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CORRESPONDENCE

Effect of dark vs. white chocolate on the multifocal electroretinogram

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To the Editor:

Dark chocolate (DC) from flavanol-rich cacao beans improves cardiovascular function, reduces Alzheimer and Parkinson disease symptoms [1–3] and can improve small target contrast sensitivity (CS) [4]. Long-term improvements in diseases are due to antioxidant effects while acute improvements are attributable to increased blood flow via nitric oxide activation [1–3]. Our purpose was to compare acute effects of DC vs. white chocolate (WC) on multifocal electroretinograms (mfERGs) which assesses retinal function from multiple retinal sites [5].

Twenty-six adults (mean age ± SD = 27 ± 3, 17 females, 9 males) with VA ≥ 20/20 participated in our randomized, double-blind crossover study after written informed consent (https://clinicaltrials.gov/ct2/show/NCT03326934). A DC bar (Trader Joe's 72% Cacao DC bar: 47 g; cacao, 34 g, total flavanols, 316.3 mg, www.consumerlab.com) was compared with a WC bar (Birthday Cake WC Bar: 58 g; cacao and flavanols, 0 mg.) Diopsys® mfERGs were recorded monocularly from each subject in two separate sessions separated by ≥72 h (mean 5.4 ± 2.5 days). In each session testing commenced 30 min after consumption of either the DC or WC bar with order randomized across subjects and neither experimenters or subjects aware of chocolate type. The mfERG stimulus was 19 hexagons (white 204 cd/m^2, black 1 cd/m^2) on an LCD display pseudorandomly reversed for four 1-min periods. Mean retinal mfERGs were recorded from the central 5-degree (R1: fovea), 5–22-degree ring (R2), and 22–42-degree ring (R3).

Two-way ANOVA across mfERGs and chocolate type showed no difference between DC and WC N1-P1 amplitudes ($F = 0.03$, $P > 0.84$) or P1-N2 amplitudes ($F = 1.1$, $P > 0.20$). However, P1 latency was significantly shorter after DC vs. WC ($F = 7.3$, $P < 0.008$; Fig. 1). Two-tailed t-tests with Bonferroni correction showed that DC foveal latency (mean [SE], 39 [0.67] ms) was decreased compared with WC (mean [SE], 42 [0.61] ms; mean decrease 3 ms [95% CI, 1–5 ms]; $P < 0.02$; Fig. 1b). After DC 17/26 (66%) showed shorter foveal latencies vs. only 8/26 after WC (31%; Wilcoxon test, $P = 0.02$). The sum of average latencies from each ring yielded shorter values for DC (mean [SE], 112 [2.4] ms) vs. WC (mean [SE], 117 [2.9] ms; mean decrease 5 ms [95% CI, 1–9 ms]; $P < 0.02$; Fig. 1c). Though baseline data were unavailable, WC foveal latency was not different from system norms ($P > 0.86$) while DC latency was significantly shorter than system norms ($P = 0.03$).

mfERG latency was shorter 30 min after consumption of DC vs. WC. The most significant decrease was from the highly vascularized fovea possibly due to increased choroidal blood flow. Summation of mfERG latencies showed a comparable effect. Study limitations include the small sample size and lack of duration analysis. These results complement improved CS after DC [4] but may underestimate positive DC effects in elderly and diseased eyes (glaucoma, AMD, diabetic retinopathy) which may show enhanced benefits from increased perfusion and antioxidants afforded by DC. Future research targets these populations.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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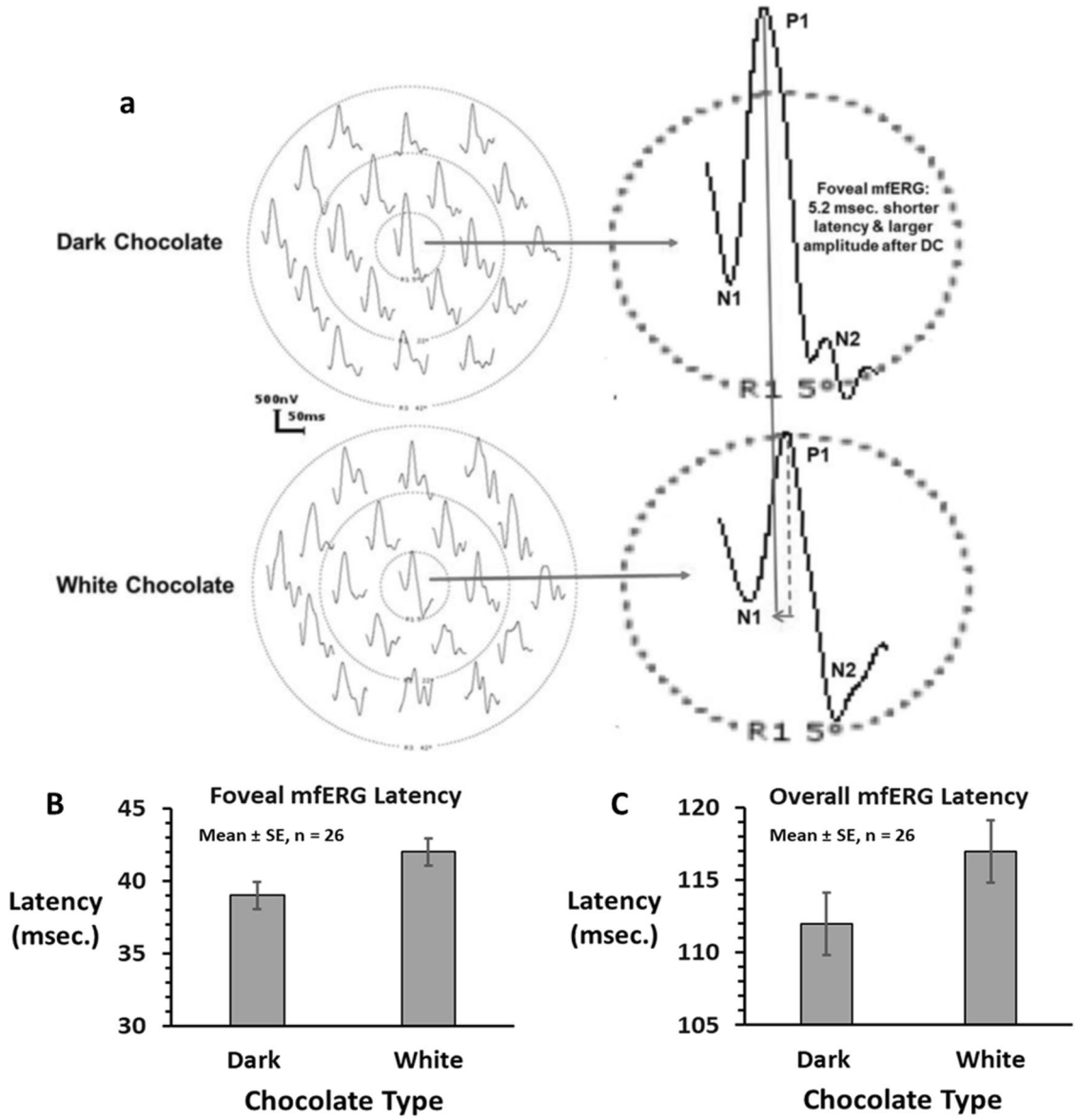

Fig. 1 **a** The mfERG is shown for a single subject after DC and WC consumption. The left plots show mfERG retinal responses each from discrete retinal sites. The negative N1 wave represents cone and off-bipolar cell light responses, the subsequent P1 wave is derived from on-bipolar cells and the N2 response may partially reflect inner retinal function. Note the shorter latency and larger amplitude after DC consumption in this subject. **b** Mean (±SE) mfERG foveal latency after DC and WC, with DC latency significantly shorter ($P < 0.02$). **c** Mean (±SE) total mfERG latency (summed across R1–R3) is shown for DC and WC, with DC latency significantly shorter ($P < 0.02$).

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