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Memory detection: The effects of emotional stimuli

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ABSTRACT

The Concealed Information Test (CIT) aims to detect the presence of crime-related information in memory. In two experiments, we examined the influence of stimulus emotionality on the outcomes of the CIT. In experiment 1, each participant was tested immediately or after one week, on a series of neutral and either negative arousing or negative non-arousing pictures. CIT detection efficiency was unaffected, but physiological and recognition data did not support the manipulation's effectiveness. In experiment 2, each participant was tested after a week on a series of neutral versus negative arousing pictures. Importantly, stimulus arousal was increased and memory ceiling effects were prevented. This time, both memory and CIT detection efficiency using the skin conductance, but not the respiration and heart rate measures, were enhanced for emotional compared to neutral pictures. Taken together, these results indicate that the use of emotional stimuli does not deteriorate and may even improve CIT validity.

1. Introduction

More than a century ago, William James (1890, p. 670) described the impact of emotion on memory as leaving "*a scar upon the cerebral tissues*". James's classical statement depicts the common intuition that highly emotional events are remembered with extensive clarity and detail and this holds particular relevance for the memory detection approach. This knowledge-based approach using the Concealed Information Test (CIT; Lykken, 1959; Verschuere, Ben-Shakhar, & Meijer, 2011) aims to uncover the presence of crime-related information in memory by measuring physiological and/or behavioral responses. In a typical CIT, examinees are presented with a series of multiple choice-like questions, each designed to examine suspects' knowledge of a distinctive crime-detail assumed to be known only to individuals involved in the crime and the investigative authorities. For each question, this critical feature of the crime (i.e., the crime-related item) is intermixed among several other plausible control items (e.g., Where was the victim's body found?... basement?... graveyard?... dumpster?... barn?... river?...). Provided that the crime-related information has been kept from the public, an innocent suspect will not be able to differentiate between the different alternatives and is therefore expected to show similar responses to all items. A guilty suspect, on the other hand, will recognize the crime-related alternatives and will show differential responses to these items (e.g., an increased skin conductance response (SCR), a shorter respiration line length (RLL), and a larger heart rate (HR) deceleration – Gamer, 2011). This pattern of differential responses elicited by the crime-related items has been labeled as the CIT effect.

While extensive research has demonstrated large CIT effect sizes with both autonomic nervous system measures and event-related potential measures (Meijer, klein Selle, Elber, & Ben-Shakhar, 2014), the external validity of this research has been questioned (e.g., Ben-Shakhar, 2012; Meijer, Verschuere, Gamer, Merckelbach, & Ben-Shakhar, 2016). Unfortunately however, it is extremely difficult to conduct methodologically sound field studies in this area (see Ginton, Daie, Elaad, & Ben-Shakhar, 1982; Iacono, 1991). CIT researchers have therefore used an alternative approach and systematically manipulated various factors that differ between the typical experimental and the forensic setting: the time between processing the crime related items and the CIT (e.g., Carmel, Dayan, Naveh, Raveh, & Ben-Shakhar, 2003; Gamer, Kosiol, & Vossel, 2010; Nahari & Ben-Shakhar, 2011), the motivation to avoid detection (see Meijer et al., 2014) and the free choice to commit a crime (Nahari, Breska, Elber, klein Selle, & Ben-Shakhar, 2017). Another factor differentiating the experimental from the real-world set-up is the experienced emotional arousal – which is expected to be higher in the field than in the laboratory (see also Verschuere, Meijer, & De Clercq, 2011). A number of previous studies have examined this factor, either by manipulating the level of arousal

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experienced during the mock-crime (Peth, Vossel, & Gamer, 2012) or by manipulating the level of arousal experienced during the CIT (Bradley & Janisse, 1981; Kugelmass & Lieblich, 1966), and found little to no effect on CIT detection efficiency.

Importantly however, in real-life forensic cases, not only the subjective experience, but also the crime-related stimuli themselves may be emotionally arousing. While the stimuli may become emotional only through their connection to the event (e.g., think of the otherwise neutral hammer that has received an emotional loading through its use in a murder), they may also be intrinsically arousing (e.g., the way a victim was raped). Naturally, it may be expected that the more violent the crime, the higher the emotionality of the crime-related items. Let's consider for example the sensational O.J. Simpson case that has captivated America for more than two decades. O.J. was a former NFL star suspected of murdering his ex-wife, Nicole Brown Simpson, and her friend, Ronald Goodman. Several important crime-related details, which could have been used in a CIT, were emotional in nature: the bloody glove, the victims' bodies and the modus operandi of the murder − the modus operandi (e.g., By beating?... By stabbing?... By drowning?... By strangling?... By poisoning?...) is actually a central feature in real life CIT investigations in Japan where the test is extensively applied (see Osugi, 2011). Japanese CIT examiners prefer these type of arousing stimuli because of their presumed high memorability. As the CIT is typically administered few weeks after a crime was committed, one of the key challenges facing CIT practitioners is the selection of memorable items that will induce a stable CIT effect.

A large body of memory research has shown that the emotional value of the stimuli affects their memorability. Most memory studies have however focussed on arousal and there is only some initial evidence that valence can influence how well a stimulus is remembered (see Kensinger, 2009). Studies that manipulated arousal have shown that all three stages of memory processing (i.e., encoding, storage and retrieval) are improved for arousing stimuli. Specifically, arousal leads to a "narrowing of attention" around the central emotional details of a stimulus, reducing the range of cues to which an organism is sensitive (Easterbrook, 1959; Kensinger, Garoff-Eaton, & Schacter, 2007; Sharot & Phelps, 2004). Further, by controlling for the influence of attention (encoding), several studies have shown that emotionally arousing stimuli are more likely to be stored in memory (e.g., Bradley, Greenwald, Petry, & Lang, 1992; Sharot & Phelps, 2004). Specifically, these studies found that memories for neutral stimuli worsen over time, whereas memories for arousing stimuli remain or even improve over time. Finally, several studies have shown that arousing stimuli (both scene-images and words) lead to better recollection than neutral stimuli (e.g., Kensinger & Corkin, 2003; Ochsner, 2000). In addition to laboratory research on the retrieval of arousing stimuli, research on the retrieval of arousing autobiographical events supports the positive influence of arousal on recollection (e.g., Bahrick, Parker, Fivush, & Levitt, 1998; Brown & Kulik, 1977; Budson et al., 2004, 2007; Sharot, Martorella, Delgado, & Phelps, 2007). Taken together, although real-life and laboratory stimuli may differ in both valence and arousal, arousal is most likely to influence memory, and consequently, the CIT effect.

The foremost aim of the two experiments presented here was to examine whether and how emotional stimuli influence CIT detection efficiency. This was accomplished by using pictures that differ in valence and arousal. To the best of our knowledge, there are no prior published studies on the topic and the vast majority of CIT studies were conducted using neutral (e.g., playing cards, mock-crime related) or even positive (e.g., personal/autobiographical) low-arousing stimuli. In Experiment 1 the emotional stimuli were either negative arousing or negative non-arousing, while in Experiment 2 all emotional stimuli were negative arousing. Based on the extensive memory literature, we formulated three separate, but related, predictions: (1) the emotional crime-related stimuli will be better remembered than the neutral crime-related stimuli; (2) the enhanced memory of the emotional crime-related stimuli will heighten CIT detection efficiency; (3) this emotional heightening effect on both memory and CIT detection efficiency will be most clear when the CIT is delayed.

2. Experiment 1

In experiment 1, each participant was tested, either immediately or after one week, on a series of neutral versus emotional pictures. To clarify whether arousal rather than valence would be key in enhancing memorability, the emotional pictures were either negative arousing or negative non-arousing.

3. Method

3.1. Participants

One hundred and thirty-six undergraduate students (91 women) of the Hebrew University of Jerusalem (HUJI) with an age range of 18–32 (M = 24.1, SD = 2.7 years) participated in this experiment. All participants were native speakers of Hebrew and received either course credits or an average payment of 35 NIS (equivalent to approximately 10 USD) for their participation. Each participant read and signed a consent form indicating that participation was voluntary and that they could withdraw from the experiment at any time without penalty. The experiment was approved by the ethical committee of the Faculty of Social Sciences of the HUJI.

3.2. Design

Experiment 1 was constructed in a 2 × 2 × (2 × 2) mixed design with both arousal (negative arousing vs. negative non-arousing) and the time delay between encoding and CIT (immediate vs. 1 week delayed) as between-subjects factors and both item-type (crime-related vs. control) and valence (negative vs. neutral) as within-subject factors. This resulted in four experimental between-subjects conditions: (1) Arousing immediate; (3) Arousing delayed; (2) Non-arousing immediate; (4) Non-arousing delayed. Participants were randomly assigned to one of the four conditions. Sixty-eight participants were tested immediately with 38 of them receiving negative arousing images (i.e., arousing immediate condition) and 30 receiving negative non-arousing images (i.e., non-arousing immediate condition). Sixty-eight participants were tested after a one week delay with 34 of them receiving negative arousing images (i.e., arousing delayed condition), and 34 receiving negative non-arousing images (i.e., non-arousing delayed condition). These conditions did not differ in gender ($\chi^2(3, N = 136) = .49$, $p = .922$), but did differ in age, $F(3,132) = 2.93$, $f = .21$, $p = .036$; nonetheless, participants' mean age in the different conditions varied between 23.3 and 24.8.

3.3. Items

The arousal level and valence of the CIT items were manipulated by using two well validated and well researched picture sets (see Appendix A Table A1): the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2008) and the Karolinska Directed Emotional Faces (KDEF; Goeleven, De Raedt, Leyman, & Verschuere, 2008; Lundqvist, Flykt, & Öhman, 1998). The selected pictures were either neutral or negative non-arousing or negative arousing. Importantly, within each CIT question, the crime-related item and all control items were equal in their arousing potential. Thus, stimuli from the selected categories (i.e., faces and scenes) were chosen on the basis of their arousal (low vs. high) and valence (neutral vs. negative) ratings, such that every question contained one crime-related item and several control items that were matched with respect to semantic category, arousal and valence levels.

The normative arousal ratings for the emotional (negative arousing and negative non-arousing) IAPS and KDEF items used in the CIT were as follows: The negative arousing pictures had a mean arousal rating of