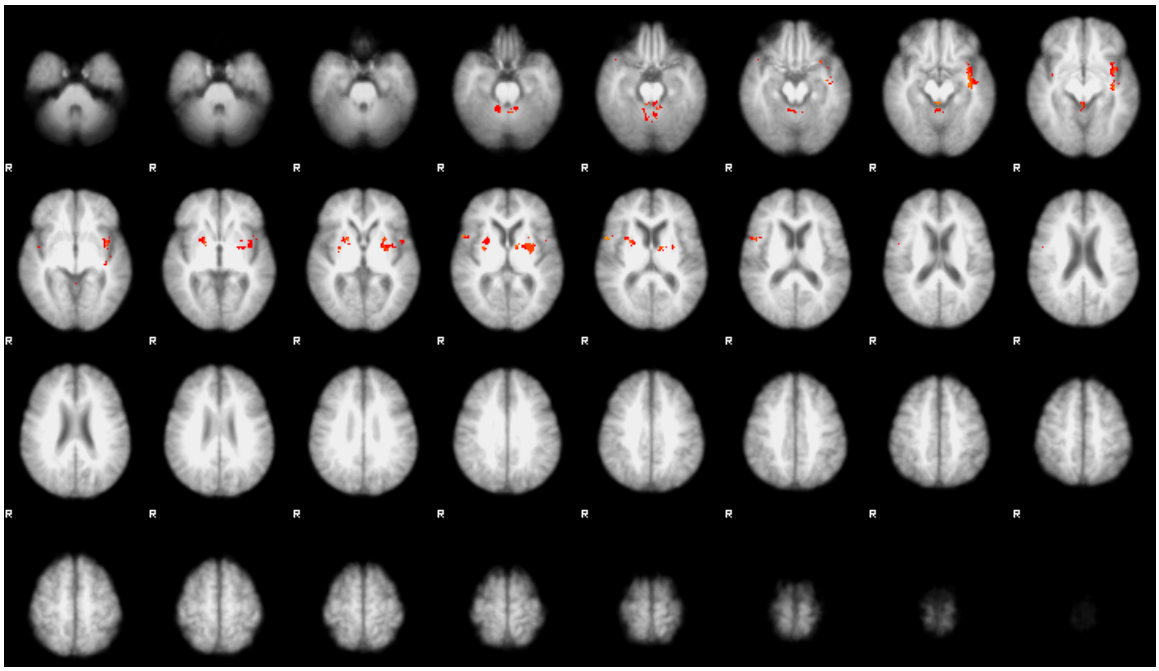
Supplementary figure 6. Brain activity for rating spontaneous pain vs. visual rating (*Rsp – Rv)all* across all treatment sessions taken from Geha et al., 2007. (n = 11; z >2.3, cluster P < 0.01).



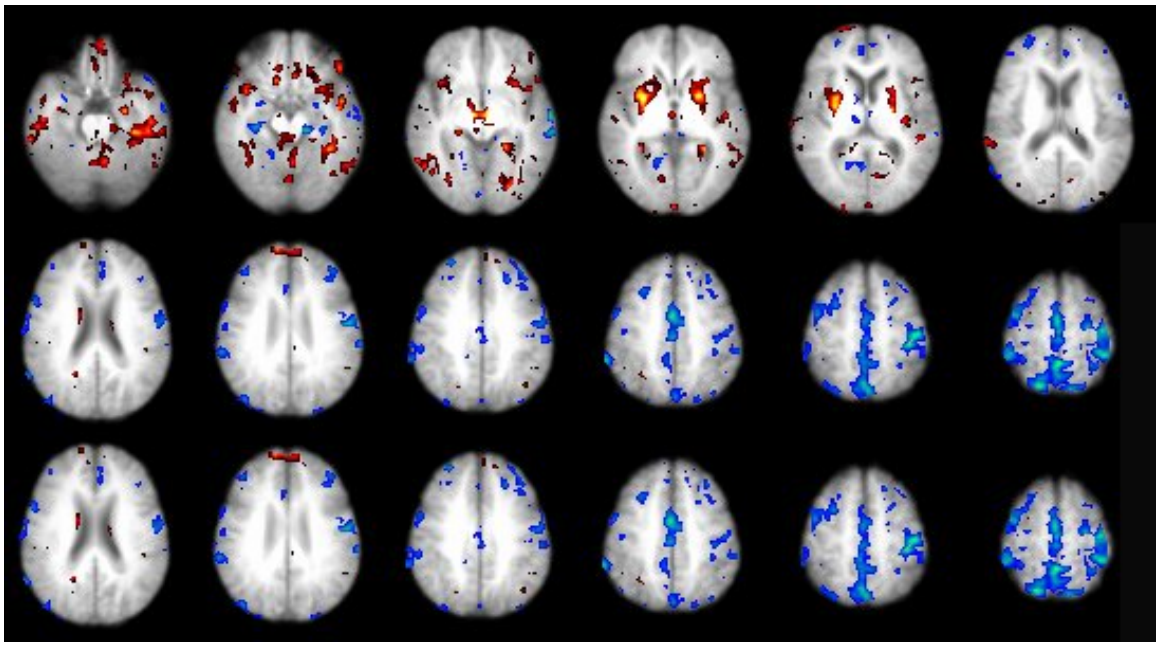
Supplementary figure 7. Contrast results between brain activity obtained for rating spontaneous pain vs. allodynia based on stimulus timings, *{ (Rsp-Rv)- (Sa-St) -}*; fixed effects (n = 47 scans for *(Sa-St)*; n = 43 scans for *(Rsp-Rv)*; z >2.3, cluster P < 0.01); after including the contribution of total pain.



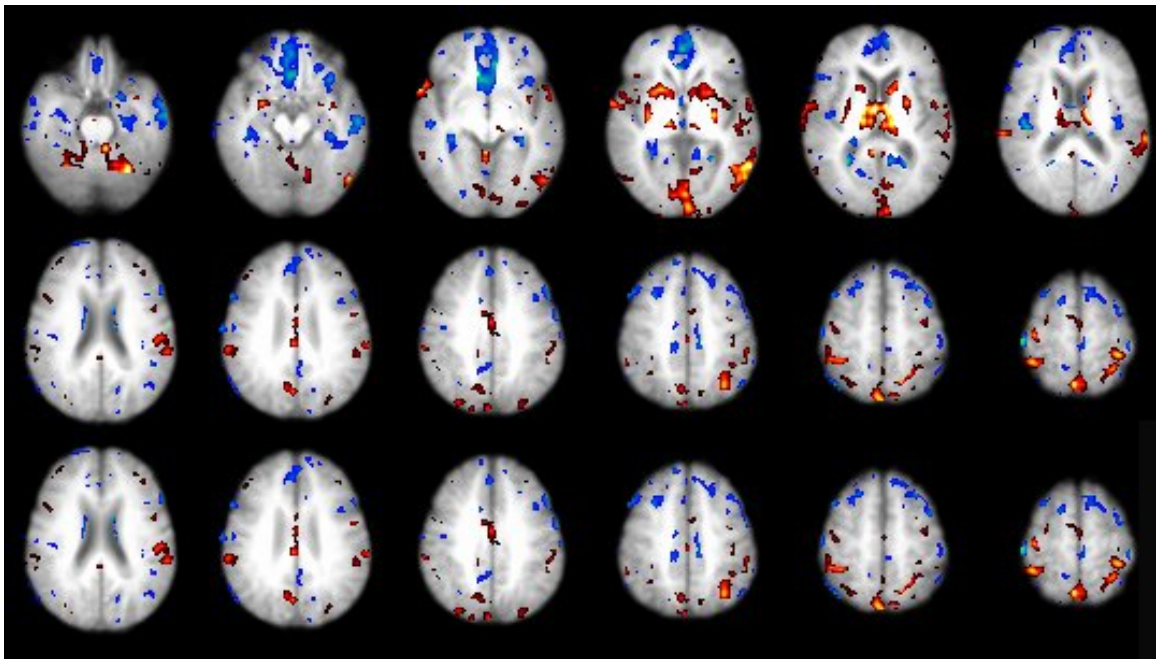
Supplementary figure 8. Contrast results between brain activity obtained for allodynia based on stimulus timings vs. rating spontaneous pain, *{(Sa-St) - (Rsp-Rv)}*; fixed effects (n = 47 scans for *(Sa-St)*; n = 43 scans for *(Rsp-Rv)*; z >2.3, cluster P < 0.01); after covarying out the contribution of total pain.



Supplementary figure 9. Covariate analysis between allodynia ratings and brain activity obtained for allodynia based on stimulus timings, *(Sa)*ratings*; fixed effects (n = 51) masked with *(Sa-St)* with z >2.3, cluster P < 0.01; after covarying out the contributions of spontaneous pain, age, and pain duration.



Supplementary Figure 10. Brain connectivity map using left putamen activity as seed and correlating the time course of this activity, delayed by – 5 s, with all voxels in the brain. The correlation coefficients are transformed to z-values and thresholded ($z > 2.3$ red; and $z < -2.3$ blue).



Supplementary Figure 11. Brain connectivity map using left putamen activity as seed and correlating the time course of this activity, delayed by + 5 s, with all voxels in the brain. The correlation coefficients are transformed to z-values and thresholded ($z > 2.3$ red; and $z < -2.3$ blue).

Supplementary Table 1. Brain regions activated for tactile allodynia based on stimulus timings					
Region	**Coordinates**			**Z-value**	**Index**
	x	**y**	**z**		
R DLPFC (10)	34	56	22	7.73	1
L IFG/OFC (47/11)	-32	32	-8	6.24	2
R IFG/OFC (47/11)	36	26	-4	8.59	2
R Ant Insula/IFG (45)	34	22	6	8.27	2
R Mid Insula	40	8	0	6.06	2
R ACC (24/32)	6	8	42	6.15	2
R Striatum	24	6	0	6.02	2
L Inf/Ant Insula	-38	2	-16	6.67	2
L Striatum	-26	0	6	6.06	2
L Mid Insula	-38	0	0	6.67	2
L Thalamus	-8	-4	6	4.6	2
R SMA (6)	2	-10	60	10.4	2
R Thalamus	6	-10	4	4.33	2
R MI (4)	34	-12	50	7.8	2
L Amygdala/SLEA	-26	2	-16	6.63	2
L MI (4)	-36	-16	62	9.24	2
R Mid Brain	6	-22	-8	6.63	2
Cerebellum	14	-56	-26	11	2
R SI (3)	42	-22	56	6.71	3
L SI (1/2)	-36	-30	64	9.18	3
L SII (40)	-52	-32	18	6.54	3
R SII (40)	60	-32	32	7.5	3
L Sup Parietal Lobule (5/7)	-36	-40	60	5.72	3
R Inf Parietal Lobule (7/40)	52	-42	52	7.5	3
R Sup Parietal Lobule (5)	26	-46	62	7.88	3
L MT	-55	-61	-2	8.2	3
L Inf Parietal Lobule (7/40)	-32	-60	46	7.97	3

The contrast was a fixed effects comparison of *(Sa – St)all* and contained three clusters: cluster 1, 489 voxels, $p < 0.01$; cluster 2, 11373 voxels, $p < 10^{-9}$; cluster 3, 11501 voxels, $p < 10^{-9}$; *Abbreviations used*: L, left; R, right; Ant, anterior; Post, posterior Inf, inferior; Sup, superior; ACC, anterior cingulated cortex; IFG, inferior frontal gyrus; MI, primary motor cortex; OFC, orbito-frontal cortex; MT, mid-temporal (visual motion);SLEA, sub-lenticular extended amygdala; SMA, supplementary motor cortex; SI, primary somatosensory cortex; SII, secondary somatosensory cortex. Numbers in parentheses are Brodmann areas.

Supplementary Table 2. Brain regions activated for tactile allodynia based on allodynia ratings					
Region	**Coordinates**			**Z-value**	**Index**
	x	**y**	**z**		
R Inf Parietal Lobule	60	-42	22	5.1	1
Cerebellum	14	-56	-26	7.67	2
L SMA (6)	-2	-10	62	6.3	3
R SMA (6)	2	-10	62	6.25	3
L MT	-50	-62	2	6.06	4
L Sup Parietal Lobule (7)	-32	-60	48	8.2	5
R IFG/OFC (47/11)	38	26	-8	5.34	6
R Ant Insula	32	18	8	4.92	6
R Striatum	22	10	-4	5.06	6
L Inf. Insula	-38	2	-16	5.01	7
L Striatum	-26	-2	2	5.08	7
L Thalamus	-12	-4	6	5.72	7
L Amygdala/SLEA	-26	2	-16	4.82	7
R Mid Brain	6	-20	-12	4.36	7

The contrast was fixed effects comparison of *(Ra – Rt)all* and contained seven clusters: cluster 1, 354 voxels, $p< 0.01$; cluster 2, 550 voxels, $p<10^{-3}$; Cluster 3, 605 voxels, $p<10^{-4}$; cluster 4, 1177 voxels, $p<10^{-7}$; cluster 5, 1262 voxels, $p<10^{-7}$; cluster 6, 1507 voxels, $p < 10^{-9}$; cluster 7, 1696, $p < 10^{-9}$. For abbreviations see supplementary table 1. Numbers in parentheses are Brodmann areas.

Supplementary Table 3. Maximum cross-correlations between BOLD and stimuli for tactile allodynia, touch, and visual tasks

ROI	Allodynia Task	Touch Task	Visual Task	Allodynia vs. Touch (P-values)	Allodynia vs. Visual (P-values)
L Putamen	0.22 (2)	0.05	0.01	$< 10^{-5}$	$< 10^{-4}$
R Putamen	0.25 (2)	0.06	-0.02	< 0.01	$<10^{-3}$
L Ext. Amygdala	0.22 (0)	0.09	-0.01	< 0.01	$<10^{-4}$
ACC	0.21 (-1)	-0.01	0.05	$< 10^{-5}$	$<10^{-3}$
R insula	0.27 (0)	0.14	0.04	$< 10^{-4}$	$< 10^{-5}$
L SII	0.36 (0)	0.38	-0.01	0.97	$< 10^{-5}$
R Thalamus	0.26 (0)	0.13	0.06	0.02	< 0.01

Numbers in parentheses indicate the time delay for peak crosscorrelation, in TRs (2.5 s increments). P-values are based on a t-tests between correlations for each scan, n= 51 for allodynia, n = 46 for touch, n = 20 for visual. *For abbreviations see table 1.*

Supplementary Table 4. Comparison between tactile allodynia and spontaneous pain, after including pain magnitudes					
Contrast 1. Brain areas for allodynia vs. spontaneous pain					
Region	**Coordinates**			**Z-value**	**Index**
	x	**y**	**z**		
L Pre-Motor Cortex (6)	-22	0	54	6.04	1
L MI (4)	-46	-10	56	5.99	1
L SMA (6)	-4	0	52	4.66	1
L Globus Pallidum internal	-11	5	-3	4.21	2
L Putamen	-28	-14	0	5.69	2
L Substantia nigra	-12	-5	-11	4.9	2
L MT ***(visual motion)***	-52	-64	-2	8.30	3
R Visual Cortex (18)	50	-70	-12	8.25	4
R MT ***(visual motion)***	48	-62	-4	5.70	4
L SI (1/2) ***(hand area)***	-34	-34	68	6.47	5
L Sup Parietal Lobule (5/7)	-42	-38	60	6.04	5
R Inf Parietal Lobe/SII (40)	60	-26	26	7.52	6
R SII	68	-26	11	8.3	6
R Ant Insula/ IFG (45)	36	26	8	9.87	7
R Mid Insula	44	2	-4	4.12	7
R Amygdala	27	5	-20	3.5	7
R Putamen	32	6	-4	6.34	7
R Globus Pallidum internal	19	-3	-7	3.5	7
Contrast 2. Brain areas for spontaneous pain vs. allodynia					
R Caudate ***(head & body)***	12	8	14	3.45	1
R Ventral Striatum	16	16	-10	5.54	1
L Ant Insula/IFG (45)	-30	26	2	4.7	2
L Post Insula	-58	-18	-10	6.31	2
R Post Insula	46	-14	6	3.38	3
R MI/SI (3/4)	52	-16	34	5.87	3
R SII	63	-26	9	5.1	3
L MI/SII (4/43)	- 56	- 8	22	6.29	4

Contrast 1 was fixed effects comparison of *(Sa – Rsp)all,* masked with positives of (Sa-St)all, and contained seven clusters: cluster 1, 441 voxels, $p < 0.01$; cluster 2, 458 voxels, $p < 0.01$; Cluster 3, 525 voxels, $p < 0.01$; cluster 4, 636 voxels, $p < 10^{-3}$; cluster 5, 683 voxels, $p<10^{-3}$; cluster 6, 949 voxels, $p < 10^{-4}$; cluster 7, 1935, $p < 10^{-8}$. Contrast 2 was fixed effects comparison of *(Rsp –Sa)all,* masked with positives of *(Rsp-Rv)all*, and contained 4 clusters: cluster 1, 414 voxels, $p < 0.01$; cluster 2, 419 voxels, $p < 0.01$; Cluster 3, 665 voxels, $p < 10^{-3}$; cluster 4, 848 voxels, $p < 10^{-4}$; For abbreviations see supplementary table 1. Numbers in parentheses are Brodmann areas. Note right brain corresponds to side opposite to PHN, left brain corresponds to side opposite to ratings.

Supplementary Table 5. Brain areas correlated/anti-correlated with left putamen activity time course when delayed by + 5 s (Perception-related) or by – 5 s (stimulus-related)

Brain region	Perception-related		Stimulus-related	
	Coordinates x, y, z	**Z-score**	**Coordinates x, y, z**	**Z-score**
L Inf Insula	-38, 22, -16	- 4.9	-34, 18, -8	4.4
L Caudate	-18, 14, 10	5.4	-18, 22 0	NS
L Insula	-40, 2, -6	4.5	-34, 18, -6	4.7
ACC (24)	-2, -10, 34	4.4	-2, -2,46	-5.0
L Putamen	-28, -12, 0	5.4	-24, 6, 0	5.4
L Inf Temporal Gyrus (20/21)	-60, -14, -20	-5.5		NS
L Thalamus	-12, -20, 6	5.2	-8, -18, 4	NS
L Post Insula/SII (40/41)	-42, -24, 10	-2.5	-36, -18,6	3.8
L SI/MI (3/4)	-40, -26,58	2.9	-38, -22, 58	-4.9
L Sup Parietal Lobule (7/40)	-38, -38, 60	5.4	-44, -40, 62	-5.8
L MT	-62, -58, -2	5.9	- 62, -52, -2	3
L Cerebellum	-30, -60, -28	6.9	-10, -44, -32	4.9
L Visual cortex (17)	-6, -96, -2	4.9	-2, -98, 2	3.9
R Sup Frontal Gyrus (9)	2, 42, 34	-4.2	2, 26, 34	-2.5
R MPFC (11/12)	8, 24, -12	-5.6	10, 20, -16	4.8
R Parahippocampal Gyrus (36)	38, -6, -32	-4.2	38, -12, -34	5.6
R SMA (6)	0, -8, 64	3.7	0, -6, 68	-5.7
R Post Thalamus	12, -20, 0	5.3	10, -18,6	-3.1
R Post Insula/SII(40/41)	44, - 22,16	-4.4		NS
Mid Brain	-14, -24, -8	3.7	6, -8, -14	5.8
R Sup Parietal Lobule (7/40)	42, -44, 58	4.9	42, -38, 64	-4.8
Precuneus (7)	4, -66, 62	5.3	2, -50, 68	-6.2

Blue = negative correlation, red = positive correlation.