Supplementary Material

Extinction of Conditioned Fear is Better Learned and Recalled in the Morning

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Supplementary Methods

Participants

Exclusion criteria included any current neurological, psychiatric or medical conditions. Excluded also were persons with any history of seizures, significant head trauma, diagnosed DSM IV Axis I mental disorder or sleep disorder. Additional exclusion criteria included current use of any sleep-altering drugs, average sleep per night <6 or >10 hours, inability or unwillingness to keep a regular sleep schedule, cigarette smoking, and excessive caffeine or alcohol consumption. Excessive caffeine consumption was defined as self-report of >5 cups or glasses of caffeine-containing beverage per day. In actuality, 24% reported not drinking caffeine, 28% reported less than 1/day, 22% reported 1/day, 10% 1-2/day, 4% 2/day, 2% 2-3/day and 4% 3-4/day with data unavailable from 6%. For purpose of covariance, any weekly caffeine use at < 1cup/day was scored as 0.5/day and ranges were averaged (e.g., 1-2/day=1.5/day). Excess alcohol consumption was defined as self-report of >12 drinks per week or of problems with alcohol or drug abuse. A 23-item telephone-screening questionnaire specifically addressed each exclusion criterion. Of a total of 121 individuals accepted into the study, 2 withdrew, 3 failed to acquire conditioning, 3 were unable to return for the second session, and data from 4 were excluded due to problems with recording. Therefore the final sample size was 109. Extinction Learning data from 1 additional individual in the 12-hr Sleep group was lost due to recording problems but his other data were analyzed. All except 12 of these 109

male participants were paid for their participation. Nine Sleep-First and 3 Wake-First subjects participated for academic credit and were required to follow study restrictions on only the 2 study days and the prior day and night.

Actigraphy

Actigraphic monitoring used the Actiwatch 2 and Actiware CT software (Philips Respironics, Bend, OR).

Evening-Morning Sleep Questionnaire (EMSQ)

The evening portion of the Evening/Morning Sleep Diary (Pace-Schott et al. 2005) contains queries concerning daytime napping, caffeine or drug intake and exercise. Morning portions query subjects about sleep and awakening times, subjective sleep onset latency and total sleep time as well as number and duration of nocturnal awakenings. Participants use visual analog scales to rate daytime alertness (in evening) and quality and depth of sleep as well as alertness and restedness (in morning).

Unconditioned stimuli

Participant chose a “highly annoying but not painful” shock level by receiving increasing intensities of a 0.5-sec mild electric shock (from 0.2 to 4.0 milliamperes) across up to 8 increments using a Coulbourn Transcutaneous Aversive Finger Stimulator (Coulbourn Instruments, Allentown, PA).

Conditioned stimuli (CS)

Stimuli were presented using SuperLab 4.0 (Cedrus Corporation, San Pedro, CA) on a Dell PC with a 17” monitor placed at approximately eye level. Participants sat in a

comfortable chair approximately 3' from the screen and were separated by a curtain from the experimenter.

Protocol

During Fear Conditioning, Extinction Recall and Fear Renewal phases, all 8 CS+Es were presented in a block (with 8 interspersed CS-s), as were all 8 CS+Us (with 8 interspersed CS-s). The order in which the blocked CS+Es and CS+Us were presented and colors assigned to be CS+E, CS+U and CS- were counterbalanced across subjects. In all phases, each trial lasted 9 seconds, with the context picture appearing initially alone for 3 seconds and then in combination with one of the CS+s or the CS- for an additional 6 seconds. The inter-trial interval (ITI), measured from CS offset to next context onset, averaged 15 sec and varied pseudo-randomly between 12 and 18 sec. Successive stimuli in each phase were arranged such that 2 CS+ or 3 CS- occurring in succession were infrequent occurrences compared to an alternation of a CS+ and CS- or just 2 CS- occurring in succession.

Skin conductance response

Skin conductance level (SCL) was recorded using the MP150 data acquisition unit (BIOPAC Systems, Inc., Goleta, CA) and BIOPAC AcqKnowledge 3.9.2 and 4.1.1 data acquisition software for the Macintosh. The BIOPAC GSR100C Electrodermal Activity Amplifier Module was connected to 2 BIOPAC EL504 disposable adhesive sensors separated by 10 mm and attached to the hypothenar surface of the non-dominant hand. Sampling rate was 2000 Hz. An event marker indicating the onset of each CS allowed precise synchronization of each stimulus onset with ongoing physiological recording. Square pulse event markers were transmitted from the PC to Acqknowledge via a PCI-DIO24 digital I/O card using a BIOPAC STP100C optical interface.

Salivary cortisol and testosterone

Saliva samples were obtained from 91 of 109 participants (missing: 1 Evening, 2 Sleep, 2 Wake, 10 Sleep-first, 3 Wake-First). Cortisol was assayed in the 86 of these individuals who also provided a usable baseline diurnal profile. Testosterone levels were obtained in 75 of these individuals. Saliva samples were obtained using the Salimetrics oral swab (Salimetrics, LLC, State College, PA). A diurnal profile of 6 samples was obtained during the pre-study week on one day that each participant self-selected to be their least physically active and/or stressful. Samples were taken immediately upon waking, exactly 30 min after awakening, at noon or just before lunch (whichever came first), 5:00 PM or just before dinner (whichever came first), 8:00 PM and 10:00 PM. Cortisol assays were performed singly (daily profile) or in duplicate samples (experimental sessions) that were averaged and reported in µg/dL. For salivary testosterone, only the first samples taken at Session 1 and Session 2 (before Habituation and Extinction Recall respectively) were assayed in duplicate, averaged and reported in pg/mL.

Statistical analyses

For simplicity, psychophysiological results are reported in terms of the main outcome variable, differential SCR. Please note, however, that higher differential SCR is indicative of greater fear and, hence, lower extinction learning and recall. Analyses were performed using SuperAnova (Abacus Concepts, Berkeley, CA).

Fear Conditioning

Fear Conditioning was compared using 3-factor ANOVA with 2 between-subjects (Time-of-Day at Session 1, assigned Delay) and 1 within-subject factor(Trial). Because at its

first presentation during Fear Conditioning each CS+ color had not yet been paired with a shock, data for the initial trial of each CS+ were not analyzed. Because the CS+E and CS+U were not yet differentiated, the means of their 2 respective trial-by-trial differential SCR values were analyzed. In other words, the Trial factor consisted of differential SCR means for 7 CS+ trials. Similarly, in the ANOVA to demonstrate differential conditioning, the means of the 2 CS+'s trial-by-trial non-differential SCRs as well as the trial-by-trial means of their 2 temporally corresponding CS-s were analyzed. Figure S1 compares morning and evening values for Fear Conditioning in the all-participant and time-congruent groupings as well as in the subset of all participants for whom initial responses in Extinction Learning were equated.

Extinction Learning

Extinction Learning was analyzed using the same 2 between-subjects factors (Time-of-Day at Session 1, assigned Delay). However the within-subject factor (Trial) consisted of mean differential SCR for 8 sequential pairs of CS+Es (i.e., mean of first and second CS+E, mean of third and fourth CS+E, etc.). Figure S1 compares morning and evening values for Extinction Learning in the all-participant and time-congruent groupings as well as in the subset of all participants for whom initial responses in Extinction Learning were equated.

Extinction Recall and Fear Renewal

Four-factor mixed ANOVA analyzed Extinction Recall in the time-congruent participant grouping. Two between-subjects factors included the Time-of-Day of Session 2 and the Delay (3 or 24 hr) between Session 1 and Session 2. The 2 within-subject factors were Trial nested within CS+Type (CS+E, CS+U). When this analysis was repeated with the

all-participants grouping, a third level of Delay (12 hr) was included. An identical 4-factor mixed ANOVA analyzed Fear Renewal.

Effects of self-report differences on Time-of-Day effects

Certain self-report measures were found to differ significantly ($p<.05$) by Time-of-Day in all-participant or time-congruent participant groupings (Supplementary Table 1). Each such measure was added, separately, as a covariate to only those ANOVAs that showed significant Time-of-Day main effects or interactions for differential SCR. Only the specific self-report differences found within each participant grouping were used as covariates in the ANCOVAs analyzing that grouping's differential SCR data.

Visual analog scales (VAS)

Mixed ANOVA analyses for retrospective shock expectancy, using the same between-subjects factors as for differential SCR, were performed using differential VAS scores reported for each phase. Instead of Trial, Position (First 2 trials, Last 2 trials) constituted the second within-subjects factor nested within CS+Type.

Salivary cortisol and testosterone

Analyses for Fear Conditioning and Extinction Learning used data from all participants providing complete samples (AUC-normalized cortisol: 44 morning, 42 evening; testosterone: 39 morning, 36 evening). Because Session 1 and Session 2 took place at different times of day in the 12-hr delay groups, analyses for Extinction Recall and Fear Renewal used only time-congruent participants (AUC-normalized cortisol: 26 evening, 29 morning; testosterone: 24 morning, 19 evening). To screen for relationships between hormone levels and differential SCR, normalized cortisol and testosterone levels, first separated into morning and evening values, were subjected to a median split to

generate high and low-hormone groups. Summary statistics for differential SCR at each of the 4 phases (e.g., mean differential SCR during Extinction Learning) were then compared between high and low-hormone individuals using unpaired t-tests. When a significant difference was found, mixed ANOVAs were computed with a single between subjects factor (High vs. Low hormone level) and a single within-subject factor (Trial). To minimize Type-1 error, only clearly significant ($p<.05$) t-test differences between high and low hormone, median-split-generated groups were thus analyzed.

Supplementary Results

Comparison of self-report measures between participants having Session 1 in morning versus evening within the 2 participant groupings.

Supplementary Table 1 compares self-report measures between the 2 times of day at Session 1 in all-participant and time-congruent groupings. Also compared are values for each of the 6 Time-of-Day x Delay duration subsets. PSQI in the all-participant grouping showed poorer sleep quality in those who had Session 1 in the evening. Also in the all-participant grouping, those who had Session 1 in the morning reported higher habitual daily caffeine consumption. In the time-congruent subsample, those who had Session 1 in the morning were significantly sleepier prior to Session 1 (i.e., higher SSS1). This difference was driven by the morning, 3-hr delay subjects who began Session 1 one hour earlier than the other participants who had Session 1 in the morning. In contrast, in in the all-participant grouping, those who had Session 2 in the evening were sleepier before (higher SSS3) and after (higher SSS4) Session 2 as were time-congruent participants at SSS4. This difference was driven by the evening, 3-hr delay participants whose Session 2 took place later than in the other participants who had Session 2 in the evening.

The most prominent Time-of-Day difference occurring in self-report measures was a shorter TSO before a morning session (see Results). TSO rather than actigraphic or diary estimates of total sleep time (TST) were used to compare participant groups because, within-subject, TSO and TST measures were expected to be tightly inter-correlated. Therefore all 3 estimates represent equivalent covariate measures. When a lights-out or wake-up time was omitted on the EMSQ, the time was obtained from that subject's corresponding event mark in actigraphic data.

Effects of Delay

Session 1: Fear Conditioning

In the all-participant grouping, there was a main effect trend for Delay [$F(2,103)=2.57$, $p=.095$] with those destined to undergo the 24-hr delay having smaller differential SCRs. There was also a significant Delay x Time-of-Day interaction [$F(2,103)=3.41$, $p=.037$] that resulted from a significant Delay main effect in the morning [$F(2,49)=4.13$, $p=.022$] but not the evening ($p=.19$). In the morning, mean differential SCR of those destined to undergo the 12-hr delay were higher than those who would undergo a 24-hr delay ($p=.008$). There were no Delay x Trial or Delay x Trial x Time-of-Day interactions ($p=.55$ and .91 respectively). In those destined to undergo the 2 time-congruent delays, the main effect trend for Delay remained [$F(1,69)=3.27$, $p=.075$, 3-hr delay greater] but there were no interactions of Delay with Time-of-Day, Trial, or Trial x Time-of-Day (.48, .91 and .65 respectively)

Session 1: Extinction Learning

At Extinction Learning in the all-participant grouping, differential SCR to the CS+E did not show a main effect for Delay [$F(2,102)=2.0$, $p=.14$] nor were there Delay x Trial or

Delay x Trial x Time-of-Day interactions (p=.34 and .73 respectively). In those destined to undergo the 2 time-congruent delays, there was a main effect trend for Delay [F(1,69)=3.70, p=.059, 3-hr delay greater] but no interactions of Delay with Time-of-Day, Trial, or Trial x Time-of-Day (p=.19, .18, and .72 respectively).

Session 2: Extinction Recall

In the all-participant grouping (Figure 2A), there was no Delay main effect [F(2,103)= 1.08, p=.34] nor did Delay interact with Time-of-Day, CS+Type, or Trial (.46, .79 and .55 respectively), or have any higher-order interactions. Addition of mean differential SCR at Fear Conditioning as a covariate (to control for the Delay x Time-of-Day interaction at Conditioning) did not change these results. In the time-congruent participant grouping, there was no main effect of Delay nor did Delay interact with Time-of-Day, CS+Type or Trial (p=.33, .73, .58 and .19 respectively), or have any higher-order interactions.

Session 2: Fear Renewal

At Fear Renewal in the all-participant grouping (Figure 2B), there was no Delay main effect [F(2,103)= 0.29, p=.75] nor did Delay interact with CS+Type or Trial (.19 and .49 respectively). There was an interaction trend for Delay x Time-of-Day [F(2,103)= 3.07, p=.051] that resulted from a significant Time-of-Day main effect in the 3-hr delay [F(1,34)= 5.16, p=.03], a trend for the 24-hr delay [F(1,35)= 3.55, p=.07] but no effect in the 12-hr delay (p=.33). There were no higher-order interactions with Delay nor did addition of mean differential SCR at Conditioning as a covariate change these results. In the time-congruent participant grouping, there was no main effect of Delay nor did Delay interact with Time-of-Day, CS+Type or Trial (p=.92, .91, .30 and .33 respectively), or have any higher-order interactions.

Effects of Time-of-Day

Extinction Learning

At Extinction Learning in the all-participant grouping, there was a trend toward higher differential SCR in the evening [F(1,102)=3.56, p=.062] that was significant among those destined to undergo the 2 time-congruent delays [F(1,69)=6.07, p=.016]. Similarly, there was a trend toward a Time-of-Day x Trial interaction both among all participants [F(7,714)=1.91, p=.074] and those destined to have time-congruent delays [F(7,483)=1.99, p=.063]. In both participant groupings, this interaction resulted from significant Time-of-Day differences being present for differential SCR at the first (p=.002 and .004 respectively) and fifth (p=.037 and .023 respectively) pairs of CS+E trials, but not at the other pairs. Both groupings showed significant main effects of Trial ([F(7,714)=3.89, p=.0006] and [F(7,483)=2.28, p=.033] respectively. However, because the Time-of-Day main effect trend was driven by the initial pair of Extinction Learning trials, differential habituation during the Fear Conditioning phase could have produced the difference seen at Extinction Learning. Therefore a subset of participants among whom the first pair of extinction trials were equalized, rather than the entire sample, was analyzed as detailed in Results.

Time-of-Day effects separated by Delay duration

At Fear Conditioning, none of the delay durations showed a Time-of-Day effect when analyzed separately: 3 hr [F(1,34)=1.71, p=.20], 12-hr [F(1,34)=3.78, p=.06] and 24-hr [F(1,35)=0.32, p=.58]. It is notable that the trend-level difference in the 12-hr group reflected higher responses in the morning. Therefore there was no evidence of lower fear acquisition in the morning.

At Extinction Learning, a main effect of Time-of-Day (better extinction learning in the morning) appeared in the 3 hr [F(1,34)=5.34, p=.027] but not in the 12-hr [F(1,33)=0.01, p=.92] or 24-hr [F(1,35)=0.96, p=.33] delay durations. However, examining only those in the upper half of a median split based upon the mean differential SCR of first two trials of Extinction Learning (excluding the first trial pairs that were equated), better extinction learning in the morning remained significant in the entire sample [F(1,52)=11.12, p=.002] as well as in the 3-hr delay duration [F(1,20)=5.64, p=.028], as well as a trend in the 12-hr [F(1,18)=3.25, p=.088] and the 24-hr [F(1,10)=3.54, p=.089] delay durations. Therefore, when examining only those who displayed the greatest fear acquisition (as indexed by median split of the first pair of extinction trials), better extinction learning in the morning was evident in groups destined to undergo all 3 delay durations.

At Extinction Recall, a main effect of Time-of-Day appeared in time-congruent-delay groups analyzed separately by delay duration: 3 hr [F(1,34)=4.11, p=.051] and 24-hr [F(1,35)=6.65, p=.014]. This effect was driven by significantly greater SCR to the CS+U: 3-hr (p=.04), 24-hr (p=.025). Notably, however, following the 12-hr delay, the Time-of-Day main effect was not significant [F(1,34)=0.95, p=.36].

At Fear Renewal, a significant main effect of Time-of-Day again appeared in time-congruent-delay groups analyzed separately by delay duration: 3-hr delay [F(1,34)=5.16, p=.03] and was a trend in the 24-hr group [F(1,35)=3.55, p=.07]. However following the 12-hr delay, the Time-of-Day main effect was again not significant [F(1,34)=0.96, p=.33].

Effects of self-report differences on Time-of-Day effects

Extinction Learning among the upper half in the median split of the first pair of trials (see Results), continued to be superior in the morning after co-varying PSQI, SSS1 or TSO

on the night prior to Session 1, or estimated daily caffeine (p=.006, .002, .018, and .003 respectively).

At Extinction Recall in the time-congruent participant grouping, superior Extinction Recall in the morning was unchanged by co-varying PSQI [F(1,68)=8.62, p=.005], SSS4 [F(1,68)=12.47, p=.0008] or estimated daily caffeine [F(1,63)=6.93, p=.01]. The Time-of-Day x CS+Type interaction was similarly unchanged for PSQI [F(1,68)=4.06, p=.048], SSS4 [F(1,67)=5.00, p=.029] and estimated daily caffeine [F(1,63)=3.74, p=.0.058] indicating that it remained the response to the CS+U that drove this Time-of-Day main effect. At Extinction Recall in the 24-hr delay participants alone (who were the only time-congruent participants who slept between sessions), the main effect of Time-of-Day was significant F(1,35)=6.65, p=.014] and remained at a trend level F(1,34)=3.93, p=.056] after co-varying the TSO between sessions.

At Fear Renewal, in the time-congruent participant grouping, superior Extinction Recall in the morning was unchanged by co-varying PSQI [F(1,68)=9.50, p=.003], SSS4 [F(1,68)=11.07, p=.001] or daily caffeine [F(1,63)=6.80, p=.011]. At Fear Renewal in the 24-hr delay participants, the main effect of Time-of-Day was a trend [F(1,35)=3.55, p=.068] and remained so after co-varying the TSO between sessions [F(1,34)=3.11, p=.087].

Salivary hormone correlates of differential SCR

When the above median-split based screening was performed on normalized cortisol values obtained before and after each session as well as on testosterone and T/C ratio values obtained solely before each sessions (testosterone values being expected to

change little across session), only high vs. low morning T/C ratio values showed a significant difference in SCR and this was the case only for mean SCR across the Extinction Phase. Therefore, only the Extinction Phase SCR values were further analyzed using mixed ANOVA. Results from this analysis are provided in the main article.

Two findings in addition to those reported in Results were notable. First, in one of the few studies in which fear conditioning was related to *endogenous* cortisol specifically in males, it was reported that higher cortisol predicted better fear acquisition (Zorawski *et al.*, 2006). If the first 4 Extinction Learning trials are considered to be an index of acquisition of conditioning during the immediately preceding Fear Conditioning phase, then current results within morning data replicate these findings [$F(1,42)=5.75$, $p=.021$]. Second, levels of salivary testosterone were highly positively correlated with concurrent levels of cortisol (Table 1).

Time-of-Day effects in a sample of females compared with males

In the subsample of females described above, there was no significant main effect of Delay nor did Delay interact with Time-of-Day therefore the full sample of 41 was analyzed. In females, there was no significant Time-of-Day main effect or Time-of-Day x Trial interaction at any of the experimental phases.

Females (who were all time-congruent) were compared to the time-congruent grouping of males. At *Fear Conditioning,* there was no Sex main effect or interaction with Time-of-Day. However, at *Extinction Learning*, there was a Sex main-effect trend [$F(1,110)=3.70$, $p=.057$] with males showing larger SCRd (poorer extinction). At *Extinction Recall,* there was no main effect of Sex ($p=.15$) or Sex x Time-of-Day interaction ($p=.15$), however,

there was a Sex x Time-of-Day x CS+Type 3-way interaction trend [F(1,110)=3.37, p=.069] that resulted from a much greater difference between the CS+E and the CS+U in males in the evening. At *Fear Renewal*, there was a significant Sex x Time-of-Day interaction F(1,109)=4.24, p=.042] with males, but not females, showing higher responses (greater fear renewal) in the evening.

All the above Sex main effects and interactions, however, were driven by the Evening group males. When the 24-hr (Sleep-First vs. Wake-First) or the 3-hr (Evening vs. Morning) delays were analyzed separately, the above Sex main effects and interactions no longer reached significance. Nonetheless, the Sex x Time-of-Day interaction remained a trend in the 24-hr delay at Fear Renewal [F(1,61)=2.77, p=.1].

Figure S1.

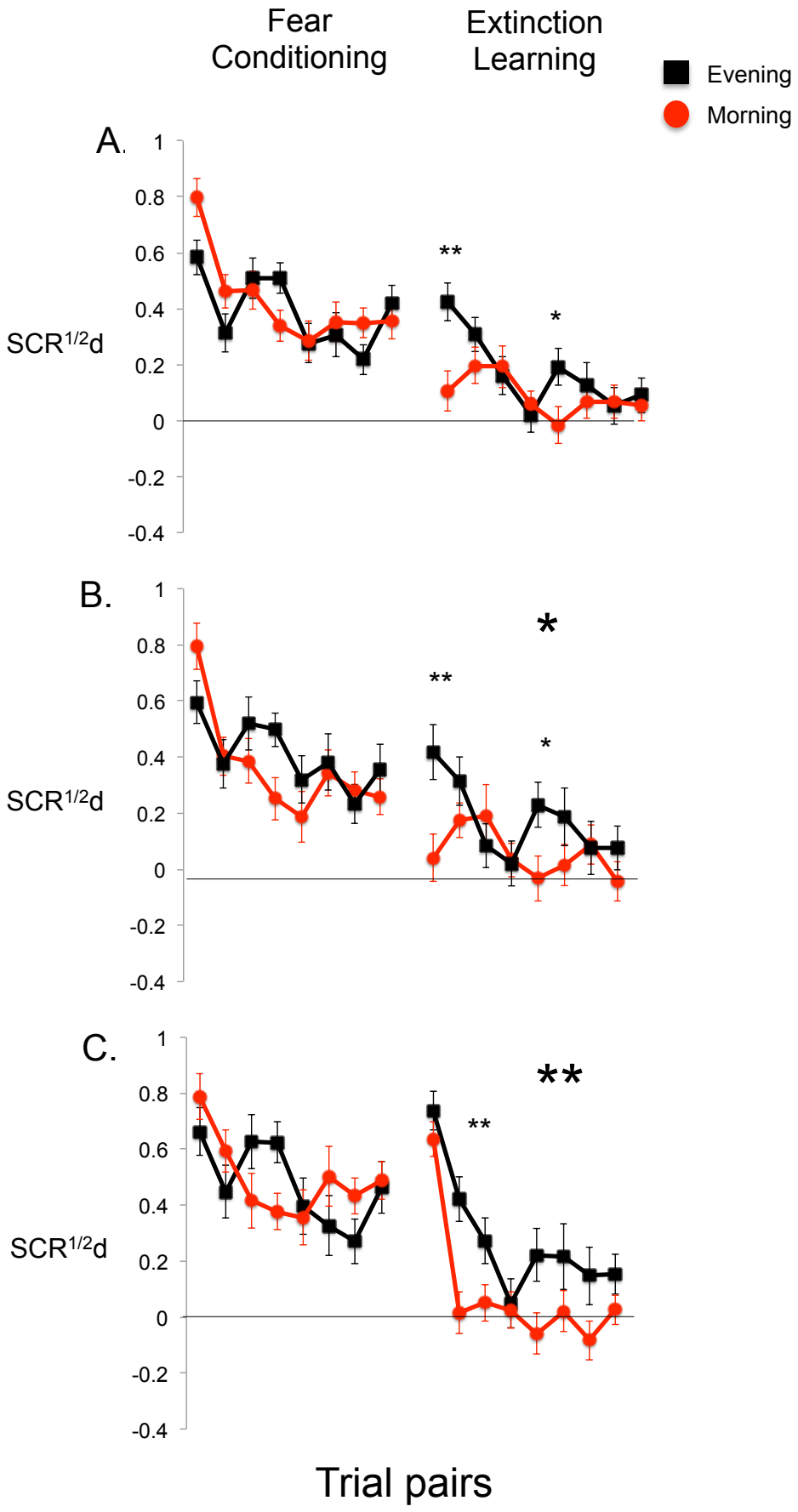
Extinction was significantly better learned in the morning whereas Fear Conditioning did not differ between morning and evening. A. Fear conditioning and Extinction learning phase data from the all-participant grouping. B. Fear conditioning and Extinction learning phase data from the time-congruent grouping. C. Fear conditioning and Extinction learning phase data when the starting point of Extinction Learning was equated by examining the upper half of a median split based upon the mean differential SCR of first two trials of Extinction Learning (N=33 evening, 21 morning). Each data point represents the mean differential SCR to two successive CS+s. During Fear Conditioning, these were trial-by-trial averages of the 2 different CS+s (i.e., mean of first to-be CS+E and first to-be CS+U, mean of second to-be CS+E and second to-be CS+U, etc.). During Extinction Learning, data points are means for successive pairs of CS+Es. Significance indicated for the Time-of-Day main effect (large asterisks) and trial-by-trial (small asterisks). SCR1/2d: differential SCR, * $p < .05$, ** $p < .01$. Large asterisks indicate main

effects of Time-of-Day in mixed ANOVA with 8 trial pairs and small asterisk indicates post-hoc comparison of an individual trial pair. Error bars depict standard error of the mean.

Supplementary Table 1. Mean self-report measures from each group, time-congruent (3 and 24-hr delay) participants and all participants.

Session 1		**Morning**			**Evening**			**F**	**p**
Session 2	**Morning**		**Evening**	**Evening**		**Morning**			
Time-of-Day	**Morning**	**Wake-1st**	**Wake**	**Evening**	**Sleep-1st**	**Sleep**			
Delay	**3 hr**	**24 hr**	**12 hr**	**3 hr**	**24 hr**	**12 hr**			
N: Time/Delay	17	18	17	19	19	17			
N: Time congruent	35			38					
N: All participant	52			55-57					
Age: Time/Delay	21.7	20.8	20.2	21.2	20.8	20.2		.88	ns
Age: Congruent	21.2			21.0				.67	ns
Age: All participant	20.7			20.9				.69	ns
ESS: Time/Delay	6.7	6.2	7.3	6.4	8.9	7.7		1.82	ns
ESS: Congruent	6.4			7.6				3.39	.07
ESS: All participant	6.7			7.7				2.24	ns
PSQI: Time/Delay	4.1	3.3[a]	3.6	4.5	5.7[a]	3.5		2.71	.02
PSQI: Congruent	3.7			5.1				5.91	.02
PSQI: All participants	3.6[a]			4.6[a]				4.34	.02
MEQ: Time/Delay	44.8	45.7	43.8	45.4	46.6	41.0		1.03	ns
MEQ: Congruent	45.2			46				.17	ns
MEQ: All participant	44.8			44.5				.03	ns
SSS1: Time/Delay	3.1[a]	2.3	2.8	2.1[a]	2.4	2.7		2.65	.03
SSS1: Congruent	2.7			2.3				3.81	.05
SSS1: All participant	2.8			2.4				3.01	.09
SSS2: Time/Delay	3.8	2.8	2.9	3.3	3.7	4.0		2.31	.05
SSS2: Congruent	3.3			3.5				.47	ns
SSS2: All participant	3.2			3.7				3.72	.06
SSS3: Time/Delay	2.3	2.7	2.0[a]	3.2	2.5	3.5[a]		3.38	.007
SSS3: Congruent	2.5			2.9				1.50	ns
SSS3: All participant	2.4[a]			3.1[a]				8.24	.005
SSS4: Time/Delay	3.3	2.9	3.1	4.1	3.6	3.9		1.62	NS
SSS4: Congruent	3.1[a]			3.8[a]				4.00	.05
SSS4: All participant	3.1[a]			3.9[a]				6.89	.01
TSO D0: Time/Delay	437[a]			506[a,b]		422[b]		10.79	.0001
TSO D0: Congruent	436[a]			506[a]				10.20	.003
TSO D0: All participant	437			464				1.97	ns
TSO D-1: Time/Delay	369[a,b,c]	439	422	495[a]	501[b]	487[c]		6.42	.0001
TSO D-1: Congruent	406[a]			498[a]				20.05	.0001
TSO D-1: All participant	411[a]			494[a]				25.07	.0001
TSO D-2: Time/Delay	452	498	508	508	481	495		.92	.ns
TSO D-2: Congruent	475			495				.73	ns
TSO D-2: All participant	486			495				.25	ns
Caffeine: Time/Delay	.82	.97	1.19	.74	.47	.69		1.78	ns
Caffeine: Congruent	.91			.60				3.18	.08
Caffeine: All participant	1.0[a]			.63[a]				6.00	.02
EtOH: Time/Delay	3.00	3.72	3.38	4.65	2.92	3.81		.57	ns
EtOH: Congruent	3.41			3.76				.18	ns
EtOH: All participant	3.40			3.77				.31	ns

Lower case letters indicate significant differences within a row between entries sharing the same letter. ESS = Epworth Sleepiness Scale. PSQI = Pittsburgh Sleep Quality Index. MEQ = Morningness Eveningness Questionnaire. SSS Stanford Sleepiness Scale (beg. = beginning). TSO = EMSQ diary Total Sleep Opportunity (lights out until time awakened) on: D0 = night between Sessions 1 and 2 (Sleep and 24-hr delay groups only); D1 = Night immediately before Session 1; D2 = two nights before Session 1. Caffeine = estimated habitual cups or glasses per day. EtOH = estimated habitual alcoholic drinks per week.


Fear Conditioning
Extinction Learning
Evening
Morning
A.
B.
C.
SCR1/2d
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
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Trial pairs