
Figures and figure supplements

Hedonic processing in humans is mediated by an opioidergic mechanism in a mesocorticolimbic system

Christian Buchel *et al*

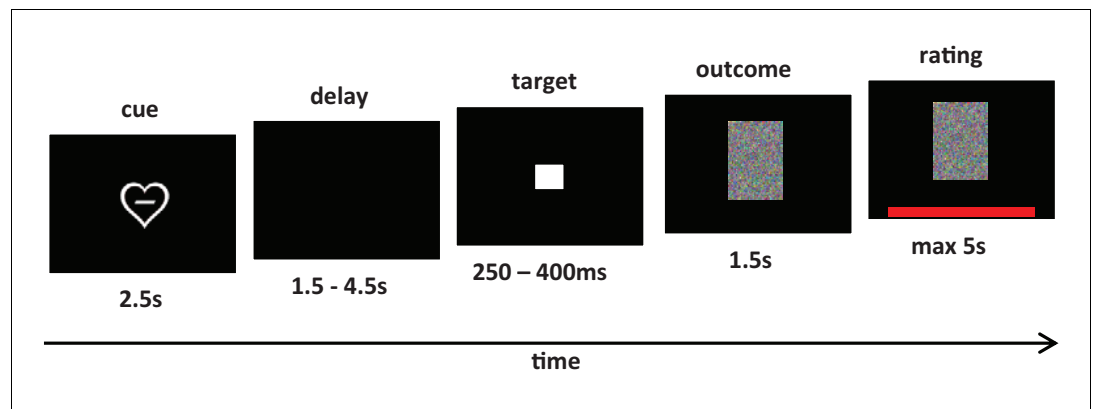


Figure 1. Adapted Monetary Incentive Delay (MID) task trial structure. An initial cue signaled potential gain for each trial (high/low pleasure erotic picture or high/low monetary reward). After a variable delay, a target briefly appeared. Responding during target display yielded the indicated gain, whereas late or early responses yielded no gain. Target durations were adapted to approximate 67% hit rate for each subject. In case of gain trials volunteers could watch the outcome picture (erotic picture or money) for 1.5 s. In case of loss trials a scrambled image was shown.

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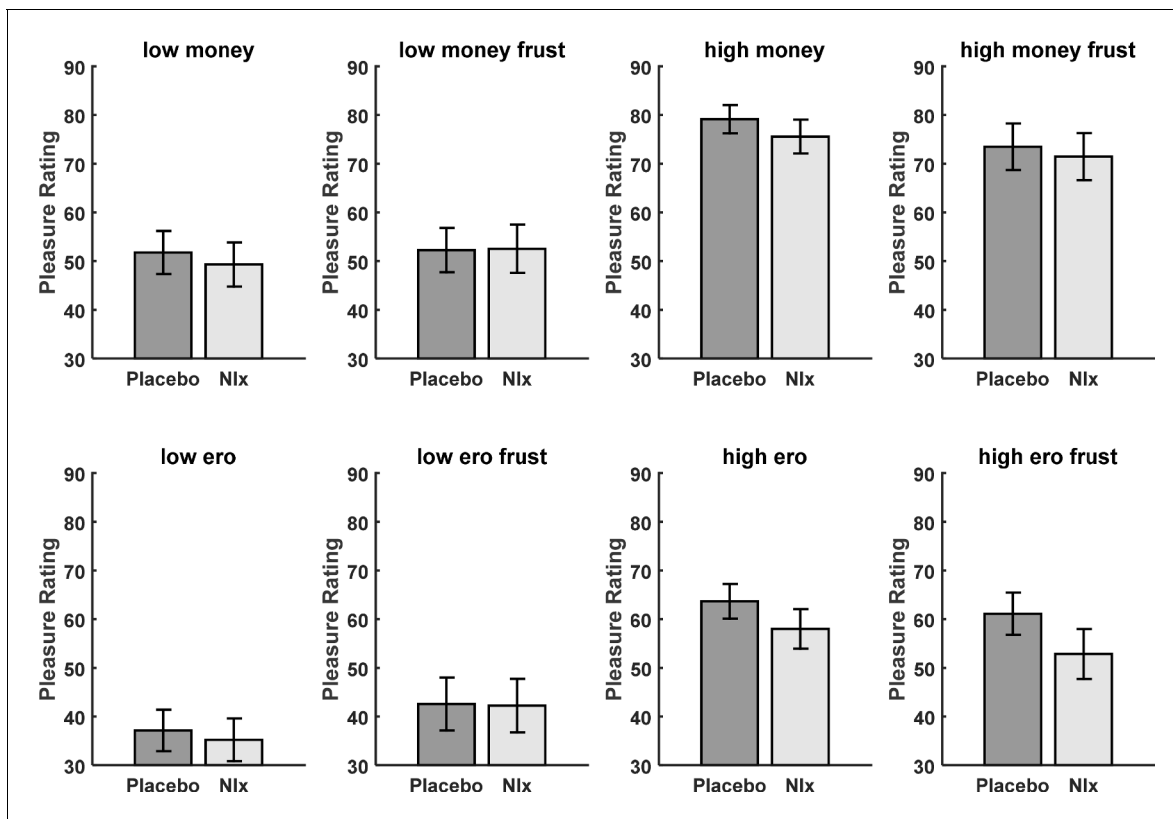


Figure 1—figure supplement 1. Behavioral rating data. Top row: Pleasure and frustration ratings for received and missed monetary rewards. Bottom row: Pleasure and frustration ratings for received and missed erotic picture rewards.

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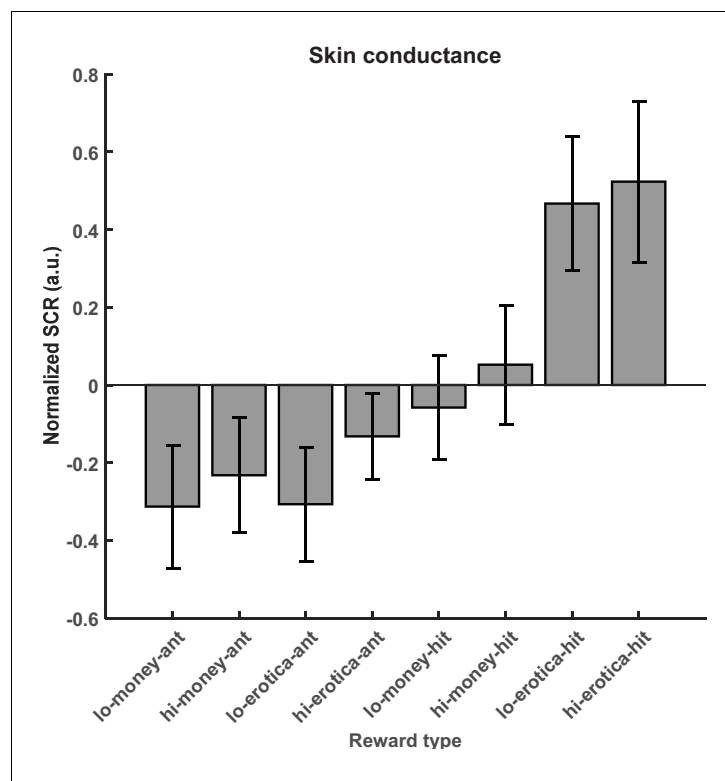


Figure 2. Z-transformed skin conductance responses for anticipation and reward. Data is shown for $n = 14$ volunteers during the placebo treatment only, because naloxone is known to directly affect autonomic regulation of SCR (Traore et al., 1998).

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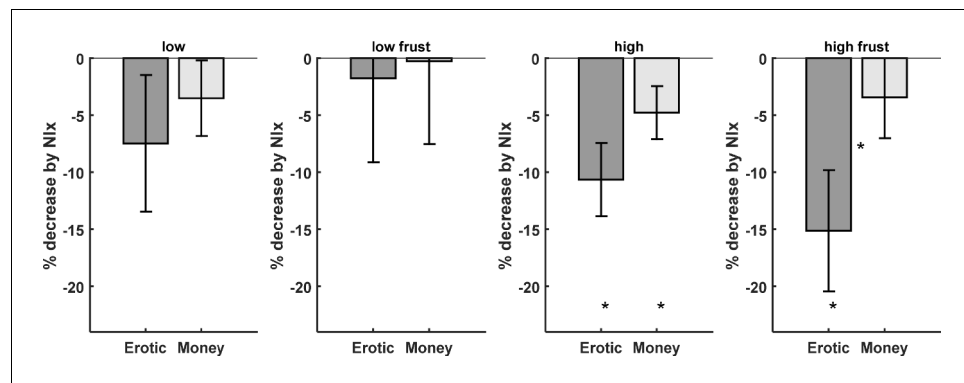


Figure 3. Behavioral data shows that the opioid antagonist naloxone significantly reduced ratings for high erotic rewards (dark gray bars). Frustration ratings for missed erotic rewards show a stronger decrease by naloxone as compared to monetary rewards (right). (* denotes $p < 0.05$; * between bars denote $p < 0.05$ for the interaction).
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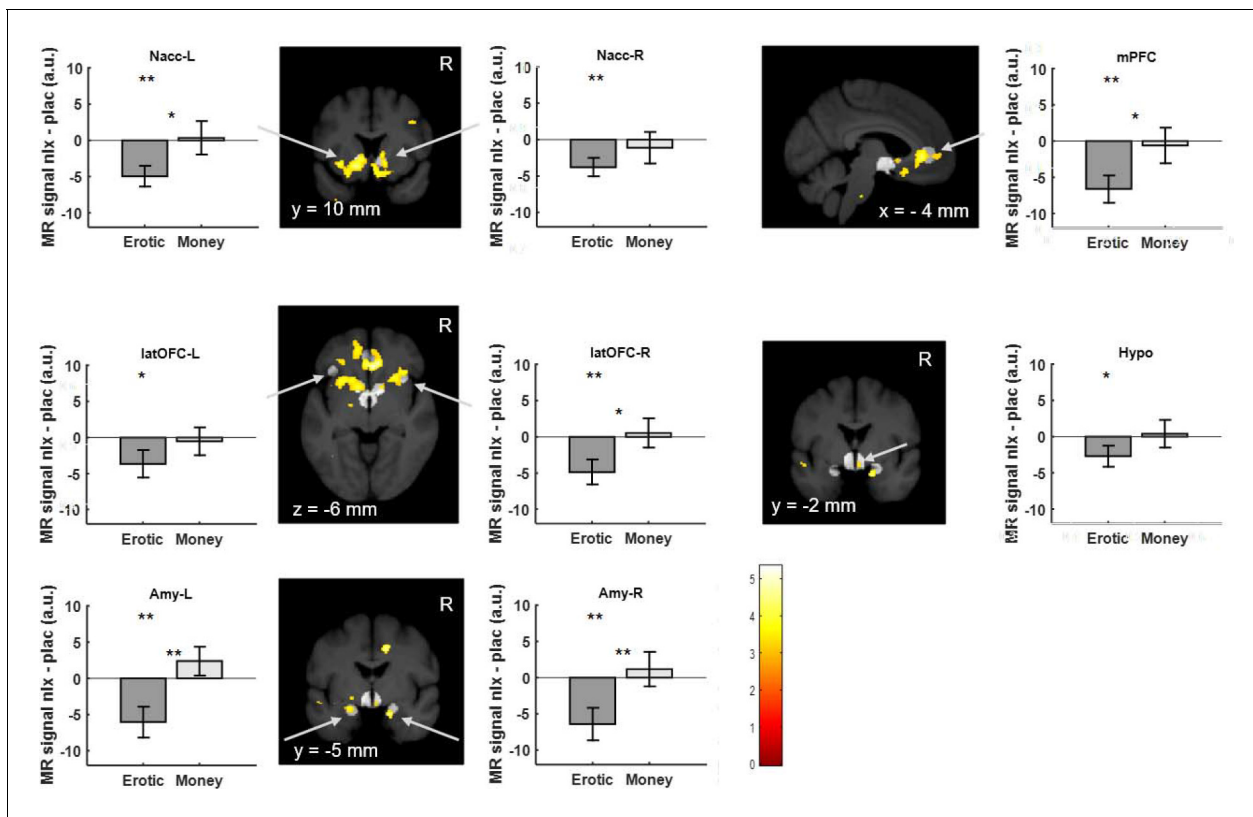


Figure 4. Region of interest brain activity for high versus low erotic picture (dark gray) and high versus low monetary reward (light gray) outcomes shows naloxone related reduced activation for erotic trials. Under naloxone treatment, activation in the ventral striatum, medial prefrontal cortex lateral orbitofrontal cortex, the amygdala and the hypothalamus is significantly reduced. This reduction is larger for erotic rewards as compared to monetary rewards. Activations for high versus low erotic pictures comparing placebo to naloxone at $p < 0.005$ (uncorrected, t-test) are overlaid on a mean structural image also indicating the predefined volumes of interest (light gray) in the ventral striatum, medial prefrontal cortex and lateral orbitofrontal cortex, amygdala and hypothalamus. (** denotes $p < 0.05$ corrected for multiple comparisons; * $p < 0.05$ uncorrected; * or ** between bars denote p values for the interaction).

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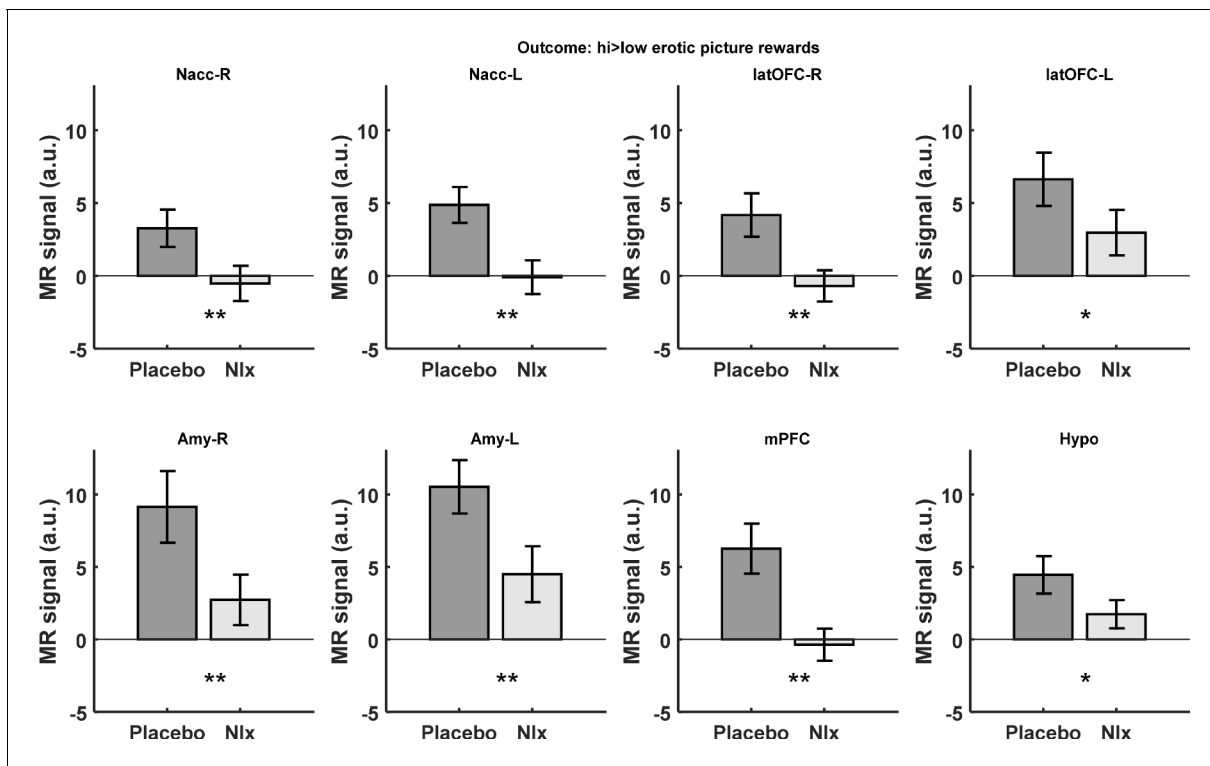


Figure 4—figure supplement 1. Region of interest contrasts of brain activity for high versus low erotic picture reward outcome for placebo and naloxone treatment. ** $p < 0.05$ corrected for multiple comparisons; * $p < 0.05$ uncorrected.

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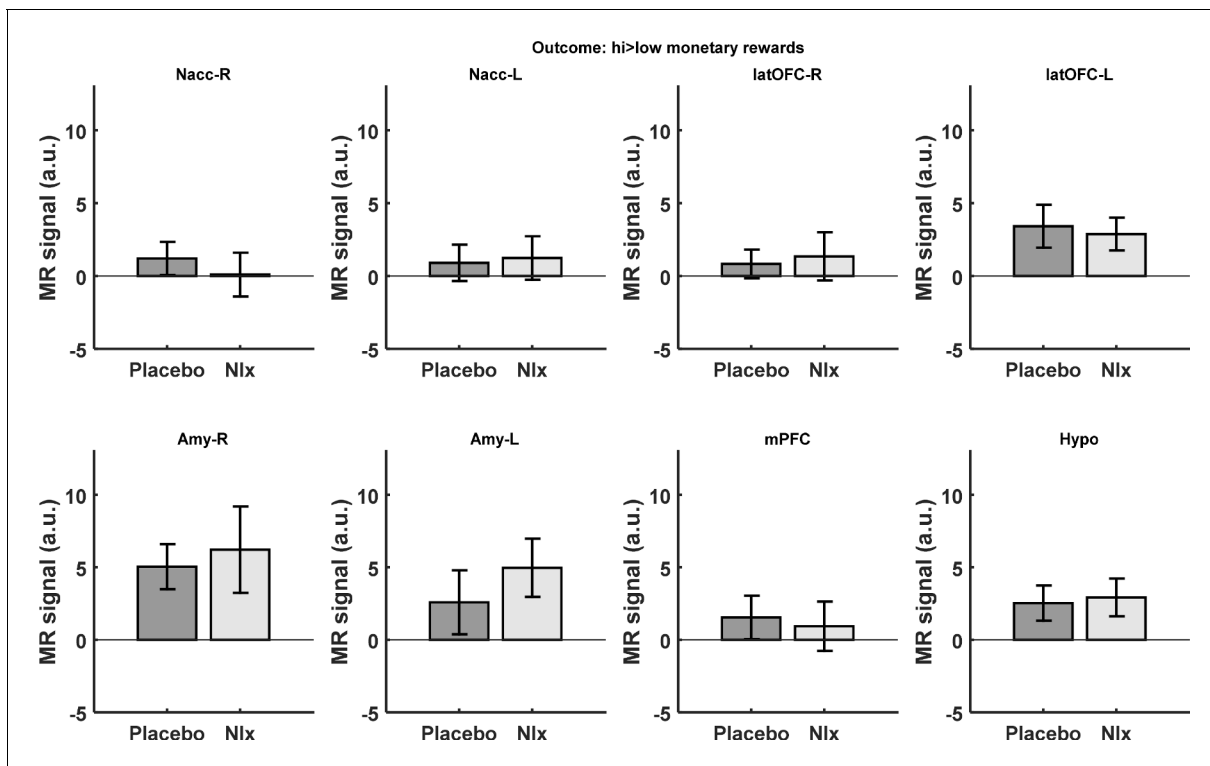


Figure 4—figure supplement 2. Region of interest contrasts of brain activity for high versus low monetary reward outcome for placebo and naloxone treatment.

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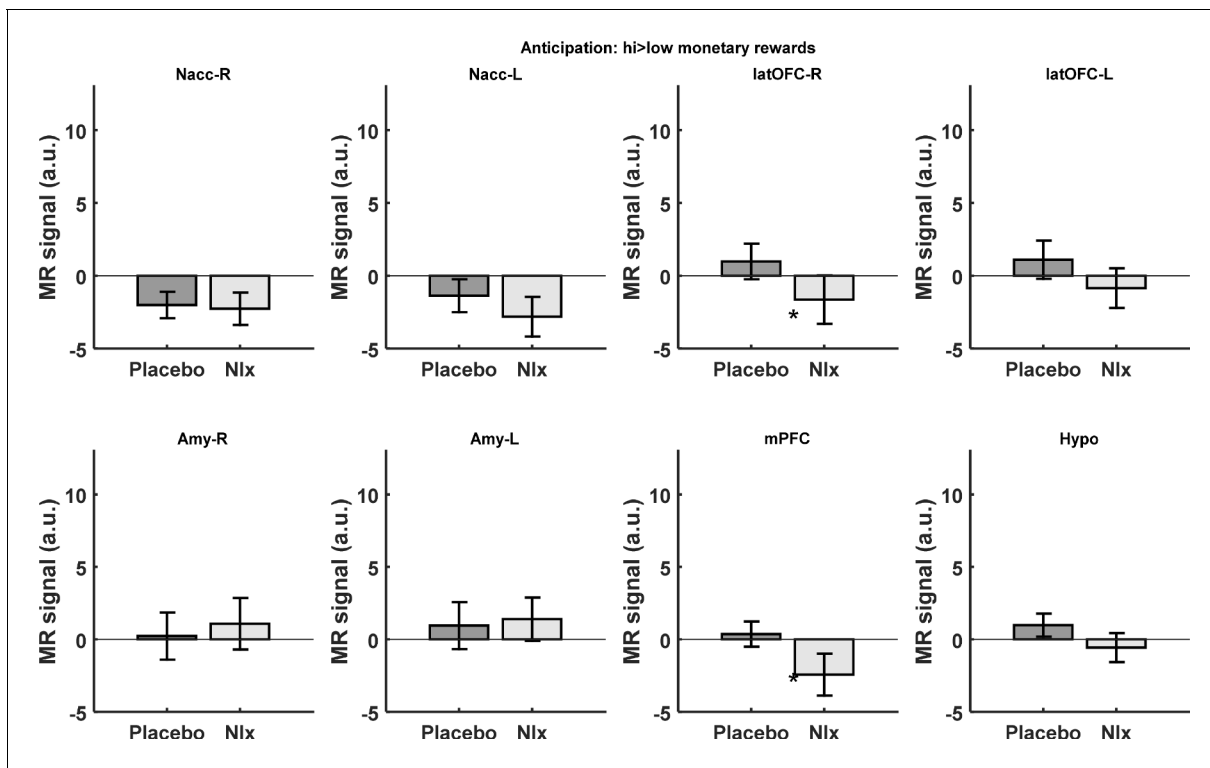


Figure 4—figure supplement 3. Region of interest contrasts of brain activity for high versus low monetary reward anticipation for placebo and naloxone treatment (* $p < 0.05$, uncorrected).

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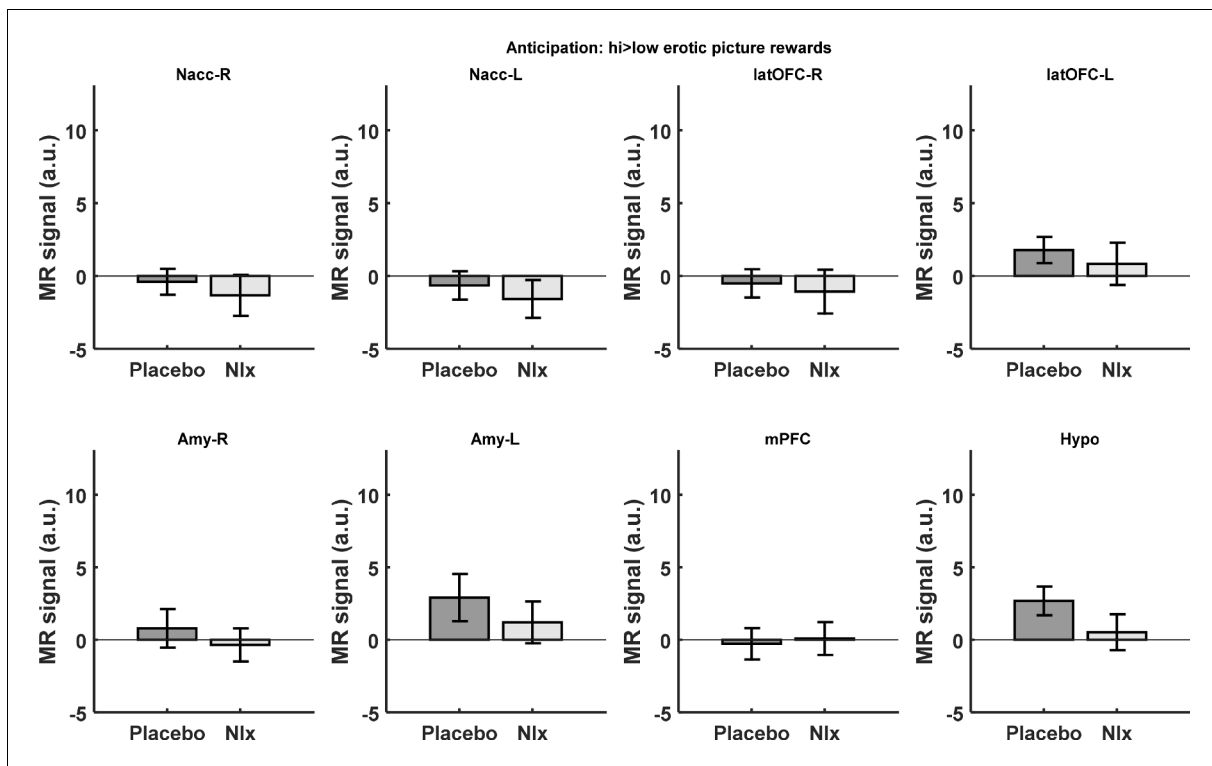


Figure 4—figure supplement 4. Region of interest contrasts of brain activity for high versus low erotic picture reward anticipation for placebo and naloxone treatment.

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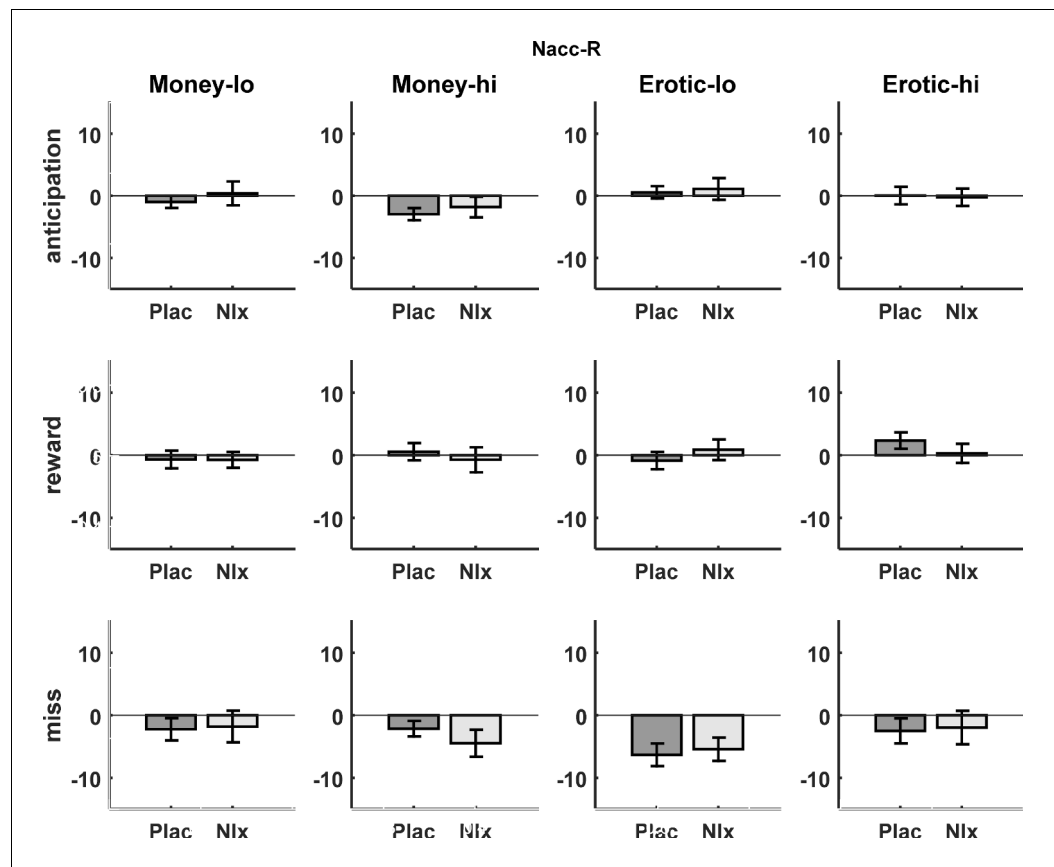


Figure 4—figure supplement 5. Right ventral striatum (nucleus accumbens) fMRI responses (arbitrary units) for all stimuli (money/erotic, high/low) and time-points (anticipation, outcome: reward, outcome: miss) under placebo (Plac) and naloxone (Nlx). Error bars represent standard error of the mean.

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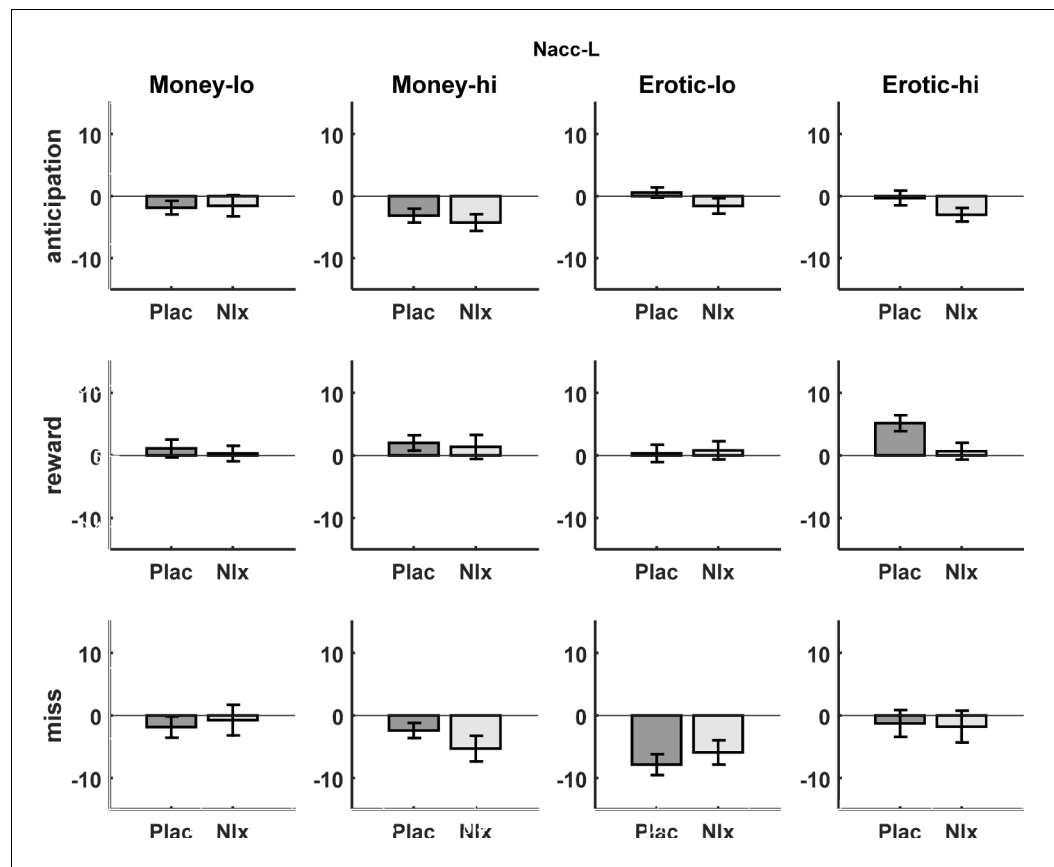


Figure 4—figure supplement 6. Left ventral striatum (nucleus accumbens) fMRI responses (arbitrary units) for all stimuli (money/erotic, high/low) and time-points (anticipation, outcome: reward, outcome: miss) under placebo (Plac) and naloxone (Nlx). Error bars represent standard error of the mean.

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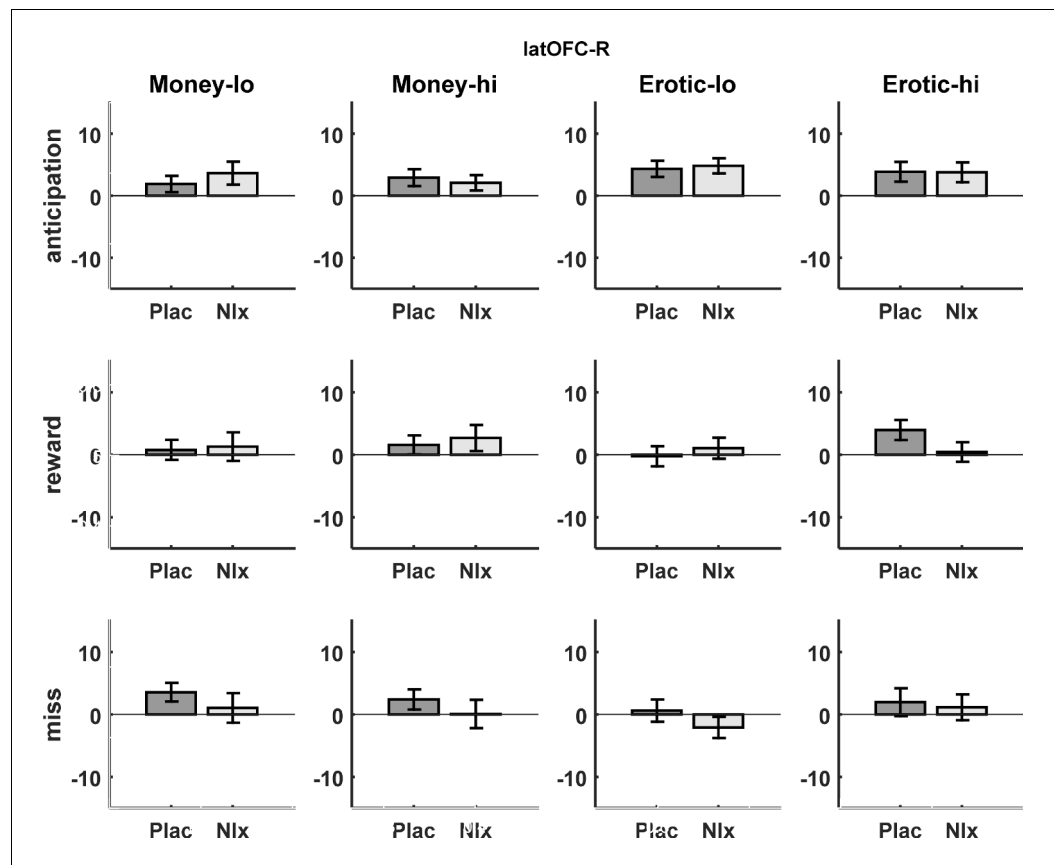


Figure 4—figure supplement 7. Right lateral orbitofrontal cortex fMRI responses (arbitrary units) for all stimuli (money/erotic, high/low) and time-points (anticipation, outcome: reward, outcome: miss) under placebo (Plac) and naloxone (Nlx). Error bars represent standard error of the mean.

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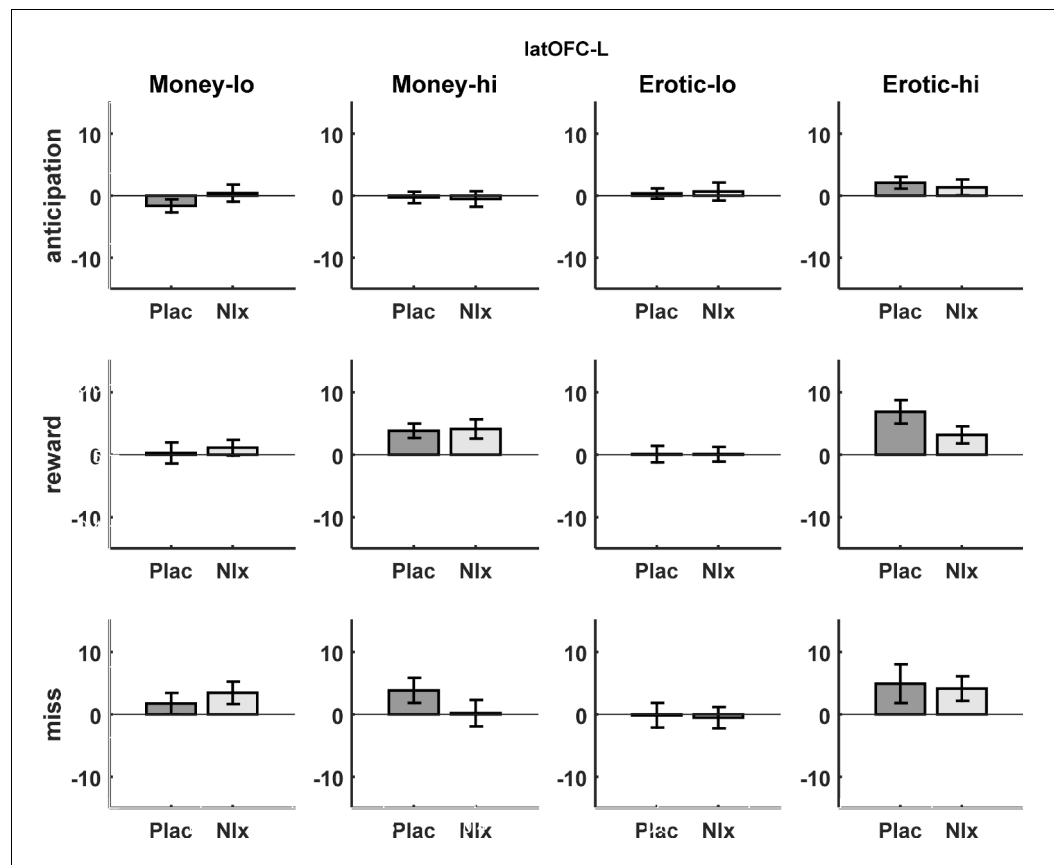


Figure 4—figure supplement 8. Left lateral orbitofrontal cortex fMRI responses (arbitrary units) for all stimuli (money/erotic, high/low) and time-points (anticipation, outcome: reward, outcome: miss) under placebo (Plac) and naloxone (Nlx). Error bars represent standard error of the mean.

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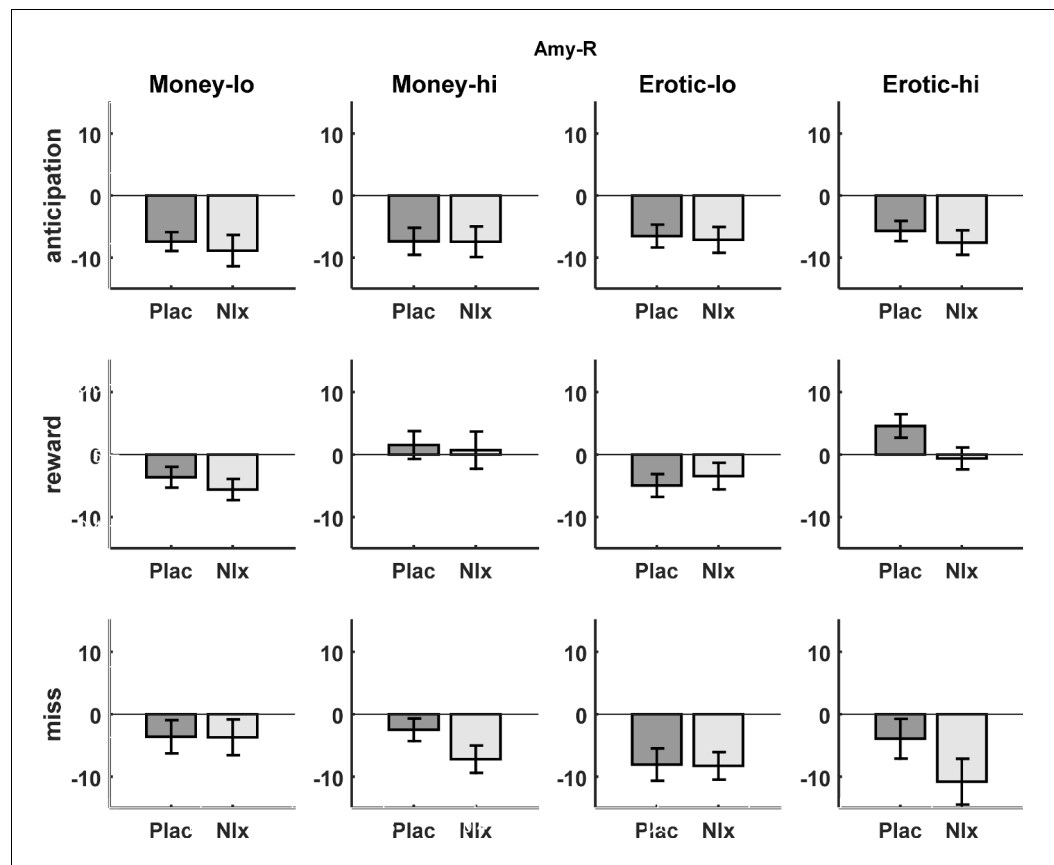


Figure 4—figure supplement 9. Right amygdala fMRI responses (arbitrary units) for all stimuli (money/erotic, high/low) and time-points (anticipation, outcome: reward, outcome: miss) under placebo (Plac) and naloxone (Nlx). Error bars represent standard error of the mean.

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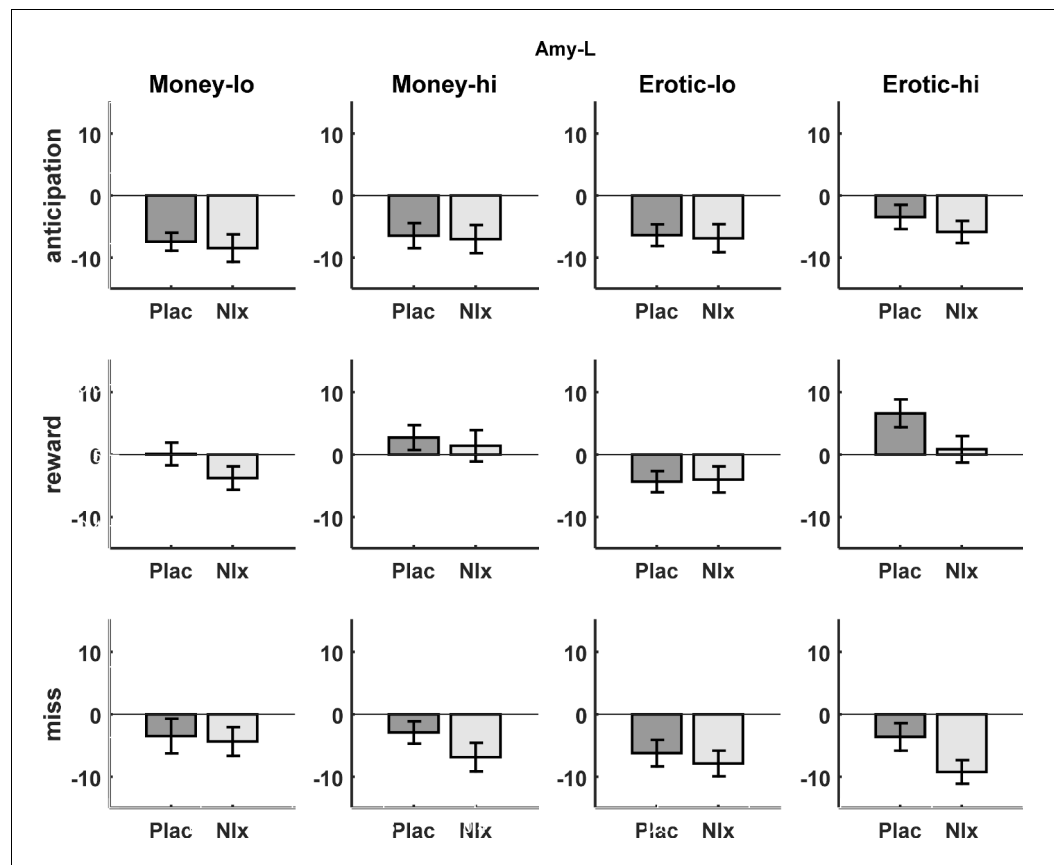


Figure 4—figure supplement 10. Left amygdala fMRI responses (arbitrary units) for all stimuli (money/erotic, high/low) and time-points (anticipation, outcome: reward, outcome: miss) under placebo (Plac) and naloxone (Nlx). Error bars represent standard error of the mean.

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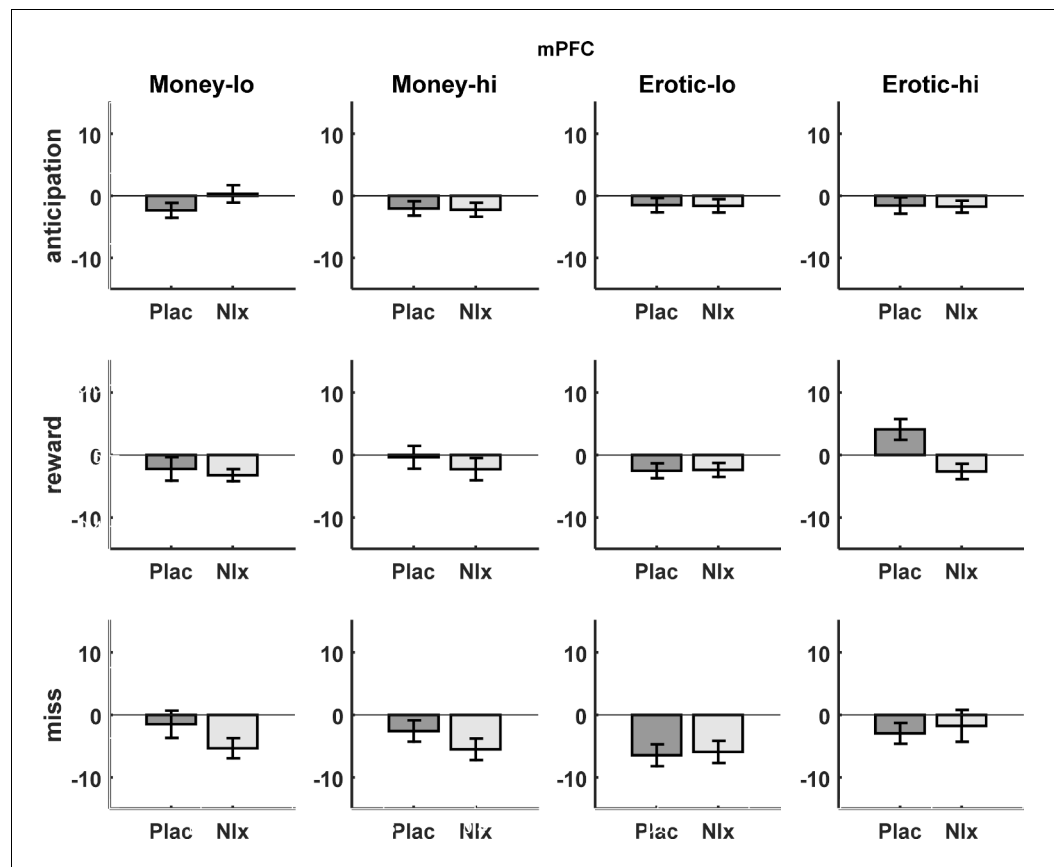


Figure 4—figure supplement 11. Medial prefrontal cortex fMRI responses (arbitrary units) for all stimuli (money/erotic, high/low) and time-points (anticipation, outcome: reward, outcome: miss) under placebo (Plac) and naloxone (Nlx). Error bars represent standard error of the mean.

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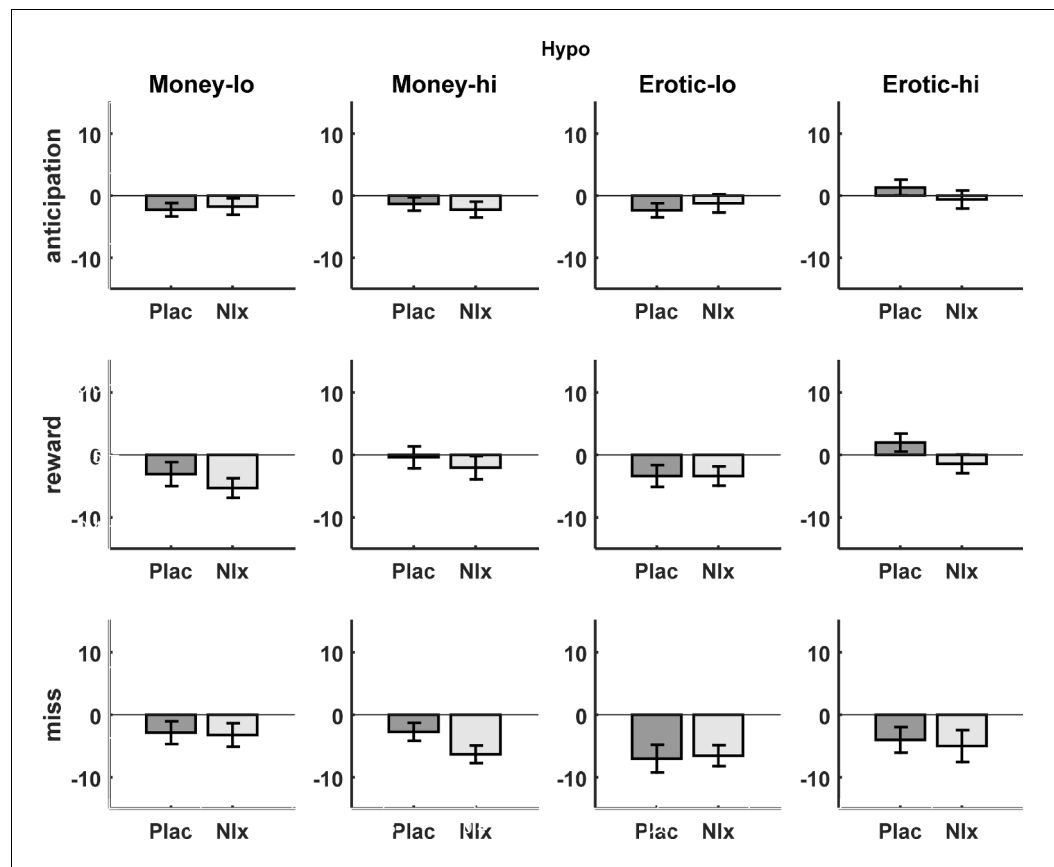


Figure 4—figure supplement 12. Hypothalamus fMRI responses (arbitrary units) for all stimuli (money/erotic, high/low) and time-points (anticipation, outcome: reward, outcome: miss) under placebo (Plac) and naloxone (Nlx). Error bars represent standard error of the mean.

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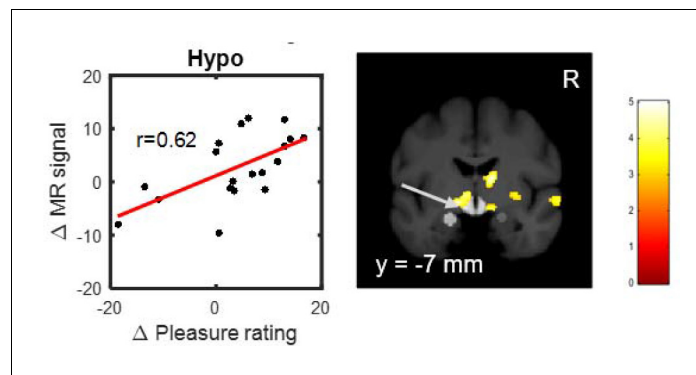


Figure 5. Positive correlation between naloxone induced decreases in fMRI signal in the hypothalamus and decreases in ratings for erotic rewards. The more naloxone reduced fMRI signal comparing high versus low erotic rewards during outcome, the more the rating difference between high and low erotic rewards was reduced (See also Table S10). Activations showing this correlation at $p < 0.005$ (uncorrected, t-test) are overlaid on a mean structural image also indicating the predefined volumes of interest (light gray) in the hypothalamus and amygdala.
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