Dreading the pain of others? Altruistic responses to others' pain underestimate dread

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A dislike of waiting for pain, aptly termed 'dread', is so great that people will increase pain to avoid delaying it. However, despite many accounts of altruistic responses to pain in others, no previous studies have tested whether people take delay into account when attempting to ameliorate others' pain. We examined the impact of delay in 2 experiments where participants (total $N = 130$) specified the intensity and delay of pain either for themselves or another person. Participants were willing to increase the experimental pain of another participant to avoid delaying it, indicative of dread, though did so to a lesser extent than was the case for their own pain. We observed a similar attenuation in dread when participants chose the timing of a hypothetical painful medical treatment for a close friend or relative, but no such attenuation when participants chose for a more distant acquaintance. A model in which altruism is biased to privilege pain intensity over the dread of pain parsimoniously accounts for these findings. We refer to this underestimation of others' dread as a 'Dread Empathy Gap'.

Key words: dread, discounting, pain, social, empathy, altruism

In experiments most people choose to hasten, rather than delay, inevitable pain (Badia et al., 1966; Cook & Barnes, 1964), and will even increase the severity of pain to avoid delaying it (Berns et al., 2006; Loewenstein, 1987; Story et al., 2013). A preference to experience pain sooner rather than later implies that delayed pain is subjectively worse than immediate pain, and therefore runs contrary to the behavioral economic notion of delay discounting, which posits that delayed events carry less motivational force than immediate ones (Frederick et al., 2002; Loewenstein & Prelec, 1991; Rachlin

et al., 1986; Van Der Pol & Cairns, 2000). Existing theories have therefore explained choice of sooner pain as arising from a process distinct from delay discounting. Specifically, since anticipating pain is known to be aversive (Boucsein & Wendt-Suhl, 1976; Grillon et al., 1993; Hodges & Spielberger, 1966; Huang et al., 2017; Koyama et al., 1998; Ploghaus et al., 1999; Richard & Berridge, 2013), expediting pain can be seen as minimizing an unpleasant anticipation of pain, aptly termed *dread* (Berns et al., 2006; Chapman & Elstein, 1995; Harris, 2012; Story et al., 2013; Tanaka et al., 2014).

Despite empirical support for the existence of dread (Berns et al., 2006), no previous studies have formally examined whether people consider dread when evaluating *others'* pain. When offered an opportunity to relieve others' pain in experiments, people are highly altruistic (Fehr & Fischbacher, 2003; Hein et al., 2011; Jackson et al., 2005; Lloyd et al., 2004): Experimental participants will suffer pain for themselves to relieve pain in an anonymous other (Batson et al., 1981; Batson et al., 1983; Batson et al., 1988; Davis et al., 2015; Story et al., 2015), and will even pay more money to reduce the pain of another

participant than to reduce their own pain by a similar amount (Crockett et al., 2014; Crockett et al., 2015; Crockett et al., 2017). Furthermore, people are known to mount anticipatory responses to upcoming pain in others (Caes et al., 2012). These findings suggest people will also act to relieve others' dread—that is, people will choose to expedite others' pain when that pain is unavoidable. This has relevance for situations, not uncommon in healthcare settings, where one person (often a doctor or nurse) controls the timing of another's pain. For example, a nurse administering a painful injection might attempt to reduce the salient waiting time by preparing equipment before bringing the patient into the room. If a tendency to relieve others' dread is sufficiently strong, people should even be willing to increase another's pain to mitigate delay.

On the other hand, there is good reason to believe a priori that people might underestimate the effect of dread when trying to relieve others' pain. People are known to be systematically inaccurate in predicting how they will behave in emotional states different from their current state, which has been referred to as an *empathy gap* (Lowenstein, 2005; Nordgren et al., 2011; Read & Van Leeuven, 1998). Evaluating others' dread of pain theoretically requires considering not only others' emotional state (response to pain), but also others' future state (response to pain in the future). In computational terms, this is a challenging interpersonal inference problem. We therefore predicted people would de-emphasize dread when deciding for others, and place more emphasis on the intensity of pain. This would manifest as a diminished tendency to expedite others' pain relative to one's own pain. We refer to this as a hypothesized Dread Empathy Gap, consistent with empathy gaps observed for other abstract aversive states, such as the pain of social exclusion (Nordgren et al., 2011). Although we use the term 'empathy' in this context, we remain agnostic as to the underlying subjective or physiological processes, and behaviorally operationalize this hypothesis.

Dread of Delayed Pain

In conventional economic models of intertemporal choice, the subjective utility, $U(x, d)$, of an outcome of magnitude x due to be received after delay d is described in terms of two independent functions. Firstly, an instantaneous utility function, $u(x)$, governs an effect of outcome magnitude; secondly, a discount function, $\delta(d)$, governs an effect of delay, giving:

$$U(x, d) = u(x)\delta(d) \qquad (1)$$

Empirically, for rewarding outcomes, discount functions are approximately hyperbolic in form (Ainslie, 1974, 1975; Kirby & Marakovic, 1995; Mazur, 1987), giving:

$$U(x, d) = u(x)\left[\frac{1}{1 + Kd}\right] \qquad (2)$$

where K is the discount *rate*. As shown in Figure 1a, an outcome received immediately $(d = 0)$ would have value $u(x)$, while delayed outcomes have lower absolute value, since the overall discount factor, given by the term in brackets, is less than 1 for $K > 0$.

As shown in Figure 1b, for a painful outcome, $u(x)$ would be negative, and hyperbolic discounting would bring its disvalue closer to zero. By contrast, choices to expedite pain imply its disvalue grows with delay. This growth in disvalue can accounted for by postulating an additional effect of dread. Following previous approaches, we formalize dread as a cost associated with waiting for pain that is added to the discounted value of pain itself (Berns et al., 2006; Loewenstein, 1987). Thus, the disvalue of one's own future pain is given by:

$$U(x, d) = u(x)\left[\frac{1}{1 + Kd} + \frac{\alpha}{\rho}\log(1 + \rho d)\right] \qquad (3)$$

The first term in brackets represents conventional hyperbolic discounting of pain, while the second term represents the effect of dread. Here dread increases with delay, under an assumption of logarithmic time perception (Han & Takahashi, 2012; Takahashi et al., 2008). The parameter ρ governs how dread depends on delay: at lower ρ, dread becomes more linear in delay and increases more steeply with delay. α is a scaling parameter that governs the overall contribution of dread. As shown in Figure 1c, under this Hyperbolic Dread model

Figure 1

Dread and Delay Discount Functions
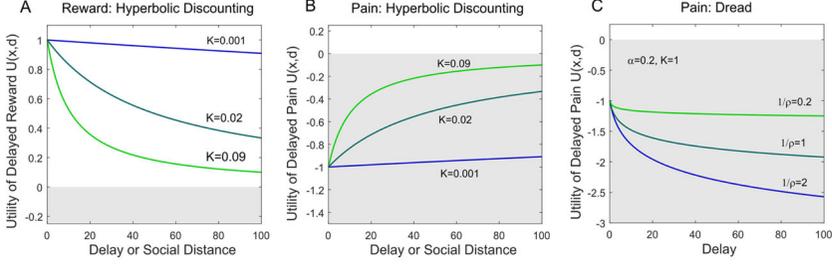
Note. Shaded grey areas denote negative utility. **A.** Hyperbolic delay discounting of reward of utility $u(x) = 1$, with rate K, as shown in Equation 2. Here reward has positive utility, which decreases with delay, motivating choices to speed-up reward. **B.** Hyperbolic delay discounting of pain of utility $u(x) = -1$. Here utility of pain becomes less negative with delay, motivating choices to defer pain. **C.** Dread of pain as shown in Equation 3: utility of pain becomes more negative with delay, motivating choices to speed-up pain. This figure is reproduced in part from our previous work published in this journal (Story et al., 2020).

the disvalue of pain increases with delay, albeit at a decreasing rate. Here, consistent with our previous work in this area (Story et al., 2013; Story et al., 2020), we behaviorally operationalize dread, without specifying an underlying process.

Dread of Others' Delayed Pain

To consider how people evaluate delayed pain *in others*, we combine effects of dread and *social discounting*. Social discounting determines the utility of others' outcomes relative to one's own (Jones & Rachlin, 2006; Jones & Rachlin, 2009; Rachlin & Jones, 2008; Rachlin & Locey, 2011). Formally, the social utility to person i of outcome x for person j is given by:

$$U_i(x_j) = \kappa\, u(x_j) \qquad (4)$$

where $0 < \kappa < 1$ is a social discount factor, and $u(x)$ a utility function over individual outcomes. For painful outcomes, $\kappa > 1$ implies that another's pain carries more disvalue than one's own pain, a pattern previously observed and referred to as *hyperaltruistic* (Crockett et al., 2014; Crockett et al., 2017; Crockett et al., 2015; Story et al., 2015). Here, we consider the social discount factor, κ, as fully encapsulating a person's generosity towards another person in a given context, regardless of the causes of this behavior. (For a more complete discussion of a behavioral approach

to social discounting of pain, the reader is referred to our recent work in this area, Story et al., 2020).

Taken together, Equations 3 and 4 predict that others' dread is taken into account as follows:

$$U_i(x_j, d) = \kappa\, u(x_j) \left[\frac{1}{1 + Kd} + \frac{\alpha}{\rho} \log(1 + \rho d) \right] \qquad (5)$$

We formalize a Dread Empathy Gap as a diminished effect of delay when choosing on behalf of others:

$$U_i(x_j, d) = \kappa\, u(x_j) \left[\frac{1}{1 + K\lambda d} + \frac{\alpha}{\rho} \log(1 + \rho \lambda d) \right] \qquad (6)$$

where λ is an additional factor which diminishes the contribution of delay. To test for a Dread Empathy Gap, we conducted two experiments wherein participants chose between different painful outcomes, while we varied the subjective intensity, timing and recipient of the pain.

Experiment 1

Experiment 1 was carried out in the laboratory with experiential painful outcomes. Participants made binary choices between painful

brief cutaneous electric shock stimuli of different intensities, at delays of up to 29 s. In this experiment, we measured participants' skin conductance responses (SCRs) to anticipated shock and actual shock for themselves and for the other participant.

The experiment consisted of four types of choice presented block-wise in a counterbalanced order (Fig. 2). In *self-now-self-later* choices, participants chose between immediate and delayed shocks for themselves. In *other-now-other-later* choices one of the participants, the 'Decider', chose between immediate and delayed shocks for the other participant, the 'Receiver.' In *other-now-self-later* choices, the Decider chose between immediate shocks for themselves and delayed shocks for the Receiver. Finally in *self-now-other-later* choices, the Decider chose between immediate shocks for the Receiver and delayed shocks for themselves. There was no opportunity for reciprocity and participants were informed of this fact. In each condition, each choice had a 0.1 probability of being realized. Participants were informed of this at the start of the experiment, however the outcomes were not described in probabilistic terms (see Discussion). In the event of a choice being implemented, there was a fixed intertrial interval of 30 s and the timing of the shock varied within this interval.

We predicted that participants would be willing to endure a more severe pain themselves to avoid delaying it (*self-now-self-later* condition), and might even assign extra pain to the Receiver to avoid delaying pain for themselves (*other-now-self-later* condition). However, in keeping with a Dread Empathy Gap, we predicted that the Decider would be less likely to increase the Receiver's pain to avoid delaying it (*other-now-other-later* condition), or to incur pain themselves to avoid delaying the Receiver's pain (*self-now-other-later* condition). The full factorial design enabled us to test separately for the effects of the recipient of immediate pain and the recipient of delayed pain on the choice of the timing of pain. We used Bayesian model comparison to compare how well alternative versions of the model described above reproduced the observed behavior. The statistical method used instantiates a Bayesian mixed effects logistic regression, in which the distribution over model parameters at the group level serves as an empirical prior over individual level parameters. This approach prevents unreliable individual parameter estimates from taking on extreme values.

Method

Participants

Sixty-three healthy participants (23 males 40 females; mean age 23.6 years, s.d. = 4.6 years) were recruited from the University College London (UCL) Institute of Cognitive Neuroscience subject database. Experiments took place at the Wellcome Trust Centre for Neuroimaging, UCL. Sessions lasted 2 hr and participants were compensated at a rate of GB£10 per hour. Participants were recruited in pairs. The two participants in each pair did not meet each other, but were informed that they would be interacting through the computer via an intranet link. The reason for this was to maintain anonymity and to ensure that choices were not influenced by characteristics of the other participant, such as their age or gender. Before the experiment, the participants were randomly allocated to the role of either 'Decider' or 'Receiver', by a method designed to reassure participants that no deception was involved (see Supporting Online Material).

Participant Flow and Exclusions

Of the 63 participants recruited, 54 (27 pairs, therefore 27 Deciders) completed all parts of the study with full datasets. In the remaining cases, either the second participant in the pair did not arrive, time constraints forced the experiment to end before all blocks had been completed, or data were saved incorrectly. *Self-now-self-later* choices were available from 60 participants.

Ethics Statement

All participants gave full informed consent before taking part in the study, and were free to withdraw their consent at any time. After the experiment participants were debriefed and given the opportunity to provide feedback. The study procedure received approval from the UCL Research Ethics Committee (4418/001).

Pain Stimuli and Thresholding

Cutaneous electrical stimuli were delivered through two silver chloride surface electrodes placed approximately 3 cm apart on

Figure 2

Experimental Protocol for Experiment 1
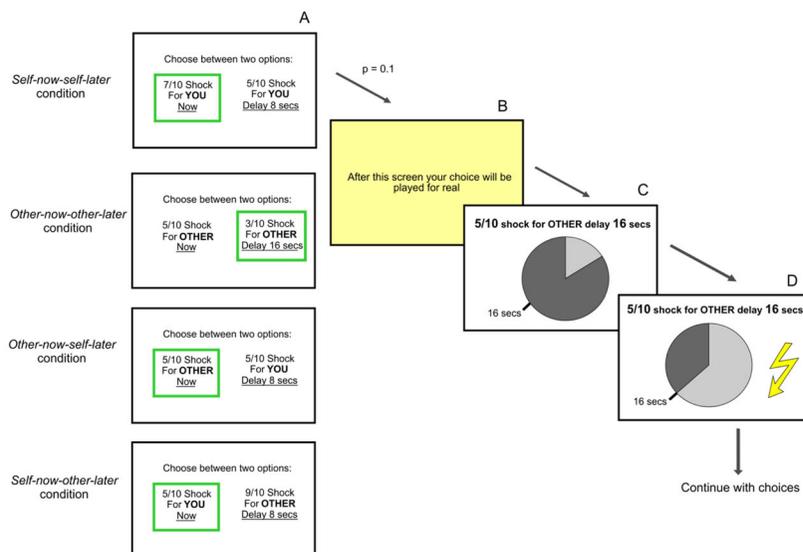
Note. **A** In each of four possible conditions (order counterbalanced across participants) the Decider was asked to choose between two possible combinations of intensity, delay and recipient of shock. **B.** Choices were selected to be realized with a 1/10 probability, in which event participants saw a yellow warning screen followed by a countdown, **C**, to shock delivery, **D.** All participants performed *self-now-self-later* choices (N = 60). Only Deciders (N = 27) performed the remaining conditions. For these conditions Deciders were informed that, in the event that an outcome was chosen to count for real, the Receiver would see the Decider's choice, followed by an identical countdown to the shock outcome

the dorsum of the hand, 1 cm distal to the wrist, via a DS5 Digitimer (Letchworth Garden City, London) constant current stimulator. A single 'shock' was composed of five 10 ms square-wave pulses at 49 ms intervals. Stimuli of this nature are considered harmless and are frequently used to study pain processing in humans (Seymour et al., 2005; Vlaev et al., 2009). After providing consent, participants underwent a standardized thresholding procedure. The purpose of this procedure was to select physical intensities of shock (voltages) corresponding to equivalent subjective levels of discomfort on a 10-point Visual Analogue Scale (VAS) for each participant (see Supporting Online Material for full details). We note that the scale confounds pain and unpleasantness (see Duncan et al., 1989; Miron et al., 1989; Price et al., 1983); in this case we are primarily interested in pain as a generic noxious stimulus. This procedure was entirely separate from choices made by participants regarding the timing of shocks.

Passive Trials and Physiological Measurements

We used the package COGENT 2000 (University College London) for presentation of choices and response acquisition. Participants first performed 10 'passive trials' in which the outcome was a 7/10 shock. Delays of 0, 2, 4, 8, 16 and 29 s were used for the main experiment. The 0 s delay was not sampled for the passive trials; all other delays were sampled once in a randomized order. Each passive trial commenced with a screen detailing the intensity of the shock, recipient and delay, for example: "7/10 shock for the other participant, delay 8 secs". After this screen, a countdown timer began, displayed on the screen as a pie chart, with the segment of time remaining decreasing each second up until the shock outcome (see Fig. 2). Participants were informed that the other participant would see an identical countdown timer. During these trials, we recorded the skin conductance response (SCR) of the Decider from two silver chloride surface electrodes attached to

the tips of the first and middle fingers, on the same hand to which the shock stimuli were being delivered (see Supporting Material Online).

Experimental Conditions

We presented four experimental conditions after the passive trials, block-wise in a counterbalanced order (Fig. 2). In the first, termed *self-now-self-later*, participants chose between immediate and delayed shocks for themselves. Both Deciders and Receivers completed these choices. The remaining three conditions were completed by Deciders alone. In the second, termed *other-now-other-later*, the Decider could choose between immediate and delayed shocks for the Receiver. In the third, termed *other-now-self-later*, the Decider could choose between immediate shocks for themselves and delayed shocks for the Receiver. Finally in the fourth, *self-now-other-later*, condition the Decider could choose between immediate shocks for the Receiver and delayed shocks for themselves. There was no opportunity for reciprocity and participants were informed of this fact. In the social conditions the Receiver was shown the options presented to the Decider and which option the Decider subsequently selected.

Choice Structure

Within each condition, choices followed a symmetrical design. Each of the four conditions consisted of 108 choices per participant; 18 choices were presented at each of six delays: 0, 2, 4, 8, 16 and 29 s. For each choice there were two options, immediate and delayed pain. In 'adjusting immediate pain' choices, the delayed shock was always of intensity 5/10, while the intensity of the immediate shock varied from one choice to the next, between 1/10 and 9/10. In 'adjusting delayed pain' choices, the immediate shock was always of intensity 5/10, while the intensity of the delayed shock varied from one choice to the next, between 1/10 and 9/10. The set of choices, shown in Table 1, was the same for all participants; no adaptive staircasing procedure was used. Choices were presented in a randomized order. Choices in which the immediate shock was the larger were designed to assess dread while choices in which the delayed shock was the larger were designed to assess delay discounting. Similar procedures are widely used in the literature to estimate various expressions of delay discounting (e.g. Kirby et al., 1999). The aim of this choice structure is to measure the subjective cost associated with delay, theoretically indicated by the point at which participants switch from preferring the immediate option to preferring the delayed option, or vice versa. Here, rather than finding indifference points directly, we used model fitting (logistic regression) to find the dread-discounting parameters which best accounted for each participant's choices.

Since there was an equal number of options in which the delayed shock was more intense, as those where the immediate shock was more intense, the proportion of choices at each delay for which participants chose the delayed shock, *p(choose later)*, provides a measure of preferences for the timing of pain. *p(choose later) = 0.5* indicates indifference between immediate and delayed shocks, termed the 50% indifference line. It follows that *p(choose later) < 0.5* indicates a preference for sooner pain and *p(choose later) > 0.5* a preference for delayed pain. In keeping with our use of logistic regression, we report *p(choose later)*, rather than estimated indifference points, as measure of time preference for pain; *p(choose later)* also has the advantage of being independent of assumptions about the functional form of dread-discounting.

In some choices, which we term *self-now-other-now* choices (36 in total per participant), the shock for both participants was immediate. Since there was an equal number of *self-now-other-now* choices in which the Decider's shock was the more intense, as was the case for when the Receiver's shock was the more intense, the proportion of these choices on which Deciders chose a shock for the Receiver, termed *p(choose other)* provides an index of altruism. While *p(choose other) = 0.5* suggests that participants were indifferent as to the recipient of the shocks, *p(choose other) < 0.5* would imply that participants were willing to endure more pain to relieve even a less severe pain for the other participant (a phenomenon termed hyperaltruism) and finally *p(choose other) > 0.5* would imply a degree of self-oriented behavior where participants would prefer that the other participant endure more pain to relieve a lesser pain for themselves.

Incentive Compatibility

In each condition, each choice had a 0.1 probability of being realized. In such an instance a yellow warning screen was first displayed to both participants for 2 s, after which the countdown timer appeared (as for the Passive Trials), followed by the occurrence of a shock at the relevant delay. This procedure was fully explained to participants in the instructions, who were asked to choose knowing that each outcome could be played for real. The timing of outcomes for the two participants was synchronized via an intranet link between the two stimulus PCs. Deciders were informed that, in the eventuality that an outcome was chosen to count for real, the Receiver would see the Decider's choice, followed by an identical countdown to the shock outcome. In the eventuality of a choice being implemented, there was a fixed intertrial interval of 30 s and the timing of the shock varied within this interval.

We note that this form of 'incentive-compatible' design in which selected choices count for real is standard in studies of reward-guided choice, albeit with the necessary difference that outcomes are realized within the current experiment, rather than at the end as is customary in reward-guided choice experiments. This arrangement was necessary to allow for a sufficient number of experimental trials to be administered within a reasonable timescale. A theoretical consideration here is that, since outcomes were probabilistic, participants may have discounted options according to their probability (e.g., Estle et al., 2006; Jones & Rachlin, 2009). Against this it is worth noting that the probabilistic nature of the outcomes was not displayed on screen during the presentation of choice options, and therefore was not likely to be a salient feature informing participants' behavior. Furthermore, the probability of a choice being realized was constant across all choice options.

Modeling Analysis

We fitted alternate versions of the model shown in Equations 3 and 5 to participants' choices. Each model yielded an estimate of the utility of each choice option, with utilities transformed into probabilities of choosing each option using a softmax function. We used a Bayesian model-fitting routine wherein group-level data is used to generate empirical priors on subject-level parameter estimates (Huys et al., 2011; Huys et al., 2012), preventing unreliable parameter estimates at the individual level from taking on extreme values. This routine instantiates a Bayesian mixed-effects logistic regression; we use a Bayesian methodology here for better alignment with existing computational approaches (Daw, 2011; the reader is referred to Young, 2018, for a discussion of mixed-effects models in a frequentist framework). We performed model comparison at the group level using the integrated Bayesian Information Criterion (BIC*int*), which scores models based on how well they fit the data (likelihood), while penalizing model complexity (number of parameters). As an additional estimate of the goodness of fit of each model we calculated the pseudo-R^2 using McFadden's formula. For a full description of the method and derivation of BIC*int* the reader is referred to Huys et al., 2011; Huys et al., 2012; Story et al., 2020. Model fitting was performed using custom code in Matlab (Mathworks, Provo, UT), available on request to the authors.

Results

Self-Now-Self-Later Choices

Choosing delayed pain on less than half of choices at any given delay ($p(choose\ later) < 0.5$) indicates a preference for sooner pain, at the

Table 1

Choice Structure

Immediate Pain (Intensity /10)	Delayed Pain (Intensity /10)	Number of Choices at each *d*
Adjusting Immediate Pain Choices		
5	1	2
5	3	2
5	5	1
5	7	2
5	9	2
Adjusting Delayed Pain Choices		
1	5	2
3	5	2
5	5	1
7	5	2
9	5	2
		Total: **18**

Note. Within each condition this set of 18 choices between immediate and delayed pain was presented at each of six delays: 0, 2, 4, 8, 16 and 29 seconds, that is, 108 choices per condition.

expense of increased pain intensity, consistent with dread. We calculated for each subject, using the trapezium method, the area between the curve relating $p(choose\ later)$ to delay and a horizontal line at $p(choose\ later) = 0.5$. Such area-under-the-curve (AUC) approaches are commonplace in quantifying discounting for reward (see Myerson et al., 2001). Since the simplest method of calculating AUC is disproportionally sensitive to indifference points at long delays (Gilroy & Hantula, 2018), we calculated AUC with delay plotted on a log scale (Borges et al., 2016). To aid interpretation of this quantity we divided each delay by the longest logged delay, such that AUC = 1 entails always choosing sooner pain, AUC = 0 entails indifference as to the timing of pain, and AUC = -1 entails always deferring pain. The mean of this area across subjects was significantly positive (mean AUC = 0.11, 95% CI [0.07 0.15], $t(59) = 5.16$, $p < .001$) indicating a group level preference to expedite pain.

To further characterize an effect of dread we fitted dread-discounting functions to participants' data. In addition to the Hyperbolic Dread model shown in Equation 2, we also tested a model proposed by Loewenstein (1987), based on exponential discounting (see Supporting Online Material for full details). The fit of the Hyperbolic Dread model is shown in Figure 3, illustrating that the model provides a good fit to the data (mean pseudo-R^2=.87), but underestimates choices of sooner pain at longer delays. Closer inspection of the data revealed this discrepancy was attributable to participants' showing a greater-than-expected tendency to expedite even very low-intensity delayed pain (Fig. S1, Supporting Material Online). To account for this finding we tested a variant of the above model in which the dread term scales with delay but not with pain intensity:

$$U_i(x_i, d) = \frac{u(x_i)}{1 + Kd} + \frac{\alpha}{\rho} \log(1 + \rho d) \qquad (7)$$

Consistent with previous findings using a similar experimental design (Story et al., 2020), this 'Unscaled' variant showed better correspondence to the data (mean pseudo-R^2 = .90; $\Delta BIC int = 190$) compared with Hyperbolic Dread), and also outperformed an exponential model of dread ($\Delta BIC int = 211$). The difference between models is not attributable

to the shape of the utility function over pain intensity, since it survives whether this function is concave, linear or convex. Both scaled and unscaled versions of the Hyperbolic Dread model have four free parameters: dread-discounting parameters α, ρ, K, and a softmax inverse temperature parameter, β, which governs the degree of randomness in choices.

### Decreased Tendency to Expedite Pain when Choosing for Others

We tested the extent to which participants were altruistic, and incorporated dread when choosing for others by plotting $p(choose\ later)$ against delay for Deciders ($N = 27$) across the four experimental conditions, shown in Figure 4a. For other-now-self-later and self-now-other-later conditions, the curves were shifted in the vertical axis due to altruistic behavior.

For these conditions AUC was calculated relative to $p(choose\ other)$ at delay zero, to correct for the degree of social discounting. In support of a self–other difference in dread, two-way ANOVA revealed a significant effect of the recipient of delayed pain on AUC ($F(1,26) = 4.53$, $p = .043$, partial $\eta^2 = 0.148$), with no significant effect of the recipient of immediate pain ($F(1,26) = 2.33$, $p = .139$, partial $\eta^2 = 0.082$) and no significant interaction ($F(1,26) = 2.69$, $p = .113$, partial $\eta^2 = 0.094$) (Figs. 4a and 4b).

Mean AUC was positive across both self-now-self-later and other-now-other-later conditions, consistent with a preference for sooner pain for both self and other, although this did not reach statistical significance for the other-now-other-later condition (Fig. 4b, self-now-self-later mean AUC = 0.11, 95% CI [0.04 0.18], one tailed $t(26) = 3.18$, $p = .004$; other-now-other-later mean AUC = 0.052, 95% CI [-0.01 0.12], one tailed $t(26) = 1.61$, $p = .12$). There was a strong and significant correlation between the tendency to expedite pain for self and others (AUC self-now-self-later vs. AUC other-now-other-later, Spearman ρ=0.81, $p < .001$), suggesting participants used their own preferences to guide choices about others. Preference for sooner pain was significantly greater in the self-now-self-later condition than in the other-now-other-later condition (AUC self-now-self-later − AUC other-now-other-later: $t(26) = 3.39$, $p = .002$), although the difference between

Figure 3

Preference for Sooner Pain in the Self-Now-Self-Later Condition in Experiment 1
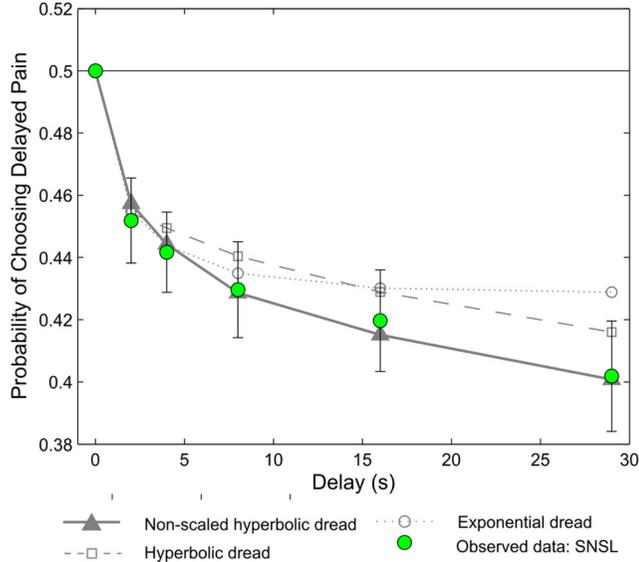
Note. Observed mean probability of choosing the delayed shock option (solid green circles) is plotted against the delay to shock (in seconds) for all participants in Experiment 1 ($N = 60$). *p(choose later)* was calculated for each participant at each delay; the group means of these participant-level estimates are displayed here. Error bars represent one standard error above and below the group mean. Overlaid are the equivalent probabilities derived from the maximum a posteriori (MAP*)* policies of alternative models of dread-discounting: Exponential Dread (hollow circles), Hyperbolic Dread (hollow squares) and Nonscaled Hyperbolic Dread (solid gray triangles). A horizontal line at $p = .5$ represents indifference between immediate and delayed pain; choosing delayed pain less than half the time (points below $p = .5$) indicates a preference for immediate pain.

other-now-self-later and *self-now-self-later* was not significant ($t(26) = 0.38$, $p = .710$).

Taken together, the above results indicate participants displayed significantly lower dread when choosing pain on behalf of others compared with when choosing pain for themselves. A possible explanation for the null comparison in *other-now-self-later* and *self-now-other-later* conditions is that these entail a greater degree of complexity, requiring participants to consider pain intensity, delay and recipient. Participants' choices might therefore have been noisier in these two conditions, tending to diminish the detectability of dread effects and obscuring self–other differences.

### Delay is Underweighted when Choosing for Others

We went on to test the Dread Empathy Gap model (shown in Eq. 6). This model accounts for a reduced contribution of dread when evaluating others' pain by means of an additional discount factor, λ, which diminishes the contribution of delay information when processing others' pain. Model fitting further allowed us to test the possibility that participants' choices were noisier when required to trade-off their pain with that of another, by allowing the softmax inverse temperature, , to be diminished by a factor $0 < \omega < 1$ in *self-now-other-later* and *other-now-self-later* conditions. To fit these models, we carried forward each participant's parameters from fitting *self-now-self-later* choices (α, ρ, K, β), and freely fitted λ, ω and the social discount factor κ. Thus we fitted 324 choices across three conditions (*other-now-other-later*, *self-now-other-later* and *other-now-self-later*) with an additional three parameters.

The Dread Empathy Gap model provided a parsimonious fit to the data (mean pseudo-$R^2 = 0.75$, and outperformed a Null model in which $\lambda = 1$ ($\Delta BIC_{int=340}$. Mean λ was significantly below 1 (mean log $\lambda = -0.86$, 95% CI

Figure 4

*Social Modulation of Dread in Experiment 1*
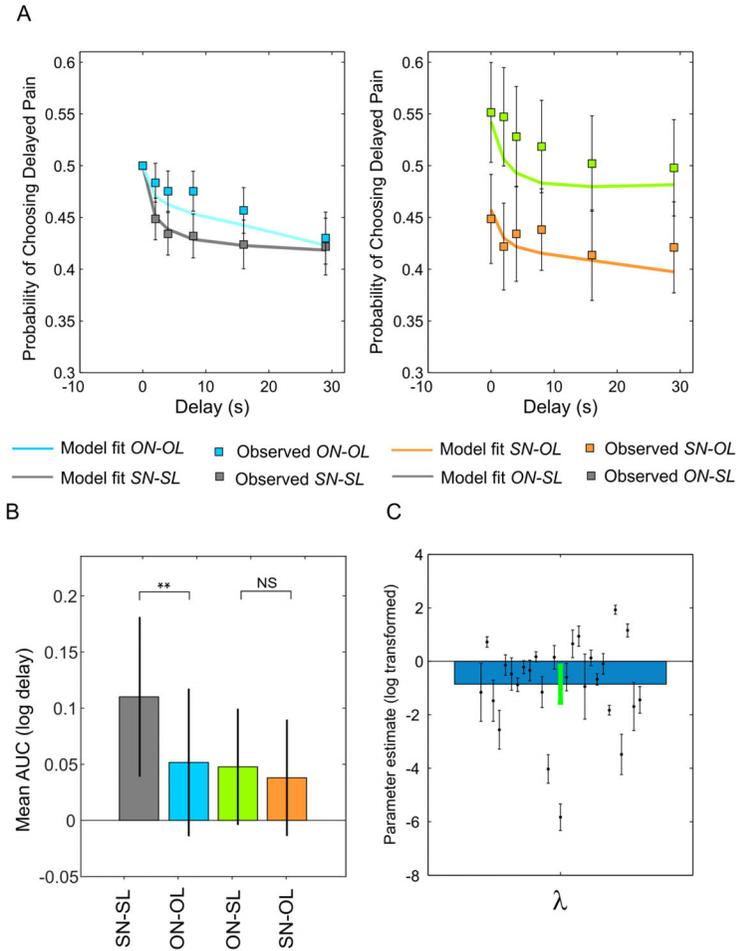
Note. **A.** Mean probability across Deciders ($N = 27$) of choosing delayed pain at each delay in each condition, overlaid with behavioral policies of the Dread Empathy Gap model, fitted jointly to all four conditions. Error bars show one standard error above and below the mean. **B.** Mean AUC in the four conditions. Positive AUC indicates preference for sooner pain, consistent with dread. Error bars represent 95% confidence intervals. **C.** Estimates of λ in log space. Negative values indicate underweighting of delay when choosing for others. The solid blue bar indicates the group mean; the bright green bar indicates the 95% CI. Black dots show the parameter estimates for individual subjects, with error bars indicating the uncertainty (square root of the second moment around each parameter)

[-1.52 -0.20], one tailed $t(26) = -2.68$, $p = .013$), supporting a downweighting of delay information relative to pain intensity when evaluating others' pain. The full model outperformed a restricted variant in which there was zero effect of delay when evaluating others' pain (i.e., $\lambda = 0$). Taken together, these results suggest that participants displayed choices consistent with dread when evaluating others' pain, though to a lesser extent than

when evaluating their own pain. The full model also outperformed a restricted variant without modulation of choice noise, that is, in which $\omega = 1$ (ΔBICint > 1000). The fit of the Dread Empathy Gap model to data from all four choice conditions is shown in Figure 4a.

Choices that required the Decider to trade-off their own pain with that of the Receiver (*other-now-self-later* and *self-now-other-later* conditions) allowed us to estimate the social

Figure 5

Effect of Dread when Choosing for Others Depends on Social Distance
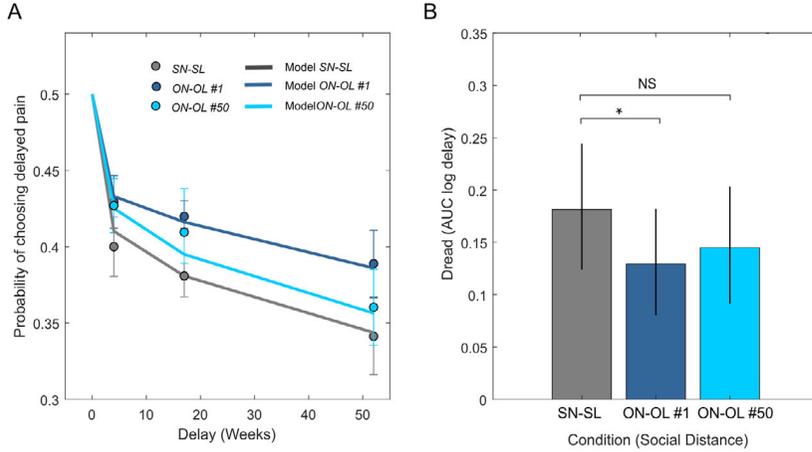
Note. **A** Observed mean probability in Experiment 2 ($N = 70$) of choosing the delayed painful treatment option versus delay for *self-now-self-later* (grey circles), *other-now-other-later* at social distance #1 (dark blue circles) and *other-now-other-later* at social distance #50 (light blue circles) conditions. Overlaid (solid lines) are the maximum *a posteriori* fits of the Dread Empathy Gap model. Error bars show one standard error above and below the mean. **B.** Mean AUC (log delays) in the three conditions. Error bars represent 95% confidence intervals. Positive values of AUC indicate a group-level preference for sooner pain, consistent with dread

discount factor, κ, when fitting the above models. Mean $\kappa = 1.19$ (95% CI [0.93 1.52]), indicating a trend towards hyperaltruistic behavior at the group level.

No Significant Relationship between Dread and Altruism

We also tested for a correlation between dread and altruism, by entering the dread-discounting parameters K, α and $1/\rho$, derived from fitting *self-now-self-later* choices, together in a weighted least-squares analysis with the social discount factor κ as the dependent variable, weighted by the posterior precision on κ. None of the three parameters emerged as a significant positive predictor ($\beta_K=-0.00$, $p=.628$; $\beta_\rho=-0.37, p=.66$; $\beta_\alpha=-0.04$, $p=.627$).

Physiological Data

Of the 27 participants designated as Deciders, skin conductance data were collected from 21 out of the 27. Physiological data from the remaining six Deciders were not obtained due to time constraints. Skin conductance data from two of the 21 were unsuitable for analysis, in one case due to movement artefacts and in another due to hyperhidrosis,

resulting in a small number of complete datasets for this analysis ($N = 19$).

We compared filtered and Z-scored conductance data against zero in one-sample tests with two event regressors, an epoch corresponding to the anticipatory period, and a stick function corresponding to the onset of pain. Raw data are shown in Figure S2 (Supporting Material Online). We found significant group-level responses to receiving a shock oneself (*shock-self t* $(18) = 3.01$, 95% CI [0.37 2.10], $p = .008$). However, surprisingly there was no significant conductance response at the group level to either the anticipation of shocks for oneself (*anticipation-self* $t(18) = 0.83$, 95% CI [-0.02 0.04], $p = .415$), anticipation of shocks for the other participant (*anticipation-other t* $(18) = 0.13$, 95% CI [-0.01 0.01], $p = .895$) or administration of shocks to the other participant (*shock-other* $t(18) = 0.65$, 95% CI [-0.14 0.26], $p = .523$).

Experiment 2

In summary, in Experiment 1 we found participants were significantly more likely to

expedite pain when they chose the timing of painful shock stimuli for themselves, rather than on behalf of another participant. This finding is consistent with our prediction of a Dread Empathy Gap.

Experiment 1 was carried out in a laboratory setting, with delays on the order of seconds, arguably a rather rarefied scenario. The aim of Experiment 2 ($N = 70$) was to test whether the effects seen in Experiment 1 manifest also in a more naturalistic situation, with more substantive painful outcomes over longer delays. Experiment 2 consisted of a direct replication of the *self-now-self-later* and *other-now-other-later* conditions, with outcomes of a hypothetical painful medical treatment over delays of up to 1 year.

In Experiment 2 we also examine how downweighting of others' dread depends on social distance. We formalized the social distance of the other by asking people to create an imaginary rank ordering of the people closest to them in the world, starting with their dearest friend or relative at position #1 and ending with a mere acquaintance at #100 (Jones & Rachlin, 2006; Jones & Rachlin, 2009; Rachlin & Jones, 2008). We sampled two points along this continuum. Participants made *other-now-other-later* choices either on behalf of either their closest friend or relative (social distance #1) or on behalf of a person at social distance #50.

The social distance manipulation follows our previous work (Story et al., 2020), where we have described how social discounting (κ) for pain depends on social distance. In the aforementioned study we found that the average participant showed hyperaltruism ($\kappa > 1$) with respect to the pain of close others; altruism diminished with increasing social distance, such that κ was below 1 with respect to others at social distance #50. Therefore, although in the current study we do not measure social discounting directly, there is strong prior reason to expect higher altruism towards close others than towards distant others.

We entertained two possibilities for effects of social distance on downweighting of others' dread. Firstly, if downweighting of others' dread operates akin to an additional social discount factor applied to effects of delay, the effect would be expected to be greater for more distant others. This would be consistent with a postulated Dread Empathy Gap, which

intuitively ought to be more pronounced for distant others. Similarly, downweighting of others' dread might arise due to uncertainty about others' degree of dread, which also might be more pronounced for distant others.

However, an alternative possibility is that uncertainty about others' dread is high, even for close others, and varies little with social distance. Furthermore, in the face of such uncertainty, increasing others' pain to avoid delay could be misconstrued as intentional harm. Since pain itself is therefore likely a more reliable yardstick of suffering than is the wait preceding pain, focusing on reducing pain intensity would be a useful heuristic to prevent inadvertent harm. Such a precautionary motive ought to reveal itself most prominently where causing inadvertent harm to others is most costly, predicting greater downweighting of dread for close others. In other words, this possibility suggests that when considering those we care about, we focus on reducing their pain directly, rather than relieving their dread.

Method

Participants and Sample Size

Healthy participants who had worker accounts on Amazon Mechanical Turk (MTurk) were recruited via an advertisement. MTurk is an online marketplace for work, now widely used as a method of data collection for psychology experiments (Mason & Suri, 2012). Responses on MTurk have been shown to be reliable (Crump et al., 2013) and replicate well-established findings in the cognitive psychology literature (Rand, 2012).

In Experiment 1, pairwise comparison between AUC in *self-now-self-later* and *other-now-other-later* conditions revealed a medium effect: Cohen's $d = 0.65$. We therefore performed a power calculation for Experiment 2 based on a paired *t*-test with a medium effect size (Cohen's $d = 0.5$), which indicated that a sample size of 32 participants was required to achieve 80% power. Since responses on MTurk are likely to be noisier than those obtained in the laboratory, as a heuristic we aimed for double this sample size. (We note that an alternative procedure would have been to calculate the sample required to detect half the previous effect size, namely, Cohen's $d = 0.33$, yielding a sample size of 72).

A total of 70 participants completed the experiment via MTurk (32 females; mean age 36.8 years, s.d. = 10.5 years; median yearly income $30,000 USD; 31/70 university educated). All workers held an MTurk 'Masters Qualification', meaning that they had consistently demonstrated a high degree of success in performing a wide range of tasks. The task was expected to take approximately 20 min; participants took an average of 17 min to complete the task, and all completed the task in less than 26 min. Participants were compensated $3 USD for their participation, an average rate of $10.29 per hour. Choices were administered via the secure online software, Qualtrics (www.qualtrics.com; Provo, UT).

Ethics Statement

All participants gave full informed consent before taking part in the study. The study procedures received approval from the UCL Research Ethics Committee (4418/002). We report all measures, manipulations, and exclusions in these studies.

Experimental Choices

Participants chose between two different hypothetical medical treatments, described as entailing a painful injection into the bone. The treatments were said to prevent the onset of dementia later in life, to be completely safe, free of charge and 100% effective if received any time in the next 10 years. Participants were told that the painful procedure would involve an injection into the bone marrow causing pain lasting for half an hour. The intensity of the pain was said to depend on the identity of a nurse available to perform the injection, and was described on a 10-point pain scale. Participants were given no additional information about why the identity of the nurse affected the intensity of pain. We explicitly told participants that neither the level of pain, nor identity of the nurse, nor the timing of the appointment would alter the effectiveness of the treatment. Participants completed *self-now-self-later* choices regarding the timing of the treatment for themselves, as well as *other-now-other-later* choices, regarding the timing of the treatment for another person, either on behalf of either their closest friend or relative (social distance #1) or on behalf of a person at social distance #50.

In each case, participants were told the timing of the appointment, and how painful the treatment would be on a 10-point scale. Seventy-two choices were offered between two possible appointment times. For each choice, one appointment option was always 'this week' (delay 0 weeks), and the other was delayed 4, 17 or 52 weeks. Choice options at each delay, and calculation of AUC using a log scale for delay, were identical to those in Experiment 1 (as shown in Table 1).

Results

Self–Other Difference in Dread Depends on Social Distance

Participants exhibited a pattern consistent with dread in all three conditions (mean AUC *self-now-self-later* = 0.18, 95% CI [0.12 0.24] mean AUC *other-now-other-later* #50 = 0.14, 95% CI [0.09 0.20], mean AUC *other-now-other-later* #1 = 0.13, 95% CI [0.08 0.18]). Repeated measures ANOVA of AUC in the three conditions revealed a significant effect of condition ($F_{(1,69)}$ = 3.31, p = .039, partial η^2 = 0.072). Inspection of the data, as shown in Figure 5, revealed a pattern consistent with diminished dread for *close* others. Indeed, pairwise tests revealed that participants exhibited significantly diminished dread in *other-now-other-later* #1 choices compared with *self-now-self-later* choices (Fig. 5; $t(69)$ = 2.23, p = .029, Cohen's d = 0.27), with no significant difference between *other-now-other-later* #50 choices and *self-now-self-later* choices (Fig. 5; $t(69)$ = 1.53, p = .136). Consistent with this in repeated measures ANOVA, there was a significant effect of the linear contrast AUCself > AUCother#50 > AUCother#1 ($F_{(1,69)}$ = 4.97, p = .029, partial η^2 = 0.067), supporting more diminished dread when choosing for *close* others than for socially distant others or oneself. These results support a hypothesis that when attempting to relieve others' delayed pain, people preferentially seek to relieve pain intensity, rather than dread, putatively to avoid causing inadvertent harm.

We fitted a Dread Empathy Gap model jointly to the three conditions, allowing κ to vary within participant across the two social conditions while holding constant λ. As shown in Figure 5 the model provided a good fit to the data (mean pseudo-R^2=0.87). We note

however that this model has a relatively large number of free parameters ($\kappa_{\#50}, \kappa_{\#1}, K, \rho, \alpha, \lambda$ and the softmax inverse temperature, β). In particular, Experiment 2 did not require participants to trade-off their own pain with that of others, and so $\kappa_{\#1}$ and $\kappa_{\#50}$ are not strictly defined. Nevertheless, as expected, $\kappa_{\#1}$ (mean = 1.15) emerged greater than $\kappa_{\#50}$ (mean = 0.93), implying greater altruism for close others than for distant others. Furthermore, the model reproduced the rank ordering of dread as a function of social distance, an effect that was driven by differences in κ. According to the model, in *other-now-other-later* choices, κ applies to both immediate and delayed pain options and therefore does not directly alter dread (relative to *self-now-self-later* choices). However, κ does have the effect of amplifying or diminishing the subjective value of both choice options, thereby modulating the effective decision temperature. This interaction of κ with decision temperature was sufficient to account for the observed differences in choice of delayed pain as a function of social distance. The effect arises since higher κ amplifies effects of λ; in psychological terms, greater concern for the pain of close others amplifies a downweighting of delay. In other words, greater altruism towards close others applies preferentially to pain itself rather than to dread.

General Discussion

In this study, across two experiments, we examined how people attempt to relieve others' delayed pain. We predicted people would choose to expedite pain both for themselves or others, even if this entailed increasing the intensity of the pain. We further hypothesized that the tendency to expedite others' pain would be less marked than for one's own pain, in keeping with a hypothesis of a Dread Empathy Gap.

Consistent with previous studies (Berns et al., 2006; Loewenstein, 1987; Story et al., 2015; Story et al., 2013), subjects chose to expedite their own pain, with most enduring a higher intensity pain to avoid waiting. Across both experiments, participants also sought to hasten the onset of pain when deciding on behalf of another person (*other-now-other-later* choices), and even increased the intensity of others' pain to avoid its delay. As predicted, in Experiment 1, where the other person was another experimental participant in an adjacent room, participants chose to expedite pain for others significantly less than for themselves. We observed a nonsignificant trend in the same direction in a comparison between *other-now-self-later* and *self-now-other-later* conditions, where participants were asked to trade-off their own delayed pain with the other participant's immediate pain or vice versa. In Experiment 2, with outcomes of a hypothetical painful medical treatment, at delays of up to 1 year, we found that participants exhibited a diminished tendency to expedite pain when choosing on behalf of a close friend or relative, but not significantly when choosing for a more distant friend or acquaintance.

In previous work (Story et al., 2020) we have established that, in similar experimental contexts, people are highly altruistic towards the pain of close others, though altruism steeply decreases with increasing social distance of the other. Notably, altruism alone was not sufficient to account for the findings observed in the current study. Instead we found support for a model in which altruism applies preferentially to pain itself rather than to dread, that is, people preferentially seek to relieve the intensity of pain itself rather than reducing a dread of pain. We showed that a computational model implementing this hypothesis provided a good fit to the behavioral data, and accounts for the effects of social distance.

Precisely why altruistic responses should privilege the relief of pain itself over the cost of waiting remains to be firmly established. At first glance our finding that downweighting of dread appears larger for close than for distant others appears surprising. The finding seems inconsistent with our original prediction that downweighting of others' dread would occur due to an empathy gap, whereby people have difficulty predicting the emotional responses of others in different situations from themselves (Lowenstein, 2005; Nordgren et al., 2011; Read & Van Leeuven, 1998). Such empathy gaps might be expected to be larger for more distant others. Similarly, uncertainty about others' dread might be expected to be greater for more distant others than for close others, thereby driving greater downweighting of dread for distant others, the reverse of the pattern seen here.

However, we cannot reject the possibility that preference uncertainty lies at the root of the phenomenon, since uncertainty about others' propensity to speed-up pain might well be very high, even for close others, and vary little with social distance. Since pain itself is therefore likely a more reliable yardstick of suffering than is the wait preceding pain, focusing on reducing pain intensity would be a useful heuristic to prevent causing inadvertent harm. In psychological terms, the tendency towards such a precautionary motive ought to reveal itself most prominently where causing inadvertent harm to others is most costly. In other words, we hypothesize that the very fact of caring for someone paradoxically makes us more likely to underestimate their dislike of waiting for pain, because we focus instead on directly reducing their pain. Further work is required to explore these beliefs directly. We also note that Experiment 2 sampled only two points along the continuum of social distance, for comparison to preferences for the self. Further investigation of differences in dread across a social distance continuum (for example, at #100) could contribute to an improved understanding of the phenomena described here.

That we observed a significant diminution in dread for socially close but not socially distant others in hypothetical choices in Experiment 2, and yet a significant diminution in dread for an anonymous stranger in Experiment 1, might also be seen as surprising. We propose that concern for others is higher in a laboratory setting than would be expected for behavior towards a complete stranger, due in part to priming an idea that both participants are 'in it together'. This idea would be consistent with findings that similar others are judged as more socially close than dissimilar others (Liviatan et al., 2008). The trend towards hyperaltruistic behavior seen in Experiment 1, and (more robustly) in previous social decision-making studies involving others' pain (Batson et al., 1983; Crockett et al., 2014; Hein et al., 2011) would appear to support this view. Indeed, levels of charitable giving seen in economic games in the laboratory appear to overestimate the extent of spontaneous altruism towards anonymous strangers in everyday life (Dana et al., 2006; Engel, 2011; Koch & Normann, 2008; List, 2007).

We found that models of dread based on hyperbolic discounting outperformed the exponential models we tested previously (Story et al., 2013). Under the best performing model, preference for sooner pain was accounted for in terms of waiting cost that scaled with delay, but not with pain intensity. This finding diverges from previous models of dread, which focus on the aversive anticipation of pain, a quantity that would be expected to scale with pain intensity. A possible explanation is that a preference for sooner pain represents a more generic form of impatience than previously thought; in other words, what we have referred to as dread could equally represent a generic cost associated with waiting for any form of outcome.

A possible explanation for an apparent lack of influence of the severity of delayed pain on dread would be that, in Experiment 1, different intensities of delayed pain did not evoke substantially different anticipatory responses. Possible factors limiting an aversive anticipation of the pain stimuli used here are that the stimuli were exceedingly brief (< 1 s), and that a countdown timer displayed on the screen reduced participants' uncertainty regarding the onset of pain. Consistent with this idea, in the current study, we did not find a significant anticipatory skin conductance response in advance of shock at the group level. Further work is needed to establish whether dread depends on pain intensity across a greater range of aversiveness. Notably, our finding of diminished dread when choosing for others does not depend on the precise form of dread-discounting model, and is also evident in analysis of raw choice frequencies.

The dread-discounting models studied here have a larger number of parameters (α, ρ, K for Hyperbolic Dread) by comparison with conventional discounting models, which usually have just one or two parameters. The additional parameters of the dread-discounting model are necessary to account for qualitatively different patterns of preference for different participants, to either defer pain (captured by the discounting term) or expedite it (captured by the dread term). However, we acknowledge that the discounting parameter K is poorly defined for participants who prefer to expedite pain, and tends to trade-off against the dread parameters. For the purposes of studying individual differences, more

reliable estimates can be achieved either by fitting separate models to sets of participants with qualitatively different preferences (e.g. a discounting model for participants who prefer to defer pain and a dread model for those who prefer to expedite it), or by using a hierarchical model-fitting routine to regularize estimates of any parameters that are poorly-defined for some participants. Here we adopt the latter approach.

In previous studies, dread has been evoked to explain why monetary losses are discounted at a lower rate than monetary gains, a phenomenon referred to as the *sign effect* (Estle et al., 2006; Gonçalves & Silva, 2015; Tanaka et al., 2014; Yates & Watts, 1975). Most people still prefer to defer losses, suggesting that losses incur less dread than is the case for pain (Harris, 2012; Loewenstein, 1987), however, a subset of individuals indeed prefer to expedite losses (Myerson et al., 2017). A key difference between monetary loss and pain is that, in experimental contexts, pain is usually transient. As a result, the negative hedonic effect of monetary loss can be more temporally extended. The model of Loewenstein (1987) also considers dread-discounting for temporally extended outcomes, showing theoretically that for more prolonged experiences discounting tends to dominate the effects of dread. Further work in this area might consider how people discount losses on behalf of others. The model introduced here suggests that the influence of delay will be diminished when choosing on behalf of others. A more nuanced prediction is that people should move towards 'zero time preference' when choosing for others. In other words, when choosing on behalf of others, people who predominantly discount delayed losses would be expected to show lower discounting compared to when choosing for themselves, while people who predominantly dread delayed losses would show lower dread. This prediction is also consistent with a finding of diminished discounting when people make intertemporal choices for rewards on behalf of others (Kim et al., 2013).

Experiment 1 used probabilistic painful outcomes, with a 1/10 chance of being realized. We note that this form of 'incentive-compatible' design, in which selected choices count for real is standard in studies of reward-guided choice, albeit with the necessary difference that, in the current study, painful outcomes

are realized within the experiment, rather than at the end. This arrangement was necessary to allow for a sufficient number of experimental trials to be administered within a reasonable timescale. Extensive research has examined effects of probability discounting, such that the subjective value of a probabilistic reward has been shown to decrease hyperbolically with the odds against its being realized (e.g., Białaszek et al., 2019; Estle et al., 2006; Jones & Rachlin, 2009). A theoretical consideration therefore is that participants may have discounted options according to their probability. Furthermore, for reward, delay discounting is less steep when outcomes are described in probabilistic terms (Andreoni & Sprenger, 2012; Keren & Roelofsma, 1995). Therefore, it is theoretically possible that the effects seen here could differ in magnitude in a design in which every painful outcome was realized.

Against this, it is worth noting that the probabilistic nature of the outcomes was not displayed on screen during the presentation of choice options, and therefore was not likely to be a salient feature informing participants' behavior. Furthermore, the probability of a choice being realized was constant across all choice options, and served only to ensure that participants were incentivized to treat all choices as potentially realizable. Any interaction between probability and delay ought therefore to have been constant across conditions. To our knowledge, interactions between probability, delay and social discounting for painful outcomes have not been explored experimentally, and remain an interesting area for future research.

A related concern is that outcomes of Experiment 2 are hypothetical rather than real. For reward discounting, hypothetical and real outcomes have been shown to be generate comparable choice patterns (Johnson & Bickel, 2002; Madden et al., 2003). However, for decisions involving others' pain, hypothetical and real choices diverge in some instances, and engage partly separable neural susbtrates (FeldmanHall, Dalgleish et al., 2012; FeldmanHall, Mobbs et al., 2012). In particular, FeldmanHall, Mobbs et al. (2012) found that hypothetical moral scenarios devoid of context or concrete consequences appeared to maximize adherence to perceived moral duties, such as not harming others.

Specifically, in an experiment that required participants to trade-off keeping money for themselves against pain for another person, participants kept significantly more money, and thereby caused others more pain, in real scenarios than in contextless hypothetical scenarios. In light of these findings, it is possible that the hypothetical outcomes in Experiment 2 overestimated participants' generosity towards distant others. Direct comparison of the effects reported here under equivalent conditions with hypothetical and real outcomes would be required to investigate this possibility. However, it is unclear how such effects would bias our key finding of diminished dread. Furthermore, FeldmanHall, Mobbs et al. (2012) found that behavior in hypothetical scenarios enhanced with additional contextual detail was intermediate between real and contextless-imaginary scenarios. Similarly, the naturalistic context used here in Experiment 2 is likely to lend these choices greater veridicality.

Finally, having control over the timing of others' pain finds application in healthcare decision-making where clinicians or policymakers control the timing of medical or surgical procedures. Our findings suggest that underestimation of others' dread of pain in healthcare decisions might have an impact on peoples' wellbeing across differing scenarios and timescales. We observe underestimation of dread in Experiment 1 with real painful outcomes over a timescale of seconds, analogous to minor in-person medical procedures, such as phlebotomy or vaccinations. We also observe the effect in Experiment 2, which involves health-related hypothetical outcomes over a timescale of months, analogous to decisions about the timing of more substantive medical treatments, such as elective surgery. Our finding of a greater reduction in dread for close others in Experiment 2 suggests this effect might be particularly prominent in real-world scenarios where the decision maker has a caring relationship with the recipient.

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