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Running head: Valence of simple shapes

Negative triangles: Simple geometric shapes convey emotional valence

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## BRIEF REPORT

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### **Abstract**

It has been suggested that downward pointing triangles convey negative valence, perhaps because they mimic an underlying primitive feature present in negative facial expressions (Larson, Aronoff & Stearns, 2007). Here, we test this proposition using a flanker interference paradigm in which participants indicated the valence of a central face target, presented between two adjacent distractors. Experiment 1 showed that, compared with face flankers, downward pointing triangles had little influence on responses to face targets. However, in Experiment 2, when attentional competition was increased between target and flankers, downward pointing triangles slowed responses to positively valenced face targets, and speeded them to negatively valenced targets, consistent with valence-based flanker compatibility effects. These findings provide converging evidence that simple geometric shapes may convey emotional valence.

## Introduction

Previous work has shown that the visual system can prioritize faces on the basis of their emotional expression. For example in visual search tasks, it is easier to find a face showing a negative or threatening expression (such as sadness or anger) than a neutral or positive expression (e.g., Eastwood, Smilek & Merikle, 2001; Öhman, Lundqvist & Esteves, 2001). In such tasks, faces showing a negative expression are found more quickly and response times (RTs) are less influenced by the number of other items in the display (the RT-set size search slope is shallower). Differential processing of negative expression appears to be a robust phenomenon and has been observed across a number of different paradigms including visual search (see Frischen, Smilek & Eastwood, 2008, for a review), enumeration (Eastwood, Smilek & Merikle, 2003), spatial cueing (Fox, Russo, Bowles & Dutton, 2001; Fox, Russo, & Dutton, 2002; Georgiou et al., 2005), and flanker interference tasks (Fenske & Eastwood, 2003; Horstmann, Borgstedt & Neumann, 2006). Not only do negative faces guide attention to their spatial location, but they can also be more difficult to disengage attention from (Fox et al., 2001; Georgiou et al., 2005) or intentionally ignore (Blagrove & Watson, 2010). These properties likely reflect adaptive pressures to detect, identify and respond to potential threats within our environment at the earliest opportunity (e.g., Öhman, 1997; Öhman & Mineka, 2001).

Previous work has suggested that negative and positive valence might be expressed by the presence of simple visual features. For example, Aronoff, Barclay and Stevenson (1988) showed that sharp angles and diagonal lines (especially v-shapes, Aronoff, Woike & Hyman, 1992) are rated more negatively than rounder or curved shapes (see also Lundqvist, Esteves, & Öhman, 1999, 2004). More recently, research has considered if the presence of such 'negatively-valenced' simple features also help to capture attention. Tipples et al., (2002) found that search for faces containing V-shaped eyebrows was more efficient than for those

containing inverted V-shaped eyebrows. They suggested that the presence of a V-shape within a facial context was important for signaling negative expressions leading to the search advantage. Larson, Aronoff and Stearns (2007) also examined the ability of V-shapes to capture attention and found that a downwards pointing triangle was detected more rapidly than an upwards pointing triangle (see also Watson, Blagrove & Selwood, in press). Moreover, some conditions suggested that it was more difficult to disengage from downwards pointing triangles. Larson et al. concluded that, even in isolation, a downwards pointing triangle expressed negative valence (see also Lundqvist, Esteves, & Öhman, 2004), causing it to guide or capture attention more efficiently than other shapes.

The above studies show that downwards pointing triangles are rated more negatively and detected more efficiently than other stimuli. In this study, we used the Eriksen flanker paradigm (Eriksen & Eriksen, 1974), to test whether triangles convey emotional valence. Typically in the flanker interference task, a central target item is flanked on each side by a distractor. Different response keys are assigned to each of two target items. The target can either be flanked by distractors which command the same response as the target (*response compatible*), the opposite response (*response incompatible*), or no response (*neutral*). Response compatible flankers speed up target responses and incompatible flankers slow them (see Fenske & Eastwood, 2003; Horstmann, Borgstedt, & Neumann, 2006 for earlier uses of this technique with face stimuli).

We examined the effects of compatible, neutral and incompatible face flankers on the ability to indicate the valence (positive or negative) of a central face target. This condition verified the presence of the basic flanker effect with face stimuli. However, of most interest, we examined performance when triangles, rather than faces, were used as the flanking stimuli. The triangles were downwards pointing (potentially mimicking the components of a negative facial expression; Larson et al. 2007), upwards pointing or pointing

outwards/inwards. If triangles do convey emotional valence, then response compatible and incompatible triangle flankers should influence RTs in the same way as compatibly- and incompatibly-valenced face flankers.

We first confirmed that our stimuli differed in perceived valence. Thirty volunteers rated facial stimuli (positive, negative and neutral) and another thirty rated triangle stimuli (upwards, left, right and downwards pointing). Participants rated each stimulus on four, 7-point scales (Lundqvist, Esteves and Öhman, 1999, 2004; Lundqvist & Öhman, 2005) labeled: Good-Bad, Kind-Cruel, Friendly-Unfriendly and Pleasant-Unpleasant, coded from -3 (negative valence) to +3 (positive valence). Valence was calculated as the mean of the four scales. In addition, to confirm that the faces were perceived as face-like, on a further 7-point scale participants rated each stimulus as 'Like a face' to 'Not like a face'. The average valence ratings were 2.39, -0.350, and -1.00 for the positive, neutral and negative faces respectively,  $F(2,58) = 135.22$ ,  $MSe=0.719$ ,  $p<.001$ . The positive face was rated more positively,  $t(29) = 16.24$ ,  $p<.001$ , and negative face more negatively than the neutral face,  $t(29) = 3.02$ ,  $p=.005$ .

For the triangle stimuli there was no reliable difference between the right and left pointing triangles,  $t(29) = 1.17$ ,  $p=.254$ , thus these data were combined to form a single neutral condition. The resulting valence ratings were 0.892, 0.383 and -0.600 for upwards, left/right and downwards pointing triangles respectively,  $F(2,58) = 14.94$ ,  $MSe=1.16$ ,  $p<.001$ . The upward pointing triangle was rated marginally more positively,  $t(29) = 1.90$ ,  $p=.067$ , and the downward pointing triangle more negatively,  $t(29) = 4.35$ ,  $p<.001$ , than left/right triangles. Thus upward pointing triangles appear to exhibit some, albeit weak, positive valence and so for comparison were treated as the triangle equivalent of a positive valenced face in the following experiments.

Face stimuli were rated as being face like (mean of 5.20 on a scale of 1 to 7) and triangles were rated as being less face-like (mean of 2.98), with the face-triangle difference being statistically significant,  $t(58) = 5.71, p < .001$ .

## **Experiment 1: Face versus triangle flankers**

### **Method**

#### **Participants**

Sixteen (8 female) students from the University of Warwick, aged 19 to 28 years ( $M = 20.8$ ) took part voluntarily.

#### **Stimuli and apparatus**

Stimuli were presented on a 22" LCD monitor attached to a Pentium-based PC. Displays were generated and responses measured via a custom written program. The stimuli consisted of positively, neutral and negatively valenced schematic faces, and triangles pointing upwards, downwards, inwards or outwards; all were presented in light gray against a black background. The target was a central positively or negatively valenced face, flanked by two distractors (Figure 1). In the face condition, a display contained two face flankers which had compatible, neutral or incompatible expressions. In the triangle condition, distractors were upwards pointing, downwards pointing or neutral (pointing inwards or outwards). Faces were 15mm ( $1.4^\circ$ ) in diameter and triangles 15mm ( $1.4^\circ$ , each edge), with items separated by 10mm ( $0.95^\circ$ ).

#### **Design and Procedure**

The experiment used a 2 (target valence: positive, negative) x 2 (flanker type: face, triangle) x 3 (compatibility: compatible, neutral, incompatible) repeated measures design. Each trial consisted of a blank screen (1000ms), followed by a central fixation dot (1000ms), followed by the stimulus display (until response). Participants indicated the valence (positive or negative) of the central stimulus by pressing keys 'Z' and 'M' (counterbalanced across

participants). Each block contained 96 randomly ordered trials divided, equally between the 12 conditions. For the neutral triangle flanker condition, on half the trials the flanker triangles pointed inwards, and on the other half they pointed outwards. Participants completed three blocks; a demonstration and short practice block preceded data collection.

### **Results**

Mean correct RTs for each cell of the design were calculated individually for each participant, overall means and error rates are shown in Figure 1. The data were split into four groups, corresponding to target valence (positive or negative) and flanker type (face or triangle) and a set of planned comparisons (2-tailed, paired t-tests) was performed within each group on the mean correct RTs (raw RT data was first  $\log_{10}$  transformed). Flanker compatibility effects were assessed by comparing the compatible and incompatible trial RTs with those of the corresponding neutral baselines. With face flankers, negative distractors slowed RTs to positive targets,  $t(15) = 2.43, p < .05$ , and positive distractors slowed responses to negative targets,  $t(15) = 2.97, p = .01$ . For the triangle flankers, 'positive' triangles speeded responses to a positive face target,  $t(15) = 2.37, p < .05$ , however no other differences were significant. Error rates followed the RTs but there were no significant effects.

### **Discussion**

For face stimuli, there was a reliable slowing of RTs when the flankers were incompatible with the target, thus oppositely valenced flankers interfered with the target response (cf. Fenske & Eastwood, 2003). However, with triangle shaped flankers, a different pattern was shown. With negative face targets, the flanking triangles had no reliable influence. For positive targets, there was a reliable facilitation by upward pointing flankers and a numerical slowing, when they pointed downwards. This difference between face and triangle flankers might arise if face flankers can be less easily filtered out, perhaps because they group more readily with face targets.



## Experiment 2: Increasing flanker competition

We might be able to increase any valence-based influence of triangle stimuli by increasing the grouping between flankers and target. This was achieved by: i) decreasing the size of the target, ii) increasing the size of the flankers, and iii) moving the flankers closer to the target; which should produce greater interference effects (Eriksen & Eriksen, 1974; Miller, 1991).

### Method

#### Participants

Sixteen (8 female) students from the University of Warwick, aged 18 to 22 years ( $M = 20.1$ ) took part voluntarily. None had participated in Experiment 1.

#### Stimuli and apparatus

The stimuli were the same as in Experiment 1, except that targets were smaller (10mm,  $1.0^\circ$ ), flankers were larger (18mm,  $1.7^\circ$ ), and item separation was reduced to 5mm ( $0.48^\circ$ ).

#### Design and procedure

Design and procedure was identical to Experiment 1.

### Results

As shown in Figure 1, negative face flankers slowed responses to positive targets,  $t(15) = 4.24, p = .001$  and speeded responses to negative targets,  $t(15) = 2.25, p < .05$ . Positive face flankers numerically speeded responses to positive targets and slowed responses to negative targets. Of most interest, triangle flankers produced the same effects as facial flankers. Downward pointing (negative) triangles slowed responses to positive face targets,  $t(15) = 4.28, p = .001$ , and speeded responses to negative face targets,  $t(15) = 3.45, p < .005$ . Upwards pointing (positive) triangles also numerically speeded up responses to positive face targets. Consistent with RTs, there were numerically fewer errors on compatible trials and

significantly more errors on incompatible trials for both face,  $t(15) = 2.55$ ,  $p < .05$ , and triangle flankers,  $t(15) = 2.46$ ,  $p < .05$ .

### **Discussion**

The results were clear; with greater target-flanker competition, negative face flankers speeded responses to negative face targets and slowed them to positive targets. However, most strikingly, downward pointing triangle flankers (suggested to exhibit negative valence) produced the same effects as negative valenced face flankers.

### **General Discussion**

Previous work has shown that some simple visual forms (such as angular lines, acute angles and V-shapes) are perceived as conveying negative valence (Aronoff et al., 1988, 1992) and has suggested that such features might be responsible for driving our perception of negative facial expressions. This evidence has been based on, for example, self-reported ratings of valence (Lundqvist, Esteves & Öhman, 2004; Larson et al., 2007; see also Horstmann, Borgstedt & Neumann, 2006), consideration of visual representations used in society (e.g., Aronoff et al, 1988) and search for V-shapes among other simple geometric distractors (Larson et al., 2007; Tipples et al., 2003; Watson et al., in press).

One problem with previous visual search studies is that downwards pointing triangles might have enjoyed a selection advantage for numerous reasons, unrelated to valence (Watson, Blagrove & Selwood, in press). Similarly, valence rating studies rely on self-report measures (see above). The aim of the present study was to provide an alternative test of whether or not triangles exhibit emotional valence. If downwards pointing triangles convey negative emotional valence, they should mimic the effects of negative valenced distractor faces in terms of interfering with valence judgments to a central face target.

Experiment 1 provided weak evidence for such an effect. However, when the triangle flankers were made more salient; then downwards pointing triangle flankers had the same

effect on responses as negatively valenced faces. Specifically, they speeded responses to negative face targets and slowed responses to positive faces. Thus, downward pointing triangles interfered with determining valence of a central target in a similar way to a negative face flanker.

Note that the current data cannot be explained on the basis of attentional capture by salient stimulus properties, familiarity effects or spatial aspects. For example, if a downwards pointing triangle was simply more attention- grabbing then we would expect it to slow RTs in all conditions, which did not happen. Instead, responses to positive face targets slowed, whereas they were speeded to negative face targets. Thus, effects of distractor orientation depended upon the valence of the target, and we can conclude that response modulation is not simply due to a greater general capture of attention by downwards pointing triangles. Moreover, the findings cannot be explained by stimulus similarity or interference at a purely visual level. This is because faces were composed entirely of curves and triangles were composed entirely of straight lines<sup>1</sup>. The findings are, however, exactly what we would predict if the triangles were interfering at a valence-based level of representation.

In summary, the present study provides evidence consistent with the view that a downwards pointing triangle conveys negative valence. The findings also have implications for visual search and attentional capture in general. There are numerous examples of visual search asymmetries where search for a particular target shape (e.g., a letter Q) amongst a set of distractors (e.g., letter Os) is more efficient than the reverse. One explanation for these asymmetries is that the more-easily-found target possesses an attribute that is absent from the distractors; thus, the target is easily detected because it produces activity which uniquely defines its presence. In contrast, search for the absence of a feature (e.g., O amongst Q distractors) is more difficult, because target presence is not indicated by a unique signal (Treisman & Souther, 1985; Treisman & Gormican, 1988; for a summary see Wolfe, 2001).

Previous work has shown that detecting a downwards pointing triangle among upward pointing triangles is easier than the reverse (e.g., Larson et al., 2007). However, rather than this asymmetry being driven by simple visual feature differences between the stimuli, the present work suggests that it is based on differences at an emotional level of processing. Thus, even simple geometric forms appear to generate differences in visual processing potentially driven by affective properties.

**Footnotes**

<sup>1</sup> We intentionally excluded eyebrows from facial stimuli in order to prevent interference between triangles and faces based on simple visual match/mis-match of the same features across stimuli.

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Figure 1. Stimuli, mean correct RTs (% errors in brackets) and interference as a function of target valence (positive or negative), distractor congruency and distractor shape (face or triangle) for Experiments 1 and 2. Asterisks indicate significance level of two-tailed, paired t-tests  $df(15)$ , \* $p < .05$ , \*\* $p \leq .01$

Compatibility	Stimuli	RT (% error)	Interference	Stimuli	RT (% error)	Interference
Face flankers			Triangle flankers			
Experiment 1						
Positive valenced target						
Compatible	☺☺☺	474.3 (0.78)	5.02 (-1.30)	△☺△	471.8 (2.60)	<b>-15.94*</b> (-0.78)
Neutral	☺☺☺	469.3 (2.08)		◁☺▷/▷☺▷	487.8 (3.39)	
Incompatible	☹☹☹	489.0 (3.39)	<b>19.73*</b> (1.30)	▽☺▽	500.7 (5.99)	12.89 (2.60)
Negative valenced target						
Compatible	☹☹☹	502.6 (1.82)	9.92 (0.52)	▽☹▽	491.9 (1.56)	-11.73 (-0.78)
Neutral	☹☹☹	492.6 (1.30)		◁☹▷/▷☹▷	503.6 (2.34)	
Incompatible	☺☺☺	512.6 (3.39)	<b>19.92**</b> (2.08)	△☹△	499.4 (3.65)	-4.22 (1.30)
Experiment 2						
Positive valenced target						
Compatible	☺☺☺	548.7 (1.82)	-7.49 (0.26)	△☺△	548.8 (0.78)	-13.03 (-2.08)
Neutral	☹☹☹	556.2 (1.56)		◁☺▷/▷☺▷	561.8 (2.86)	
Incompatible	☹☹☹	584.2 (4.43)	<b>28.04** (2.86*)</b>	▽☺▽	582.0 (6.77)	<b>20.15** (3.91*)</b>
Negative valenced target						
Compatible	☹☹☹	557.8 (2.34)	<b>-15.40*</b> (-1.04)	▽☹▽	555.2 (1.04)	<b>-25.96**</b> (-0.52)
Neutral	☹☹☹	573.2 (3.39)		◁☹▷/▷☹▷	581.2 (1.56)	
Incompatible	☺☺☺	588.5 (3.13)	15.27 (-0.26)	△☹△	576.2 (1.82)	-4.95 (0.26)