# TITLE: Novelty and emotion in distractor processing

**Theoretical background**

The monitoring of the environment for significant events and the selection of goal-relevant stimuli have evolved to assist in selecting appropriate survival behaviors and are paramount in successfully completing everyday tasks. Efficient cognitive functioning often entails the ability to filter out task-irrelevant events to focus on a task at hand, nevertheless it is also necessary to simultaneously detect changes in the environment. A trade-off between selective attention and novelty detection is crucial and provides an optimal solution to these divergent needs but may come at a cost: distraction. In life, there are abundant instances in which task-irrelevant stimuli (distractors) capture attention and interrupt ongoing goal-directed activity; for example, drivers may have their attentional focus briefly drawn away from the road ahead by a flashy billboard advertisement. Here, we are interested in examining how distractor processing is affected by stimulus change (novelty). This issue was previously examined using repeated neutral stimuli (e.g., geometric or colored shapes), showing that distractors capture attention more strongly when they are infrequent and possess task-relevant features (Folk & Remington, 2015). Unlike these attentional-capture paradigms, the visual world we experience in real life is more variable in appearance as well as in emotional relevance. Emotional stimuli activate cortico-limbic appetitive and defensive systems, which, in turn, prompt an involuntary capture of attention (Bradley, 2009). Research has demonstrated that when emotional pictures are task-irrelevant stimuli, they are especially disruptive for the ongoing task, elongating response times more than neutral distractors (Codispoti et al., 2016). The activation of several cortical and subcortical structures sensitive to emotional processing (e.g., the locus coeruleus and the amygdala) is also enhanced in response to novel neutral stimuli, compared to repeated ones, suggesting that novelty is integral of their function. Therefore, emotion and novelty might share the same motivational circuits that evolved to support adaptive perceptual and motor processes in survival contexts (Bradley, 2009).

**Aims and Hypotheses**

We aim to investigate the role of novelty and emotion in the processing of task irrelevant distractors. While participants will be asked to perform a central discrimination task, distractors (emotional and neutral pictures) will be briefly presented in peripheral vision. The experimental session will consist of a habituation phase where distractors will be repeatedly presented followed by a novel phase (only novel distractors). In the habituation phase we expect to observe a larger reduction of the attentional capture by emotional distractors compared to neutral ones. The introduction of a novel phase, with wholly novel distractors, will help to assess whether the sensitivity to stimulus change (novelty) is different for emotional and neutral stimuli. If the introduction of novel stimuli, after an extensive habituation phase, will trigger a response recovery only for emotional distractors but not for neutral ones, it would suggest that novelty interacts with emotionality, possibly because it is advantageous to thoroughly detect and process any specific change that might belong to emotional distractors. Conversely, if novelty will set off a response recovery for both emotional and neutral novel distractors, it would suggest that novelty processing is prioritized regardless of distractor content, and automatically triggers attentional capture. Since distractor filtering may occur at various stages of processing, in addition to the traditional behavioral measures of attentional capture (RTs) we will measure event-related potentials (Late Positive Potential, LPP) and brain oscillations (alpha-band activity) to better clarify at which stage the filter can operate (Klimesh, 2012), and to assess the engagement of motivational systems.

**Methods**

Participants and Sample

A total of 40 participants (females=20), selected among university students, will take part in the experiment. The sample size was decided based on previous studies and using a power analysis, with 85% power to detect a medium-sized effect of *f* = 0.25 (Cohen, 1988). All participants will have normal or corrected-to-normal visual acuity and normal color vision, and all participants with current or previous neurological or psychological problems will not be included in the study.

Tools

Experiments will be conducted using PCs equipped with E-prime 2.0. Electroencephalogram (EEG) will be recorded using a high-density EEG system.

Procedure

In each trial, following a fixation cross, a central Gabor patch will appear for 150-ms. The participant’s task will be to determine the orientation of the Gabor (vertical or horizontal), and the behavioral responses will be collected in the following intertrial interval. In distractor-present trials, a distractor picture (either emotional or neutral) will be presented simultaneously with the Gabor, appearing equally often in the left or right visual field. Participants will be explicitly required to ignore distractors (see Micucci et al. 2020). The experimental session will consist of two blocks of distractor repetition (habituation phase) and one novel block (all novel pictures). Distractor pictures will be pleasant, unpleasant, and neutral scenes, selected from the International Affective Picture System (Lang, Bradley, & Cuthbert, 2008).

Statistical Analyses

For Response Times, Late Positive Potential, and Alpha Power, data will be examined using ANOVAs with the 2 within-subject factors of Block (2 habituation and 1 novel blocks) and Emotionality (emotional, neutral) to examine the effects of distractor novelty and emotion on distractor processing.

Declaration of commitment to request ethical approval

Approval by the Bioethical committee of the University of Bologna will be requested.

**Expected results and implications**

Since it can be advantageous to thoroughly monitor and detect any specific change that might belong to emotional distractor compared to a neutral one, we expect that in the novel phase only emotional stimuli will trigger a recovery of the attentional capture to promote further “information gathering” (Näätänen, 1992). On the other hand, we expect that cortical responses, reflecting stimulus evaluation and emotional engagement (i.e. LPP), would be less affected by stimulus repetition and change. The expected results of this project will add evidence on the recent debate on the contribution of distractor experience in the deployment of visual attention. Since emotional distraction has been implicated in several disorders, including anxiety, future studies should seek to elucidate the contribution of novelty and emotion in clinical populations.

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**References**

1. Bradley, M. M. (2009). Natural selective attention: Orienting and emotion. *Psychophysiology*, 46, 1– 11
2. Codispoti, M., De Cesarei, A., Biondi, S., & Ferrari, V. (2016). The fate of unattended stimuli and emotional habituation: Behavioral interference and cortical changes. *Cognitive, Affective, & Behavioral Neuroscience*, 16(6), 1063-1073.
3. Cohen, J. (1988). Statistical Power for the Behavioural Sciences. Hilsdale. NY: *Lawrence Erlbaum.*
4. Folk, C. L., & Remington, R. W. (2015). Unexpected abrupt onsets can override a top–down set for color. *Journal of Experimental Psychology: Human Perception & Performance*, 41, 1153–1165.
5. Klimesch, W. (2012). Alpha-band oscillations, attention, and controlled access to stored information. *Trends in cognitive sciences*, 16(12), 606-617.
6. Micucci, M., Ferrari, V., De Cesarei, A., & Codispoti, M. (2020). Contextual modulation of emotional distraction: Attentional capture and motivational significance. *Journal of Cognitive Neuroscience*, 32(4), 621–633.
7. Näätänen, R. (1992). Attention and brain function. *Hillsdale,NJ: Erlbaum.*
8. Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (2008). International affective picture system (IAPS): Affective ratings of pictures and instruction manual. Technical Report A-8. Gainesville: University of Florida

**Plan of activities**

Project activities and training activities:

Project activities will consist in the preparation and submission of the approval request to the Bioethical Committee of the University of Bologna, and in the preparation of the setup of the paradigms. Data collection and data analyses will be subsequently performed. Periodically meeting will be established to discuss advances, and results will be presented at international conferences. Training activities will include a detailed review of the relevant literature and a methodological apprenticeship. The theoretical study will focus on topics related to selective attention, its neurobiological basis and the interaction of emotion and attention. The methodological training will focus on the analysis of ERPs and cortical oscillation. The EEG training will focus on different aspects of data reduction and signal processing - including Morlet wavelet time - frequency analysis using the FieldTrip software (FieldTrip: Open Source Software for Advanced Analysis of MEG, EEG, and Invasive Electrophysiological Data) - brain mapping and source localization techniques.

Timing of activities:

During the first 3 months the documents needed for the approval of the research projects by local Ethical Committee will be prepared and submitted, and the relevant literature will be reviewed in detail hand-in-hand with the preparation of the material and setup for the experiments. In the next six months, the experiment will be run and analyzed. The final 3 months will be dedicated to present the results at international conferences and submit a draft to a high-impact journal in the field of attention.

Feasibility of the project:

The project follows a line of studies which we conducted previously, concerning the behavioral and electrocortical correlates of the attention allocation to emotional contents. Regarding the experimental setup (stimulus creation, data collection, behavioral/EEG data analysis), every necessary procedure is already well established in the Psychophysiology of Cognitive and Emotional Processes Laboratory.

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