Seeing through the face of deception

Thermal imaging offers a promising hands-off approach to mass security screening.

We have developed a high-definition thermal-imaging technique that can detect attempted deceit by recording the thermal patterns from people's faces. This technique has an accuracy comparable to that of polygraph examination by experts and has potential for application in remote and rapid security screening, without the need for skilled staff or physical contact.

There is an urgent need to devise technologies that can be used for automated, high-throughput screening to identify individuals intending to perform acts of terrorism. At present, practicalities dictate that we rely on subjective assessment of responses to brief questions such as "Did you pack your own bags?" and "Why are you entering this facility?"

Although polygraph examinations, which have high precision when applied by experts[1], are good at identifying liars, they are impracticable for mass screening because skilled operators are needed, subjects have to be attached to instrumentation for several minutes, data analysis is time-consuming and the interpretation of data is delayed.

We explored the possibility of using high-definition thermal imaging of the face for detecting deceit[2] because it enables rapid automated analysis of changes in regional facial blood flow to be quantified[3,4]. We have shown previously[2] that auditory startling is associated with a specific facial 'thermal signature', in which there is instantaneous warming around the eyes — probably as part of a fright/flight response mediated by the sympathetic nervous system[5,6]. Although the psychophysiology of startling differs from volitional deception, the nonspecificity of this facial thermal signature is reminiscent of the nonspecific variables monitored during a polygraph (respiration, pulse, relative blood pressure and electrodermal response). Were this thermal signature to accompany lying, independently of startling, it could be used for instantaneous lie detection without the subject even being aware of the test.

We therefore asked volunteers to commit a mock crime and then testify to their innocence under experimental conditions at the US Department of Defense Polygraph Institute (DoDPI; http://www.dodpi.army.mil)[7]. Twenty individuals were randomly assigned to stab a mannequin, rob it of $20 and then assert their innocence of the 'crime'. Control subjects had no knowledge of the crime or of the crime scene. The thermal imaging system correctly categorized 83% of these subjects (Fig. 1); three-quarters (6 of 8) of the guilty individuals were correctly identified as guilty and 90% (11 of 12) of the innocent individuals were correctly categorized as innocent. Traditional polygraphs, performed by experts at DoDPI on the same subjects, correctly categorized 70% of the subjects: 6 of 8 subjects were correctly identified as guilty and 8 of 12 were correctly identified as innocent. Under these experimental conditions, the accuracy of the thermal imaging system was comparable to that of the traditional polygraph.

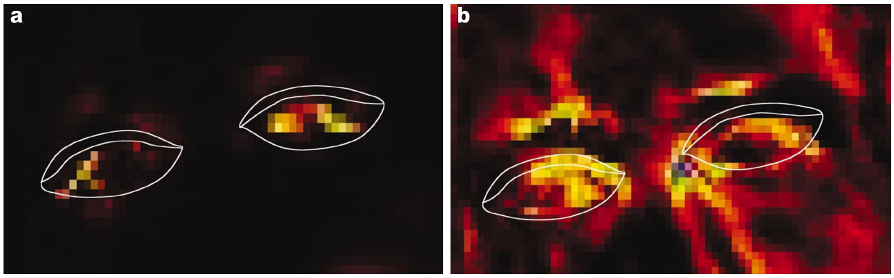

Figure 1 Periorbital, high-resolution thermal images of the face of a 'guilty' subject. Images were obtained before (**a**) and after (**b**) lying in reply to the question "Did you steal the $20?" Images were obtained at 30 frames per second with a cooled thermal camera with a thermal sensitivity of 0.025 °C. The camera was calibrated daily to T_{min} = 29.00 °C (black) and T_{max} = 38.00 °C (cyan) with an external black body; red, orange and yellow represent progressively warmer temperatures in between. White lines indicate eye contours.

High-definition thermal imaging of the face is therefore a promising technology that should allow psychological responses to be detected and analysed rapidly and without physical contact, in the absence of trained staff and in a variety of different situations.

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Satellite tagging

Expanded niche for white sharks

Until the advent of electronic tagging technology[1–4], the inherent difficulty of studying swift and powerful marine animals made ecological information about sharks of the family Lamnidae[5,6] difficult to obtain. Here we report the tracking of movements of white sharks by using pop-up satellite archival tags, which reveal that their migratory movements, depth and ambient thermal ranges are wider than was previously thought.

White sharks (*Carcharodon carcharias*) are globally distributed, and have been reported to inhabit primarily continental-shelf waters in temperate seas[6]. Most tracking studies, however, have been limited to seasonal investigations around coastal pinniped colonies[7–9]. We have extended these over much wider ranges by retrieving data from pop-up satellite archival tags applied to the dorsal musculature of six adult white sharks (3.7–5.0 m in length) caught off the coast of central California. The tags collected pressure, temperature and light-level data at 2-min intervals over a cumulative 650 days (see supplementary information). Light-level data were used to estimate local midnight or noon for longitude calculations[10,11]. At a pre-programmed date, the tags detached from the fish and transmitted a summary of stored data through the *Argos* satellite system.

We tagged six sharks in 1999–2000 and tracked them for periods ranging from 0.5 to 6 months (Fig. 1a). All sharks underwent a near-shore phase immediately after tagging. Diving patterns and ambient-temperature preferences during the coastal-residence period were similar for all sharks, who spent most of their time between the surface and a depth of 30 m, with the deepest dives reaching 75 m (Fig. 1b, c). During this period, the sharks experienced a narrow ambient water-temperature range of 10–14 °C.

Four sharks, which we tracked for 4–6 months, then moved offshore, where they remained exclusively pelagic. One individual (shark 5) travelled 3,800 km to waters off the western coast of the Hawaiian island of