DECLARATION OF DENNIS LEVI
PURSUANT TO 28 U.S.C § 1746

I, Dennis Levi, make the following statement:

1. I am a Professor of Optometry and Vision Science at the University of California, Berkeley. I served as Dean of the UC Berkeley School of Optometry from 2001 – 2014. I am also a Professor in the Helen Wills Neuroscience Center, at the University of California, Berkeley. I received my initial training in Optometry from Witwatersrand School of Optometry in South Africa. I received an O.D. degree, M.S. and Ph.D. from the University of Houston in 1971, 1973 and 1978, respectively. I joined the faculty there and advanced through the ranks as an instructor, a Cullen Distinguished Professor and then as Associate Dean at the University of Houston, College of Optometry.

2. As part of my professional responsibilities, I conduct scientific research in my field. I have published over 275 scientific papers and two books. I served as Chair of the National Eye Institute Vision Science B. study section from 1988 to 1990, and was a member of the Strabismus, Amblyopia & Visual Processing Panel of the National Eye Institute. The National Eye Institute (NEI) has funded my research on amblyopia, spatial vision and perceptual learning since 1976. I was Editor-In-Chief and Chairman of the Board of Vision Research from 2004 – 2012. I currently serve as Editor-In-Chief of Journal of Vision and on the Editorial Boards of Ophthalmic and Physiological Optics and Scientific Reports. I served on the National Research Council (NAS) Committee on Disability Determination for Visual Impairments from 1999 - 2001. I was elected in 1995 Fellow of the Optical Society of America for research contributions in the areas of amblyopia and spatial vision, and have received numerous awards including the Glenn Fry Award, the Garland Clay Award and the Prentice Medal from the American Academy of Optometry. Exhibit A contains a copy of my Curriculum Vitae.

3. I have never worked with or collaborated with Aaron Seitz, Adam Goldberg or Carrot Neurotechnology, Inc. In February 2015, I was retained by their attorney James A. Kaminski to review substantiation in association with their Ultimeyes product.

4. I reviewed three recent peer-reviewed articles by Aaron Seitz (Deveau, Ozer & Seitz, Current Biology, 2014; Deveau, Lovcik & Seitz, Vision Research, 2014; and Deveau & Seitz, Frontiers in Psychology, 2014). Exhibit B contains the articles I reviewed. Exhibit C contains thirty articles and reports representing the scientific literature on perceptual learning and video game training, which I cite to in this Declaration.

5. Based on my review, I believe the studies are based on a solid foundation of scientific literature. The results of the Seitz studies are solid and conclusive on their own, and even

more so when taken in light of the vast existing literature on this topic. I shall first review the main features and results of the studies and then discuss the standards of evidence that are accepted by experts in this field.

Visual Perceptual Learning

6. Perceptual Learning (PL) has been a field of active investigation for over 50 years. Eleanor Gibson (1963) defined Perceptual Learning as "Any relatively permanent and consistent change in the perception of a stimulus array following practice or experience with this array . . .". [Note: by "array", Gibson was referring to the visual stimulus or target]. Over the last half-century or so, PL has been studied intensively. It has formed the basis of thousands of articles, chapters and books. A Google search results in about 1,640,000 hits.

7. The focus of work on visual perceptual learning is on a rather narrower definition of perceptual learning – specifically, the notion that practicing visual tasks can lead to dramatic and long-lasting improvements in performing them. Specifically, it is possible to improve performance on sensory tasks through repeated practice or perceptual learning (for recent reviews see Fine & Jacobs, 2002; Fahle, 2005; Sagi, 2011; Watanabe & Sasaki, 2014), and this learning is considered to be a form of neural plasticity that also has consequences in the cortex.

8. While much basic research on PL has focused on its specificity and neural mechanisms and models, there has also been a great deal of recent attention to developing methods to optimize and generalize learning, and to apply PL to a broad range of visual problems such as amblyopia ('lazy eye'), myopia (near sightedness) and presbyopia (the age-related loss of ability to focus on close objects or read without reading glasses).

9. A closely-related line of research has focused on action video games. To date, perceptual learning has had limited impact on clinical practice, because of its limited transfer and the rather dull nature of the training, leading to boredom and compliance issues. Work by Shawn Green and Daphne Bavelier suggests that in normal vision, similar to PL, action video game play results in significant improvement on a broad range of visual tasks, and reflects the brain learning to develop the best perceptual template for the task at hand (Green & Bavelier, 2007; 2012; Bavelier, Green, Pouget & Schrater, 2012). In contrast to perceptual learning, action game play is extremely varied in its demands and rich in the set of visual experiences it offers. Thus, they suggest that the very act of action game playing seems to train the brain to learn, on the fly, how to make the best use of the available information in the display, independently of the specifics of this display allowing for the broad transfer of learning, and thus possible improvements in quality of life (Bavelier, Green, Pouget & Schrater, 2012).

The Seitz Studies

10. In order to develop an effective product for visual perceptual learning, Seitz and co-workers have developed an "integrative" approach to PL, based on the widely held principles derived from a substantial body of basic science. One major goal of any product aimed at application to improving vision, is that it should be effective in producing a broad range of improvements (rather than simply improve an isolated learned skill). Another important goal is that it should be highly motivating, so that patients will be willing to devote substantial amounts of time to the training. To meet these goals, Seitz combines several well-established approaches that have been clearly shown to enhance the speed, magnitude and generality of learning, into an integrated PL video game. Specifically, their product combines the following principles derived from now well-established basic science:

    a. Diverse stimuli. The usefulness of perceptual learning is often limited by location and feature specificity, in that a learned task often needs to be relearned when the stimulus is switched to a new retinal location, or to a new feature value, such as a new orientation or direction. However a number of recent studies show convincingly that by training with a diverse set of stimulus features and locations, learning shows broad generalization to other features and locations (Xiao et al., 2008; Zhang et al., 2010, 2014; Wang et al., 2012; Wang et al., 2014). This eliminates the limited transfer issue discussed in Paragraph 9. It is also worth noting that Seitz uses Gabor patches – the industry standard stimuli - to achieve this. Gabor patch stimuli have been used to induce learning in dozens of studies.

    b. Optimized stimulus presentation. Seitz's game varies the orientations, spatial frequencies and distractor types across blocks in order to maximize learning and avoid the effects of 'roving' (varying the stimulus on a trial by trial basis) which has been shown to suppress learning (Yu et al., 2004; Zhang et al., 2008; Seitz et al., 2005; Otto et al., 2006). In addition, Seitz uses rapid flicker (20 Hz), which has been shown to induce learning even in the absence of a perceptual task (Beste et al., 2011; Dinse et al., 2006; Godde, Stauffenberg, Spengler, & Dinse, 2000; Seitz & Dinse, 2007).

    c. Multisensory facilitation. Learning is most effective when multiple senses (e.g. sound and sight) are coordinated (Kim, Seitz & Shams, 2008; Seitz et al., 2006). Thus, Seitz uses sound to provide complementary information about the locations of the visual stimuli.

    d. Consistent reinforcement. A number of basic science studies have shown that consistent reinforcement is critical to effective perceptual learning (Seitz & Watanabe, 2003; Seitz et al., 2009). Thus, Seitz has incorporated consistent reinforcement into the game.

11. One study (Deveau, Lovcik & Seitz, 2014) which was conducted during Spring 2011, tested this game on 14 normal healthy adult subjects, who trained for ≈ 12 hours. They report statistically significant improvements in visual acuity and contrast sensitivity (both peripheral and central). A control group of 21 normal healthy adult subjects who were tested twice (8 on the central vision tests and 13 on peripheral vision tests), showed no such benefits. The magnitude of improvement in the trained subjects is consistent with that found in many previous studies using PL and/or video game training (Levi & Li, 2009a & b; Polat, 2009).

12. A second study (Deveau, Ozer & Seitz, 2014) that began in Fall 2012, tested the game on 19 members of a baseball team, while 18 pitchers served as an untrained control group. The trained players showed highly significant improvements in visual acuity and contrast sensitivity, whereas the control group showed no improvement. Interestingly, the trained players also showed improved baseball skills, with fewer strike-outs and more runs scored, which appear to have led to 4 or 5 additional team wins.

13. The third study (Deveau & Seitz, 2014), which I understand was conducted between January 2012 and June 2014, applied their integrated approach to evaluate its effect on reading skills and on adults with presbyopia. They report that in 44 normal adults, training resulted in significantly improved reading acuity and reading speed. While they did not include a control group in their study, previous work shows that the reading test they used (the MNREAD test), is impervious to practice effects. They also report significant improvement in near visual acuity in 13 adults with presbyopia following training. The magnitude of improvements was similar to that reported by Polat et al., 2012). While Seitz did not include a presbyopic control group, Polat et al did, and found the improvement could not be explained by simple practice effects (i.e., repeating the tests).

Evaluation

14. My understanding is that the standard proposed by the FTC is that "at the time of making such representation, Defendants possess and rely upon competent and reliable scientific evidence to substantiate that the representation is true. For purposes of this Section, competent and reliable scientific evidence shall consist of human clinical testing of the Covered Product or Service that is sufficient in quality and quantity, based on standards generally accepted by experts in the relevant field, when considered in light of the entire body of relevant and reliable scientific evidence, to substantiate that the representation is true. Such testing shall (1) be randomized, double-blind, and adequately controlled; and (2) be conducted by researchers qualified by training and experience to conduct such testing."

15. In my view, Dr. Seitz is a highly qualified and very well-regarded researcher, who has spent much of his career studying perceptual learning. He has published more than 100 scientific articles in top-notch international peer reviewed journals including PNAS (2),

Current Biology (3), Neuron, Nature, and influential review papers in Current Opinion in Neurobiology and Trends in Cognitive Science, and Current Biology. His work has been cited in the scientific literature more than 2100 times.

16. Based on his extensive experience and expertise, Dr. Seitz has developed a training method that is based on a foundation of solid scientific evidence and is generally accepted by experts in the field. This work stands on its own merits, and is all the more convincing when considered in light of the entire body of relevant and reliable scientific evidence. Moreover, the results reported in the three manuscripts discussed above (which were all subjected to rigorous peer review), are completely consistent with the results of previous studies.

17. I believe that the evidence presented in Dr. Seitz's studies (and many other studies using similar procedures) is sufficient in quality and quantity, based on standards generally accepted by experts in the relevant field, to substantiate his conclusions. This work stands on its own merits, and is all the more conclusive when considered in light of the overwhelming body of relevant and reliable scientific evidence. Similar procedures have been applied widely to the treatment of amblyopia (Levi & Li, 2009a & b; Levi, 2012), myopia (Durrie & McMinn, 2007) and presbyopia (Polat, et al., 2012) as well as to other conditions, with comparable results. To the best of my knowledge, there have been no reports of negative results. Many of the extant studies include control groups for test-retest effects, and several have active control groups. While there are no randomized clinical trials (RCTs) of these procedures, I argue below that the proposed requirement of a randomized, double-blind study is inappropriate for the situation at hand, and indeed has several disadvantages for studies in this area.

Control Groups

18. The issue of control groups is highly controversial. While some studies of PL include control groups, this is far from standard practice, and there is no general agreement on the type of control group and whether subjects should be randomized. Some studies (including two of the Seitz studies) do include "no-contact/passive" control groups – i.e., subjects who perform the same pre- and post- tests, but do not participate in the training. This type of control group is important to rule out simple practice effects that can influence the test-retest scores. There are some videogame studies that include "active" control groups. For example, in the action game literature the control is often a non-action game (like Tetris – e.g. Green & Bavelier, 2007). However, it is not clear if it is possible to devise an appropriate active control for a study in this area. Almost any alternative active, engaging video game is likely to engage vision and require visually guided judgments, and would also likely suffer the disadvantages noted below.

19. For specific medical disorders often the control is the current best treatment. However, there is no standard "treatment" for presbyopia. Patients with presbyopia are simply given glasses to compensate for the disorder. Finally, while random group assignment is often thought of as the "gold standard" for medical trials, for training and transfer studies, random group assignment can be quite problematic. One major problem with random group assignment is that it can lead to unequal performance at the outset (i.e., at pre-test). Unequal group performance at the pre-test can introduce several confounds due to floor and ceiling effects, that can make interpretation of the training results difficult or impossible. For example, the magnitude of learning effects often depends on the initial performance level (Li, Klein & Levi, 2008; Astle, Webb, McGraw & Levi, 2013). Other highly contentious issues relate to the question of what to do about patients who fail to adhere to the trial protocol, and how to deal with those subjects with missing outcome assessments (Altman, 2009). Thus, I believe that the proposed standard of a randomized, double-blind study does not apply to studies in this area, and indeed has several disadvantages for studies of this type.

Conclusion

20. My review of Dr. Seitz's studies, and the vast extant literature on perceptual learning suggests that the evidence is sufficient in quality and quantity to substantiate his conclusions and that it would satisfy the relevant scientific community as to the truth of his conclusions. Further, as noted above, the requirement of a randomized, double-blind study does not apply to studies in this area, and indeed has several disadvantages.

I state, under penalty of perjury, that the foregoing is true and correct.

Executed in Berkeley, California, on February 25, 2015.

_____

Dennis M. Levi