Supplementary Material

Additional Results

A secondary aim of our study was to examine potential interactions between the effects of conceptual conditioning and the level of explicit information about cue meaning. Previous studies have shown that prior instructions about abstract cue-outcome associations can bias feedback-based learning of these association (e.g., Biele, Rieskamp, & Gonzalez, 2009; Doll, Jacobs, Sanfey, & Frank, 2009), whereas the presence of reliable information about each upcoming outcome can block feedback-based learning as well as striatal prediction-error signals thought to underlie this form of learning (Li, Delgado, & Phelps, 2011). To examine potential instruction by conditioning interactions on pain, we combined conditioning for different pairs of CS_{high} and CS_{low} cues with either (i) no instructions; (ii) one-time valid instructions about the CS-heat associations, provided before conditioning; or (iii) valid instructions about the upcoming heat level during each conditioning trial.

Effects of explicit instructions in the conditioning phase

Participants' heat predictions asymptoted closer to the actual average displayed heat levels (horizontal lines in Figure 2A in the main text) in the no-instruction condition than in the two instruction conditions. A regression analysis on the average heat predictions during the last 5 conditioning trials revealed that the CS effect (CS_{high} vs. CS_{low}) was larger in the instruction conditions than in the no-instruction condition (CS type x [No instruction vs. Instruction] interaction, $p = .05$), indicating over-prediction in the instruction condition. The CS effect did not differ between the two instruction conditions (CS type x [One-time-instruction vs. Per-trial

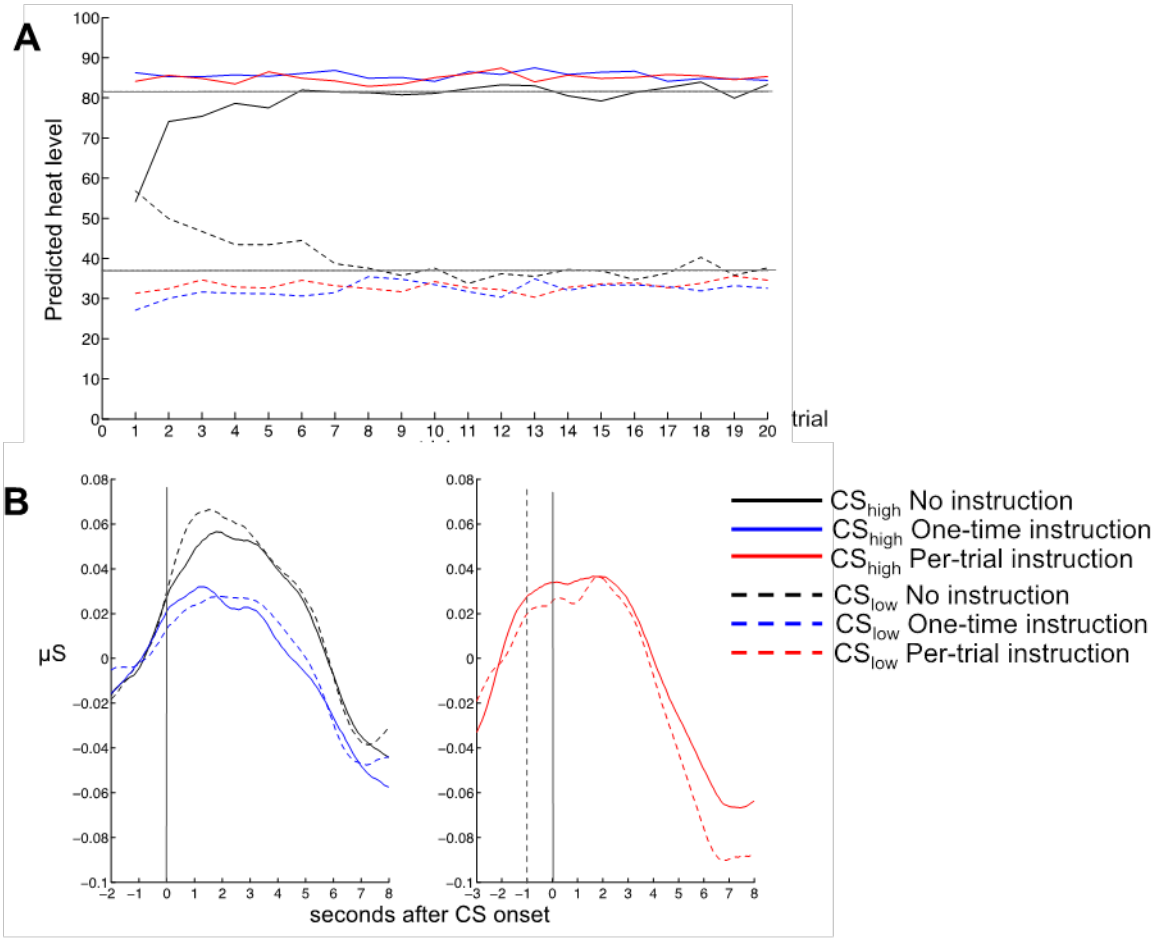
instruction] interaction, p = .20). Thus, explicit instructions about the heat levels—provided either before or during conditioning—resulted in over-prediction of these heat levels.

Effects of explicit instructions in the test phase

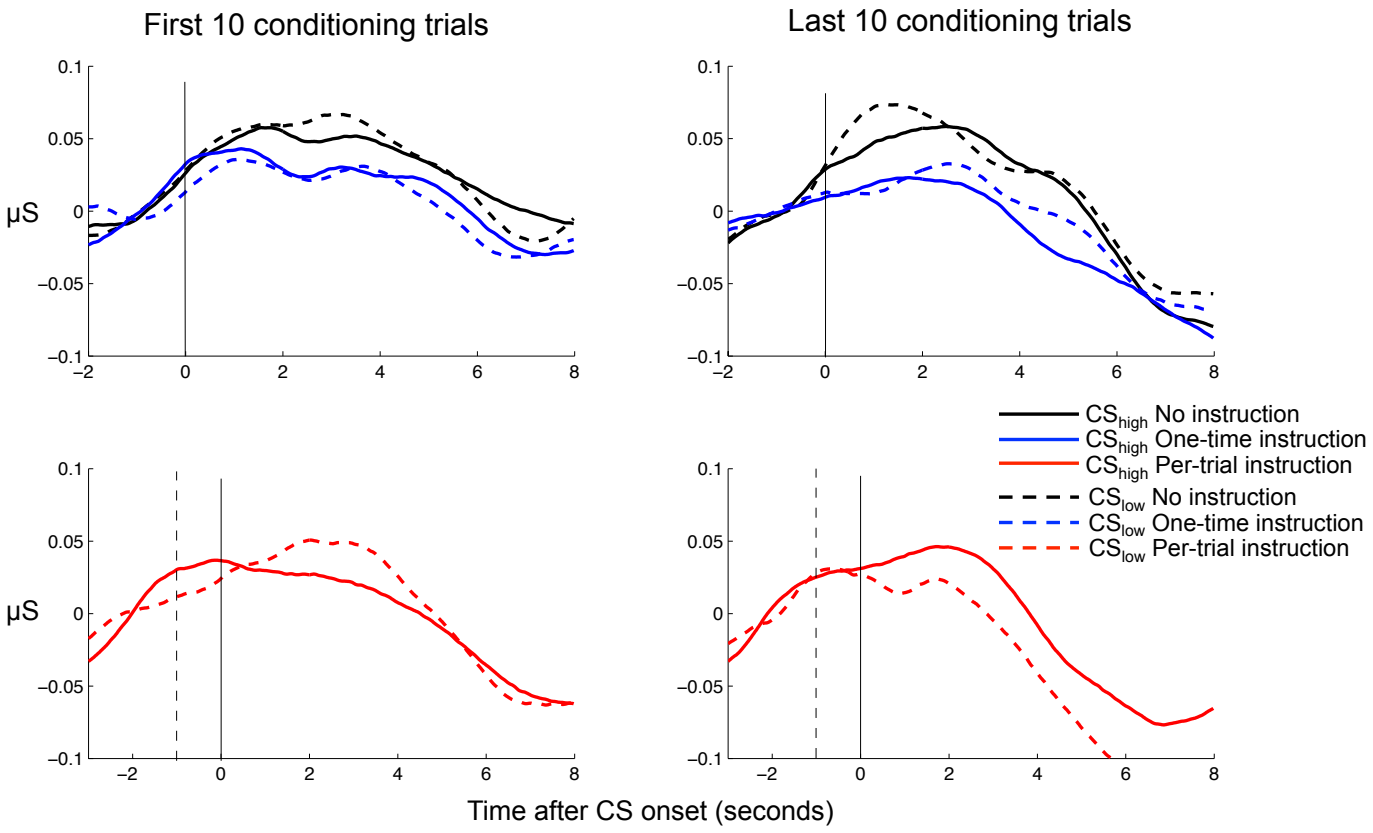
Heat-evoked SCRs and pain ratings were significantly higher on CS_{high} than CS_{low} trials for all instruction conditions. The CS effect on heat-evoked SCRs did not differ between the instruction conditions (CS x instruction interactions, p's > .3). There was an interaction between instruction condition and CS type on self-reported pain though, reflecting that the CSs which associated heat levels had been instructed to participants prior to conditioning and the words HIGH vs. LOW had the largest effects on self-reported pain (Table S2; see also CS x Instruction interactions in Table 1 in the main text). Note that the words LOW and HIGH contained explicit information about heat levels *and* had been repeatedly paired with high and low heat levels during the conditioning phase; hence their effects are hard to interpret.

Thus, one-time valid instructions about CS-heat associations provided prior to conditioning seemed to boost the conditioned modulation of self-reported pain, but not of pain-evoked SCRs. We did not find evidence that pairing a CS with explicit outcome information during conditioning diminished the capacity of that CS to modulate subsequent pain. This may be related to the fact that the CS and the explicit heat information were presented sequentially rather than simultaneously—unlike in Li et al.'s, 2011, study—so that the explicit information did not necessarily interfere with the processing of the CS.

Supplementary Figure 1. Conditioning results. **A.** Mean expected-heat ratings, as a function of CS-specific trial, CS type (CS_{high} = straight, CS_{low} = dotted lines) and instruction condition. The horizontal gray lines indicate the average displayed heat levels on CS_{high} and CS_{low} trials. **B.** Grand average CS-evoked SCR, as a function of CS type and instruction condition. The vertical dotted line in the right panel indicates the onset of the word LOW or HIGH in the per-trial instruction condition. Note that the skin-conductance level started to rise before CS onset, likely reflecting the anticipation of the CS. This makes it hard to define the SCR onset but, since the different conditions were presented in a random and unpredictable order, does not preclude a comparison of SCR amplitudes across conditions.



Supplementary Figure 2. Grand average CS-evoked SCR in the first (left panels) and second (right panels) half of the conditioning phase. The vertical dotted lines in the lower panels indicate the onset of the word “LOW” or “HIGH” in the per-trial instruction condition.



Supplementary Figure 3. Grand average thermometer-evoked SCR in the conditioning phase, separately for thermometers displaying high and low heat levels. Note that the decrease in skin-conductance signal before/at thermometer onset likely reflects the downward phase of the SCR to the preceding CS.

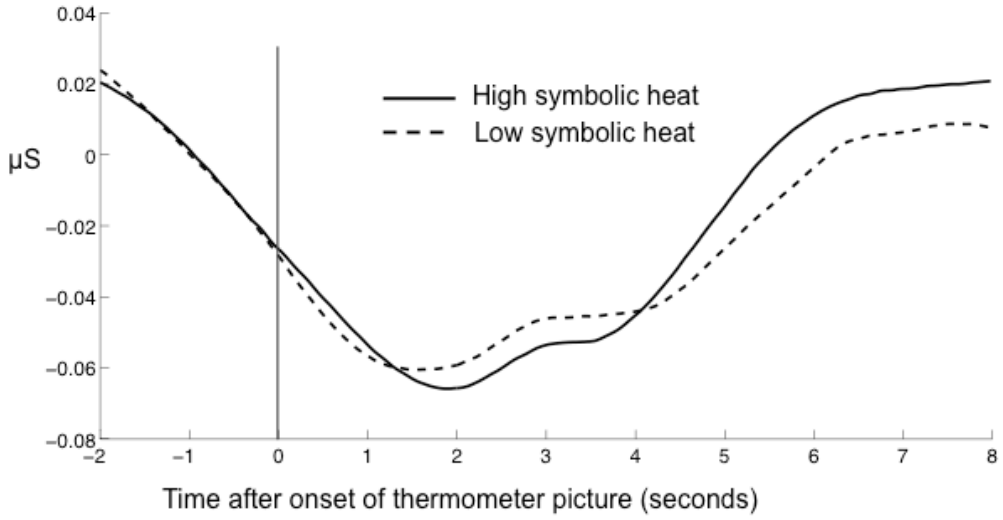


Table S1. Predictors of expected-heat rating and SCRs in the conditioning phase

	Coefficient	STE	Cohen's *d*	*t*	*p*
Expected-heat rating					
Intercept	59.1	0.34	34.09	171.4	< 0.001
CS (CS_{high} > CS_{low})	24.3	0.57	8.36	42.9	< 0.001
CS x Trial L	0.19	0.05	0.75	4.13	< 0.001
CS x Trial Q	-0.04	0.01	0.78	5.7	< 0.001
CS x Trial L x [No-instruction > Instruction]	0.49	0.05	1.92	10.3	< 0.001
CS x Trial Q x [No-instruction > Instruction]	-0.08	0.05	0.31	8.9	< 0.001
CS-evoked SCR					
Intercept	0.22	0.04	1.08	5.6	< 0.001
No-instruction > Instruction	0.01	0.005	0.39	2.7	0.01
Thermometer-evoked SCR					
Intercept	0.2	0.04	0.98	5.1	< 0.001
Trial L	0.0006	0.0002	0.59	2.9	0.009

Note. L = linear effect; Q = quadratic effect; STE = standard error

Table S2. Mean expected and experienced pain ratings in the test phase (standard errors of the mean in parentheses), as a function of CS type, instruction condition, and stimulus temperature. The CS effects (CS_{high} – CS_{low}) are shown as well; these were highly significant in all conditions (all *p*'s < .001). Note that pain-expectancy ratings were made before heat onset, hence did not differ as a function of temperature.

Pain-expectancy rating			
	CS_{low}	CS_{high}	CS effect
No instruction	28.8 (2.2)	49.2 (3.9)	20.4 (2.8)
One-time instruction	25.6 (2.2)	50.5 (3.8)	24.9 (2.5)
Per-trial instruction	28.9 (2.4)	48.3 (3.5)	19.4 (2.7)
Word (LOW/HIGH)	24.8 (2.2)	51.5 (3.9)	26.7 (2.9)

Pain rating	47°C			48°C		
	CS_{low}	CS_{high}	CS effect	CS_{low}	CS_{high}	CS effect
No instruction	30.7 (2.7)	41.5 (3.6)	10.8 (2.0)	36.1 (3.1)	47.8 (4.0)	11.7 (2.2)
One-time instruction	29.1 (2.7)	41.8 (3.6)	12.7 (1.9)	33.8 (2.7)	48.9 (4.0)	15.1 (2.1)
Per-trial instruction	31.1 (2.8)	40.8 (3.4)	9.7 (2.2)	36.2 (3.2)	47.4 (3.8)	11.2 (1.8)
Word (LOW/HIGH)	28.5 (2.6)	41.8 (3.5)	13.3 (1.8)	32.8 (2.7)	49.0 (4.1)	16.2 (2.2)