Help or flight? Increased threat imminence promotes defensive helping in humans

Joana B. Vieira, Sabine Schellhaas, Erik Enström and Andreas Olsson

Note: Reports are unedited and appear as submitted by the referee. The review history appears in chronological order.

Review History

RSPB-2020-1473.R0 (Original submission)

Review form: Reviewer 1

Recommendation
Accept with minor revision (please list in comments)

Scientific importance: Is the manuscript an original and important contribution to its field?
Excellent

General interest: Is the paper of sufficient general interest?
Excellent

Quality of the paper: Is the overall quality of the paper suitable?
Excellent

Is the length of the paper justified?
Yes

Should the paper be seen by a specialist statistical reviewer?
No

Do you have any concerns about statistical analyses in this paper? If so, please specify them explicitly in your report.
No

It is a condition of publication that authors make their supporting data, code and materials available - either as supplementary material or hosted in an external repository. Please rate, if applicable, the supporting data on the following criteria.

Is it accessible?
Yes

Is it clear?
Yes

Is it adequate?
Yes

Do you have any ethical concerns with this paper?
No

Comments to the Author
This study examines the effect of proximal and distal threats on empathic protection of others (at a cost to oneself). This is a wonderful study that points to the intuitive nature of human empathy. My comments are brief but important to address.

I was a little confused by Figure 1 – how did the authors measure imminence? For imminent threats, was it the spider close to the right side? Figure 1 seem to show the same image for distal and imminent (proximal?).

Did the authors examine the effect of trait anxiety? There is evidence that trait anxiety predicts higher vicarious anxiety in high empathic subjects (Shu et al., 2017; JEP:G). Would be a nice link between the two literature.

Rather than using P<0.05 could the authors use the actual p value?

I would love to know if ratings of the victims face influenced these effects (how similar, likeable?).

The authors do a great job of discussing the limitations. The paper is well written and I believe it will make a great contribution to the literature.

Review form: Reviewer 2

Recommendation
Accept with minor revision (please list in comments)

Scientific importance: Is the manuscript an original and important contribution to its field?
Excellent

General interest: Is the paper of sufficient general interest?
Excellent

Quality of the paper: Is the overall quality of the paper suitable?
Excellent

Is the length of the paper justified?
No

Should the paper be seen by a specialist statistical reviewer?
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    Is it accessible?
    N/A

    Is it clear?
    N/A

    Is it adequate?
    N/A

Do you have any ethical concerns with this paper?
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Comments to the Author
This paper reports the results of a single experiment that examines if threat imminence and risk likelihood influence an individual's decision to help another when helping puts the individual at risk. Threat imminence is manipulated by the time between warning stimulus and an aversive shock. Risk likelihood is manipulated by the probability of the warning stimulus ending in shock. The findings suggest that increasing threat imminence increases helping; although likelihood does not. This is a novel and interesting finding that is quite timely as well. So, I recommend publication. However, there are a few issues that need attention.

One thing that is surprising that warrants some additional discussion is the lack of effect of the likelihood manipulation. Given that threat imminence is multiply determined it is somewhat surprising that this wouldn't also affect imminence. For example, in one of the first threat imminence papers (Fanselow, 1989) shock probability is specifically mentioned as something that maps into imminence, at least in rodents.

The authors use an active/passive defensive behavior distinction quite a bit. I encourage them to avoid this terminology as it is both misleading and inaccurate. This distinction arose from an intuitive view that freezing is somehow passive and it would be better to take (locomotor) action. Animals engage in freezing when it is the most effective thing to do to in terms of preventing attack. It's is more of an active module where the prey chooses an optimal location to freeze and also the animal prepares for the next phase of defense if it becomes necessary. There is also no interplay between freezing and other defenses- for example, running occurs at a different level of imminence than freezing- it is not in competition with freezing. The data in this paper make this point quite clearly. Under high imminence the participants showed increased helping, faster reaction times, and higher heart rate. Does that sound passive?

The discussion is overly long and speculative especially with respect to brain function, which is not examined.

The prediction made on page 6 just before the methods is a critical one. However, I did not find the logic of the prediction particularly clear.

Page 18 "comprise" should be compromise.

Decision letter (RSPB-2020-1473.R0)

15-Jul-2020

Dear Dr Vieira:

Your manuscript has now been peer reviewed and the reviews have been assessed by an Associate Editor. The reviewers' comments (not including confidential comments to the Editor) and the comments from the Associate Editor are included at the end of this email for your reference. As you will see, the reviewers and the Editors have raised some concerns with your manuscript and we would like to invite you to revise your manuscript to address them.

We do not allow multiple rounds of revision so we urge you to make every effort to fully address all of the comments at this stage. If deemed necessary by the Associate Editor, your manuscript will be sent back to one or more of the original reviewers for assessment. If the original reviewers are not available we may invite new reviewers. Please note that we cannot guarantee eventual acceptance of your manuscript at this stage.

To submit your revision please log into http://mc.manuscriptcentral.com/prsb and enter your Author Centre, where you will find your manuscript title listed under "Manuscripts with Decisions." Under "Actions", click on "Create a Revision". Your manuscript number has been appended to denote a revision.

When submitting your revision please upload a file under "Response to Referees" - in the "File Upload" section. This should document, point by point, how you have responded to the reviewers' and Editors' comments, and the adjustments you have made to the manuscript. We require a copy of the manuscript with revisions made since the previous version marked as 'tracked changes' to be included in the 'response to referees' document.

Your main manuscript should be submitted as a text file (doc, txt, rtf or tex), not a PDF. Your figures should be submitted as separate files and not included within the main manuscript file.

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If your study uses animals please include details in the methods section of any approval and licences given to carry out the study and include full details of how animal welfare standards were ensured. Field studies should be conducted in accordance with local legislation; please

include details of the appropriate permission and licences that you obtained to carry out the field work.

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It is a condition of publication that you make available the data and research materials supporting the results in the article. Please see our Data Sharing Policies (https://royalsociety.org/journals/authors/author-guidelines/#data). Datasets should be deposited in an appropriate publicly available repository and details of the associated accession number, link or DOI to the datasets must be included in the Data Accessibility section of the article (https://royalsociety.org/journals/ethics-policies/data-sharing-mining/). Reference(s) to datasets should also be included in the reference list of the article with DOIs (where available).

In order to ensure effective and robust dissemination and appropriate credit to authors the dataset(s) used should also be fully cited and listed in the references.

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Best wishes,
Dr Robert Barton
mailto: proceedingsb@royalsociety.org

Associate Editor
Board Member: 1
Comments to Author:
We have now heard from two experts, both of whom are positive about your manuscript. At the same time, they have raised some issues that need to be addressed before we move forward. There are some methodological and statistical concerns (please report the actual p values, for

example). In addition, you should edit your Discussion by curbing some of the speculation that goes well beyond the data.

Reviewer(s)' Comments to Author:

Referee: 1

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Author's Response to Decision Letter for (RSPB-2020-1473.R0)

See Appendix A.

Decision letter (RSPB-2020-1473.R1)

03-Aug-2020

Dear Dr Vieira

I am pleased to inform you that your manuscript entitled "Help or flight? Increased threat imminence promotes defensive helping in humans" has been accepted for publication in Proceedings B.

You can expect to receive a proof of your article from our Production office in due course, please check your spam filter if you do not receive it. PLEASE NOTE: you will be given the exact page length of your paper which may be different from the estimation from Editorial and you may be asked to reduce your paper if it goes over the 10 page limit.

If you are likely to be away from e-mail contact please let us know. Due to rapid publication and an extremely tight schedule, if comments are not received, we may publish the paper as it stands.

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Thank you for your fine contribution. On behalf of the Editors of the Proceedings B, we look forward to your continued contributions to the Journal.

Sincerely,
Dr Robert Barton
Editor, Proceedings B
mailto: proceedingsb@royalsociety.org

Associate Editor:
Comments to Author:
I have now looked at your revised manuscript and rebuttal -- and I was impressed with your detailed responses to the comments of the reviewers.

Appendix A

Associate Editor: *We have now heard from two experts, both of whom are positive about your manuscript. At the same time, they have raised some issues that need to be addressed before we move forward. There are some methodological and statistical concerns (please report the actual p values, for example). In addition, you should edit your Discussion by curbing some of the speculation that goes well beyond the data.*

R: We thank the editors for the opportunity to revise and resubmit our manuscript. As you will see, the issues raised by the reviewers (including statistical concerns and discussion of findings) have been addressed in the revised version. We believe the changes have substantially improved our manuscript, and hope you will now find it suitable for publication. Please find below a point-by-point response addressing all the changes.

Referee: 1

I was a little confused by Figure 1 – how did the authors measure imminence? For imminent threats, was it the spider close to the right side? Figure 1 seem to show the same image for distal and imminent (proximal?).

R: We thank the reviewer for their comments, and appreciate the opportunity to clarify this important aspect. Our task manipulated imminence based on the distance of the visual cue (spider/butterfly) to the right side of the screen. In threat trials, when the spider reached the right side, there was a certain probability of a shock being administered. In all trials, the visual cue started static on the left (4 seconds), corresponding to the distal phase of the trial, and then moved to the right of the screen (another 4 seconds), corresponding to the imminent phase. Thus, all trials had a distal and imminent phase. In terms of helping responses, what characterized our Imminence variable (distal, imminent) was the moment when responses were prompted during the trial. Specifically, in the distal condition, helping responses were prompted immediately after the first 4 seconds, when the stimulus was still in the distal position (on the left); in the imminent condition, responses were prompted at the end of the imminent phase, when the stimulus had moved all the way to the right side of the screen. In the figure, this is represented by the two response slides with vertical arrows indicating when these slides were displayed over the course of the trial.

We fully agree with the reviewer that the way imminence was manipulated in the task is a critical aspect that should be clarified in Figure 1. We thus edited the legend in the following way:

P. 8: Figure 1: Schematic of the experimental task. Participants made trial-by-trial decisions about whether or not to help a co-participant avoid an aversive electrical shock, at the risk of receiving a shock themselves. The task included shock (left panel) and safe trials (right panel). Responses were prompted either in the beginning of the trial, when the visual cue was static on the left side (Distal), or at the end of the trial, after the visual cue had moved to an endpoint on the right, and thus immediately before shock delivery (Imminent). In the schematic, the imminence manipulation is represented by the response slides and vertical arrows signalling when responses were prompted.

Did the authors examine the effect of trait anxiety? There is evidence that trait anxiety predicts higher vicarious anxiety in high empathic subjects (Shu et al., 2017; JEP:G). Would be a nice link between the two literature.

R: We did not examine the effect of trait anxiety, since we had no a priori hypotheses about its relation with our study measures. Indeed, since our study was preregistered, we tried not to deviate from the preregistration and only perform non-planned analyses that were directly linked with our hypotheses. However, we acknowledge this is a very interesting suggestion, and have performed two exploratory correlations examining this question. The results were as follows:

Helping during <u>Distal</u> threats and Trait Anxiety: r = -.01, p = .904
Helping during <u>Imminent</u> threats and Trait Anxiety: r = -.01, p = .943

Given the absence of hypotheses regarding trait anxiety in our study, we have opted to leave these exploratory analyses out of the manuscript, but we restate in the Supplementary material that data collected on trait anxiety is openly available in the OSF project page, for those with an interest in further exploring these data:

P.2 of the Supplementary material: In addition to the IRI, participants completed the Triarchic Psychopathy Measure (TriPM; Patrick et al., 2009) and Form 2 of the State-Trait Anxiety Inventory (STAI; Spielberger et al., 1983). Data from these measures were not analysed and are not reported here, but are available on the OSF project page (https://osf.io/nb6cf/).

Rather than using P<0.05 could the authors use the actual p value?

R: We have edited the legends of the plots on Figures 2 and 3 to provide full p values. However, in Figure 3, to keep reported values within the 3 decimal range, p values below .001 are still referred to as <.001. In the manuscript text, full p values were already reported.

P. 12. Figure 2: … (*main effect of imminence, p= .025, **main effect of risk, p=.003).

P. 13. Figure 3: **a.** … (main effects of imminence and threat, ***p < .001). **b.** … (main effect of imminence, *p = .015).

I would love to know if ratings of the victims face influenced these effects (how similar, likeable?).

R: In our post-task questionnaire, two of the included questions (rated on a 7-point Likert scale) were related to the aspects raised by the reviewer, namely "How much did you identify with the coparticipant?" and "How authentic did the co-participant seem to you?". Exploratory correlations between helping behaviour and responses in these questions yielded the following results:

Helping during Distal threats and Identify question: r = .12, p = .22
Helping during Imminent threats and Identify question: r = .09, p = .38
Helping during Distal threats and Authenticity question: r = .14, p = .18
Helping during Imminent threats and Authenticity question: r = .14, p = .17

As noted above for the data on Trait anxiety, we refrained from including additional exploratory correlation analyses in the manuscript for which we had no previous hypotheses. However, like before, we added a sentence in Supplementary material stressing that these data are available in the OSF project page for those interested in exploring them further.

P. 2 of the Supplementary material: Responses to the post-task questions are available on the OSF project page (https://osf.io/nb6cf/).

Referee: 2

One thing that is surprising that warrants some additional discussion is the lack of effect of the likelihood manipulation. Given that threat imminence is multiply determined it is somewhat surprising that this wouldn't also affect imminence. For example, in one of the first threat imminence papers (Fanselow, 1989) shock probability is specifically mentioned as something that maps into imminence, at least in rodents.

R: We thank the reviewer for their positive and helpful comments on our manuscript. Regarding the likelihood of threat, specifically the risk of receiving a shock following a helping decision (low, 30% or high, 70%), we did observe that helping responses were significantly more frequent in the low risk than the high risk group (cf pg. 11 of the results, Table 2, and Figure 2). However, we found no significant imminence by risk interaction, suggesting that regardless of risk level, participants helped more under imminent than distal threat. We realize that this result may have not been made sufficiently clear in the manuscript, and thus edited the results and discussion as following:

P. 11 (Results): Overall, these results indicate that individuals helped more in the low risk group. Importantly, independent of the risk involved in the decision, increased threat imminence facilitated helping behaviour.

P.15 (Discussion): Our results showed participants helped more if the risk of shock was low, but provided no evidence for an interaction between risk and threat imminence ....

As the reviewer points out, the absence of a significant interaction between imminence and risk may be in itself surprising. In fact, in ecological settings, shorter spatiotemporal distance to a threat often corresponds to higher probability of harm, both contributing to a perception of higher imminence of danger, as pointed out in the animal predatory imminence literature. In our study, however, we dissociated the two dimensions to be able to quantify the interaction between them. To do so, we manipulated risk level <u>between subjects</u> (high and low risk group), ensuing that within an individual, risk level and spatiotemporal distance to the threat could not simultaneously contribute to the perception of imminence. Our risk manipulation thus taps more into the influence of overall dangerousness of the situation in helping behaviour, rather than being used as an added cue of imminence. This methodological aspect may have contributed to the absence of a significant interaction between risk and imminence.

To highlight this important conceptual point, we added the following in the Discussion:

P.15/16: Our results showed participants helped more if the risk of shock was low, but provided no evidence for an interaction between risk and threat imminence, contrary to previous reports that shock level had a greater impact on escape decisions when facing slow versus fast predators (33). Methodological differences between the two studies, including different outcome variable (help or escape responses), are likely to account for this discrepancy. The most critical difference is that, in our study, risk level was manipulated between subjects, ensuing that within-individuals risk level and spatiotemporal distance of threat did not simultaneously contribute to imminence perception. Rather, our risk manipulation allowed us to assess the influence of overall dangerousness of the situation on helping behaviour.

The authors use an active/passive defensive behavior distinction quite a bit. I encourage them to avoid this terminology as it is both misleading and inaccurate. This distinction arose from an intuitive view that freezing is somehow passive and it would be better to take (locomotor) action. Animals engage in freezing when it is the most effective thing to do to in terms of preventing attack. It's is more of an active module where the prey chooses an optimal location to freeze and also the animal prepares for the next phase of defense if it becomes necessary. There is also no interplay between freezing and other defenses- for example, running occurs at a different level of imminence than freezing- it is not in competition with freezing. The data in this paper make this point quite clearly. Under high imminence the participants showed increased helping, faster reaction times, and higher heart rate. Does that sound passive?

R: We thank the reviewer for pointing out that our terminology was misleading. In fact, with the passive and active distinction, we intended to characterize freezing and active avoidance as optimal responses for different stages of the threat imminence continuum. I.e., when the attack has been initiated and freezing is no longer optimal, active escape is triggered. However, we do agree with the reviewer that this terminology may inaccurately suggest that freezing is never an optimal defense strategy. We have corrected all instances wherein we refer to passive versus active defensive behaviour throughout the manuscript, as detailed below:

P. 3: … as threat imminence increases, more fixed and species-specific behaviours are activated, such as freezing or, when immediate avoidance is necessary, fight-or-flight.

P. 4: The flow of information between these neural circuits enables adaptive switches between different defensive states as a function of dynamic threat properties like spatial proximity, direction or speed of movement (35), which ultimately inform the animal about the imminence of danger.

P. 10: Reaction times were expected to be slower during distal relative to imminent trials, following suggestions that defensive responses to lower/moderate threat imminence are characterized by behavioural immobility (i.e., freezing) in preparation of subsequent active avoidance if/when immediate escape becomes necessary (i.e., fight-or-flight).

P. 13: Taken together, our reaction time and heart rate effects suggest the threat imminence manipulation successfully induced shifts between defensive states, with distal threats eliciting slower responses and bradycardia, and imminent threats eliciting faster responses and tachycardia.

P. 15: At the neural level, switching from freezing to active avoidance as a function of threat imminence (…) increased threat imminence enabling defensive states that facilitate care to conspecifics in the form of defensive helping.

P.15: Participants displayed faster responses and increased heart rate during imminent compared to distal threats, in line with evidence of behavioural immobility and fear bradycardia and during freezing, and active avoidance and tachycardia during fight-or-flight (44,45,61–64).

The discussion is overly long and speculative especially with respect to brain function, which is not examined.

R: To address this concern, we have shortened the discussion in order to limit the reference to brain function that was not directly assessed. A limited amount of references to brain mechanisms implicated in defensive behaviour was kept in, which have been well established in animal and some human studies, and were considered relevant to contextualize the processes we investigated in our

experiment. Importantly, we now highlight that some of our interpretations remain speculative in the absence of brain data.

P. 14: Human research examining the interplay between helping and defensive responses under real threat is lacking, but some animal studies have addressed the link between defense and caregiving, and its underlying mechanisms. At the neural level, switching from freezing to active avoidance as a function of threat imminence has been linked to oxytocin-mediated exchanges between the basolateral and central amygdala nuclei (48–51). Notably, in rodents, central amygdala activation by oxytocin has also been shown to trigger maternal and caregiving behaviours in virgin females (52), and to enhance maternal defensive aggression (53,54). More importantly, in rats, the ability to inhibit freezing in favor of active threat coping behaviours is necessary to allow females to engage in offspring defense (55). These previous findings in animals demonstrate that neurohormonal circuits activated in situations of imminent danger are not only implicated in active individual defense, but also enable caregiving behaviours like offspring protection. While the discussion about underlying mechanisms remains speculative at this point, one possibility raised by our results is that, in humans, increased threat imminence may also enable defensive states that facilitate care to conspecifics in the form of defensive helping.

The prediction made on page 6 just before the methods is a critical one. However, I did not find the logic of the prediction particularly clear.

R: We fully agree that this is an important prediction, which should be clarified, and have thus re-worded the paragraph in question:

P. 5. Importantly, we predicted empathic concern would be more strongly associated with helping under imminent threat. Since higher threat imminence favors the activation of rapid and reflexive responses, it presumably hinders the engagement of slower and more taxing processes like cognitive control and emotional regulation (31,33). Those processes may, in addition to empathic concern, contribute to decisions to help others in threatening contexts (38); if they are hindered under imminent compared to distal threat, we would expect empathic concern to be the key individual motivator of helping decisions in situations of higher threat imminence.

Page 18 "comprise" should be compromise.

R: This typo has been corrected.