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Preliminary evidence for physiological markers of implicit memory

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ABSTRACT

The Concealed Information Test (CIT) aims to detect concealed knowledge and is known to be sensitive to explicit memory. In two experiments, we examined whether the CIT is also sensitive to implicit memory using skin conductance, respiration and heart rate measures. For each participant, previously studied items were either categorized as explicitly remembered, implicitly remembered or forgotten. The two experiments differed in the strength of memory encoding, the type of implicit memory test, the delay between study and test and the number of critical CIT items. The results of Experiment 1 revealed that CIT detection efficiency was weak and significant only in the explicit memory condition. In Experiment 2, however, CIT detection efficiency was stronger and significant in both the explicit and implicit memory conditions as indexed by skin conductance and respiration. Altogether, our results provide initial evidence that the CIT may be sensitive to implicit memory. Theoretical and practical implications are discussed.

1. Memory detection

Memory detection using the Concealed Information Test (CIT; Lykken, 1959; Verschuere, Ben-Shakhar, & Meijer, 2011) is a valid method to detect concealed memories through the measurement of physiological and/or behavioral indices. In a typical CIT, examinees are presented with several multiple-choice questions. For each question, one critical item (e.g., a distinctive crime-detail) is presented among a series of control items (e.g., "Where was the victim found?"… "in the garage?"… "under the bridge?"… "in the barn?"… "in the river?"… "in the car?"…). Individuals involved in the criminal event are expected to have encoded and stored the critical items in memory. Consequently, they will recognize these items and show differential responses to them in the CIT (e.g., an increased skin conductance response, SCR; a shorter respiration line length, RLL; and a deceleration of the heart rate, HR – Gamer, 2011). This pattern of differential responses elicited by the critical items has been labeled as the CIT effect (Ben-Shakhar, 2012). Extensive research has demonstrated large CIT effect sizes with different physiological measures and different concealed memory paradigms (e.g., card-test, personal items, mock-crime; see Ben-Shakhar & Elaad, 2003; Meijer, klein Selle, Elber, & Ben-Shakhar, 2014).

As the CIT is essentially a "memory test", it is important to explore its sensitivity to different types of memory (i.e., explicit vs. implicit). While explicit memory typically refers to the conscious retrieval of past events, implicit memory typically refers to an unintentional, non-conscious form of retrieval (see Schacter, 1992). This is especially important from an applied perspective as explicit memory cannot be ensured in real-life forensic cases. Specifically, the crime-related information may have been encoded too shallow to be explicitly remembered. Moreover, even when the information had been strongly encoded, this type of memory may decay due to the passage of time. This concern is particularly relevant to real-life cases where long time delays between crimes and interrogations are common (see e.g., Elaad, 1990; Elaad, Ginton, & Jungman, 1992). Hence, it is crucial to examine whether the differential responses to the critical items can reflect implicit memory. A positive answer to this question may enhance the applicability of the CIT and a negative answer may limit it. In any case, it would shed light on an important question in this research area.

2. Explicit versus implicit memory

Memories of past events are not always verbally accessible, but may be preserved in an implicit form. According to the classical threshold account, implicit memory was thought to represent a memory trace that was too weak to enter consciousness (Korsakoff, 1889; Leibniz, 1916; Prince, 1914). Hence, explicit and implicit memories were assumed to be qualitatively the same and variables that affect one type of memory should also affect the other type. During the last three decades, however, a number of studies have shown a dissociation between explicit and implicit memory using a combination of retention tasks (Graf & Schacter, 1985). The most compelling evidence for this dissociation comes from amnesic patients who often perform at chance in explicit

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memory tests, but perform normally in implicit memory tests, speaking against the idea that implicit memory is merely a weaker form of explicit memory, but rather suggesting the existence of two types of memory (e.g., Girelli, Semenza, & Delazer, 2004; Graf & Schacter, 1985; Graf, Squire, & Mandler, 1984). Graf et al. (1984), for instance, assessed the memory performance of three kinds of amnesic patients (patients with Korsakoff syndrome, patients receiving bilateral electroconvulsive therapy, and patients with anoxic encephalopathy) and found these patients to be impaired on different measures of explicit memory (i.e., free recall, recognition, and cued recall), but to perform normally on a measure of implicit memory (i.e., word completion).

A comparable dissociation between explicit and implicit memory performance has been observed in healthy individuals when cognitive load was high (e.g., Jenkins, Burton, & Ellis, 2002), when a shallow encoding task was used (Roediger & McDermott, 1993), or when tested after a long delay from encoding (e.g., Kolers, 1976; Mitchell & Brown, 1988; but see also Moscovitch & Bentin, 1993). In the studies manipulating time-delay, individuals were tested at different intervals (from a week to a year), for both explicit and implicit memory of previously encoded stimulus material (e.g., pictures, inverted text). Mitchell and Brown (1988) for example used a picture-naming paradigm; participants were presented with a large array of pictures and were requested to name each picture as quickly as possible. Implicit (naming latencies) and explicit (recognition) memory performance were tested 1 week, 4 weeks and 6-weeks later. Consistent with other studies, faster picture naming latencies were observed over the 6-weeks period. Episodic recognition, on the other hand, showed a decline across this time interval. Thus, in contrast to explicit memory performance, implicit memory performance remains relatively stable over time. Taken together, these data are inconsistent with the threshold account and support a multiple memory systems account, which holds that neurologically distinct systems underlie the different types of memory (Schacter, 1992; Squire, 1992; Tulving & Schacter, 1990). Consequently, explicit and implicit memories are also assumed to be qualitatively different.

3. Explicit memory in the CIT

Nearly all CIT research up to date has focused on explicit memory. These studies revealed a clear positive association between explicit recollection and CIT detection efficiency (e.g., Carmel, Dayan, Naveh, Raveh, & Ben-Shakhar, 2003; Iacono, Boisvenu, & Fleming, 1984). Carmel et al. (2003), for instance, compared a standard mock crime procedure, where all the relevant details are specified in advance to a more realistic procedure and found that both recall and SCR detection efficiency were attenuated in the realistic procedure. Using a code word paradigm, Waid, Orne, Cook, and Orne (1978) found CIT detection efficiency to be positively correlated with the number of words recalled after the test. Moreover, recalled items were more likely to evoke a SCR than non-recalled items (see also Waid, Orne, & Orne, 1981). A similar positive correlation between recall and skin conductance was also observed in orienting response studies (e.g., Corteen, 1969; Maltzman, Kantor, & Langdon, 1966; McLean, 1969). Importantly however, it is unclear how many of the non-recalled items in these studies were purely forgotten and how many were implicitly remembered. Hence, although these findings imply that CIT detection efficiency for explicit memory is likely to be higher than that for implicit memory, it leaves the question of whether the CIT is sensitive to implicit memory unanswered.

4. Is the CIT sensitive to implicit memory? Clinical evidence

A number of clinical observations demonstrated that the CIT may be sensitive to implicit memory. Bauer (1984) indexed spared recognition in a patient with prosopagnosia (i.e., a profound inability to recognize faces). The prosopagnosic patient was shown two sets of faces, one including famous personalities and one including family members. During the presentation of each face, five names, only one of which matched the face, were presented auditorily. As expected, the patient was unable to spontaneously identify any of the faces and performed at chance level when asked to select the correct name from the five alternatives. Electrodermal discrimination of the name that matched the correct identity was however well above chance and comparable to control subjects. Two follow-up studies with patients suffering from prosopagnosia found similar results and suggest that SCR differentiation can represent covert recognition (Bauer & Verfaellie, 1988; Tranel & Damasio, 1985). Importantly however, the results of these case studies should be interpreted with caution as they are based on either one or two patients.

Using a CIT-paradigm, case-studies of patients suffering from the “amnesic syndrome” also revealed enhanced SCRs ($n = 1$; Verfaellie, Bauer, & Bowers, 1991) and event-related potentials (ERPs; $n = 1$; Lalouschek et al., 1997) to items that could not be explicitly recalled or recognized. Likewise, Allen and Movius (2000) used a CIT paradigm to examine amnesia associated with Dissociative Identity Disorder (DID) in a sample of four patients. DID is characterized by the presence of at least two identities that alternately control the individual's behavior. These identities are allegedly accompanied by amnesia of personal information, which goes beyond that of ordinary forgetfulness, usually referred to as inter-identity amnesia. The authors administered a learning protocol to one personality and tested a second personality for recognition in the CIT. While the second identity denied knowledge of the learned material, enhanced ERPs and response latencies were observed, which could be interpreted as evidence for implicit familiarity of the material (see also Huntjens, Verschuere, & McNally, 2012). The status of amnesia in DID patients is however strongly debated, and the case can also be made that the CIT actually assessed explicit memory (e.g., Huntjens et al., 2012; Kong, Allen, & Glisky, 2008; Merckelbach, Devilly, & Rassin, 2002).

5. Is the CIT sensitive to implicit memory? Experimental evidence

Although memory is typically high in laboratory CIT studies, it is known to decrease with time especially when tested on memory for peripheral CIT items (Carmel et al., 2003; Gamer, Kosiol, & Vossel, 2010; Gronau, Elber, Satran, Breska, & Ben-Shakhar, 2015; Nahari & Ben-Shakhar, 2011; Peth, Vossel, & Gamer, 2012). Considering that memory loss is not an all-or-none phenomenon and may be confined to the explicit system, an examination of the differential responses to the explicitly forgotten items (as indicated by a recognition or recall test), may provide some insight into the sensitivity of the CIT to implicit memory. Gamer et al. (2010) examined this question and found a small CIT effect for the forgotten critical items (Cohen’s $f = 0.19$). This finding indicates that the sensitivity of the measures used in the CIT may expand beyond conscious recognition (for CIT studies on false recognition: see Allen & Mertens, 2009; Baioui, Ambach, Walter, & Vaitl, 2012; Volz, Leonhart, Stark, Vaitl, & Ambach, 2017).

The potential sensitivity of the CIT to implicit memory is further supported by a CIT study using a subliminal perception paradigm (Maoz, Breska, & Ben-Shakhar, 2012). There is an apparent parallel between implicit memory and subliminal perception. In implicit memory there is evidence of memory despite the subjects' claim that they can't remember, and in subliminal perception there is evidence of perception despite the subjects' claim that they can't perceive. Maoz et al. (2012) showed that subliminally presented personally significant items can elicit a SCR CIT effect. It bears mentioning however that in spite of the usage of highly significant personal items (i.e., first name, family name), the effects were rather small and solely observed in the first block of the CIT.

Further evidence for the implicit sensitivity of the CIT comes from a number of other research areas: Maybe the most convincing evidence comes from two different child studies examining covert face recognition of former classmates (i.e., Newcombe & Fox, 1994; Stormark,