Effects of Valence and Arousal on the Allocation of Attention to
Motivationally Significant Stimuli

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ABSTRACT

Innate attentional mechanisms that prioritise the processing of potential threats and opportunities for satisfying basic primordial needs serve a highly adaptive function for an individual and the species. Existing research has revealed preferential spatial attention for threatening stimuli, including: (i) facilitated attentional engagement, (ii) delayed disengagement, and (iii) attentional avoidance. Theoretical models that have attempted to explain these phenomena are predicated on the assumption that a threat detection mechanism operates automatically to facilitate preferential processing of threatening information. According to motivational accounts of emotional processing, however, an adaptive attentional system should also prioritise high arousing, appetitive stimuli that are symbolic of our evolutionary needs. Although relatively unexplored, there is evidence to suggest that appetitive stimuli may also preferentially capture attention, with recent studies suggesting that stimulus arousal determines the allocation of cognitive resources, independent of valence.

To disentangle the effects of valence and arousal on visual attention, a novel set of motivationally significant pictures was developed. The pictures were validated in Study 1 using physiological indices of the orienting response, a precursory mechanism to attentional processing. Skin conductance responses (SCRs) and heart rate were measured while nonselect participants passively viewed threatening, appetitive, and neutral pictures that varied in arousal. Verbal ratings of valence, arousal, and interest were obtained following the viewing task. Irrespective of valence, SCRs and cardiac deceleration were greatest for high arousing pictures (blood injuries and heterosexual erotica) relative to low arousing pictures (human aggression and nurturance of offspring), suggesting that orienting is augmented on the basis of stimulus arousal. The physiological indices were found to share a strong
association with verbal ratings of arousal, even after controlling for subjective interest. Arguing against threat-superiority theories, orienting responses did not vary as a function of valence.

The picture stimuli were subsequently employed in a series of spatial cueing experiments designed to examine the individual and interactive effects of stimulus valence and arousal on the distinct components of spatial attention. Pictures preceded probes that appeared in either cued (valid trials) or non-cued locations (invalid trials) to capture the effects of valence and arousal on attentional engagement and disengagement, respectively. The exposure duration of the pictures varied between 24 ms and 1000 ms in order to clarify the time-course of these effects. All experiments were conducted using nonselect samples, and individual differences in state and trait anxiety were statistically controlled.

In Study 2, latencies for responding to the probe’s location indexed the allocation of spatial attention. Reaction times were slower on valid trials, indicative of inhibition of return. Even when the cues predicted the location of the probe on 75% of trials (Experiment 2.2), and the exposure duration of the cues was reduced to ≤ 100 ms (Experiment 2.3), valid cues failed to prompt faster responses. Contrary to predictions that high arousing pictures would facilitate attention to the probes on valid trials relative to neutral pictures, results indicated inhibited engagement of these stimuli between 100-1000 ms post-stimulus onset (Experiments 2.1 & 2.2). Although these findings suggest that attention avoided the high arousing cues, the same pictures produced slower responses on invalid trials, indicative of delayed disengagement, as did the less arousing, threatening pictures. These discordant findings were explained in terms of distinct effects of stimulus arousal on perception and attentional shifting. On valid trials, perception of the cues may have interfered
with detection of the probes due to the overlapping configuration of the stimuli, thereby masking facilitated engagement effects. Perceptual competition is less likely to have occurred when the cues and probes were spatially distinct on invalid trials, supporting interpretations that attention was slower to disengage the high arousing pictures. A second series of spatial cueing studies was conducted to test this interpretation.

In Study 3, a more demanding probe classification task was employed and the spatial configuration of the cues relative to the probes was amended to eliminate spatial overlap. Following these methodological changes, a robust cue validity effect was observed, characterised by faster responding on valid trials. In support of threat-superiority theories, facilitated engagement of high arousing, threatening pictures was observed at 24 ms post-stimulus onset (Experiment 3.1). Although a general slowing effect of stimulus arousal on the speed of responding was observed irrespective of exposure duration, there was no evidence that attentional disengagement was influenced by the affective qualities of the pictures. Delayed disengagement effects were absent even when the cues accurately predicted the location of probe on 75% of trials (Experiment 3.2), and the exposure duration of the cues was increased to 100-400 ms (Experiment 3.3). In contrast to the comparatively simple localisation task employed in Study 2, classification of the probes is assumed to have placed greater demands on top-down, attentional control that attenuated the effects of arousal on attentional shifting. The deleterious effects of high stimulus arousal on non-spatial components of attention (i.e., processing speed and capacity), however, appear to be more resistant to attentional control, as demonstrated by a general effect of stimulus arousal. Because arousal-driven interference was observed in the absence of delayed disengagement, these appear to be dissociable effects,
supporting conclusions that stimulus arousal influences both spatial and non-spatial aspects of visual attention, depending on contextual demands.

The results of Study 2 and 3 were interpreted with respect to existing models of attention to emotional stimuli. An integrated model is proposed that accounts for the effects of both valence and arousal on the allocation of attention according to the findings of the current research and existing literature. Limitations of the research are also discussed and directions for future studies are suggested.

*Keywords:* emotion, visual attention, spatial cueing, motivational significance, valence, arousal, threat
DECLARATION OF ORIGINALITY

This thesis is submitted to Bond University in fulfilment of the requirements of the degree of Doctor of Philosophy (PhD). This thesis represents my own original work towards this research degree and contains no material which has been previously submitted for a degree or diploma at this University or any other institution, except where due acknowledgement is made. All raw data and analyses have been retained and are available upon request. I certify that I have made and retained a copy of this document.

Name: James C. Champion

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Date: 22 December 2016
RESEARCH OUTPUTS & PUBLICATIONS

Journal Publications


Conference Proceedings


ETHICS DECLARATION

The research reported in this thesis received ethics approval from the Bond University Human Research Ethics Committee (BUHREC). Ethics application number RO1607.
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LIST OF ABBREVIATIONS

ADM……….Affective decision mechanism
ANOVA…….Analysis of variance
ANCOVA……Analysis of covariance
CPU…………Central processing unit
CRT………….Cathode ray tube
CVI………….Cue validity index
ERP………….Event-related potential
GES…………Goal engagement system
HAA………….High arousing appetitive
HAT………….High arousing threatening
HR………….Heart rate
Hz…………Hertz
IAPS………….International Affective Picture System
IoR………….Inhibition of return
LAA………….Low arousing appetitive
LAT………….Low arousing threatening
M…………..Mean
ms………….Milliseconds
OR………….Orienting response
PRT………….Picture rating task
RAM………….Resource allocation mechanism
RT…………..Reaction time
SAM…………Self-Assessment-Manikin
SCR………….Skin conductance response
SCT…………Spatial cueing task

SD…………Standard deviation

SOA…………Stimulus onset asynchrony

STAI-S……..State Anxiety Scale of the State-Trait Anxiety Inventory

STAI-T……..Trait Anxiety Scale of the State-Trait Anxiety Inventory

TES…………Threat evaluation system

VES…………Valence evaluation system