Advanced method of perceptual training for improving near visual functions using mobile devices

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Introduction

What is presbyopia?

Presbyopia, the Greek word for aging eye, is an age-related near vision impairment:

- the first-reported effects of presbyopia occur between 42–44 years of age
- everyone is affected by the age of 51
- common solution is reading glasses or bifocals

Presbyopia causes a decline in contrast sensitivity and processing speed

Perceptual learning improves vision and restores visual deficits (Polat et al., 2004, 2008, 2009; Fahle 2002; Sagi & Tanne, 1994)

Our recent study used structured perceptual learning to improve near vision by improving contrast sensitivity, discrimination and processing speed, with no changes in either of the optical functions: pupil size, accommodation or depth of focus!

Training the brain to overcome the effect of aging on the human eye

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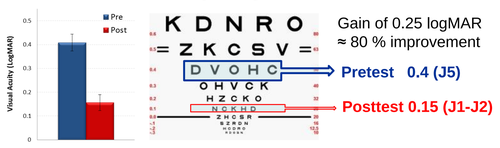
Visual Acuity using ETDRS

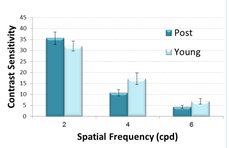


Gain of 0.25 logMAR
≈ 80 % improvement

Pretest 0.4 (J5)

Posttest 0.15 (J1-J2)

Contrast Sensitivity



Reading Speed Gain

3.89 sec per smallest sentence

Eye Age Gain

Despite the expected deterioration, the biological "eye age" has decreased **from 50.5 to 41.9 (8.6 years)**

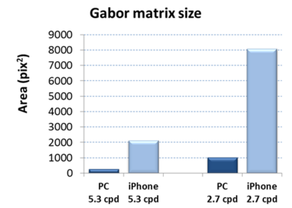
Apparatus & Stimuli

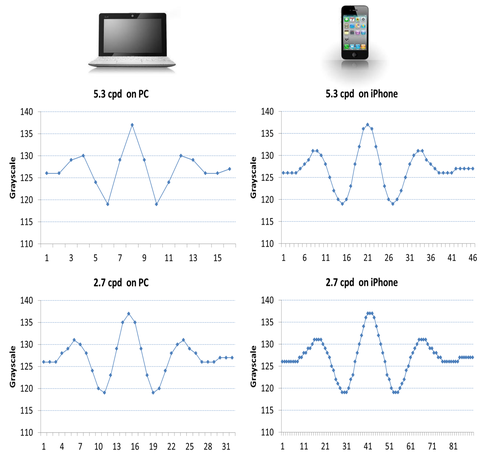
Gabor's quality is higher on iPhone vs. PC, as illustrated by:

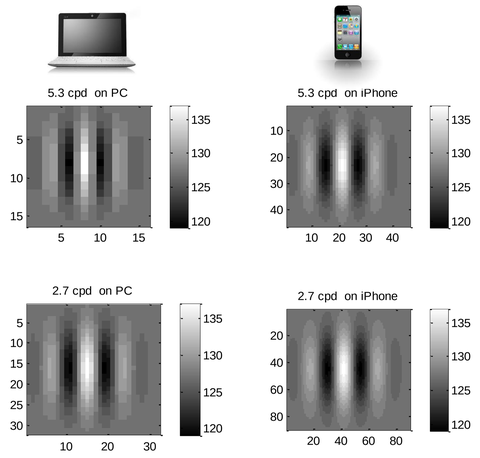
- Gabor profiles with low (2.7 cpd) and high (5.3 cpd) spatial frequency
- remarkable differences in Gabor's matrix sizes

Pixel size (height & width)

Gabor matrix size





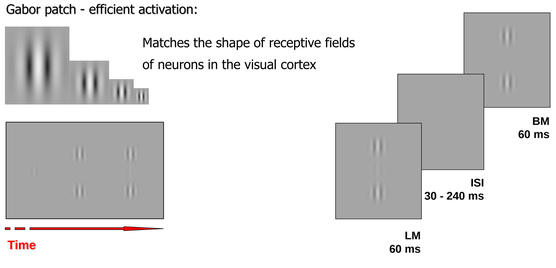


Gabor matrices are scaled for presentation, keeping their real axes

Methods

Training improves temporal and spatial processing

Gabor patch - efficient activation:

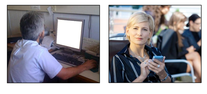


- Detecting low-contrast Gabor patches (GPs) is improved by collinearly oriented high-contrast flankers
- With backward masking the facilitation is disrupted

PC & iPhone users

Divided into two subgroups:

1. "Early Presbyopic Stage"
2. "Advanced Presbyopic Stage" depending on their initial near acuity (cutoff at 0.2 logMAR)



SESSION DURATION	25-30 min	12-15 min
TRAINING FREQUENCY	2-3 sessions / week	2-3 sessions / week
VIEWING DISTANCE	40 cm	40 cm
LOCATION	home / office	anywhere
RESPONSE VIA	mouse	touch
HIGHEST SPATIAL FREQUENCY	5.3 cpd	8 cpd

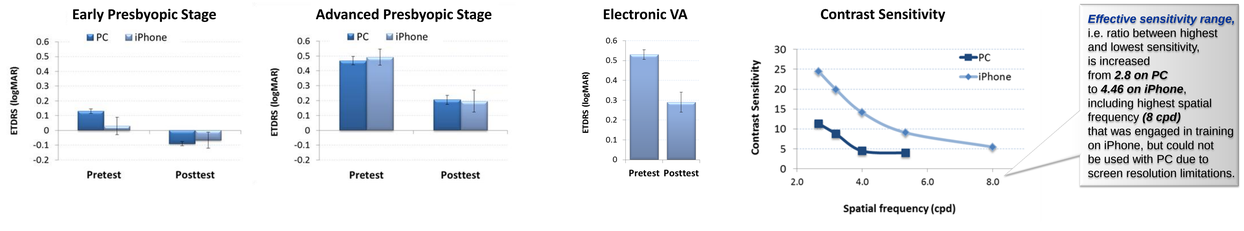
Results

iPhone users in Early Presbyopic Stage subgroup had better initial acuity, still they achieved improved acuity of 1 ETDRS line below 20/20 similar to PC users, most likely due to a "flooring" effect (*p<.001*):

iPhone and PC users in Advanced Presbyopic Stage subgroup achieved similar improvement of above 2.5 ETDRS lines (*p<.005*):

iPhone users showed comparable acuity improvement using dynamic Electronic VA test (*p<.00001*):

Contrast sensitivity of iPhone users is better by a factor of ~2.5 compared to PC users (*p=.01*):



Conclusions

- Our training method is effective in improving visual functions in people with presbyopia by enhancing the image representation in the brain
- The results show that smartphones and mobile devices can be used as an effective solution for training near visual functions

Financial interest: Ucansi Inc. *www.glassesoff.com*

REFERENCES:

Polat, U. (2008). Restoration of underdeveloped cortical functions: Evidence from treatment of adult amblyopia. Restorative Neurology and Neuroscience, 26, 1–12.
Sagi, D., & Tanne, D. (1994). Perceptual learning: Learning to see. Current Opinion in Neurobiology, 4(2), 195–199.
Fahle, M. (2002). Perceptual learning: Gain without pain? Nature Neuroscience, 5(10), 923–924.
Polat, U., & Sagi, D. (1994). Spatial interactions in human vision: From near to far via experience-dependent cascades of connections. Proceedings of the National Academy of Sciences USA, 91(4), 1206–1209.
Polat, U., & Sagi, D. (1993). Lateral interactions between spatial channels: Suppression and facilitation revealed by lateral masking experiments. Vision Research, 33(7), 993–999.
Polat, U., Ma-Naim, T., Belkin, M., & Sagi, D. (2004). Improving vision in adult amblyopia by perceptual learning. Proceedings of the National Academy of Sciences USA, 101(17), 6692–6697.
Polat, U. (2009). Making perceptual learning practical to improve visual functions. Vision Research, 49, 2566–2573.