Attentional Bias for Negative Expressions Depends on Previous Target Location: Replicable Effect but Unreliable Measures

Journal:	*Journal of Cognitive Psychology*
Manuscript ID	JCP-FA 20-02.R2
Manuscript Type:	Full Article
Date Submitted by the Author:	17-Jul-2020
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Keywords:	Carryover, Visual probe, Attentional bias, Mental health, Cue offset, Reliability

Attentional Bias for Negative Expressions Depends on Previous Target Location: Replicable Effect but Unreliable Measures~~Conditionality of Attentional Bias on Previous Target Location: Replicable Effect but No Reliable Individual Differences~~

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Declarations of interest: none. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Word count: 3967.

Bias Carryover and Reliability

Abstract

Spatial attentional bias to threat may only be observable after prior responses to threat-related locations. Such carryover has scarcely been studied, and little is known about its relationship to reliability. Study 1 aimed to replicate and generalize the effect and evaluate individual differences. A sample was analysed of 131 participants who performed the diagonalized Visual Probe Task (dVPT) online with colour, anger, fear and disgust stimuli, and filled in questionnaires on aggression, anxiety, depression and impulsivity. Carryover was replicated: Bias towards negative stimuli was found only following targets probes on the negative location. Study 2 aimed to confirm whether the effect is related to cue-evoked attention. 101 participants were analysed on anger and disgust versions of the online task with blocks in which the cue was removed when probes appeared, or in which probes were superimposed on the cue. Aggression, anxiety and depression scales were included. Carryover was replicated with no interaction with cue offset. In both tasks, reliability was low and no robust correlations with questionnaires were found. Trial-to-trial carryover thus determined whether attentional bias to negative facial expressions was observed, but analyses taking this into account did not improve reliability or reveal correlations.

Keywords

Carryover; visual probe; attentional bias; mental health; cue offset; reliability

Bias Carryover and Reliability

Spatial attention can be defined as the selection of information for further processing conditional on its location in space, as can be modelled in terms of neural networks (Soltani & Koch, 2010). Spatial attentional biases are automatic processes (Deutsch & Strack, 2006; Schneider & Shiffrin, 1977) that influence attention relative to locations associated with emotionally salient stimuli (Cisler & Koster, 2010; Matthews & Wells, 2000). In addition to their theoretical interest, attentional biases may play a role in mental health disorders such as anxiety (Mogg & Bradley, 2016) and addiction (Field & Cox, 2008). A widely-used method to measure spatial attentional biases is the dot-probe task (MacLeod et al., 1986), in which task-relevant probe stimuli are preceded by task-irrelevant cue stimuli. This provides a bias score based on reaction time when a probe appears at the location of a previously-presented salient versus control cue. An only relatively recently studied influence on the detectability of such biases is the trial-to-trial carryover effect (Gladwin, 2017a; Gladwin et al., 2019; Gladwin & Figner, 2019). This refers to the dependence of the bias on the current trial on the location of probe stimuli on the previous trial. An example of carryover would be ~~when~~the situation in which, if a probe stimulus to which a participant responds appears on the location associated with a salient cue, the bias towards that cue type is greater on the following trial. Carryover has been studied using the diagonalized Visual Probe Task (dVPT), a variant of the dot-probe task designed to reduce unwanted trial-to-trial influences by presenting cues and probe stimuli on alternating locations, and using a ~~target~~ detection rather than a discrimination ~~speeded choice~~ task (Gladwin, 2016). In a detection task, the response on a given trial is determined by the location of a target probe stimulus; while in a discrimination task, the response is determined by which of a set of possible choice probe stimuli are presented. This results in stimulus locations and responses never repeating from one trial to the next. Carryover on the dVPT was found for colour and threat stimuli (Gladwin & Figner, 2019). When a target appeared at the location of one of the two colour cues, the bias on the next trial was towards the same colour; and an attentional bias towards threat was found only following trials when the previous target had been presented at the threat location. The latter asymmetric result was also found for anticipatory threat-related biases evoked by predicted,

rather than actually presented, stimuli (Gladwin et al., 2019). The conditionality of attentional bias on the previous response could involve various, not necessarily mutually exclusive, processes, for instance, (1) a limitation involving attentional disengagement, as the direction of probe-evoked attention persists from one trial to the next; (2) a temporary binding of stimulus category to attentional processes (Roelfsema et al., 1997), or, similarly, the establishment of a task set involving these elements (Monsell, 2003); (3) the inhibition of the category located away from the previous ~~probe or~~ target; or (4) the enhancement of the salience of the category associated with the previous probe or target. However, before future investments into uncovering the exact mechanisms of carryover and their implications for the concept of spatial attentional bias, this relatively novel phenomenon requires replication and further exploration. Further, the existence of carryover raises the question whether this could play a role in reports of low reliability of bias scores (MacLeod et al., 2019; Rodebaugh et al., 2016; Van Bockstaele et al., 2019; Waechter et al., 2014). Possibly, analyses taking carryover into account could isolate reliable bias scores, e.g., by considering biases derived only from trials on which a bias would be expected given carryover.

Study 1

The goal of Study 1 was to confirm and expand previous findings on carryover. The emotionally salient stimuli were photographic negative facial expressions: angry, afraid and disgusted. Simple colour stimuli were also used~~,~~ to replicate the effect for this low-level visual feature. There were three primary aims. First, within-subject tests of carryover were performed to test an overall carryover effect. Second, the split-half reliability of individual differences in carryover scores was evaluated. Finally, in exploratory analyses aimed at providing direction for future research, correlations were tested between carryover scores and a range of mental health issues.

Methods

Participants

Study 1 was successfully completed online by a sample of 131 healthy adult participants (100 female, 31 male; age 21, *SD* = 2.8) for course credit or financial reward. Other participants performed the experiment but were excluded in quality checks that aimed to ensure consistently sufficient accuracy (accuracy in any condition < .80, *n* = 60; please note that the carryover effect remained significant when all participants were included, but the relatively stringent exclusion was retained to reduce concerns with the influence of low-quality data, which given the current results was considered to be more important than retaining a larger proportion of the sample). All participants gave informed consent and the study was conducted following institutional ethical procedures.

Diagonalized Visual Probe Task (dVPT)

The task was programmed in JavaScript, based on the onlineCBM software (Gladwin, 2017b).

Each dVPT consisted of 10 blocks of 24 trials (Figure 1). Trials began with a central fixation cross for 350, 400, or 450 ms. This was followed by a cue stimulus consisting of two cues, one from each of two stimulus categories. ~~These cues~~ Cue stimulus categories varied per task. On the Colour task, cues were blue versus yellow squares; on the Angry task, faces with angry versus neutral expressions; on the Afraid task, faces with fearful versus neutral expressions; and on the Disgusted task, faces with a disgusted versus neutral expressions. Faces were front-facing photographic images taken from the Karolinska Directed Emotional Faces, KDEF (Lundqvist et al., 1998). The cues were located on one of the screen-diagonals, alternating per trial: i.e., either on the top-left and bottom-right, or on the bottom-left and top-right. Due to this, cues and probe stimuli never appeared at the same absolute spatial location (e.g., top-left) as the previous trial. The cues were presented onscreen for a Cue-Probe Interval (CPI) of 600 ms. Following this period, a probe stimulus overlaid

each cue. Probes consisted of a target, >><<, presented at one of the cue locations, and a distractor stimulus, /\/\ or \/\/, at the other cue location.~~After this period, overlaid over the cues, a probe stimulus was presented, consisting of a target and distractor. The target, >><<, was presented at one of the cue locations, and a distractor, /\/\ or \/\/, at the other cue location.~~ There was a 5% chance of a trial being a catch trial, on which there were two distractors and no target, and no response should be given. This was done to reduce the chance of participants responding to distractors, which in principle could be used to determine that the target was at the opposite location of the diagonal, rather than seeking out the target. The probe was presented for 1000 ms, or until a response was given if faster than 1000 ms. The task was to quickly and accurately press a key (R for top-left, F for bottom-left, J for bottom-right or I for top-right) corresponding to the target location. Fingers were instructed to be placed on the keys so that the spatial congruence between target and key positions was clear, i.e., left and right index fingers on the F and J keys, respectively and left and right middle fingers on the R and I keys, respectively. Note that due to the alternating diagonals used for stimuli and the target detection responses, responses were never repeated from one trial to the next. Errors were followed by a red "Incorrect!" for incorrect responses, and a red "Too late!" if no response was given. The feedback was presented during the first 200 ms of the following intertrial interval.

Questionnaires

The Rosenberg Self-Esteem Scale, RSES (Rosenberg, 1965), was used to measure self-esteem. Cronbach's alpha was .89. The Buss-Perry Aggression Questionnaire, BPAQ (Buss & Perry, 1992), was used to measure aggression on four dimensions: Physical Aggression (alpha = .81), Verbal Aggression (alpha = .79), Anger (alpha = .81) and Hostility (alpha = .85). The Trauma Screening Inventory, TSQ (Brewin et al., 2002) was used to measure post-traumatic stress disorder symptoms (alpha = .76). The Patient Health Questionnaire-4, PHQ4 (Kroenke et al., 2009), was used to measure Anxiety

(alpha = .78) and Depression (alpha = .78). The short-form version of the Urgency, Premeditation, Perseverance, Sensation Seeking, Positive Urgency, Impulsive Behavior Scale, SUPPSP (Cyders et al., 2014), was used to measure five dimensions of impulsivity: Negative Urgency (alpha = .77), Lack of Perseverence (alpha = .50), Lack of Premeditation (alpha = .66), Sensation Seeking (alpha = .67) and Positive Urgency (alpha = .73).

Procedure

Participants performed the experiment online. First an information sheet was presented and informed consent was given by clicking on a consent button. Then the questionnaires were completed. Finally, the Colour, Angry, Afraid and Disgusted dVPTs were performed, in an order randomized per participant.

Preprocessing and statistical analyses

Preprocessing included removal of trials that were relatively likely to be abnormal. Per participant, these were: the first four trials of the task, trials following an error, the first trial of each block, and trials with an RT more than 3 SD from the mean of the condition it was in. Of the remaining trials (at least 189 per task in the sample used for analyses), the median reaction time of accurate trials was used in analyses. Medians rather than means were used to reduce the impact of any remaining outlying RTs as was done, e.g., in the previous studies on carryover (Gladwin et al., 2019; Gladwin & Figner, 2019).

Repeated measures ANOVAs were used to test effects of target location relative to the cues (i.e., target on one versus the other colour cue, or target on the negative expression versus neutral expression cue) and previous target location (the target location on the previous trial). There were

thus four conditions, defined by the current and previous trial type, e.g., one condition would consist of trials that followed target-on-neutral trials and on which the current trial's target appeared on the negative expression. The analyses were done separately for the Colour dVPT and for the dVPTs involving facial expressions; for the latter analyses, expression type used in the respective tasks (angry versus neutral, afraid versus neutral, and disgusted versus neutral) was used as an additional within-subject factor. Please note that the essential test is the interaction between target location and previous target location. If this is significant, then the cue-related attentional bias (i.e., the RT difference score for targets on one versus the other category) is significantly different when the target was presented at one versus the other cue location on the previous trial. The main effect of target location represents the test of the usual bias: Are RTs faster when the target is presented on the location of a cue from one category versus another?

Split-half reliabilities of carryover contrast scores (i.e., bias towards category X following target-on-X minus bias towards category X following target-off-X, where bias is the RT for targets on versus off the category X location) were evaluated using Spearman's correlations between the sets of even versus odd trials ("even/odd" referring to the current trial) and the Spearman-Brown formula.

Spearman correlations between the carryover contrast scores for each task and the questionnaire scores were calculated, to explore possible relationships of interest for future confirmatory research. It was determined whether results survived multiple testing using Bonferroni correction for the number of carryover scores (n = 4, one for each of the four tasks) and the number of questionnaire subscales (n = 13), leading to a critical *p*-value of .05 / 52 = .00096. Correlations between questionnaire scores and simple bias scores were also calculated for completeness.

Bias Carryover and Reliability

Data are available at: https://osf.io/bgqzm/.

Results

Descriptive statistics are shown in Table 1.

<Table 1 around here>

For the Colour task, the carryover effect was confirmed, $F(1, 130) = 63.39$, $p < .001$, eta_p^2 = 0.33. Responses were faster to targets on the location of the same cue as the previous trial. There was no main effect of target location or previous target location.

For the facial expression tasks, the carryover effect was confirmed, $F(1, 130) = 21.88$, $p < .001$, eta_p^2 = 0.14, and showed the previously found asymmetric pattern: The bias towards negative expressions was non-significant following a target-on-neutral trial, $F(1, 130) = 2.6$, $p = 0.11$, eta_p^2 = 0.020, and significant following a target-on-negative trial, $F(1, 130) = 44.49$, $p < .001$, eta_p^2 = .26. Further, there was a main effect of target location, $F(1, 130) = 24.70$, $p < .001$, eta_p^2 = 0.1597. This further interacted with expression type, $F(2, 260) = 3.81$, $p = 0.024$, eta_p^2 = 0.028: The main effect of target location reached significance for Anger, $t(130) = -3.52$, $p < .001$, $d = -0.31$, and Disgust, $t(130) = -4.60$, $p < .001$, $d = -0.40$, but not Afraid, $t(130) = -1.42$, $p = 0.16$, $d = -0.12$. There were no further significant effects.

The split-half reliability of the carryover scores was: .32 for Colour, 0 for Angry (negative split-half correlation, $r = -.050$), .25 for Afraid, and .20 for Disgusted. The split-half reliability of the bias was:

.18 for Colour, 0 for Angry (r = -.00034), .25 for Afraid, and .22 for Disgusted. For the facial expression tasks, the split-half reliability of the bias following target-on-neutral trials was: 0 for Angry (r = -.044), .30 for Afraid, and .38 for Disgusted; the split-half reliability of the bias following target-on-threat trials was: .044 for Angry, .15 for Afraid, and 0 (r = -.0051) for Disgusted.

These findings suggest that these scores may be too noisy for use in correlational analyses, but as noted previously (Gladwin et al., 2019) this inference may be somewhat complicated by the possibility that only a subset of trials in a psychological task reflect an individual's bias. Therefore, and for completeness, the exploratory correlational analyses were nevertheless performed. Only one correlation involving carryover was found that survived correction for multiple testing, indicated with a * below; the other correlations shown here are those that were only nominally significant. The carryover contrast for the Angry dVPT was correlated with Verbal Aggression, r = -.13, p = .044, and Anger, r = -.30, p = .00061 *, on the BPAQ,; Anxiety on the PHQ4, r = -.23, p = .0079; and Negative Urgency on the SUPPSP, r = -.25, p = .0042. The negative correlations indicate higher questionnaire scores being related to a relatively strong bias towards the negative expression following a target-on-negative versus target-on-neutral trial. The carryover contrast for the Disgust dVPT was positively correlated with Anxiety, r = .18, p - .040, and Depression, r = .18, p = .042, on the PHQ4. Correlations involving the bias were also tested for completeness. The bias for the Angry dVPT was correlated with Verbal Aggression, r = -.20, p = .024, on the BPAQ; and Positive Urgency, r = -.17, p = .048, on the SUPPSP. The bias for the Afraid dVPT was correlated with Physical Aggression, r = -.20, p = .023, on the BPAQ.

Discussion of Study 1

Study 1 had three aims: to confirm and extend previous findings of within-subject trial-to-trial carryover effects on spatial attentional bias for colour and for a range of negative facial expressions;

to determine the split-half reliability of the carryover contrast score; and to explore correlations between carryover scores and mental health-related questionnaires.

The predicted within-subject effects were found. For Colour cues, attentional bias was drawn towards the colour cue on which ~~with~~ the target was presented in the previous trial. This replicated the previous finding on colour cues and carryover (Gladwin & Figner, 2019). Carryover was also found for negative facial expressions, as in previous findings for threatening stimuli (Gladwin et al., 2019; Gladwin & Figner, 2019). Importantly, this effect was asymmetric: a bias towards the negative expression was found following target-on-negative trials, but there was no reversal of the bias following target-on-neutral trials. Thus, the effect for negative emotions is not merely due to a learning effect ~~in which emotion does not play a role~~independent of emotional stimulus features, in which the target is predicted to occur at the location of the same cue category. The effect did not significantly differ between the tasks with different expressions.

Split-half reliability was low~~,~~ for both carryover and bias scores. This is in line with other findings of low reliability of dot-probe tasks (Ataya et al., 2012; Brown et al., 2014; Chapman et al., 2017; Christiansen, Schoenmakers, et al., 2015; Dear et al., 2011; Jones et al., 2018; Kappenman et al., 2014; McNally, 2018; Schmukle, 2005; Waechter et al., 2014). Such findings have led to attempts to improve reliability, e.g., via eye tracking or personalized stimuli (Christiansen, Mansfield, et al., 2015) and via predictive cues (Gladwin & Vink, 2020). It has been noted that it is essential to draw valid, nuanced conclusions from such findings (MacLeod et al., 2019). For example, if a study's interest is in within-subject effects, e.g., to test for a law-like effect common to all individuals in a population, then reliability of individual differences is likely irrelevant. A range of correlations between carryover and mental health-related questionnaires showed nominal significance, but only the association between Anger and carryover on the Angry dVPT survived correction for multiple testing.

Study 2

In the tasks used in Study 1, probe stimuli were overlaid on the cues. Results could potentially have been sensitive to this task feature, which could affect interpretation – could carryover involve interactions with searching for and responding to a target overlaying cues, rather than attentional shifts evoked by the cues prior to probe presentation? Therefore Study 2 aimed to determine whether results would differ when probe stimuli overlaid cues versus when cue offset occurred prior to probe presentation. All task variants now contained two trial types, which varied over blocks. One trial type was as in Study 1, with probe stimuli overlaid on cues. In the other trial type, cues were removed when the probe appeared. The primary question was whether carryover would be influenced by this manipulation of cue offset. Further, the reliability of contrast scores and correlations with a selection of individual differences used in Study 1 were calculated, separately for the cue offset variants.

Methods

Participants

Study 2 was successfully completed online by a sample of 101 healthy adult participants (70 female, 31 male; age 28, S*D* = 14). Other participants performed the experiment but were excluded in quality checks for low accuracy (accuracy in any condition < .80, *n* = 30). All participants gave informed consent and the study was conducted following institutional ethical procedures. ~~We n~~Note that there may have been some overlap in participants performing Study 2 and Study 1.

Diagonalized Visual Probe Task (dVPT)

The dVPT used in Study 1 was adjusted as follows (Figure 2). Each task consisted of 20 blocks of 24 trials. All trials within a block either removed the cue when the probe appeared (cue offset) or overlaid the probe on the cue as in Study 1 (no cue offset). Cue offset was pseudo-randomly selected per block, by permutating the order of sequential pairs of blocks of which one had cue offset and one did not.

Questionnaires

Two questionnaires were retained from Study 1: the Buss-Perry Aggression Questionnaire and the PHQ-4. Reliabilities were .84 for Physical Aggression, .79 for Verbal Aggression, .83 for Anger, .90 for Hostility, .85 for Anxiety, and .76 for Depression.

Procedure

The procedure was the same as in Study 1, except only two dVPTs versions were used, with the expressions Anger and Disgust, respectively, as these tasks had tended to show the strongest effects and most suggestive correlations in Study 1. The tasks were presented in randomized order.

Preprocessing and statistical analysis

The same preprocessing steps were used as in Study 1 (at least 367 trials remained per task in the sample used for analyses). Repeated measures ANOVAs were used to analyse RT with the factors: facial expression (the Anger or Disgust task), target location (negative expression or neutral expression), previous target location (negative expression or neutral expression) and cue offset.

There were two tasks and six questionnaire scales, so the alpha for significance was set to .05/12 = .0042. Correlations that were at least nominally significant in Study 1 were tested one-sided.

Results

Descriptive statistics are shown in Table 2.

<Table 2 around here>

As in previous results, there was a carryover effect, $F(1, 100) = 8.43$, $p = 0.0045$, eta_p^2 = 0.078, that was due to a significant bias towards negative following target-on-negative trials, $F(1, 100) = 19.38$, $p < .001$, eta_p^2 = 0.16, but not following target-on-neutral trials, $F(1, 100) = 2.07$, $p = 0.15$, eta_p^2 = 0.020. Further, there was a significant target location effect, $F(1, 100) = 15.7$, $p < .0001$, eta_p^2 = 0.14, reflecting a bias towards negative; this effect interacted with cue offset, $F(1, 100) = 4.79$, $p = 0.031$, eta_p^2 = 0.046. The target location effect was stronger in blocks without cue offset, $F(1, 100) = 15.13$, $p < .001$, eta_p^2 = 0.13, than in block with cue offset, $F(1, 100) = 6.08$, $p = 0.015$, eta_p^2 = 0.057. No other effects were significant.

The split-half reliability was as follows. For the blocks without cue offset, reliability of the carryover effect was .24 for Angry and .13 for Disgust, and reliability of the bias was .19 for Angry and .18 for Disgust. In these blocks, the bias following target-on-neutral trials was .18 for Angry and .046 for Disgust; the bias following target-on-negative trials was .25 for Angry and .33 for Disgust. For the blocks with cue offset, reliability of the carryover effect was 0 for Angry ($r = -.0013$) and .097 for Disgust, and reliability of the bias was 0 for Angry ($r = -.12$) and .33 for Disgust. In these blocks, the

bias following target-on-neutral trials was .23 for Angry and .37 for Disgust; the bias following target-on-negative trials was 0 (r = -.16) for Angry and .14 for Disgust.

No nominally significant correlations were found.

Discussion of Study 2

The within-subject carryover effect was replicated and did not appear to depend on whether probes occurred after the removal of cues or were overlaid on top of them. This suggests that the effect involves attentional processes evoked by the cues, rather than some form of interference during response selection. As before, the effect was asymmetric: a bias towards negative was found after responding to a target on the negative-associated location, but no bias was found after responding to a target on the neutral location. As in Study 1, reliability was poor. Neither the carryover effect nor the usual bias scores had reliabilities far from zero, for either task and for either the cue offset or the no cue offset blocks. Note that this is compatible with a strong within-subject effect (MacLeod et al., 2019), i.e., the mean bias in a given population could strongly differ from zero (measured, e.g., with a within-subject t-test), without measurements of individual differences being stable (assessed, e.g., via split-half reliability). No correlations were found with the aggression, anxiety or depression questionnaires in this study.

General Discussion

The current studies aimed to replicate the trial-to-trial carryover effect on attentional bias with new stimulus sets; to determine the split-half reliability of the carryover and explore associations with individual differences; and to determine whether the effect depends on whether cues were removed prior to probe presentation. Taken together, the results show that attentional bias, at least

as measured in the current task, is highly dependent on trial-to-trial carryover. The bias is only found on those trials following a response to threat, that is, following a response to a target on a location associated with a negative facial expression. This cannot be explained merely by automatic shifts of attention evoked by the current cues in a stimulus-response association that is consistent over trials. There is some form of latent bias that only results in an observable bias dependent on the phasic state evoked by responding to a location associated with threat. Understanding the nature of that latent bias will require further study, but speculatively could arise from an asymmetry in the ability of one stimulus category to inhibit the other. That is, to a first approximation, the act of responding to a target at a location associated with a certain stimulus category appears to facilitate selection of information from locations subsequently associated with that stimulus category rather than the other. However, the neural representation of the threat category appears able to inhibit the neutral category, resulting in an observed bias towards threat on subsequent trials; while the neutral category can only achieve equality with the threat category, resulting in the absence of an observed bias. The reliability of individual differences in the bias scores was very low. As noted previously, this is in line with other reports of low reliability for the bias on the dot-probe task; further, the carryover effect involves a difference-of-difference measure which could affect reliability (Nunnally & Bernstein, 1994). We found no patterns suggestive of a reliable subset of trials related to trial-to-trial carryover effects. There were no replicable correlations between bias-related contrast scores and mental health-related variables over the studies.

Limitations include the stimulus categories. First, the current results hold only for the used stimulus categories. Future research would be needed to determine whether similar carryover effects would be found for other kinds of stimuli, e.g., positive expressions or appetitive food or drinks. Second, there was also only a single CPI; results could potentially differ with alternative intervals. Third, the study was online, which reduces the level of control over the testing situation relative to lab studies. However, online data can in principle produce reliable attentional bias scores (Gladwin & Vink, 2020), and effects on psychological tasks do not appear to be strongly affected by online

performance (Chetverikov & Upravitelev, 2016). The cost-effectiveness of online studies is a significant benefit for research, allowing researchers with limited resources to contribute to the field. Online studies should be considered as one of a variety of approaches that play a role in exploring and establishing the robustness of an effect. Fourth, in future studies a practice block could be considered to allow more familiarization with the task prior to assessment. Finally, the procedure of the studies may have reduced reliability and the ability to detect correlations, because of the exposure of participants to multiple task versions and conditions.

In conclusion, spatial attentional bias for threat depends on carryover. Fully understanding bias must take carryover into account: Why is bias to threat only found in the set of trials following responses to stimuli at a location associated with threat? Although within-subject effects appear to be robust, reliability was low; however, comparisons between populations could yet reveal group differences.

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Figure 1. Illustration of the diagonalized Visual Probe Task (dVPT). The Figure shows a trial on the dVPT. On each trial, cues were presented on one of the diagonals of the screen, i.e., top-right and bottom-left, or top-left and bottom-right. A target and distractor replaced the cues after 600 ms. One of four response keys had to be pressed corresponding to the location of the target. On the next trial, the stimuli were presented on the other diagonal, so that cue positions and responses were never repeated.

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Figure 2. Illustration of a trial of the diagonalized Visual Probe Task (dVPT) with cue offset

Table 1. Descriptive statistics

1A. Questionnaires

Questionnaire	Sub-scale	Mean (SD)
Rosenberg Self-Esteem Scale		3.03 (0.47)
Buss-Perry Aggression Questionnaire	Physical Aggression	20.1 (7.66)
	Verbal Aggression	17.8 (5.29)
	Anger	17.7 (6.21)
	Hostility	20.9 (8.44)
Trauma Screening Inventory		2.84 (2.41)
PSQ-4	Anxiety	3.63 (1.43)
	Depression	3.06 (1.36)
Impulsive Behaviour Scale	Impulsivity – Negative Urgency	2.13 (0.63)
	Impulsivity – Lack of Perseverance	2.08 (0.39)
	Impulsivity – Lack of Premeditation	1.96 (0.43)
	Impulsivity – Sensation Seeking	2.43 (0.66)
	Impulsivity – Positive Urgency	1.83 (0.51)

1B. Diagonalized Visual Probe Task (dVPT)

	Reaction Times [ms]				Accuracy			
	Blue-Previous Blue	Blue-Previous Yellow	Yellow-Previous Blue	Yellow-Previous Yellow	Blue-Previous Blue	Blue-Previous Yellow	Yellow-Previous Blue	Yellow-Previous Yellow
Colour	458 (55.3)	469 (57.4)	468 (55.8)	456 (52)	0.961 (0.034)	0.961 (0.0311)	0.96 (0.0298)	0.958 (0.0307)
	Neutral-Previous Neutral	Neutral-Previous Negative	Negative-Previous Neutral	Negative-Previous Negative	Neutral-Previous Neutral	Neutral-Previous Negative	Negative-Previous Neutral	Negative-Previous Negative
Anger	474 (62.1)	479 (60.1)	474 (60.5)	470 (55.4)	0.959 (0.0323)	0.96 (0.036)	0.962 (0.0296)	0.96 (0.0332)
Fear	469 (59.9)	471 (59.1)	469 (53.9)	468 (56.8)	0.96 (0.0323)	0.96 (0.0325)	0.958 (0.0292)	0.96 (0.0322)
Disgust	474 (59.4)	476 (53.5)	471 (54.9)	466 (51.5)	0.958 (0.0334)	0.959 (0.0327)	0.964 (0.0301)	0.961 (0.0303)

Note. Table 1A and 1B show means and standard deviations (in parentheses) for the questionnaire and task data, respectively. For the task data, trial types are defined by the combination of the probe location on the current trial and on the previous trial. The task data are given for the four tasks, involving the stimulus categories colour, angry faces, fearful faces, and disgusted faces.

Table 2. Descriptive statistics

2A. Questionnaires

Questionnaire	Sub-scale	Mean (SD)
Buss-Perry Aggression Questionnaire	Physical Aggression	21.2 (9.05)
	Verbal Aggression	17.4 (5.80)
	Anger	17.3 (6.86)
	Hostility	19.9 (10.20)
PSQ-4	Anxiety	3.5 (1.45)
	Depression	2.96 (1.28)

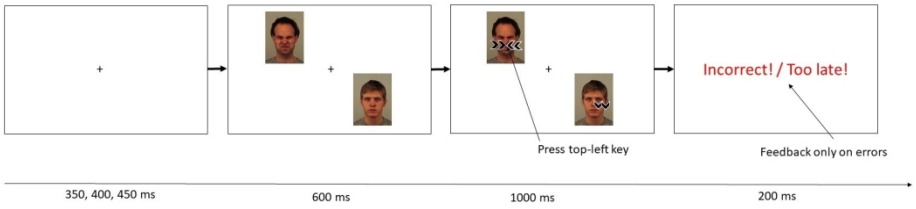
2B. Diagonalized Visual Probe Task (dVPT), reaction time [ms]

	Neutral-Previous Neutral		Neutral-Previous Negative		Negative-Previous Neutral		Negaive-Previous Negative	
	No offset	Offset	No offset	Offset	No offset	Offset	No offset	Offset
Anger	488 (71.1)	489 (67.2)	491 (75.4)	490 (63.8)	487 (71.2)	487 (66.6)	480 (66.6)	487 (66.9)
Disgust	495 (73.9)	497 (64.5)	497 (75.3)	498 (66.4)	490 (70)	496 (63)	489 (67.7)	492 (64.7)

2C. Diagonalized Visual Probe Task (dVPT), accuracy

	Neutral-Previous Neutral		Neutral-Previous Negative		Negative-Previous Neutral		Negaive-Previous Negative	
	No offset	Offset	No offset	Offset	No offset	Offset	No offset	Offset
Anger	0.963 (0.0315)	0.967 (0.0308)	0.964 (0.0292)	0.97 (0.0279)	0.966 (0.0284)	0.965 (0.0345)	0.962 (0.0317)	0.966 (0.03)
Disgust	0.963 (0.0308)	0.969 (0.0289)	0.962 (0.0279)	0.963 (0.0319)	0.962 (0.0293)	0.968 (0.0294)	0.957 (0.0325)	0.973 (0.0286)

Note. Table 2A, 2B and 2C show means and standard deviations (in parentheses) for the questionnaire and task data. For the task data, trial types are defined by the combination of the probe location on the current trial and on the previous trial, and on the block type: cue offset or no cue offset. The task data are given for the two tasks, involving the stimulus categories angry faces and disgusted faces.



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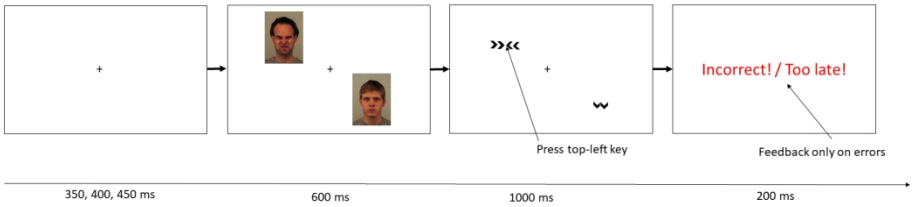

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