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BRAIN FINGERPRINTING: CORRECTIONS TO ROSENFELD

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The following article is a brief summary of the relevant information, with specific focus on correcting the misinformation contained in a previous article in the *Scientific Review of Mental Health Practice* (Rosenfeld, 2005). More details are available at http://www.brainwavescience.com/Scientific_Review_of_Mental_Health_Practice_Farwell_Corrections_to_Rosenfeld.pdf, which also contains references to independent sources wherein all of the significant statements made herein can be independently verified.

Key words: popular science, pseudoscience, psychotherapy, Sokal hoax

BRAIN FINGERPRINTING: A BRIEF OVERVIEW

Brain fingerprinting is a scientific technique to detect concealed information stored in the brain by measuring brainwave responses non-invasively. An EEG event-related potential brain response known as a P300-MERMER is elicited by stimuli that are significant in the present context. Brain fingerprinting detects a P300-MERMER response to words or pictures relevant to a crime or terrorist act, terrorist training, bomb-making knowledge, inside knowledge of a terrorist cell or intelligence agency, etc.

Brain fingerprinting detects information stored in the brain by measuring cognitive information processing. Brain fingerprinting is not lie detection. It does not detect lies, stress, or emotion.

The brain fingerprinting system computes a determination of "information present" (the subject knows the crime-relevant information) or "information absent" (he does not know it) and a statistical confidence for the individual determination. Laboratory and field tests at the FBI, CIA, US Navy and elsewhere have resulted in no false positives and no false negatives; 100% of determinations made by brain fingerprinting have been correct. Overall, including studies that measure only the P300 and studies that measure the full P300-MERMER, 3% of results have been "indeterminate." Since the inclusion of the full P300-MERMER in the computations, there have been no false positives, no false negatives, and no indeterminates: 100% of tests have produced correct determinations. (See Farwell, 1992a, 1994, 1995a,b; Farwell & Donchin, 1991; Farwell & Richardson, 2006a,b; Farwell & Smith, 2001.)

My colleagues and I have successfully applied brain fingerprinting in criminal cases, including helping to bring serial killer J. B. Grinder to justice. Brain fingerprinting and my expert testimony on it have been ruled admissible in trial court in a murder case (*Harrington v. State*, 2001).

Effective application of brain fingerprinting in the laboratory and the field requires an understanding of the relevant scientific principles and the proper role of brain fingerprinting in forensic science and judicial proceedings (see Farwell & Smith, 2001; Iacono, 2008). Maintaining proper brain fingerprinting scientific standards is necessary for accuracy and validity.

Brain fingerprinting is not only highly accurate; it is also highly resistant to countermeasures. No one has

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ever beaten a brain fingerprinting test with countermeasures or through any means, despite life-and-death consequences in actual criminal cases and a $100,000 reward for beating the test.

HOW THE BRAIN FINGERPRINTING TEST WORKS

A brain fingerprinting test involves presenting stimuli, generally words or phrases presented briefly on a computer screen, and measuring brain responses. When a subject reads a phrase, understands and processes the information contained therein, and recognizes it as significant in context, the brain emits a specific, identifiable brain response known as a P300-MERMER (Farwell & Donchin, 1991; Farwell & Smith, 2001). When a subject reads and processes irrelevant information, or does not read and process information presented, no P300-MERMER occurs. In a brain fingerprinting test, brainwave responses are measured to three types of stimuli. "Target" stimuli contain information that the subject knows. "Irrelevant" stimuli are, as the name implies, irrelevant. "Probe" stimuli are phrases containing details about the crime or investigated situation that are known only to the perpetrator and investigators. (Brain fingerprinting experimental procedures ensure that the subject does not recognize the probes for a reason other than participation in the crime.) For example, a probe might be the murder weapon, such as a knife. Irrelevant stimuli might be other plausible, but incorrect, murder weapons, such as a pistol and a rifle. A target might be the name of the victim (if it had been publicly released). Experimenters make sure that the subject knows the targets before the test.

All subjects who read and process the stimuli recognize the targets as significant in context. All subjects emit the corresponding P300-MERMER brain response. The irrelevant stimuli are not significant in context, and do not elicit a P300-MERMER. A subject without the crime-relevant knowledge does not recognize the probes. All stimuli other than targets appear equally irrelevant. Thus, for a non-knowledgeable subject, probes, like irrelevants, do not elicit a P300-MERMER.

For a subject with the crime-relevant knowledge, the "other" stimuli (those that are not targets) consist of irrelevant stimuli and probes. If he reads and processes the probes, he recognizes the probes as being as being significant in the context of the crime. Consequently a knowledgeable subject's brain will emit a P300-MERMER in response to probes. In short, all subjects will emit a P300-MERMER in response to targets; no subjects will emit a P300-MERMER in response to irrelevants; and only subjects possessing crime-relevant knowledge will emit a P300-MERMER in response to probes. The brain fingerprinting data analysis algorithm compares the responses to the three types of stimuli and computes a determination of "information present" (the subject knows the crime-relevant information contained in the probes) or "information absent" (the subject does not know the relevant information).

ROSENFELD'S (2005) *SRMHP* ARTICLE

In an article in the *Scientific Review of Mental Health Practice*, Rosenfeld (2005) discussed my brain fingerprinting technique and some of the relevant scientific research, and extensively discussed the Brain Fingerprinting Laboratories, Inc. website. The Rosenfeld article contains numerous demonstrably false statements and extensive misinformation, which in the interest of limiting the length of this article I have corrected only in part herein. It contains demonstrably false statements regarding my scientific methods, published research, courtroom testimony, field applications, and public statements regarding brain fingerprinting. It contains Rosenfeld's unsupported and incorrect speculation about experiences in the lives of my subjects, and Rosenfeld's baseless and incorrect scientific conclusions about my research based on thereon. It contains irrelevant information, such as Rosenfeld's touting his own non-brain fingerprinting research. It contains inappropriate information, such as Rosenfeld's personal emails, his unsupported subjective opinions, and his speculations as to what I might say (but did not say) on various subjects. If all of these were removed, the article would contain virtually nothing of substance.

Rosenfeld used the *SRMHP* article (Rosenfeld, 2005) and the false statements he made therein to provide purported support for his subsequent false statements about brain fingerprinting and also his subsequent false claims regarding his own technique (e.g., Rosenfeld et al., 2008).

ROSENFELD'S (2005) FALSE STATEMENTS AND SUBSEQUENT FALSE CLAIMS BASED THEREON

Rosenfeld made false statements regarding my statements on the availability of brain fingerprinting for field use.

In the *SRMHP* article, Rosenfeld (2005) accused me of making "false and misleading" claims regarding the availability of brain fingerprinting for field use. Rosenfeld took issue with this statement on the brain fingerprinting web site: "The technology [brain fingerprinting] is fully developed and available for application in the field" (p. 34).

In fact, that is an understatement. Brain fingerprinting is not only "available for application in the field." I already have successfully applied brain fingerprinting in the field. In addition to successfully performing on contracts for the CIA and conducting research at the FBI and the US Navy (e.g., Farwell & Richardson, 2006b), I have successfully applied brain fingerprinting in criminal cases, including one in which it was instrumental in bringing serial killer J. B. Grinder to justice. A trial court in Iowa ruled brain fingerprinting and my testimony on it admissible as evidence in the Harrington murder case (*Harrington v. State*, 2001). I have successfully used brain fingerprinting in real criminal justice cases, with the extreme difficulties, consequences, motivations, and complications inherent thereto.

Rosenfeld made false statements regarding my scientific publications in peer-reviewed journals.

In his *SRMHP* article, Rosenfeld (2005) made demonstrably false statements regarding my scientific publications. Referring to the paper authored by FBI scientist Sharon Smith and myself (Farwell & Smith, 2001), Rosenfeld stated: "this later paper appeared in an outlet which is not a peer-reviewed or leading journal in psychology, neuroscience, or psychophysiology . . . it is unlikely that this report would have appeared in a major journal" (p. 23).

The Farwell and Smith (2001) paper was published in the *Journal of Forensic Sciences*, one of the leading peer-reviewed journals in forensic science. (Rosenfeld had previously misinformed the press on this subject, stating that the Farwell and Smith paper on the MERMER was not published in any peer-reviewed journal. When the AP checked their facts after publishing Rosenfeld's false statement, they published a correction correctly identifying the *Journal of Forensic Sciences* as the peer-reviewed publication where the Farwell and Smith paper was published.)

Rosenfeld's (2005) first statement above has so many qualifiers ("psychology, neuroscience, or psychophysiology") that it might not technically be totally false, but it is certainly misleading. This would be equivalent to saying Rosenfeld has never published anything in a peer-reviewed or major journal in biology or forensic science, without mentioning his relevant publications in other relevant peer-reviewed journals.

Rosenfeld's second statement is unequivocally false. It is not "unlikely" that the Farwell and Smith forensic-science paper would be published in a "major journal," because it has been published in one of the major journals, if not *the* major journal, in forensic science.

In dismissing the *Journal of Forensic Sciences*, Rosenfeld (2005) stated, "(T)here has been only one serious publication (on brain fingerprinting)" (p. 34), namely the seminal paper on the subject by Farwell and Donchin (1991). He provides no hint of the criteria by which he dismissed the *Journal of Forensic Sciences* as not being "serious" or "major."

In fact, the *Journal of Forensic Sciences* is by any standard both "serious" and "major" among forensic science journals. It is the official journal of the American Academy of Forensic Sciences. Its impact factor of 1.524 is among the highest for forensic science journals. This impact factor compares favorably with the impact factor of 0.884 for the journal where Rosenfeld published his first two articles on EEG-based detection methods, the *International Journal of Neuroscience.*

Rosenfeld used his false and misleading statements in his SRMHP article to support his subsequent false claims for the accuracy of his alternative technique.

Rosenfeld used these false statements he made in *SRMHP* (Rosenfeld, 2005) to lend false credibility to his subsequent false claims of accuracy for his technique. In an article in *Psychophysiology*, Rosenfeld falsely claims that his "complex trial protocol" is more accurate and resistant to countermeasures than brain fingerprinting and other techniques. Rosenfeld et al. (2008) stated:

> The studies reported here suggest that the CTP [complex trial protocol] is more accurate and resistant to CMs [countermeasures] than previously published ERP-based [event-related potential] studies in detecting concealed information. (We do not include here more recent reports and claims of Farwell, e.g., Farwell & Smith, 2001, and on his web site called "Brain Fingerprinting" for reasons detailed in [Rosenfeld (2005)].) (p. 917)

On the face of it, this statement is clearly false with respect to accuracy. (It is also false with respect to countermeasures, as discussed below.) Brain fingerprinting has never resulted in a false negative or a false positive.

Rosenfeld's complex trial protocol has resulted in as many as 47% false negatives in some conditions (Meixner et al., 2009), even without countermeasures, and has averaged about 19% false negative errors.

Moreover, the complex trial protocol is unusable in the field due to a fatal design flaw. The complex trial protocol involved the following procedure. Stimuli in the form of words or phrases were presented on a computer screen. Each trial consisted of two stimuli. The first stimulus was either a probe or an irrelevant. The subject made no discrimination between probes and irrelevants, but simply pushed an "I saw it" button to show that he had seen something on the screen. The second stimulus was either a target or a nontarget. The subject was required to read and comprehend the second stimulus and push one of two buttons to indicate whether it was a target or not. The next stimulus was either a probe or an irrelevant, and so on. Experimenters instructed all subjects to cooperate by reading and processing all stimuli, including not only each target/nontarget but also each probe/irrelevant. The cooperative laboratory subjects accommodated the experimenters by doing so.

The complex trial protocol can obviously be defeated by an extremely simple and totally effective procedure, as described below. In Rosenfeld's procedure, it is obvious that stimulus presentations wherein a discrimination is made (target/nontarget) alternate one-to-one with stimulus presentations wherein no discrimination is made (probe/irrelevant). Subjects are told this. Subjects are informed that all probes are presented only in a position in the totally predictable, alternating sequence where there is no required discrimination, and consequently no requirement to read, comprehend, and process the stimuli. Recall that probes are the only stimuli containing the crime-relevant knowledge of interest.

Faced with Rosenfeld's method, real-world terrorists or criminals would have no reason to accommodate the experimenters and voluntarily reveal their concealed knowledge. They could simply pay attention to each target/nontarget stimulus presentation, read and comprehend the target or nontarget stimulus, and make the required discrimination and appropriate button-press response. They know from experimental instructions that on the next stimulus presentation no discrimination, comprehension, or processing of the meaning of the stimulus is required. Hence they could avoid reading or even looking directly at the next stimulus, at the only time where the stimulus might be a crime-relevant probe. They could simply push the one required "I saw it" button as soon as anything appeared on the screen, without processing the stimulus except as a momentary brightening in that general area of the visual field. Then they could read, process, and respond appropriately to the next target/nontarget stimulus, and so on.

Real-world subjects with something to hide could effectively follow instructions for the overt button-press task without making the probe-irrelevant discrimination. Thus they would show no enhanced P300-MERMER response to the probes. (Nor would there be any slowing of reaction time.) Following each target/nontarget stimulus, they would not read or process the next (probe/irrelevant) stimulus. Following each unread probe/irrelevant stimulus presentation, they would read the next stimulus and make the required target/nontarget distinction, and so on.

Rosenfeld and colleagues (e.g., Rosenfeld et al., 2008) instructed their subjects not to take advantage of this fatal flaw. Their laboratory subjects were accommodating. They read and processed the probe stimuli, even though there was no need to do so in order to follow the instructions for overt behavior. Consequently they exhibited large P300-MERMERs in response to probes and were detectable even by this fatally flawed procedure.

In a field situation, covertly uncooperative subjects undoubtedly would not have accommodated the experimenters in this way, and would have been undetectable by either brainwaves or behavior. The complex trial protocol is unusable in the field, and has never been used in the field.

Brain fingerprinting, by contrast, requires subjects to read, process, and discriminate each and every stimulus, and to behaviorally report discriminations with a button press on each and every stimulus. This is why brain fingerprinting has been successfully used on real-world criminals such as serial killer J. B. Grinder, people who have very high motivation to beat the test and are not accommodating except so far as the instructions require on every trial.

Rosenfeld falsely attributed the inaccuracy of other, non-brain-fingerprinting techniques to brain fingerprinting.

Rosenfeld asked, "Regarding P300-based GKT [guilty knowledge test] studies from independent laboratories, how does the BF [brain fingerprinting] method fare?" (p. 25)

As an answer, he discussed several non-brain fingerprinting studies that reported low accuracy rates, including one of his own, Rosenfeld et al. (2004). That study

was not a test of "how does the BF [brain fingerprinting] method fare?" It failed to meet the brain fingerprinting scientific standards that have been adhered to in all brain fingerprinting research and are described in detail elsewhere. He also cited a study published by Mertens et al. (2003) that failed to meet many of the brain fingerprinting standards and reported low accuracy rates. We have discussed these studies elsewhere as examples of several of the most common errors in brainwave-based detection of concealed information and errors that have resulted in the greatest decrements in accuracy.

The Mertens et al. (2003) study, which Rosenfeld (2005) apparently found sufficiently well published to cite and consider in his arguments, was published in abstract form in *Psychophysiology*. Rosenfeld did not cite or consider several studies published by my colleagues and me in the same form in the same journal (Farwell & Donchin, 1986, 1988b; Farwell, 1992b, 2008; Farwell & Richardson, 2006a,b). Unlike the Mertens et al. (2003) study, these studies actually tested brain fingerprinting. All of these brain fingerprinting studies reported 100% accurate determinations, with no false positives, no false negatives, and no indeterminates. All the results reported therein either have been or shortly will be published in full form in peer-reviewed journals.

Rosenfeld cited Miyake et al. (1993), another study that is a prime example of the negative consequences of failure to meet the brain fingerprinting scientific standards, as I have discussed in detail elsewhere (see, for example, *Harrington v. State*, 2001)

There is nothing wrong with conducting studies that attempt to detect concealed information using event-related brain potentials and using different techniques from brain fingerprinting, as these experimenters have done. There is nothing wrong with obtaining inaccurate results as a result of the (non-brain fingerprinting) scientific procedures followed. There is nothing wrong with reporting these results. The only valid scientific conclusion that can be drawn, however, is that these alternative, non-brain fingerprinting techniques are inaccurate. These data do not support Rosenfeld's (2005) conclusion that brain fingerprinting must also be inaccurate.

Testing other techniques that fail to meet a majority of the brain fingerprinting scientific standards does not tell us "how does the BF [brain fingerprinting] method fare?" It tells us how these alternative, non-brain fingerprinting methods fare. Rosenfeld's (2005) answering his question regarding the accuracy of "the BF [brain fingerprinting] technique" with a discussion of the inaccuracy of alternative, non-brain fingerprinting techniques is misleading at best.

Rosenfeld made demonstrably false statements regarding my sworn expert testimony in the Harrington case.

Rosenfeld cited a study conducted by Miyake et al. (1993) in Japan as purported evidence of the inaccuracy of brain fingerprinting. As discussed below, an examination of the relevant facts reveals that the Miyake et al. study was fundamentally different from brain fingerprinting, used fundamentally different methods, and did not meet minimal scientific standards necessary for accurate or valid results. The fact that Miyake et al. obtained highly inaccurate results was due to the different procedures they followed and to their failure to implement standard or adequate scientific methods. This in no way reflects on the accuracy of the procedures and scientific protocols used in brain fingerprinting.

In this context, Rosenfeld (2005) falsely accused me of not telling the truth, the whole truth, and nothing but the truth while under oath when I testified as an expert witness. An examination of the relevant science and testimony reveals that Rosenfeld's accusation is without any foundation in fact.

Rosenfeld quoted my sworn testimony on brain fingerprinting science in the Harrington case (*Harrington v. State*, 2001). This was a murder trial wherein brain fingerprinting science and my testimony on it were ruled admissible, as discussed above. Rosenfeld (2005) then characterized my testimony as "erroneous and misleading" (p. 25). The independently verifiable facts, however, show that Rosenfeld's characterization of my testimony is false. The historical and scientific facts support my testimony as being truthful and accurate.

The subject at hand was the article by Miyake et al. (1993). The prosecution attempted to present the article as evidence in the Harrington case, and questioned me about it. I testified that their methods were fundamentally different from brain fingerprinting and did not meet the necessary scientific standards. The opposing expert witness did not disagree. The court did not accept the Miyake et al. (1993) article into evidence.

Rosenfeld (2005) quoted my testimony, "They [Miyake et al. (1993)] recorded from Cz [the central midline scalp site], so I don't know what they were measuring . . . it appears they were doing something that was in no way related to what we did." (p. 25).

My further testimony (which Rosenfeld did not quote) cited specific scientific reasons why what Miyake et al. (1993) were doing was "fundamentally different from what I do [brain fingerprinting]" (*Harrington v. State*, p. 127) and did not meet the relevant scientific standards.

Miyake et al. (1993) failed to meet the brain fingerprinting scientific standards, and used fundamentally different procedures. Moreover, the experimenters failed to implement data collection, artifact rejection, and data analysis procedures that meet the universal standards met by other laboratories in the field of event-related brain potential research. They measured P300 from the wrong scalp location. Their classifications were based not on any mathematical algorithm but on subjective judgments by the operators. They failed to use well-known standard methods, or any method, for artifact rejection or correction, resulting in inadequate data for accurate analysis or conclusions. Their timing parameters were outside the range used in other laboratories in event-related potential research. They used an insufficient number of trials. They attempted to detect lying, rather than information. These errors resulted in an exceptionally low accuracy rate. Only 65% of their determinations were correct, with 17% indeterminate.

I clearly pointed out in my testimony (*Harrington v. State*, 2001) that the Miyake et al. (1993) study has numerous serious methodological flaws, and numerous differences from brain fingerprinting.

In view of these relevant facts, my testimony was truthful and accurate. Rosenfeld's accusations to the contrary are false.

Rosenfeld falsely described my peer-reviewed publications and falsely criticized my expert witness testimony on that basis.

Rosenfeld (2005) stated: "In any case, neither Farwell and Donchin (1991) nor Farwell and Smith (2001) provide support for this retrospective use of BF [brain fingerprinting] as in the Harrington case, since these studies tested for recently acquired information by well practiced subjects. There is, in fact, no published, peer reviewed, scientific evidence whatsoever supporting this retrospective testing as was done in the Harrington case" (p. 31). Rosenfeld's (2005, p. 31) two sentences quoted immediately above contain several demonstrably false statements, as follows.

The Farwell and Smith (2001) study was specifically designed to use brain fingerprinting to detect information regarding real-life events in the lives of FBI agents, events that in some cases took place many years previously. Contrary to Rosenfeld's (2005) statements, the information was not "recently acquired," nor were the subjects "well practiced." Farwell and Smith clearly stated these facts (Farwell and Smith, 2001, p. 138).

I also clearly described this experiment in my testimony in the Harrington case (*Harrington v. State,* 2001). At the time, the Farwell and Smith (2001) article had been accepted for publication in the *Journal of Forensic Sciences*, a major peer-reviewed forensic science journal, as discussed above. It had not yet been printed, however. As I testified (*Harrington v. State*, 2001, p. 12), Farwell and Donchin (1991) conducted two experiments. "Experiment 1" was a mock espionage scenario. "Experiment 2" was essentially the same as the Farwell and Smith (2001) study on real-life events in the lives of FBI agents. I referred to the former in the above trial transcript (*Harrington v. State*, 2001, p. 12) as "the study that we did initially on the students." Contrary to Rosenfeld's (2005) statements, the information was not "recently acquired" nor were the subjects "well practiced." I described the study in my testimony in *Harrington v. State* (pp. 7-8).

Contrary to Rosenfeld's (2005) false statement, both Experiment 2 of Farwell and Donchin (1991) and the Farwell and Smith (2001) study contain support for exactly the kind of real-life (or as Rosenfeld erroneously called it "retrospective") testing applied in the Harrington case. In neither case was the information "recently learned." In neither case were the subjects "well practiced."

These same facts make it clear that Rosenfeld's second sentence quoted above ("There is, in fact, no published, peer reviewed, scientific evidence whatsoever . . .") is false. Contrary to Rosenfeld's false statement, both Farwell and Smith (2001) and Farwell and Donchin (1991) provide "published, peer reviewed, scientific evidence" supporting the kind of testing conducted in the Harrington case.

These same facts demonstrate that another similar statement Rosenfeld (2005) made is false as well: "[A] criminal suspect in the field would hardly have had the kind of rehearsal opportunities present in both experiments of Farwell and Donchin (1991)" (p. 24). There were no "rehearsal opportunities" in Experiment 2, the real-life experiment. Rosenfeld stated, without evidence, that the subjects in Experiment 2 "*no doubt had had much review of their crimes at the hands of campus investigators, teachers, parents, etc.* [italics in original]" (p. 24). Rosenfeld's speculation is without foundation or evidence, and is in fact false. No such review was mentioned in Farwell and Donchin, and no such review took place. (I know this because I interviewed all of the subjects and informants.)

All three expert witnesses, including the expert witness on the opposing side, testified that Farwell and Donchin's (1991) use of the P300, explicitly including

both Experiment 1 and the real-life Experiment 2, was well accepted in the scientific community (*Harrington v. State*, 2001). As described in detail above, the expert witnesses provided sufficient information regarding the validity of brain fingerprinting science and its acceptance in the scientific community that the court ruled the brain fingerprinting evidence and my testimony on it admissible (*Harrington v. State*, 2001).

Rosenfeld falsely alleged that the Brain Fingerprinting Laboratories website misrepresented the role of brain fingerprinting in the Harrington case.

Rosenfeld (2005) stated: "The BF [brain fingerprinting] Web site clearly suggests that the BF evidence was of major importance in that Supreme Court decision." (p. 30). Rosenfeld (2005) reproduced the heading of a page about the Iowa Supreme Court decision from the Brain Fingerprinting Laboratories website, as follows:

> Iowa Supreme Court overturns the 24 year old conviction of Terry Harrington,
> Brain Fingerprinting Test aids in the appeals;
> Iowa Supreme Court Reverses Harrington Murder Conviction after 24 Years
> Brain Fingerprinting Test Supports Innocence (p. 31).

On the same web page referred to by Rosenfeld (2005; http://www.brainwavescience.com/IowaSupCourtPR.php), the Brain Fingerprinting Laboratories, Inc. website clearly and accurately stated the role of the brain fingerprinting evidence in the Iowa District Court and the Iowa Supreme Court. The same Brain Fingerprinting Laboratories, Inc. web page quoted in its entirety the Supreme Court's discussion of the brain fingerprinting evidence. It also provided a link to the full text of the Iowa Supreme Court decision (*Harrington v. State*, 2003).

The referenced web page not only did not "clearly imply," as Rosenfeld (2005) falsely stated, "that the BF [brain fingerprinting] evidence was of major importance in that Supreme Court decision" (p. 30). The Brain Fingerprinting Laboratories website explicitly and accurately stated that the Supreme Court did not reach a consideration of the brain fingerprinting evidence. It stated accurately that the brain fingerprinting evidence was ruled admissible in the district court, and that the Supreme Court left undisturbed the law of the case, including the district court's admitting the brain fingerprinting evidence. (Note that "the Supreme Court left undisturbed the law of the case" is a legal term of art signifying that in their review of the case, the Supreme Court could have reversed the district court's decision to admit the brain fingerprinting evidence, but elected to let it stand.)

In short, once again Rosenfeld's (2005) allegation is false.

The scientific and legal role of brain fingerprinting in the Harrington case is described in detail in writings by myself and my attorney Tom Makeig (Farwell & Makeig, 2005) and others (Erickson, 2007; Moenssens, 2002; Roberts, 2007).

Rosenfeld misrepresented the fundamental procedures of brain fingerprinting testing and falsely accused me of not correctly representing them.

Rosenfeld misrepresented the fundamental procedures of brain fingerprinting testing. Although such a false description of the fundamental science involved is not defamatory, it is extremely important in the context of a purportedly scientific critique of my scientific methods. One of the most important fundamental distinctions that I have made both in my peer-reviewed scientific writings and in my courtroom testimony is the distinction between detecting lies and detecting information. These are fundamentally different processes, scientifically and legally. Clearly understanding that brain fingerprinting detects information and not lies, and acting accordingly, is one of the fundamental brain fingerprinting scientific standards.

Rosenfeld (2005) quoted me in Farwell and Smith (2001) and other sources as stating that brain fingerprinting is distinct from lie detection, since it detects information, not lies. He then went on to falsely state that my statements to this effect are "misleading" (p. 22). In support of his false contention, Rosenfeld entirely misrepresented the scientific procedures of brain fingerprinting, as follows. In brain fingerprinting and several other techniques, subjects press one button in response to target stimuli (information known to the subject) and a different button for both irrelevant stimuli and probes (the latter are the crime-relevant information being tested). The subject instructions are vital for determining what mental task the subject is actually performing while his brainwaves are being measured, and consequently what the science is in fact measuring.

Regarding brain fingerprinting methods, Rosenfeld (2005) falsely stated: "One button means, 'No, I don't recognize this stimulus.' If the guilty subject presses this no button to a guilty knowledge [probe] item, he is lying with his button press, if not his voice" (p. 22).

This may be the case in Rosenfeld's methods (e.g.,

Rosenfeld et al., 2004), which have fundamentally different subject instructions that may in fact tell the subject that pressing the button as instructed constitutes a "lie." Rosenfeld's description of the experimental protocol is not true of brain fingerprinting, however. In brain fingerprinting, the subject is given a list of the target stimuli and instructed to press one button in response to targets, and another to all other stimuli (Farwell & Donchin, 1991; Farwell & Smith, 2001; *Harrington v. State*, 2001). The latter include irrelevant stimuli and crime-relevant probe stimuli. The subject is not instructed to lie, or given any opportunity to lie during the test. Nor is he told that his button-press responses constitute "lies." Whether he has something to hide or not, the subject neither tells the truth nor lies by his button presses during the test. He simply presses buttons as instructed.

Brain fingerprinting, like all other forensic sciences, can of course be used to catch a subject in a lie that takes place outside of the scientific procedure. Whether the subject lies about his participation in the crime before or after the test is an entirely independent question, and has no effect on the brain fingerprinting test.

In their seminal publication on the subject, Farwell and Donchin (1991) used the term "interrogative polygraphy" as an umbrella concept including both detection of deception and detection of information, through both central-nervous-system and peripheral measures. They made it clear in the publication that the methods reported therein are for the detection of information, not lies. The title of the article is "The truth will out: Interrogative polygraphy ('lie detection') with event-related potentials." The term "lie detection" was enclosed in quotation marks to emphasize that it is not meant literally, as anyone who reads the article or even the abstract will clearly recognize. Farwell and Donchin state explicitly stated that the term "lie detection" is "inaccurate and misleading" (p. 531).

Despite Farwell and Donchin's (1991) explicit statements to the contrary, Rosenfeld (2005) falsely took our inclusion of the words "lie detection" in the article as evidence that brain fingerprinting is "lie detection," and that brain fingerprinting actually attempts to detect lies. In short, Rosenfeld (2005) falsely described the fundamentals of brain fingerprinting testing, falsely described the relevant scientific procedures, and falsely accused me of not being truthful about the procedures when I described them accurately. Rosenfeld falsely characterized brain fingerprinting as lie detection, and falsely stated that my statements distinguishing brain fingerprinting from lie detection are "misleading." To support his position, Rosenfeld misrepresented and incorrectly described the well-documented brain fingerprinting experimental protocol.

Rosenfeld falsely attributed to my colleagues and me obviously illogical "implications" that we never stated or implied.

Rosenfeld falsely attributed to my colleagues and me a number of obviously illogical "implications" that neither I nor any other competent brain fingerprinting scientist ever stated or implied. Rosenfeld (2005) falsely stated that Farwell and Smith's (2001) statements regarding the applicability of brain fingerprinting in detecting crime-relevant information stored in the brain contain a "critical implication" that "The brain is constantly storing undistorted, detailed representation of experience that the BF [brain fingerprinting] method can extract from the brain just as easily as real fingerprints can be lifted from murder weapons" (p. 24).

Neither I nor any other scientist has ever stated or implied such an "implication."

These facts are indisputable: 1) the brain is intimately involved in the commission of every crime; 2) the brain constantly stores a record of our experiences of all kinds. It goes without saying that this is not a perfect record. Neither I nor anyone else one thinks or says otherwise.

Obviously, it is not necessary for the representation of experience stored in the brain to be "undistorted, detailed" for the information stored in the brain to be useful in criminal investigations. Eyewitness testimony depends entirely on memory, and is routinely used in investigations and universally admitted in court. This does not mean that the courts are foolish enough to believe the above "implication." The courts' universal admittance of witness testimony means two things: 1) the courts recognize that the brain stores information with sufficient accuracy for remembered information to be useful in court proceedings; and 2) judges, juries, and everyone else with common sense are aware of the fact that memory is imperfect, and they routinely take this into account in their deliberations.

The same considerations that apply to the information stored in the brain that is reported in eyewitness testimony also apply to the information stored in the brain that is detected by brain fingerprinting. In both cases, judges and juries are capable of weighing and evaluating the probative value of information stored in a subject's brain while taking into account common sense and the well known fact that memory is not "undistorted, detailed." I have discussed the limitations of human

memory and their implications for interpretation of brain fingerprinting results extensively elsewhere (*Harrington v. State*, 2001 and the reports presented as evidence therein).

The above facts make it clear that my statements regarding brain fingerprinting and memory are fundamentally different from the notions that Rosenfeld (2005) attributes to me—notions that are clearly illogical on their face and that grossly misrepresent my well documented position.

Rosenfeld falsely stated that brain fingerprinting is susceptible to countermeasures, when his research showed only that his alternative techniques are susceptible to countermeasures.

Rosenfeld (2005) falsely stated that brain fingerprinting has been shown to be susceptible to countermeasures. He cited as evidence a paper that he published in 2004 (Rosenfeld et al., 2004). Rosenfeld et al. report several different experiments and several different data-analysis and statistical methods. In every case, they used fundamentally different subject instructions, statistics, data acquisition procedures, and methods (or lack of methods) for establishing ground truth than those of brain fingerprinting. Their methods failed to meet the brain fingerprinting scientific standards, and applied fundamentally different methods.

Rosenfeld's false statement that his research shows that brain fingerprinting is susceptible to countermeasures is one of his false statements that were previously published by other unsuspecting publishers and then corrected after they checked the facts, as described elsewhere.

Unlike Rosenfeld's various techniques described herein, brain fingerprinting has proven to be highly resistant to countermeasures. Farwell (2008) tested countermeasures in a series of brain fingerprinting tests on actual crimes. In order to produce life-changing effects regardless of judicial outcomes, my colleagues and I have offered perpetrators of actual crimes a $100,000 cash reward for beating the brain fingerprinting test. The subjects were trained in Rosenfeld's et al.'s (2004) countermeasure described above. No one has succeeded in beating the brain fingerprinting test. Brain fingerprinting accurately detected the crime-relevant knowledge in all such subjects, with no false positives, no false negatives, and no indeterminates.

As a result of the fundamental differences between Rosenfeld's methods and those of brain fingerprinting, Rosenfeld et al. (2004) did not achieve the consistently extremely high accuracy rates achieved by brain fingerprinting. For some of Rosenfeld's methods, accuracy was as low as 54%, no better than chance. All but one of their methods are very different from brain fingerprinting. Even their method that they correctly characterize as most similar to brain fingerprinting lacks some of the most essential features of brain fingerprinting subject instructions and tasks, statistics, data acquisition methods, and methods for establishing ground truth. Their methods that they tested generally were found to be susceptible to countermeasures.

In their only method that was even somewhat similar to brain fingerprinting, however, they report that countermeasures had no effect at all. Rosenfeld et al. (2004) showed that *their* alternative, non-brain fingerprinting methods were susceptible to countermeasures, but the only results that might be construed to apply to brain fingerprinting showed no effect of countermeasures. (Countermeasures would have been unnecessary, however, since the accuracy of their specific method was only 54% even without countermeasures.)

The countermeasure taught in Rosenfeld et al. (2004) was to perform covert actions such as wiggling the toe in response to each irrelevant stimulus. This was predicted to increase the P300 amplitude to irrelevants, thus lessening the difference between probe and irrelevant brainwave responses.

The same subjects had slower reaction times to the stimuli when they were practicing this countermeasure. Reaction times, however, are easily manipulated and therefore not suitable for detection in real-life situations with real consequences.

Rosenfeld and colleagues conducted other studies that showed that his non-brain fingerprinting methods were susceptible to countermeasures. One study (Rosenfeld et al., 2008) failed to meet most of the brain fingerprinting scientific standards and used fundamentally different methods. Accuracy was 92% without countermeasures and 83% when subjects practiced Rosenfeld et al.'s (2004) countermeasure described above. Another study (Meixner et al., 2009) failed to meet the same standards and resulted in 36% accuracy (lower than chance) with countermeasures.

As discussed above, these and other recent studies using Rosenfeld's complex trial protocol also suffered from a fatal procedural error that made Rosenfeld's method unusable in the field.

Rosenfeld and colleagues' detection rates in laboratory experiments with this technique for subjects who were practicing countermeasures have been as low as 36% (Meixner et al., 2009) and averaged approximately

71%. The inescapable conclusion is that Rosenfeld's technique, and not brain fingerprinting, is susceptible to countermeasures. As described above, it is also fatally flawed and consequently unusable in the field.

Another non-brain fingerprinting study, Mertens and Allen (2008), found similar countermeasures to be effective against their procedure. As discussed elsewhere, their procedure failed to meet the brain fingerprinting scientific standards, resulting not only in susceptibility to countermeasures but also in very low accuracy even without countermeasures.

Other countermeasure experiments (Sasaki, Hira, & Matsuda, 2002) found a simple mental-task distraction countermeasure to be ineffective.

In short, Rosenfeld falsely stated that published results show that brain fingerprinting is susceptible to countermeasures, whereas actual published research points to the opposite conclusion. Rosenfeld's research has shown only that his methods, and not brain fingerprinting, are susceptible to countermeasures. My research on real-life crimes has shown that brain fingerprinting is not susceptible to Rosenfeld's countermeasures.

Rosenfeld falsely attributed to me statements made by others, and on that basis falsely criticized me for allegedly exaggerating the accuracy of brain fingerprinting.

Rosenfeld (2005) falsely contended that I have made inflated claims regarding the accuracy of brain fingerprinting. Rosenfeld stated:

> "Another of Farwell's Web sites implies that the technique has perfect accuracy by using the phrase '100% accurate' as the subheading of large sections of text (e.g., http://www.brainwavescience.com/Chemistry.php)" (p. 21).

The text in question was not a statement by me or a quotation attributed to me. It appeared only within an article published in *Chemistry and Industry* in March 2004 (Murphy, 2004) that was reproduced in its entirety on the Brain Fingerprinting Laboratories website. Moreover, the text below the subheading (written by Murphy) clearly and correctly states that the term 100% was applied to results actually obtained in specific studies and applications, not to a general characterization of the technology by myself or anyone else.

With respect to accuracy, in my public and private statements, including the ones cited by Rosenfeld (2005), I have consistently stuck to the established facts. Legitimate commentators who have extensively reviewed the relevant literature and other sources have recognized this (see, for example, Moenssens, 2002, p. 900 and Erickson, 2007, p. 16).

In my scientific publications, expert testimony, court documents, scientific reports, and public statements, I have correctly stated the actual accuracy rates achieved in my various studies. I have used the term "100%" only as a statement of specific, actual past results achieved, never as a prediction of future results or a general characterization of the technology. Everyone knows, and I have stated countless times, that there is no such thing as a "100% accurate" in any science—there is always a margin for error, a margin of uncertainty. It is, however, correct to use the number 100% (and incorrect to use any other figure) when reporting on *specific past results* wherein the accuracy was in fact 100%. A technology can, and brain fingerprinting does, have a *record* of 100% accuracy *in past research and applications*. Correctly stating this established fact about the past—which the brain fingerprinting web site does—is not the same thing as predicting a 100% accuracy rate in the future—which the web site has never done and I have never done.

In over 100 interviews in the national and international press, I have never once predicted a specific accuracy rate for future uses of brain fingerprinting. Even when pressed, I have refused even to predict that brain fingerprinting will achieve the specific numerical accuracy (100%) in future real-life cases that it has in past real-life cases (*Harrington v. State*, 2001; Moenssens, 2002; Roberts, 2007). For example, I address this question of "100% accuracy" directly in the *Supplement to Forensic Science Report: Brain Fingerprinting Test on Terry Harrington*. I prepared this report for the Harrington case. It was admitted as evidence in the Harrington trial (*Harrington v. State*, 2001). I state therein that in science nothing is absolutely 100%, and brain fingerprinting is no exception.

In short, I have stuck to the truth, publicly and privately, regarding the accuracy and applicability of brain fingerprinting.

ROSENFELD'S OTHER MISLEADING STATEMENTS, UNSUPPORTED SUBJECTIVE OPINIONS, AND OTHER IRRELEVANT AND INSUBSTANTIAL INFORMATION INCLUDED IN HIS ARTICLE

Rosenfeld's doubts about the value of brain fingerprinting for government agencies are unsupported by relevant, current evidence.

Rosenfeld (2005) stated, "There is considerable doubt, however, about [brain fingerprinting] fulfilling

urgent needs by U.S. government agencies" (p. 34.) "It is documented that, in fact, U.S. government agencies most concerned with detecting deception do not envision use of BF [brain fingerprinting]" (p. 20.)

He cited as evidence for his contention a 2001 report entitled "Federal Agency Views on the Potential Application of 'Brain Fingerprinting'" issued by the US General Accounting Office (GAO) (General Accounting Office, 2001). The report was essentially a sampling of opinions of individuals associated with detection of deception in the federal government prior to 9-11. (It was completed before 9-11-2001 and issued shortly thereafter.) It reported that most such individuals interviewed did not see the need for brain fingerprinting in their pre-9-11 operations nearly a decade ago.

An analysis of the current inner workings of US intelligence, national security, law enforcement, military, and special operations agencies, and those of other countries, is beyond the scope of this article. Suffice it to say: that was then, this is now.

Senator Charles Grassley, who commissioned the original GAO report, has asked the GAO (now renamed Government Accountability Office) to develop a new report addressing the post-911 situation. He asked the GAO to discuss the applications of brain fingerprinting in criminal investigations and counterterrorism in the post-9-11 world. He also asked the GAO to include the views of experts well versed in brain fingerprinting and MERMER technology, and to include the brain fingerprinting research at the FBI, CIA, and US Navy.

Rosenfeld (2005) is entitled to doubt that brain fingerprinting currently fulfills an urgent need for governments and law enforcement agencies, but a nine-year-old, pre-9-11 report soon to be supplanted by a more current assessment is insufficient evidence to be convincing that his doubt is well founded in current reality.

Rosenfeld offered his subjective opinions regarding the brainwave plots in the Harrington case; subjective opinions are irrelevant to the brain fingerprinting scientific determination.

Rosenfeld (2005) spent considerable verbiage discussing his subjective opinions of the plots of Harrington's brainwave responses and other waveforms. He is entitled to his opinions, but this is not how brainwave responses are analyzed in brain fingerprinting. In brain fingerprinting, determinations are computed using a mathematical algorithm, not arrived at by subjective assessment based on looking at the waveform plots.

Rosenfeld expressed his opinions on optimal digital filters but did not conduct relevant research.

Rosenfeld (2005) discussed Farwell et al.'s (1993) published research on optimal digital filters. Farwell et al. pioneered the use of optimal digital filters in event-related brain potential research. These filters are optimal in the strict mathematical sense. They provide very precisely specifiable performance characteristics. We conducted research showing that optimal digital filters have advantages over other previously used, less sophisticated filters for long-latency, event-related brain potential research. Many laboratories now use these optimal digital filters. Farwell et al. (1993) conducted their research on real EEG data. Rosenfeld (2005) suggested, but did not conduct, research using artificial data. He expressed his various opinions regarding the type of research to conduct and the type of filters to use. Rosenfeld is of course entitled to his opinions, but science only advances when people not only express opinions but also test them with scientific research. My colleagues and I have conducted such research on digital filters and published it in a peer-reviewed journal. Rosenfeld has not.

Rosenfeld included his personal email exchanges, speculation on what others might think or say, etc., and did not include extensive relevant material.

Rosenfeld (2005) spent considerable verbiage touting his own research, discussing news reports (and falsely attributing to me statements that were made not by me but by reporters), reproducing his own email correspondence, and discussing his subjective opinions about the graphics and wording on the brain fingerprinting web site and various other subjects. He speculated about what I might say about various subjects. Rosenfeld did not, however, include some of the most significant and relevant information a reader would require to make an informed decision regarding brain fingerprinting. Rosenfeld did not include the vast majority of the relevant published scientific data, intellectual discussions, field applications, and successful use in court of brain fingerprinting science.

For example, Rosenfeld (2005) failed to describe the process through which brain fingerprinting was ruled admissible in court, the standards for admissibility, or how and why the court ruled that brain fingerprinting meets these standards. This is described *Harrington v. State* (2001).

Rosenfeld (2005) did not describe how my brain fin-

gerprinting science and technology, unlike Rosenfeld's methods (e.g., Rosenfeld et al., 2004) which he touted in the article, have been successfully used in real-life applications including criminal cases in the field. For example, my brain fingerprinting was instrumental in bringing serial killer J. B. Grinder to justice, as described elsewhere.

Rosenfeld (2005) did mention that *Time* magazine selected me to the Time 100: The Next Wave, the innovators who may be "the Einsteins or Picassos of the 21st Century," but only to criticize *Time*'s selection as indicating that they "uncritically accepted" my discoveries and inventions. *Time* did their own research on me and my scientific discoveries and inventions, and I did not know that I was being considered for the honor until after *Time* had made their decision.

SUMMARY AND CONCLUSION

The Rosenfeld (2005) article fundamentally misrepresented the science of brain fingerprinting, my relevant peer-reviewed publications, the nature of the respected peer-reviewed journals wherein they were published, my successful applications of brain fingerprinting in the field, brain fingerprinting's success as admissible evidence in court, my truthful and accurate testimony as an expert witness, the content of Brain Fingerprinting Laboratories, Inc.'s website, and my public statements. Rosenfeld falsely attributed to me statements made by others and "implications" that I never made. His article contained extensive inappropriate, irrelevant, and misleading information. In short, Rosenfeld (2005) did not contribute to an accurate understanding of the relevant brain fingerprinting science and technology, its publication in the peer-reviewed literature, or its successful application in the real world. This is discussed in detail at http://www.brainwavescience.com/Scientific_Review_of_Mental_Health_Practice_Farwell_Corrections_to_Rosenfeld.pdf.

REFERENCES

Erickson, M.J. (2007). Daubert's Bipolar Treatment of Scientific Expert Testimony—From Frye's Polygraph to Farwell's Brain Fingerprinting. *Drake Law Review*, *55*, 763–812.

Farwell, L.A. (1992a). *The brain-wave information detection (BID) system: A new paradigm for psychophysiological detection of information.* Unpublished doctoral dissertation, University of Illinois at Urbana-Champaign.

Farwell, L.A. (1992b). Two new twists on the truth detector: Brain-wave detection of occupational information. *Psychophysiology*, *29*(s4A), S3.

Farwell, L.A. (1994). *U.S. Patent #5,363,858*. Washington, DC: U.S. Patent and Trademark Office.

Farwell, L.A. (1995a). *U.S. Patent #5,406,956.*Washington, DC: U.S. Patent and Trademark Office.

Farwell, L.A. (1995b). *U.S. Patent #5,467,777*. Washington, DC: U.S. Patent and Trademark Office.

Farwell, L. (2008). Brain fingerprinting detects real crimes in the field despite one-hundred-thousand-dollar reward for beating it. *Psychophysiology*, *45*(s1), S1.

Farwell, L.A. & Donchin, E. (1986). The "brain detector": P300 in the detection of deception. *Psychophysiology, 23*(4), 434.

Farwell, L.A. & Donchin, E. (1988b). Event-related brain potentials in interrogative polygraphy: Analysis using bootstrapping. *Psychophysiology*, *25*(4), 445.

Farwell, L.A., & Donchin, E. (1991). The truth will out: Interrogative polygraphy ("lie detection") with event-related potentials. *Psychophysiology*, *28*(5), 531–547.

Farwell, L.A. & Makeig, T.H. (2005). Farwell brain fingerprinting in the case of *Harrington v. State*, *Open Court* X [10]:3, 7–10. Indiana State Bar Assoc.

Farwell, L.A., Martinerie, J.M., Bashore, T.R., Rapp, P.E., & Goddard, P.H. (1993). Optimal digital filters for long-latency components of the event-related brain potential. *Psychophysiology*, *30*(3), 306–315.

Farwell, L.A. & Richardson, D.C. (2006a). Brain fingerprinting in laboratory conditions. *Psychophysiology, 43*(s1), S37–S38.

Farwell, L.A. & Richardson, D.C. (2006b). Brain fingerprinting in field conditions. *Psychophysiology, 43*(s1), S38.

Farwell, L.A. & Smith, S.S. (2001). Using brain MERMER testing to detect concealed knowledge despite efforts to conceal. *Journal of Forensic Sciences*, *46*(1), 135–143.

Harrington v. State, Case No. PCCV 073247 (Iowa District Court for Pottawattamie County, March 5, 2001).

Harrington v. State, 659 N.W.2d 509 (Iowa 2003).

Iacono, W.G. (2008). The forensic application of "Brain Fingerprinting": Why scientists should encourage the use of P300 memory detection methods. *The American Journal of Bioethics*, *8*(1), 30–32.

Meixner, J.B., Haynes, A., Winograd, M.R., Brown, J., & Rosenfeld, P.J. (2009). Assigned versus random, countermeasure-like responses in the p300 based complex trial protocol for detection of deception: Task demand effects. *Applied Psychophysiology and Biofeedback*, *34*(3), 209–220.

Mertens, R., Allen, J., Culp, N., & Crawford, L. (2003). The detection of deception using event-related potentials in a highly realistic mock crime scenario. *Psychophysiology*, *40*, S60.

Mertens, R., & Allen, J.J.B. (2008). The role of psychophysiology in forensic assessments: Deception detection,

ERPs, and virtual reality mock crime scenarios. *Psychophysiology*, *45*(2), 286–298.

Miyake, Y., Mizutanti, M. & Yamahura, T. (1993). Event related potentials as an indicator of detecting information in field polygraph examinations. *Polygraph*, *22*, 131–149.

Moenssens, A.A., (2002). Brain fingerprinting—Can it be used to detect the innocence of persons charged with a crime? *UMKC L. Rev.*, *70*, 891–920.

Murphy, M. (2004, March 15). Infallible Witness. *Chemistry & Industry*, pp. 31–34.

Roberts, A.J. (2007). Everything new is old again: Brain fingerprinting and evidentiary analogy, *Yale J. L. & Tech*, *9*, 234–270.

Rosenfeld, J.P. (2005). "Brain fingerprinting:" A critical analysis. *Scientific Review of Mental Health Practice*, *4*, 20–37.

Rosenfeld, J.P., Labkovsky, E., Lui, M.A., Winograd, M., Vandenboom, C., & Chedid, K. (2008). The Complex Trial Protocol (CTP): A new, countermeasure-resistant, accurate P300-based method for detection of concealed information. *Psychophysiology*, *45*, 906–919.

Rosenfeld, J.P., Soskins, M., Bosh, G., & Ryan, A. (2004). Simple effective countermeasures to P300-based tests of detection of concealed information. *Psychophysiology*, *41*(2), 205–219.

Rosenfeld, J.P., Tang, M., Meixner, J.B., Winograd, M., & Labkovsky, E. (2009). The effects of asymmetric vs. symmetric probability of targets following probe and irrelevant stimuli in the complex trial protocol for detection of concealed information with P300. *Physiology and Behavior*, *98*(1–2), 10–16.

Sasaki, M., Hira, H., & Matsuda, T. (2002). Effects of a mental countermeasure on the physiological detection of deception using P3. *Studies in the Humanities and Sciences*, *42*, 73–84.