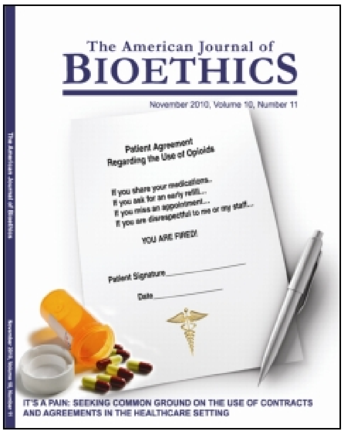

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Emerging Neurotechnologies for Lie-Detection: Where Are We Now? An Appraisal of Wolpe, Foster and Langleben's "Emerging Neurotechnologies for Lie-Detection: Promise and Perils" Five Years Later

Steven E. Hyman[a]
[a] Harvard University,

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Invited Commentary

Emerging Neurotechnologies for Lie-Detection: Where Are We Now? An Appraisal of Wolpe, Foster and Langleben's "Emerging Neurotechnologies for Lie-Detection: Promise and Perils" Five Years Later

Steven E. Hyman, Harvard University

In 2005 Wolpe, Foster, and Langleben published an article in the *American Journal of Bioethics* on emerging technologies for lie detection. Although the authors touched on such fundamental ethical concerns as "brain privacy," they focused primarily on the technical limitations of these new approaches, and aptly concluded that it was premature to apply them outside of research settings. They recommended discussions to shed light on the circumstances under which new technologies for lie detection might appropriately be marshaled for civil, forensic, or security use. Moreover, they made it clear that such technologies, even when advanced enough to be applied, would continue to have limitations that would be associated with societal and individual risk.

The authors noted that although the technologies under review, such as functional magnetic resonance imaging (fMRI) and novel applications of electroencephalography, were relatively new, the psychological paradigms employed to activate neural responses have not advanced much if at all. These paradigms, which are used with older methods of lie detection, such as polygraphy, include the control question test (CQT) and the guilty knowledge test (GKT). The CQT compares physiological responses to questions that are relevant to the matter under investigation with responses to two types of control questions, those expected to have a high emotional valence in all subjects and those expected to be emotionally neutral. The GKT detects physiological or neural activation to stimuli that would be expected to elicit a strong or emotional response only in an individual with prior (e.g., guilty) knowledge. As more sensitive measurement technologies are developed, such as those that detect brain responses rather than relying on the peripheral nervous system (e.g., sympathetic activation), the underling psychological paradigms, which purportedly separate truth from deception, must remain a matter of scientific focus. Not only do these paradigms ultimately determine the utility of the technologies for society, but for those under investigation they also provide an opportunity to design convincing countermeasures.

Had Wolpe and colleagues (2005) focused purely on ethical concerns such as whether our brains should somehow be privileged as the last bastions of privacy in an increasingly transparent world, many readers might have assumed that the technologies under review were far more advanced than, in fact, they were. In my view the authors performed an important service by focusing on such fundamental, if general, issues of testing as sensitivity and specificity. From their discussion the reader would learn, for example, that for any test that yields an appreciable rate of false positives (in this case falsely classifying an honest person as deceptive), the rate of false positives might exceed the rate of true positives when screening populations with low base rates of deception (e.g., as in routine airport screening). One implication is that it is critical to consider the full costs to society and to individuals of false positives rather than thinking only of sensitivity (i.e., not allowing bad guys to evade detection). Another important issue raised is that of external validity: most of the laboratory experiments performed with fMRI, for example, have used college student volunteers. When using the CQT paradigm or some derivative of it, the subjects must be instructed to lie at some point, a very different circumstance than purposeful deceit in the "real world". It is an important question as to how those

Address correspondence to Steven E. Hyman, Office of the Provost, Harvard University, Massachusetts Hall, Cambridge, MA 02138, USA. E-mail: seh@harvard.edu

who wish to detect deception will have access to enough real world experience to develop truly useful models (Sip et al. 2008).

The kind of analysis performed by Wolpe and colleagues (2005) is even more pressing today because of progress in the analysis of fMRI data. Modern pattern-classification algorithms for distributed patterns of fMRI data are permitting investigators (within real, but narrowing limits) to classify mental states in the brains of human subjects. Such approaches began in basic scientific investigations. For example Haxby and colleagues (2001) empirically determined the patterns of fMRI signal changes across multiple voxels in human ventral temporal cortex that correlated with seeing human faces, cats, different categories of man-made objects, and nonsense pictures. The investigators then derived multi-voxel patterns could be used subsequently to predict, with high accuracy, what a subject was seeing among these choices (Haxby et al. 2001).

As such approaches to data analysis have gained in sophistication, they have been applied with increasing success to the classification of diverse conscious mental states, including intentions (Haynes and Rees 2006) and more recently, to cognitive processes, such a reward coding, that may contribute to unconscious behavioral control (Kahnt et al. 2010). Thus increasingly the focus on technical limitation for the use of fMRI to detect deception has moved from questions of measurement to the psychological paradigms that might permit investigators to develop a classification scheme that would accurately separate truth from lies under diverse "real-world" circumstances (Sip et al. 2008). Put crudely, a key question for this field is how to gain access to real world liars under diverse circumstance in order to constrain classification algorithms. (It is often speculated that this task might be easier to accomplish for guilty knowledge paradigms than for CQT paradigms.)

Of course it is always important for academics to recall that their discussions and the related scientific evidence do not always lead to wise regulation of technologies that seem to answer pressing problems. Thus, for example, polygraphy is more widely used for security screening purposes than would give comfort to a far more skeptical scientific community (National Research Council, 2003). That said, the conversation joined by Wolpe and colleagues (2005) is continuing and deserves intensification in parallel with technological advancement. Given recent scientific progress, conversations about privacy should also be increasingly extended to technologies that peer directly into the human brain.

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