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Commentary: A review on the role of affective stimuli in event-related frontal alpha asymmetry

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A Commentary on
A review on the role of affective stimuli in event-related frontal alpha asymmetry

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Introduction

This commentary addresses the discrepancies in measuring and interpreting frontal alpha asymmetries (FAAs) as electrophysiological makers for motivation and affect identified by a recent review (Sabu et al., 2022). Specifically, the authors aim to identify under which circumstances FAAs yield meaningful results and index emotional or motivational states. Thus, they categorize and review the stimuli used in the literature into five categories being less to more effective in eliciting emotions: (1) images and sounds, (2) videos, (3) real cues, (4) games, and (5) other tasks. As a result, the potency to elicit pronounced FAAs seems to vary as a function of modality with planar 2D stimuli being less potent to elicit emotions as opposed to more realistic and engaging stimuli. Nevertheless, no category induces FAAs consistently, hence casting doubt on whether FAAs are a universally applicable measurement for emotion and motivation solely dependent on the potency of the stimulus. I argue that potency as an ordinally scaled factor does not account for FAAs because different stimuli types belong to different categories. Hence, if FAAs carry meaning, they might be specific to the domain in which they occur.

2D and 3D emotions

Although we often directly compare emotions elicited under different circumstances and use the same taxonomy for them, there are fundamental differences. Specifically,

emotions and motivation in a screen setting do not convey their original, i.e., real-life psychological and behavioral implications. For example, under real-life conditions, emotions provide information about the environment, so that a hazard elicits fear, promoting adaptive behavioral responses (Lynch and Martins, 2015). However, this cascade is rendered obsolete when presented with fear-eliciting stimuli on a screen under laboratory conditions. The information presented on the screen does neither provide information about the actual environment the participant is situated in nor does it facilitate behavior that would be appropriate under real-life conditions.

It does not necessarily mean that the stimuli are weaker, bear less (self-) relevance, or are less potent; however, their meaning and purpose are reframed. People watch horror movies for entertainment and like being scared. In this particular context, the negative arousal does not promote appropriate real-life behavior, i.e., avoidance which is presumably indexed by a relatively left-sided FAA. The fact that a "2D emotion" has a different meaning which in turn is associated with other behavioral patterns has further consequences for the regulation thereof. Emotions are regulated to facilitate behavior pursuing a goal (Schwarz, 2000), e.g., downregulating the fear promotes the respective fight or flight reaction. However, 2D emotions do not need to be regulated, or to go back to the horror movie example, there is often no intention to regulate them.

Potency or category change: The difference between seeing and experiencing

To address the differences between seeing and experiencing a scene, we systematically investigated FAAs in response to 2D videos and the very same scene presented in a realistic 3D/360° virtual reality setting (Schöne et al., 2021a). The results partly confirm the authors' notion that engaging, realistic stimuli *can* be more potent and thus lead to a comparably more pronounced FAA in the VR condition. For example, being in an emergency room elicits a much stronger avoidance-related FAA as opposed to just seeing it in 2D. However, this principle of unidirectional amplification does not hold for all stimuli. In some cases, the presentation of a stimulus in VR leads to a weaker FAA effect; in other cases, an FAA while the corresponding 2D presentation does not.

Rather neutral videos that do not elicit an FAA in 2D led to a positive FAA (car dealer) or negative FAA (tunnel) in the immersive VR condition. The results and most importantly models for 2D studies do not translate to more realistic settings, regardless of what motivational or affective construction underlies the generation of FAA effects. Similarly, clinical meta-studies raise doubt about the general meaningfulness of FAAs at least with respect to their application as a marker for depression (Van Der Vinne et al., 2017; Kołodziej et al., 2021).

Nevertheless, FAAs obtained in immersive VR can be interpreted in a meaningful way, considering that VR creates the illusion of a realistic environment that gives the impression of going beyond what the user experiences with the possibility or illusion of physical interaction (refer to Schöne et al., 2021b). As a result, being in a virtual environment, users act and react realistically with their whole body (Kisker et al., 2021a). Hence, a 2D encounter with horses does not provoke an FAA effect, but VR exposition leads to a negative, i.e., approach-related FAA. This might result from the observation that "virtual horses" promote haptic exploration as many users try to pet them. It is clear that emotions and motivational tendencies toward 2D and immersive 3D content differ, regardless of whether this specific line of reasoning is correct or not (see above).

In conclusion, VR-FAAs *can* be interpreted in a meaningful way; the anecdotical *ad hoc* explanations only hold under the premise that FAAs actually index emotion and motivation according to the models that build upon data from 2D stimuli presentation. At this point, the only valid conclusion which can be drawn is that the way a stimulus is presented (e.g., static image, video, and realistic) does not enhance its potency, but rather represents a category change. The data show that the FAAs and, if indexed by them, the emotional and motivational reactions do not translate from one category to another (2D to VR), even for the same stimulus.

As Snow and Culham highlight, images are experimental proxies, not actually present, thus lacking actability (Snow and Culham, 2021). They are reminders and, as such, do not have an intrinsic value. The picture of a cake is just that—a picture. It has no nutritional value or, when presented briefly on a screen for 1 or 2 s, any other value. The reason why studies presenting participants with pictures of dessert do not report FAAs (Harmon-Jones and Gable, 2018) is not rooted in their potency. The reason is that there is a fundamental categorical difference between a 2D picture and the real-life stimulus it represents. Hence, a shift in category does not necessarily lead to a more pronounced FAA indexing the same emotional and motivational state.

Domain-specific models for 2D and realistic settings

Thus, the questions are (a) can we expect that the psychological models and theories can be applied to realistic settings and (b) does it pose a problem if they do not? Like most models in experimental psychology, the models on FAAs are built upon the laboratory data, and given the categorical differences between pictorial and real-world stimuli, it seems like a stretch to assume that laboratory-based models accurately predict real-world behavior.

A recent study by our laboratory confirmed that conjecture: in a mixed-reality setup, participants explored a cave where

they encountered a werewolf leading to fight or flight behavior (Kisker et al., 2021b). In contrast to a control group that only faced a sheep, the FAAs mostly yielded null results, albeit the werewolf cave was perceived as extremely frightening. The few significant results we did obtain do not fit within any contemporary framework of FAAs. Nevertheless, the results make sense on a meta-cognitive level. For example, approaching the werewolf comes with an FAA indexing avoidance because, on an overall goal, people want to get out of the cave. FAAs appear to be an indicator of motivational processes, but the laboratory-based model does not provide an accurate prediction or a theoretical basis to explain them under realistic conditions. Although comprehensive, the review does not identify a factor accounting for the discrepancies between the categories or the absence of FAAs in over 50% of the studies. However, a study by Rodrigues highlights the relevance of movement and actability (Rodrigues et al., 2018). Eventually, approach or avoidance motivation only has a purpose when the environment is responsive, and a person can effectively act upon it. From an evolutionary perspective, this is the context in and for which the motivational system has been developed and what most monitor-based studies are missing.

In response to the aforementioned two questions, there is no *a priori* reason why we could expect that the results and hence the models based upon them translate from one category to another. To assume differently accounts for the perceived discrepancies within and among categories. Nevertheless, this does not pose a problem when the FAAs are interpreted as what they are: an indicator for an emotional or motivational response to a certain type of stimuli. Like the underlying affective motivation system, FAAs are domain-specific. Whenever the system exhibits adaptive functional properties specific to the environment, e.g., monitor or real-life, the FAAs do the same. They reflect one aspect of the system that varies as a function of factors such as potency, (self-) relevance, and actability. Hence, comparing FAAs between stimuli, tasks, and environments seems not to be appropriate as is the case for other electrophysiological markers. As highlighted by Yarkoni (2022), extrapolation beyond the observations, i.e., statistical expressions, of a particular experimental design underlies many problems of psychological science, especially the replication crisis.

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The author confirms being the sole contributor of this work and has approved it for publication.

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