RESEARCH ARTICLE

Investigating the Influence of Tears-relevant Visual Cues on Contingency Judgments and Perceived Agency

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ABSTRACT: Emotional crying refers to a unique human behavior of shedding tears in response to emotional events. Prior findings have suggested interpersonal benefits of eliciting social support can be triggered by emotional crying. We hypothesized that crying has a communication value in signaling distress or helplessness to others. Specifically, we investigated whether tear-related visual cues influenced how individuals learn about and assess others' helplessness. Participants (N = 40) were presented with tearful and non-tearful facial stimuli during a learning sequence involving a contingency judgment task – assessing the correlation between an individual's actions (studying) and outcomes (passing a test). Results revealed that in both zero and positive contingency conditions, the presence of tears decreased the mean contingency rating; this suggested that the participants viewed the individual as more helpless. However, participants were also unable to discriminate between positive and zero contingency conditions when exposed to tear stimuli. We propose that the emotional salience of tears interferes with cognitive processes related to learning. We discuss these results in relation to alternative hypotheses involving potential carryover effects during learning. However, these findings suggest that tears function as a potent nonverbal cue for helplessness, highlighting their role in fostering social support.

KEYWORDS: Behavioral and Social Sciences, Clinical and Developmental Psychology, Emotional Crying, Contingency Learning, Helplessness.

Introduction

Background:

Auditory crying is a universal behavior found across different species. For the majority of the species, these behaviors are limited during infancy to vocalize distress or physical pain – which elicits an instant response from the caregiver.[1] *Homo sapiens* exhibit a unique type of crying that spans throughout their entire life span: emotional crying.[2] Emotional crying refers to the shedding of tears from the lacrimal apparatus in response to emotional events, in the absence of any irritation of the eyes. Research suggests that, in the United States, women cry an average of 3.5 times per month and men cry an average of 1.9 times a month.[3]

Despite the ubiquitous nature of emotional crying across human cultures, empirical research on its functional value remains limited. Darwin, the pioneering evolutionary biologist, concluded that "We must look at weeping as an incidental result, as purposeless as the secretion of tears from a blow outside the eye, or as a sneeze from the retina being affected by a bright light."[4] Other perspectives suggest that emotional tears function as a natural 'handicap.'[5] Handicapping aggressive or defensive actions by blurring vision, or tears have been proposed to make an individual more vulnerable – functioning as a sign of appeasement. Research on the impact and value of crying and emotional tears remains incomplete.

Motivation:

The ambiguity behind crying has been countered by the public belief that crying has an intrapersonal benefit – leading to a cathartic experience of distress relief. This notion, known as the 'catharsis' hypothesis, has been supported by Vingerhoets; among thirty countries, both men and women reported feeling better after crying.[6] However, the intrapersonal benefits were hardly found in controlled laboratory studies, those which artificially induce crying by mood induction techniques or standardized crying stimuli. Rather, these laboratory studies find that people report emotional impacts that are consistent with the feelings experienced while crying, that is, those related to sadness and depression. People who cried while watching a sad film felt more depressed relative to the participants who did not.[7] Similarly, Kraemer and Hastrup, examining the psychophysiological effects of crying such as heart rate and skin conductance, concluded that crying does not seem to reduce depressive symptoms as might have been expected given the catharsis hypothesis.[8]

Recent studies have shifted focus to the interpersonal effects of crying. They propose that crying, rather than directly influencing the individual, promotes prosocial behaviors of others that secondarily benefit the crier – therefore improving the crier's socio-environment. An investigation across forty-one countries analyzed the interpersonal effects of emotional crying, for instance, suggesting tears evoke the intention to offer social support.[9] Empirical findings have shown that individua-

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ls who have less frequent crying reportedly received less emotional support,[10] suggesting crying may play a role in triggering help from others. However, a research gap remains in understanding the intermediary step between crying and the social support it elicits – how does the crier communicate the need for help?

Human beings are ultrasocial animals that rely heavily on complex forms of cooperation, coordination, and division of labor for survival.[11] It is therefore plausible that the communicative role of infant crying –calling for help by displaying helplessness – has extended into adulthood. In this extension, the roles of caregivers could have simply shifted from parents to other socially interacting individuals. Based on this social-functional perspective, the current project aims to explore the tear-related cues' influence on how helpless an individual appears to others.

Hypotheses:

- **H_0:** There will be no statistical difference in observers' implicit assessments of helplessness between individuals presented with tear-related visual cues and those without such cues.
- **H_1:** Tear-related visual cues will significantly influence observers' implicit assessments of an individual's helplessness, which is posited to be a key factor in eliciting social support behavior.

Although we present this as a two-directional hypothesis, our intuition was that tear stimuli would impair contingency sensitivity.

Agency, as the opposite of helplessness, refers to one's capacity to perform an action (input) to derive a desired outcome (output). In other words, agency is proportional to the degree of correlation between one's input and desired outcome. Observers evaluate this correlation—the contingency between input and output—to infer an individual's level of helplessness. If a subject is perceived to be more helpless, the observer's assessed contingency would be lower than the actual contingency, reflecting cognitive bias. Therefore, participants' sensitivity to contingency-related information in a fictitious learning scenario was assessed to measure how helpless a subject appeared. This methodology was chosen as an alternative to directly asking the participants to rate the figure's helplessness to minimize explicitness; in explicit tasks, participants may consciously respond in ways to meet perceived expectations rather than being based on their instinctive, underlying cognition.

Methods

Participants:

A sample of forty participants composed of twenty-three male and seventeen female participants and aged 21 to 52 (M= 34.08, SD= 6.97) were recruited through MTurk for English speakers. The age cap was based on the general trend of decline in cognitive function and crystallized intelligence starting from age 45-60.[12,13] Participants completed a consent form and were given an honorarium for $4 for maximum 20-minute participation. The study was approved by the University of Oxford Central University Research Ethics Committee: Ethics Approval Reference: R88481/RE001.

Stimuli:

Four faces of individuals from Chicago Face Database9 were used as stimuli. All individuals, spanning from White, Asian, Black, and Latin, showed a neutral expression. To minimize the influence of stimulus-specific facial features on helplessness assessment, images with similar helplessness index – 2.336, 2.336, 2.336, and 2.277 – were selected. The helplessness index provided for each image was calculated from helplessness rating surveys across forty-one countries and 7,007 participants by Zickfeld. Three of the individuals were female, while the other was male. Imbalance in gender was disregarded as the variation due to their gender would have already been taken into account in the helplessness index. For each individual, an additional image with tears digitally added by using a Photoshop action by Küster was utilized.[8] Thus, the final stimulus pool was composed of eight pictures: four tearful and four non-tearful pictures of four different individuals of four different ethnicities. Stimuli for each condition were presented prior to the condition's contingency task with instructions. Each participant was exposed to all four facial stimuli, while the combination between the facial stimuli and condition was randomized.

Contingency task:

Stimulus presentation and response measurement were controlled by Gorilla Experiment (www.gorilla.sc), running on each participant's computer. Each cue-outcome pair was presented with a total duration of 1200 ms, displayed in the bottom half of the white screen. The facial stimuli were one each trial as shown in Figure 1.

The two types of predictive cues were 'STUDY' and 'Not STUDY', while the two possible outcomes were images written 'PASSED' or 'FAILED'. Each predictive cue with its paired outcome was shown simultaneously for 600 ms, which was followed by a fixation screen that appeared for 600 ms prior to the next trial (Figure 1).

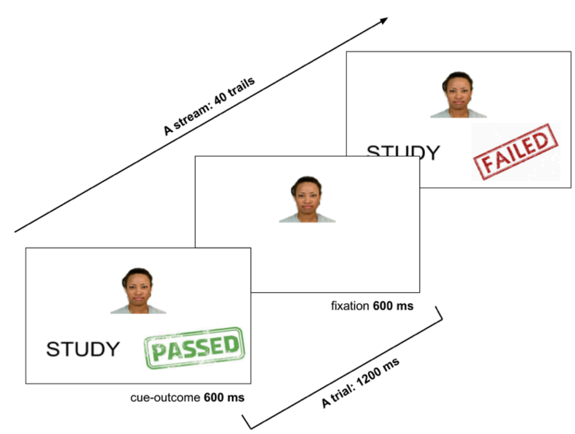

Figure 1: Example trial for the rapid presentation of predictive cues and outcomes in streaming trial procedure, along with facial fixation.

How predictive each action - STUDY or NotStudy - was for its consequences varied by altering four types of events. The events refer to the number of times that preemptive action 'STUDY' (Cue) has resulted in a positive outcome 'PASSED' (Outcome); b events refer to the number of times that pre-

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emptive action 'STUDY' (the cue, C) was present but the outcome, 'NotPassed', was neutral (~O); c events were when the preemptive action was absent (~C) but a positive outcome was resulted (O); and d events were when both preemptive action and positive action was absent, meaning both cues and outcomes were neutral (~C and ~O). As demonstrated in Table 1, the number of a, b, c, and d events were altered to create a positive and zero contingency, judged based on Allan's (1980) metric Delta P – a measure for contingency that ranges between -1 and +1.

Table 1: The distribution of trials for each cell along with statistical relations for conditional probability (P of O) and Delta P (ΔP). a= Cue (+C) and Outcome (+O), b= C+ and No Outcome (–O), c= No Cue (–C), and +O, d= –C and –O).

Zero				Positive			
	O+	O-	P		O+	O-	P
C+	10	10	0.5	C+	15	5	0.75
C-	10	10	0.5	C-	5	15	0.25
sum of +O			ΔP	sum of +O			ΔP
			0				0.5

The experiment followed a 2 x 2 within-subjects design, composed of two contingency levels (P= +.50, 0.0) and two stimulus types (tearful image, non-tearful image). Combined, this experiment had four conditions: (1) PT (Positive contingency, tearful image), (2) ZT (Zero contingency, tearful image), (3) PnT (Positive contingency, non-tearful image), and (4) ZnT (Zero contingency, non-tearful image). Each participant viewed each of the four contingency conditions, with one face assigned for each condition. Faces were randomized for assignment to each condition. Randomization was used to minimize the influence of facial-specific features on helplessness assessment (Table 2). Each condition consisted of forty trials with a total duration of approximately 48 seconds.

Table 2: F1, F2, F3, and F4 indicate distinct facial images of different individuals. Each participant was randomly assigned a trial sequence stream among $\alpha, \beta, \gamma, \delta$.

No tears		Tears		
Positive	Zero	Positive	Zero	
F1	F2	F3	F4	α
F4	F1	F2	F3	β
F3	F4	F1	F2	γ
F2	F3	F4	F1	δ

Procedure:

After participants read the information sheet and consent form, they completed an anagram task to exclude involvement by bots. The anagram task was followed by a demographic questionnaire - questioning age and ethnicity – followed by the contingency task with four conditions. On each of the four conditions, participants were instructed to imagine a specific scenario: "IMAGINE that (Name) has currently failed a test. They are very keen to do well, but as we know people sometimes have the best intentions but do not always follow through. Over a series of images, you will see on the left side of the screen, whether (Name) actually does study for future tests, and then on the right side of the screen you will be given information about whether (Name) has passed each test." In conditions with positive contingency, studying resulted in an increased likelihood of passing, while in the zero contingency conditions, studying had no impact on performance. They were also given the following instruction: "The left image indicates that the figure studies for future tests, while the picture on the right suggests he/she does not." Every participant received the same order of conditions, which was presented sequentially as PnT, ZnT, PT, and ZT. After viewing each stream of cues and outcomes, participants were asked to rate the relatedness between the subject's studying action and passing. Particularly, they were asked to respond on a rating scale from -10 to +10, where -10 indicates a 'strong negative relationship' (i.e., contingency), 0 indicates 'no relationship', and +10 indicates a 'strong positive relationship. Following the final condition, the experiment ended with a thank you statement and an offer to answer any questions.

Results and Discussion

The descriptive statistics suggest that the presence of tears in facial stimuli reduced the perceived contingency among participants, as shown in Figure 2. For both positive and zero contingency levels, the participant's mean judgment for non-tearful facial stimuli was lower than that of tearful facial stimuli. In the zero-contingency condition, the presence of tears decreased the mean contingency rating by 2.63, while in the positive contingency condition, the value was 4.23. This effect of tears was more pronounced in positive contingency conditions than zero contingency conditions; The error bars represent the 95% confidence intervals for each condition's mean.

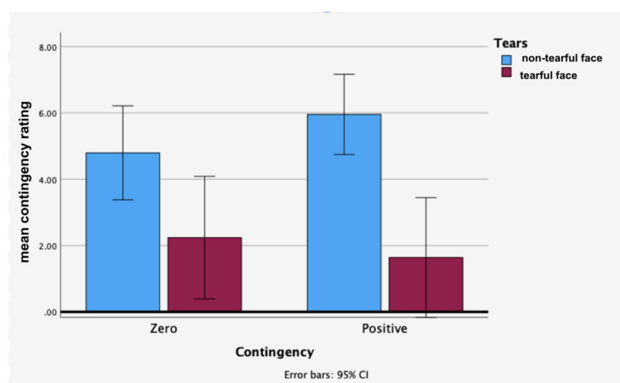

Figure 2: Participants' mean contingency rating along with contingency (zero, positive) and presence of tear in facial stimuli. For both contingency levels, the mean contingency rating decreased with the presence of tears. However, a lack of sensitivity to the contingency condition was observed.

The support for these observations come from the 2x2 factorial ANOVA with the within-subject factors contingency (zero, positive) and stimulus type (tearful, non-tearful). There was a significant main effect for tears [$F(1, 36) = 22.360$, $p<.001$]. This indicates that the presence of tears in facial stim uli significantly reduced the perceived contingency judgment of participants.

However, the descriptive statistics also depict that the participants could not discriminate between positive and zero contingency conditions. While contingency ratings for non-tearful stimuli increased slightly as the condition changed from zero to positive, ratings for tearful stimuli displayed an opposite trend; the mean contingency rate increased from 4.77 to 5.85 in shifting from Condition ZnT to PnT, while it decreased from 2.15 to 1.62 in shifting from condition ZT to PT. Overall, the ANOVA analysis reflects the effect of contingency was not significant [F (1, 36) = .148, p=0.703]. This suggests that participants were incapable of discriminating between positive contingency conditions and negative contingency conditions.

The interaction effect between the combination of face type and condition type by tears was not significant in testing the within-subject effect [F (3, 36) = 0.951, p= 0.462], nor was the interaction between the combination and contingency [F (3, 36) = 1.497, p= 0.232]. Similarly, the combination did not have a significant between-subject effect on perceived contingency [F (3, 36) = 0.832, p=0.485]. This suggests that the combination of face type and condition was not a significant covariate for the contingency task and therefore can be disregarded from further analysis.

Our results have demonstrated that the presence of tears in facial stimuli and participants have a negative impact on contingency judgments. Specifically, the presence of tears significantly reduced the perceived contingency in both positive and zero contingency conditions. The analysis supported this trend.

A potential explanation for the participants' impaired ability to distinguish different contingency levels might be the tears' innate emotionality. Emotional tears facilitate the recognition of sadness, creating an emotional context for perceived information.[14] Humans show a priority of emotional over neutral stimuli in terms of processing information. For instance, emotional meaning captures orienting and engages attention early relative to neutral stimuli.[15] This prioritized perception of emotional stimuli could interfere with the attention in the process of executive functions that require cognitive flexibility, inhibition, and updating for manipulation of information.[16] In other words, the salience of tears could have interfered with the contingency learning process of participants. In fact, there has been evidence from ERPs and time-varying brain networks that suggest negative emotion interferes with cognition.[17] These aspects potentially provide an explanation why lack of contingency discrimination was only exhibited with exposures to tear-relevant cues.

Another possible explanation is the emotional carryover effect in serial tasks. The presence of tears, along with the given scenario of figures failing a test, could promote sympathy – eliciting negative emotional responses such as sadness. According to Morriss,[18] in studying emotional reactivity, it took 3500 ms for emotional recovery after offset of negative stimuli. However, this investigation lacked time intervals between each conditional task. The lack of time for emotional recovery from trial PT could have led to an emotional carryover effect, hindering the contingency rating in the subsequent trial ZT. This could suggest why the mean contingency rating was higher in zero contingency conditions than positive contingency conditions, but only in the presence of tearful faces.

A potential solution to this issue would be to randomize the order of tasks. Our study currently used a fixed sequence—PnT, ZnT, PT, and ZT—for all participants. Randomizing the order of conditions in future studies would reduce predictable emotional build-up or carryover effects, allowing each condition to be evaluated independently. Future research should also consider appropriate time intervals to further isolate the effects of trial order on observers' implicit assessments.

However, despite how the mean contingency rating was higher in the positive contingency condition than in the zero contingency condition without tearful stimuli, it appears that participants still exhibited an impaired ability to distinguish different contingency levels. For example, the mean rating for ZnT was 4.77, deviating substantially from the ideal value of 0, and the error bars for ZnT and PnT overlapped.

One possible explanation is that participants held a strong prior belief associating studying with success, and thus relied more on heuristics than on statistical information. In the no-tears condition, they may have simply defaulted to this prior belief of equating studying to passing a test.

Moreover, due to the serial design of the investigation, participants may have become skeptical about the purpose of showing them neutral and crying faces. Therefore, the participants could have relied on their common sense that passing a test requires being mentally stable (having confidence, being rational rather than emotional, etc.), guessing that crying people are more likely to fail. This compromises the reliability of the investigation as it becomes unclear whether the results are specific to the content of the contingency task.

A solution could be changing the content of contingency tasks so the outcome does not depend on the pictured person's emotional state. For instance, the input could be whether the person waters a plant and the outcome could be about whether the plant grew over a few weeks. While the content can still assess the individual's agency, it excludes the individual's emotional status as a factor that influences the outcome.

■ Conclusion

In conclusion, this study's findings underline the role of tears in making an individual appear more helpless. Tears, therefore, may be a potent non-verbal cue for communicating helplessness and subsequently eliciting social support– not only in infants but also in adults. One possibility is that the empathic response elicited by the tears allows observers to experience the sense of helplessness experienced by the crier. An alternative is that viewing tears activates memories in observers that activate helplessness. Either way, this form of empathy is activated by visual cues and has a direct effect on the cognitions of the observer. In this case, that effect was on the ability of the observers to process stimuli involving working memory and computational judgment.

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