distracters are eliminated from what is defined as the no-distraction condition. It also is important to determine whether behavioral results can be extended to procedures involving non-spatial memoranda [2,3,5]. In addition to the specific results, the Vogel *et al.* study [8] shows that a combination of experimental, psychometric and physiological methods can strengthen our understanding of how the human mind processes information.

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Letters

Detecting deception by manipulating cognitive load

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The traditional arousal-based approach

Concern with crime and terrorism makes it increasingly important to be able to detect lying. Most lie detection tools used to date are arousal-based protocols. The majority of these protocols are based on the assumption that, because of their fear of being caught, liars will be more aroused when answering key relevant questions ('*Did you steal the money?*') than when answering comparison questions. According to the US National Research Council's well-documented report [1], however, this premise is theoretically weak. Liars do not necessarily reveal more signs of arousal when answering key questions. Conversely, truth tellers might be anxious and hence show signs of arousal when answering key questions.

Another arousal approach to detecting deception is based upon the premise that liars will show enhanced orienting responses when they recognize crucial details about the crime in the key questions [2]. Suppose a body was found in the kitchen, but the suspect denies knowledge of the crime. The suspect could then be asked where the body was found: '*in the bedroom, bathroom, kitchen or living room?*' Interview protocols designed to demonstrate orienting responses could be difficult to apply, however, because they require the examiner to possess specific knowledge about the crime, and also because they require impractically sophisticated equipment to measure physiological responses (e.g. skin conductance, EEG).

The innovative cognitive-load approach

Given the theoretical weakness of the fear-based arousal approach and the practical difficulties of the orienting-based arousal approach, we propose a new approach to discriminate between liars and truth tellers. This novel approach rests on the premise that, in interview settings, lying is cognitively demanding. This extra cognitive demand is caused by liars having to engage in additional tasks: inferring what others are thinking, 'keeping their story straight' and monitoring and controlling their behaviour so they avoid creating the impression of lying.

Many sources support the premise that lying is cognitively demanding. First, in police interviews with real-life suspects, lies are accompanied by increased pauses, decreased blinking, and, for males, decreased hand and finger movements, all of which are signs of cognitive load [3,4]. Second, police officers who saw videotapes of interviews with suspects judged that the suspects were thinking harder when they lied than when they told the truth [5]. Third, participants in mock-suspect experiments directly assessed their own cognitive load during interviews and reported that lying was more

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cognitively demanding than truth telling [6]. Fourth, deceiving is associated with activating executive 'higher' brain centres such as the prefrontal cortex [7]. Increased activation in these areas inhibits ongoing unnecessary motor behaviours (e.g. fidgeting) [8]. This last finding might account for two interesting phenomena: (i) when police officers examined video fragments of real-life suspect interviews, they thought that the suspects looked less nervous when they lied than when they told the truth [5], and (ii) professional lie detectors who focus on suspects' fidgeting behaviour are poor at detecting deception [9].

If lying is cognitively demanding, then attending to signs of cognitive load should improve people's ability to detect deception. In experimental testing, police officers discriminated between liars and truth tellers more accurately when asked 'How hard is the person thinking?' than when asked 'Is the person lying?' [9]. Moreover, only when asked to look for cues of cognitive demand ('thinking hard'), did they pay attention to the cues that actually discriminate between truth tellers and liars, such as decreased hand movements.

Lie detection could be enhanced further by using interview techniques strategically to increase interviewees' cognitive demand; for example, by requiring interviewees to perform a concurrent secondary task ('time-sharing') while being interviewed. Liars, whose cognitive resources will already be partially depleted by the act of lying, should find this additional, concurrent task particularly debilitating. This should show up as a poorer performance on the primary task (e.g. providing a statement during the interview), and also on the secondary task (e.g. remembering information provided through a set of headphones). We would encourage researchers to develop manipulations to increase cognitive load during interviews, and to develop new dependent measures of cognitive load, in the service of enhancing lie detection.

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A developmental perspective on the neural code for written words

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Two recent *TICS* articles [1,2] converge on the idea that, in mature reading, written words are coded by an abstract neural representation comprising either 'open bigrams' [2] or bigrams in combination with larger units [1]. For example, the input TAKE is represented by the units TA TK TE AK AE and KE. However, open bigrams do not map onto phonology. Because phonology is fundamental in both acquisition and skilled reading [3], we argue that open bigrams cannot be the full story.

Children begin 'reading' written words by using salient visual cues like logos [4]. Pre-readers can identify words like PEPSI in a logo, but if the non-word XEPSI appears in the logo, it is 'read' as 'pepsi'. When visual cues are primary, open bigrams are not coded. Once letter names and sounds are learned, simplified phonetic spellings have an advantage over visually distinctive groupings of letters: thus, novice kindergarten readers find it easier to learn that JRF is 'giraffe' and PNSL is 'pencil', than to learn that WBC is 'giraffe' and QDJK is 'pencil' [4]. Clearly, phonology is an integral part of creating and storing the visual codes for written words. When words have 'silent' letters (e.g. B in LAMB, and S in ISLAND), children require extra storage cues. In paired-associate learning tasks involving the presentation of word–letter pairs, children are better at recalling words from silent letter cues than from sounded letter cues (e.g. which word

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