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Arousal-biased preferences for sensory input: An agent-centered and multi-source perspective

Kai Kaspar
Social and Media Psychology, Department of Psychology, University of Cologne, Richard-Strauss-Str. 2, 50931 Cologne, Germany
+49 221 470 6828
kkaspar@uni-koeln.de
http://kai-kaspar.jimdo.com/

Abstract: I argue that the GANE model basically explains an arousal-based amplification of emotional stimuli while effects on neutral stimuli indicate a contextualization process aiming to reduce stimulus ambiguity. To extend the model's validity, I suggest to distinct between internal and external emotional sources as well as to consider the stimulus valence, also addressing age-related differences in attention and memory preferences.

Mather, Clewett, Sakaki, and Harley beautifully describe the neuronal mechanisms likely to account for an arousal-based modulation of selectivity phenomena in attention and memory. In addition to previous emotion-cognition models focusing on the competition between emotional and neutral stimuli, the GANE model also aims to explain how arousal resolves the competition between neutral stimuli. In this context, I propose a complementary perspective. I argue that the GANE model mainly explains the mechanisms underlying the processing of emotional stimuli, while co-occurring effects on the processing of neutral stimuli may be interpreted as side-effects of a contextualization process targeting the emotional stimulus. The empirical evidence presented by Mather and colleagues suggests that arousal-based amplification or inhibition of neutral input is heavily constrained by the spatiotemporal relationship between an emotional stimulus, which is the driving source of arousal, and neutral stimuli constituting the sensory context. I claim that effects of emotional stimuli on proximal neutral ones are a signature of stimulus contextualization in favor of a disambiguation of emotional stimuli. Indeed, for the perceiving agent, emotional stimuli are often characterized by significant ambiguity (cf. Duval, Moser, Huppert, & Simons, 2013). For

example, the recognition of an arousing facial expression may be context-dependent (cf. Barrett, Mesquita, & Gendron, 2011). The valence and the discrete emotional category of an arousing stimulus are not completely inherent features of the stimulus but they are also constituted by the context (including neutral stimuli) in which the arousing stimulus is embedded. Therefore, the processing of an emotional stimulus benefits from an amplification of salient neutral stimuli standing in an optimal spatiotemporal relationship to the emotional target stimulus. It appears beneficial for the human organism that emotional stimuli are not processed in isolation from rather neutral context information. Amplifying the processing of otherwise prioritized neutral stimuli in the presence of an emotional stimulus creates a context that facilitates the appropriate classification and encoding of the properties of the emotional stimulus. Indeed, the context seems to be routinely encoded during emotion perception (Barrett & Kensinger, 2010). In this sense, the arousal-based mechanisms outlined in the GANE model cannot be generalized to settings in which emotional stimulation is rather negligible. However, based on this perspective, two aspects may help to further improve the conceptual framework of the model and its validity:

First, I propose that the GANE model would benefit from a more explicit distinction between internally and externally located sources of arousal (cf. Kaspar & König, 2012; Kaspar, 2013). The current model primarily addresses the latter type, namely sensory stimuli located outside the perceiving agent, whereas internal forms of emotion represent the agent's current emotional/mood state. While the arousing power of external stimuli is tied to the stimuli and hence places tight spatiotemporal constraints for an amplification or inhibition of the neutral surrounding, arousal elicited by thoughts of the agent might be more easily linked to any neutral stimulus. Of course, internal arousal might be also elicited by an external source, but some residual arousal (i.e. mood) continue for a while after source offset. Indeed, excitation-transfer theories (Bryant & Miron, 2003; Zillmann, 1983) propose that the residual arousal from a stimulus can be transferred to a subsequent stimulus while the emotional valence of the stimuli may differ. If residual arousal can be actually tapped by another than the original stimulus in this way (still to be shown), we

can extend the validity of the GANE model by implementing a multi-source approach to arousal-biased information processing.

Second, the model neglects the valence aspect of arousing sources being of central relevance, not only from the perspective of disambiguation tendencies. It seems that the arousal and valence ascribed to a stimulus are not completely independent features (cf. Kaspar & König, 2012), whereby negative (versus positive) stimuli show a tendency towards higher arousal (Kim & Hamann, 2007; Ito, Cacioppo, & Lang, 1998). Thus, negative stimuli may have a higher potential to ignite neuronal hot spots and to fine-tune priority signals. This bias is plausible from an evolutionary perspective as it is more prejudicial to miss a potential threat than a potential reward. Thus, across different scenarios, external negative stimuli may elicit stronger modulation effects on neutral stimuli being in an optimal spatiotemporal distance, while a negative (versus positive) mood state might have more long-lasting effects due to more residual excitation.

Indeed, the location (internal versus external) and valence of the arousing source have a critical influence on attention and memory processes. For example, younger adults showed an attentional preference and a better memory performance for negative stimuli, compared to positive ones, while this bias was more pronounced when participants had been in a positive (versus negative) mood (Kaspar, Ramos Gameiro, & König, 2015). Thus, internal and external sources of arousal may show specific interactions depending on their valence. With regard to the GANE model, negative stimuli presumably have a higher likelihood to bias perception and memory when they are in strong contrast to emotional background noise within the perceiving agent. However, preferences for positive over negative information have also been reported for younger adults under specific circumstances (Becker & Leinenger, 2011; Parrott & Sabini, 1990; Schwager & Rothermund, 2013), indicating more complex mechanisms of the processing of emotion-laden stimuli than delineated in an exclusive arousal-based model.

Finally, in this context, the GANE model suggests a brain-based explanation for the very reliable information processing bias towards positive (versus negative) information in

older adults (Reed, Chan, & Mikels, 2014). Mather and colleagues proposed that arousal may not increase selectivity similarly effectively among older adults because of age-related changes in the LC-NE system. If so, negatively valenced stimuli would gradually lose their arousing potential across the lifespan, facilitating controlled attentional shifts towards positive stimuli at a higher age (cf. Hahn, Carlson, Singer, & Gronlund, 2006; Knight et al., 2007). Thus, the GANE model adds a brain-based explanation for this age-dependent change in biased competition that is mainly discussed in terms of the Socioemotional Selectivity Theory (Carstensen, Fung, & Charles, 2003) emphasizing age-related changes in emotion-regulation motivation.

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