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Infrared Emotions and Behaviours: Thermal Imaging in Psychology

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COMMENTARY

Psychology is a social science that studies behavioural changes and mental processes. Usually, the theory and diagnosis of conditions has been based on a consultation process of working with a therapist through a series of questions, exercises and techniques. When we consider, for example, social anxiety – a fear of social situations and an avoidance of normal social interactions – a therapist traditionally talks through the issues with the client and relies purely on the descriptions of the client's feelings and emotions connected to these events. When working through a treatment program, the therapist would need to rely on the client reporting improvements in their approach to triggers, based on their changing emotional response to the situations that caused them anxiety. Although, there are demonstrative physiological responses, they are usually not measured as their recording requires a special process.

The physiological response is a change in the equilibrium in the body which can be felt as an increase in heart rate, blood pressure, breathing rate and changes in Gastrointestinal (GI) tract motility. This state of arousal does not quickly fade; in fact it can take between 20 to 60 minutes for the body to return to its pre-arousal levels (Changeux, 1985; Huitt, 1999; Faizi et al, 2014; Richardson et al, 2015). These physiological changes could be further investigated, analyzed and the results of these analyses provide additional knowledge and hence improved treatment or treatment techniques.

Within the last decades, several methods have been developed and used for the detection and recording of the physiological changes and activities. However, researchers studying the neurovascular elements behind social interactions and emotions are frequently confronted with the restrictions of methods commonly used in neuroscience and psychological research. Such methods involve applying electrodes, sensors or other contact instruments on the skin of participants to measure and monitor activity of the autonomic nervous system. However, using such methods can make it difficult to distinguish between spontaneous behavior and event-related behavior, and contact of the instrument with the participant is required (Bach et al, 2010). On the other hand, non-contact methods, for example functional magnetic resonance imaging (fMRI), require the participant to remain still to minimize the induction caused be motion inside the magnetic field (Wong et al, 2011).

A potentially novel solution used in recent years is thermal imaging (TI). TI is a contact free, non-invasive and free from any contra-indications method. TI records infrared radiation that is naturally emitted by the human body based on its temperature, therefore not submitting the participant to any form of radiation. All objects above the absolute zero temperature (0 K) emit infrared radiation. With the use of a thermal camera the temperature variations can be captured and displayed as an image, allowing participants to move freely and researcher to gather data in real time (Ring and Ammer , 2000); Modest, 2013; Ioannou et al, 2014; Topalidou and Downe , 2016).

A variety of emotional changes or conditions and/or responses to a trigger elicit thermal responses (changes in temperature) in several areas of human body, such as face and hands indicating that skin temperature variation can be suggestive to emotional or behavioral changes. It has been demonstrated that a range of emotional states, such as aggression (O'Kane et al, 2004) and emotional arousal (Zajonc et al, 1989; Shearn et al, 1990; Nozawa and Tacano, 2009; Nhan and Chau, 2010), stimulate thermal responses that are indicative of a certain state. Fear, for example, is associated with an increase in blood flow to the eyes (300 ms) and a decrease in temperature of the cheeks (Pavlidis et al, 2000); Levine et al, 2001). Whilst the responses associated with stress can differ depending on the activity and age. Stress in infants showed a decrease in forehead temperature due to lower arousal levels caused by separation from the mother (Mizukami et al, 1987; Mizukami et al, 1990). On the other hand, stress in adults correlated with an increase of blood flow to the frontal region (Puri et al, 2005; Merla and Romani, 2007) and the periorbital regions (Pavlidis and Levine , 2002); this was accompanied with a temperature decrease in the region of the jaw (Merla and Romani, 2007) . Merla and Romani (2007) conducted a study to investigate the thermal response of stress, pain and sexual arousal in 10 healthy males . Pain and stress were observed to cause an overall decrease in facial temperature, particularly in the perioral region, while sexual arousal lead to increased facial perfusion rates in specific regions: the forehead, lips and nose.

Thermographic measures of these conditions were correlated with other forms of arousal, for example galvanic skin response and penile turgidity. The results suggested that specific thermal signatures related to specific emotions possibly exist due to varying types of emotional arousal. Another study (Hahn et al, 2012) – more aimed at whether temperature changes can be stimulated by interpersonal social contact – saw similarities with the study of Merla and Romani (2007). Their results demonstrated that during interpersonal interactions, changes in skin temperature were a sensitive index of arousal.

Furthermore, another study which explored the temperature variations of the nasal tip and maxillary area averaged for a group of children and for a group of mothers, found a strong correlation in thermal variations between children and their mothers which were shown during the emotional phases of the experiment. During the experiment, children were invited by the researcher to play with a toy. The toy was designed to break during play, giving the impression that the child had accidentally broken it. Mothers were invited to observe their children in interaction with the researcher through a one-way mirror from a separated room. Results showed that during the experiment the emotional distress caused by the 'breaking' of the toy lead to thermal variations in the specified facial region of interest of the child. The facial thermal modulations observed in the mothers were surprisingly similar to those observed in the child. Thus, mother-child dyads demonstrated a significant and condition-related synchronicity between the autonomic reactions individually exhibited by each of them (Ebisch et al, 2012).

It has also been demonstrated that a specific physiological activity will have a distinct thermal signature; this is a result of the environmental demands the human body is faced with, such as the “fight or flight or freeze” response. Changes in the autonomic nervous system due to the “fight or flight or freeze” response will cause changes to cutaneous temperature, therefore affecting temperature control. However, temperature can vary depending on the level and type of arousal. The distinct thermal signature associated with this response can be clearly observed using an infrared camera (Ioannou et al, 2014). Most scientists have described TI as an emerging and favorable method for detecting stress as well as anxiety (Pollina, 2006). Yoshitomi et al , (1997) addressed the accuracy of TI method within their study with the aim of developing a TI process that would aid computer vision in recognition of facial expression. Along with thermal image processing, the Neural Network was used; data of temperature-difference was the input data for the Neural Network to distinguish between different facial expressions. The results showed that this method had 90% accuracy in detecting neutral, happy, surprised and sad facial expressions.

TI is a reliable method that offers new opportunities to those wanting to study psychological responses, emotional and behavioral changes. TI turns emotional and psychological changes that are invisible to the naked eye into a thermal infrared image with measurable data.

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