

## INTRODUCTION

### Emotional Content and Context

- Emotional stimuli are detected faster and are more distracting than neutral stimuli, but the boundary conditions under which emotion facilitates or disrupts cognitive performance are unclear (Yiend & Mathews, 2001).
- It has been shown that low-arousal negative stimuli facilitate attention performance (Sussman, Heller, Miller, & Mohanty, 2013), including human emotional faces (Dennis & Chen, 2007a, 2007b; Finucane & Power, 2010; O'Toole, DeCicco, Hong, & Dennis, 2011). However, low-arousing negative emotional stimuli have also been shown to disrupt attention performance (Birk, Dennis, Shin, & Urry, 2011; Dennis, Chen, & McCandliss, 2008).
- Moreover, little is known about how the context of the emotional information – such as whether pairing stimuli with affectively dissimilar or neutral material – influences effects. One study suggests that processing of emotional information is unaffected by context while processing of neutral information is (Pastor et al., 2008).

### Task Relevance

- Another factor that may influence whether negative stimuli facilitate or disrupt attention performance is task-relevance.
- A stimulus can be considered task-relevant when it provides important cueing information or is the imperative stimulus with which a participant must be engaged in order to complete the task.
- Stimuli as cues: When participants are invalidly cued by a negative stimulus, they show longer response times, presumably due to a negative bias that enhances recruitment of attentional resources (Fox, Russo, Bowles, & Dutton, 2001; Koster, Crombez, Verschuere, & De Houwer, 2006).
- Imperative stimuli: When participants must respond to negative information they are better able to ignore other distracting stimuli; but in contrast, negative distracters interfere with non-negative imperative stimuli (Barratt & Bundesen, 2012; Fenske & Eastwood, 2003).

### Present Study

- In this study, we tested the effects of emotional stimuli on attention performance while systematically varying task-relevance of negative, positive, and neutral stimuli.
- We predicted that negative faces (angry versus happy or neutral) would facilitate attention performance when the negative stimuli are task-irrelevant, but increasingly disrupt attention performance as stimuli become more task-relevant (e.g., are the imperative stimuli or directly distracting to imperative stimuli).
- We explored the effects of emotional context by pairing negative and positive emotional faces with each other versus with neutral faces.

## METHODS

### Participants

	Gender		Age		
	Males	Females	Range	M	SD
Study 1 (N = 46)	15 (32.6%)	31 (67.4%)	18-52	20.07	5.36
Study 2 (N = 49)	15 (30.6%)	34 (69.4%)	18-32	19.71	2.96
Study 3 (N = 47)	9 (19.1%)	38 (80.9%)	18-30	20.17	3.01

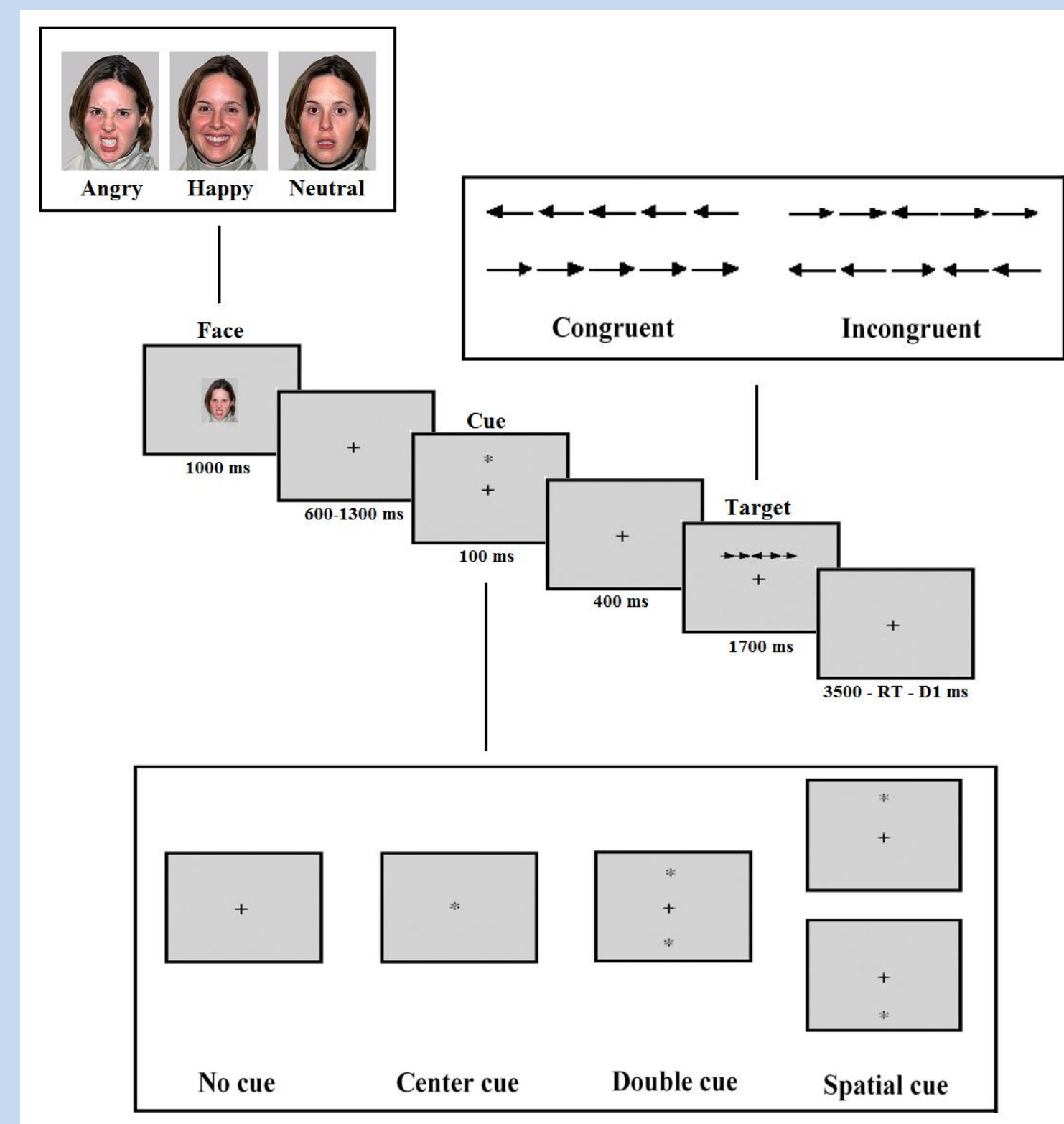
- All participants scored in the normative range on the Beck Depression Inventory (< 29; Beck, Steer, & Brown, 1996) and the State-Trait Anxiety Inventory (< 3 SD above the college norm; Spielberger, 1983).

### Attention Network Test (ANT)

- The ANT is a combination of a cued reaction time (RT) and a flanker task that requires the subject to determine whether a central arrow points to the left or right (Fan, McCandliss, Sommer, Raz, & Posner, 2002).
- Emotional stimuli included 48 color photographs of angry, happy, and neutral faces from 16 actors (half black, half Caucasian) (Tottenham et al., 2009).
- For all studies, emotional faces were presented in mixed blocks: angry and happy (A-H), angry and neutral (A-N), or happy and neutral (H-N).

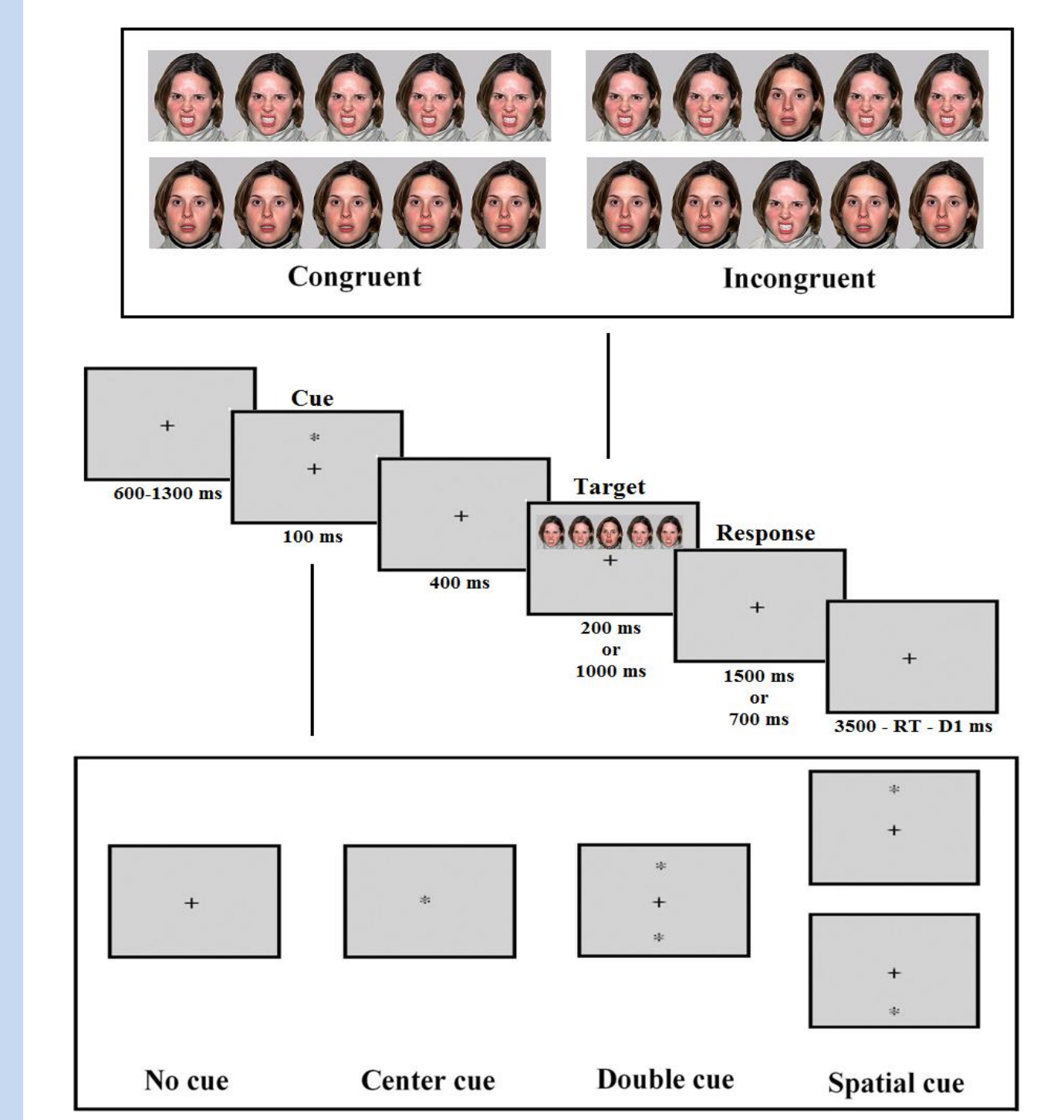
### Study 1: Task-Irrelevant Emotional Faces

Emotional faces were presented prior to each trial



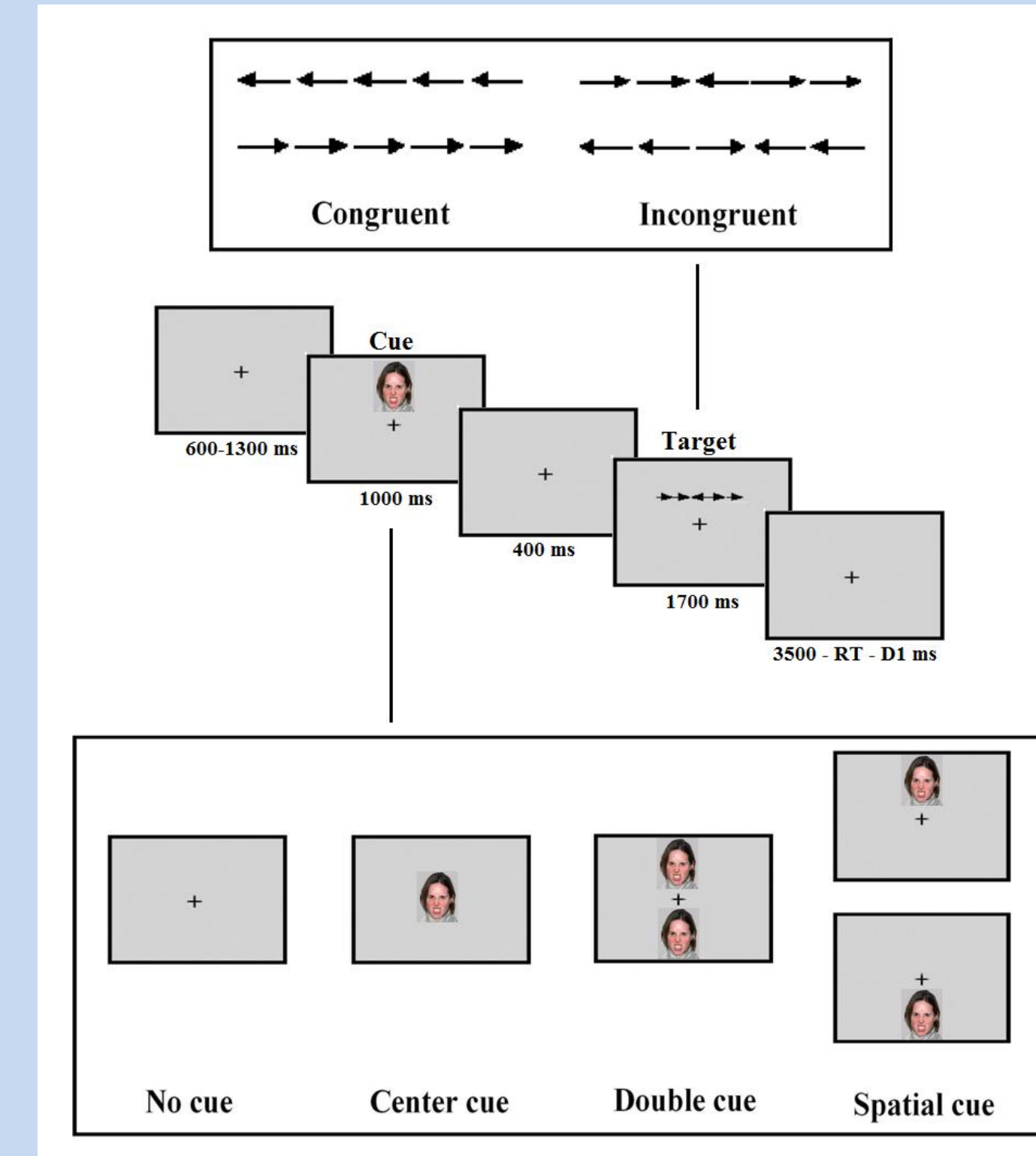
### Study 3: Imperative Emotional Faces

Emotional faces were presented as the target and flanking stimuli during each trial



### Study 2: Task-Relevant Emotional Faces

Emotional faces were presented as the cue stimulus during each trial



- The ANT measures the performance of three attentional networks:
  - Alerting:** achieving and maintaining a state of awareness.
    - RT no cues – RT double cues
  - Orienting:** ability to engage, disengage, and shift spatial attention.
    - RT center cues – RT spatial cues
  - Executive attention:** ability to respond to conflict among response options.
    - RT incongruent flankers – RT congruent flankers
- A higher score indicates greater alerting and orienting efficiency while higher executive attention scores indicate *decreased* executive attention efficiency (greater conflict interference).

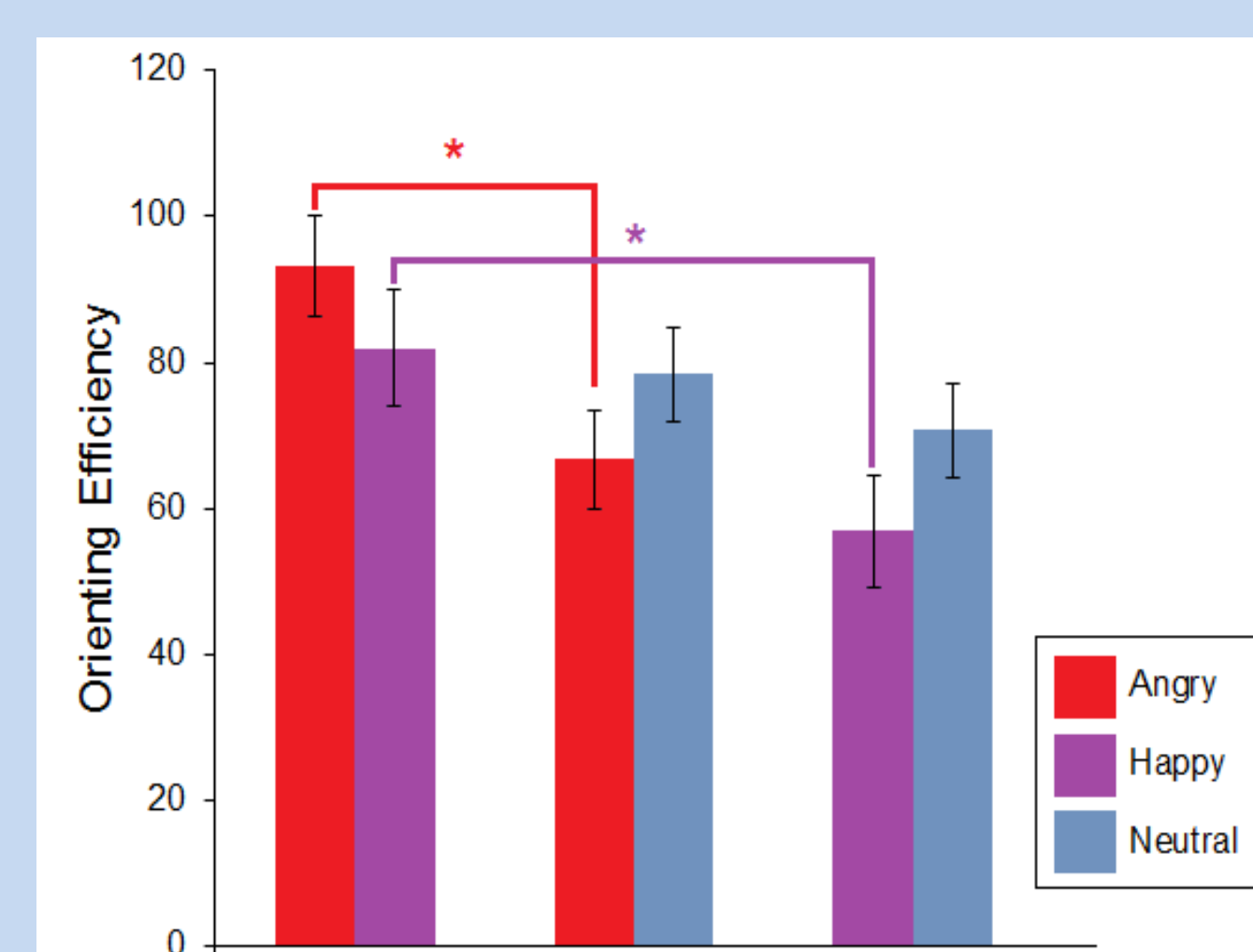
## RESULTS

- For Study 1 and Study 2, paired samples t-tests were conducted for each attention score.
  - First, we compared the two emotion types within each block (e.g., attention following angry face cues versus happy faces cues in the angry-happy block).
  - Second, we compared the two blocks in which each emotion appeared (e.g., attention following angry face cues in the angry-happy block versus the angry-neutral block).

### Study 1: Task-Irrelevant Emotional Faces

**Alerting:** *ns*  
**Orienting:** Orienting was facilitated by both angry and happy faces when they were paired together, as compared to when they were paired with neutral faces [angry:  $t(45) = 3.01, p = .004$ ; happy:  $t(45) = 2.53, p = .02$ ]

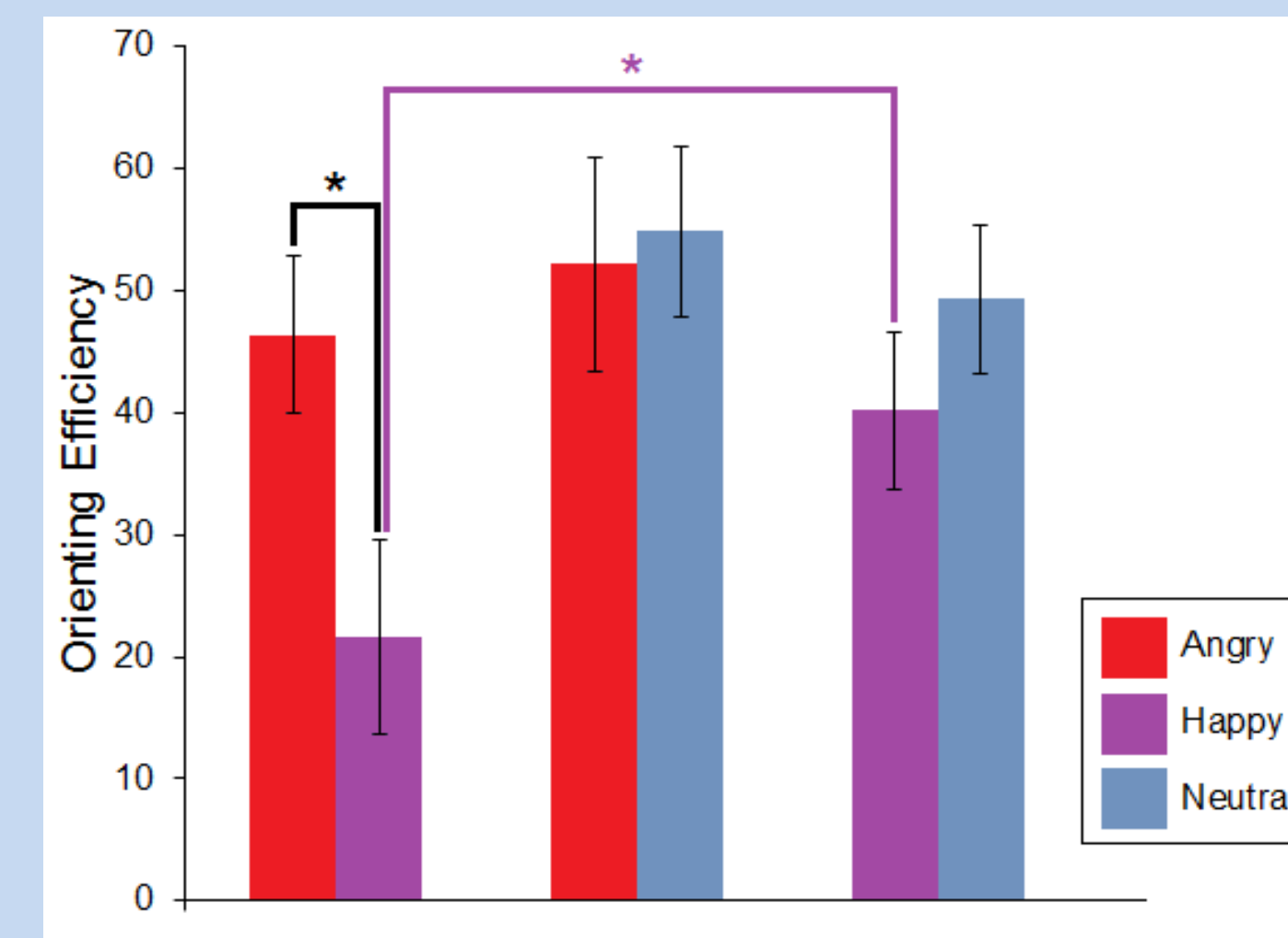
**Executive attention:** *ns*



### Study 2: Task-Relevant Emotional Faces

**Alerting:** *ns*  
**Orienting:** Orienting was facilitated following angry versus happy face cues when they were paired together [ $t(48) = 3.26, p = .002$ ]. The disruptive effects of happy faces was greater when paired with angry versus neutral faces [ $t(48) = 2.63, p = .01$ ].

**Executive attention:** *ns*



### Study 3: Imperative Emotional Faces

- Since Study 3 presented emotional faces in place of the arrows in the typical target/flanker display, analyses focused on only the executive attention score. A 2 (target: [angry, happy] or [angry, neutral] or [happy, neutral]) x 2 (congruency: congruent, incongruent) repeated-measures ANOVA was conducted separately for each block.
- Conflict interference was increased for both emotions in the A-H block [ $F(1, 46) = 7.87, p = .007$ ] but only for neutral targets in the A-N block [ $F(1, 46) = 6.95, p = .01$ ]. There was no effect of congruency in the H-N block.

		Conflict Interference Effect (RT Incongruent > RT Congruent)	
Block	Target		
Angry-Happy	*Angry		$p < .001$
Angry-Happy	*Happy		$p < .001$
Angry-Neutral	Angry		$p = .45$
Angry-Neutral	*Neutral		$p < .001$
Happy-Neutral	Happy		$p = .34$
Happy-Neutral	Neutral		$p = .07$

## SUMMARY AND DISCUSSION

- When emotional stimuli are task-irrelevant:** Orienting was facilitated by both angry and happy faces, compared to when they were paired with neutral faces. The pairing of two emotional stimuli, rather than an emotional stimulus with a neutral one, may have created a context of heightened orienting.
- With increasing task-relevance:** When emotional faces were cues, orienting was facilitated by angry but not happy faces. This suggests that low-arousal negative stimuli bootstrap orienting, perhaps due to the social-communicative value of angry faces to orient the perceiver towards danger (Sussman et al., 2013).
- Emotional imperative stimuli:** When faces were imperative to the task, conflict interference was increased for both emotions in the A-H block but only for neutral targets in the A-N block. Angry faces may be most disruptive, since conflict interference was heightened both when angry faces were targets (with happy faces as flankers) and when angry faces were distractors (with both happy and neutral faces as targets).
- Summary:** Emotional content, context, and task-relevance influenced effects of emotion on attention performance in multiple domains, with low-arousal negative stimuli (angry faces) facilitating orienting when task-irrelevant and when serving as cues but disrupting executive attention when serving as imperative stimuli.

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