



The acute and chronic effects of flavanol/ anthocyanin intervention on human cognitive function

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Dietary Flavonoids



**A wide array
of Fruits and
vegetables**



**Green & Black Tea:
(Flavanols)**



**Red wine:
(Flavanol, Flavonols)**



**Citrus:
(Flavanone)**

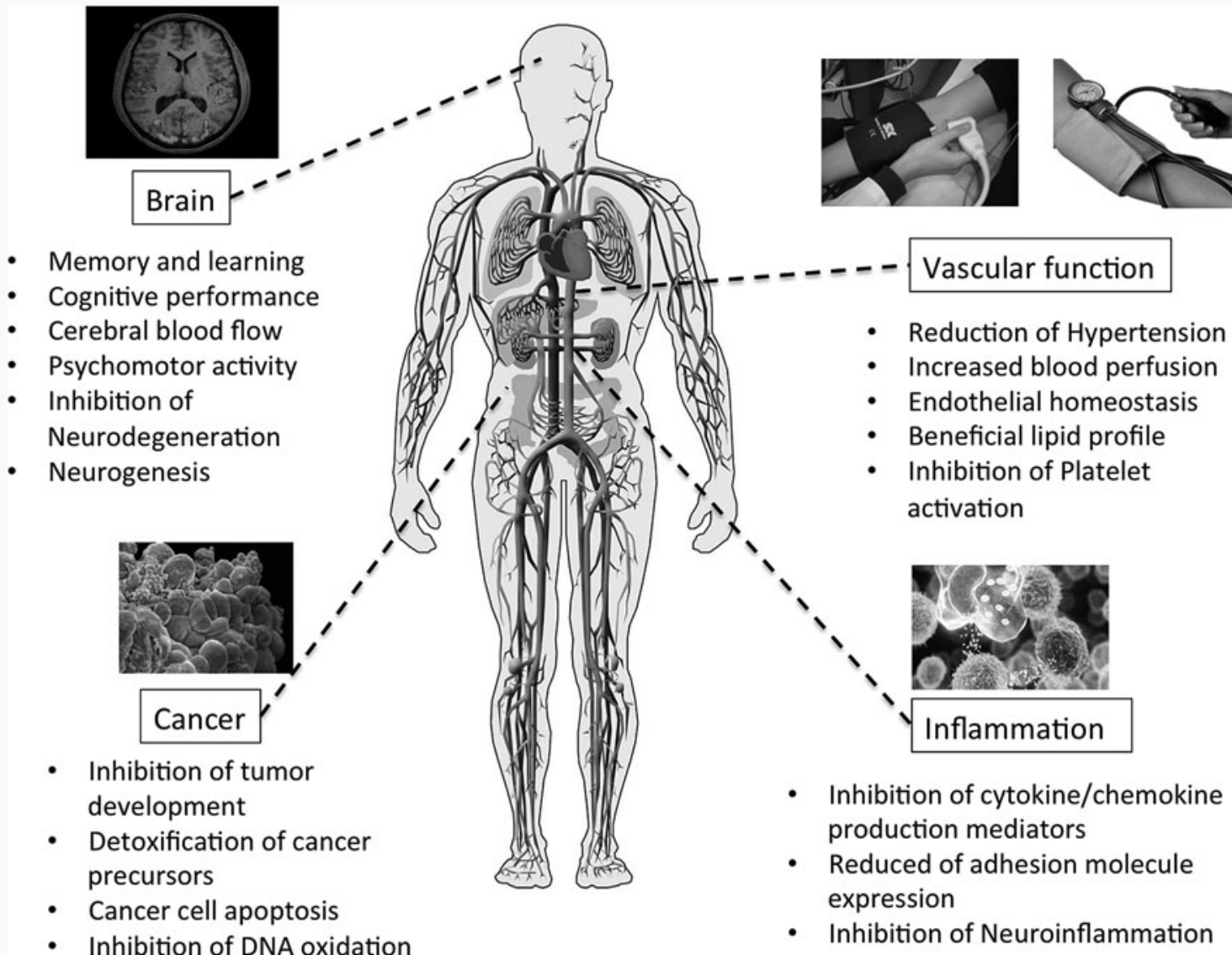


**Cocoa:
(Flavanols
and procyanidins)**

**Berries:
(Anthocyanins)**



The physiological actions of dietary flavonoids



Enhancement human memory and cognition by dietary flavonoids

Flavonoid Intake and Cognitive Decline over a 10-Year Period

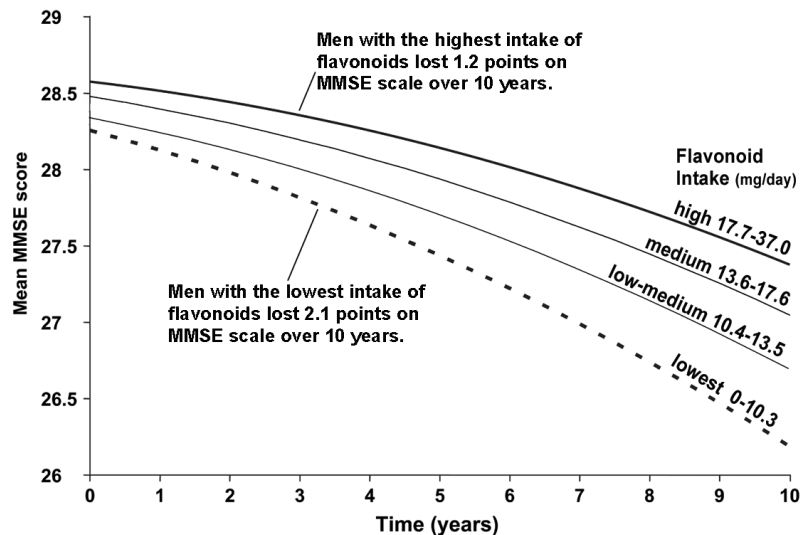
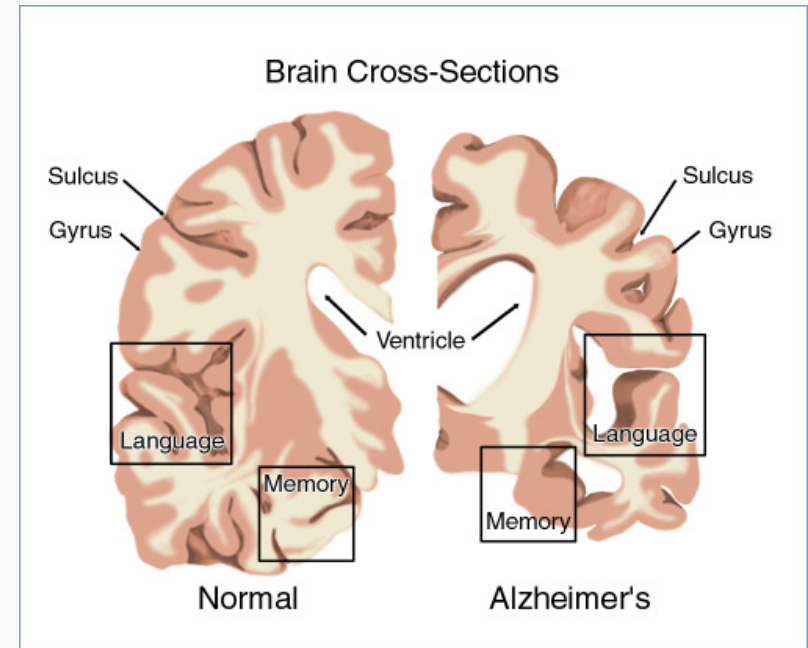


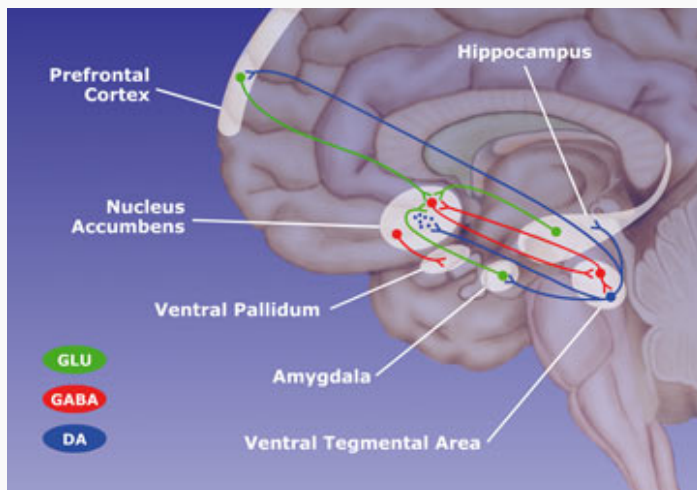
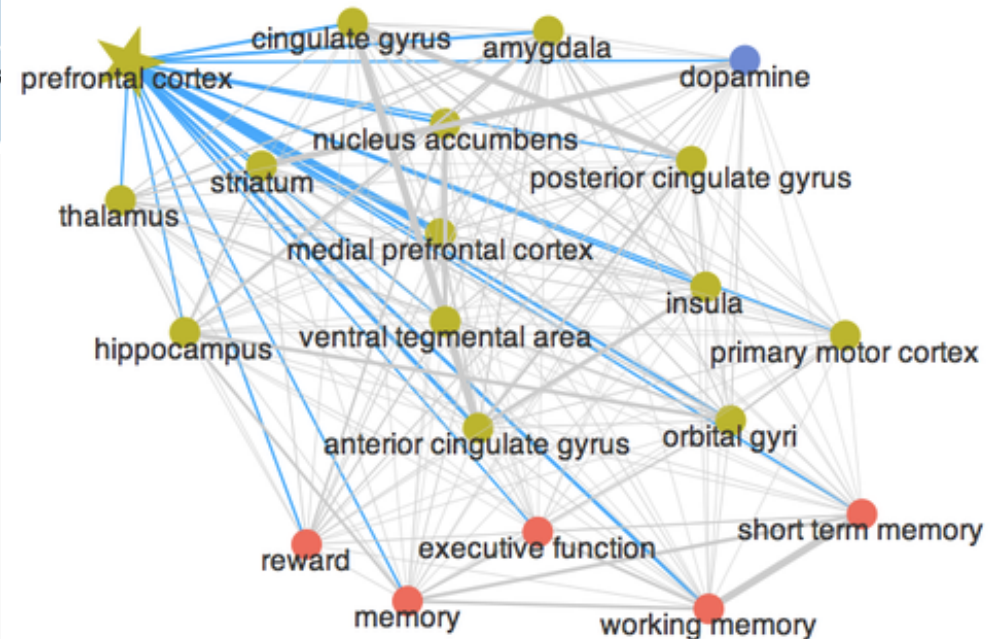
Figure 1. Change in mean Mini-Mental State Examination (MMSE) score over 10 years in men 65-70 years old by quartiles of flavonoid intake. Letenneur, L. et al Am J Epidemiol 165: 1364-1371; 2007.



Measurement of multiple cognitive domains

Primary domains of human cognition

Cognitive measure	Definition
Working memory	Temporary online storage of information and mental manipulation of information
Attention (sustained focused attention or vigilance)	Ability to maintain a consistent behavioral response throughout a continuous or repetitive activity
Speed of processing	More basic cognitive processes involving speed of performance, whether perceptual or motor
Verbal learning and memory	The ability to acquire and retain verbal instructions
Visuospatial learning and memory	The ability to acquire and retain visual figures and maps



Impact of cocoa flavanol supplementation on cognitive performance

63 healthy 65-80 yrs

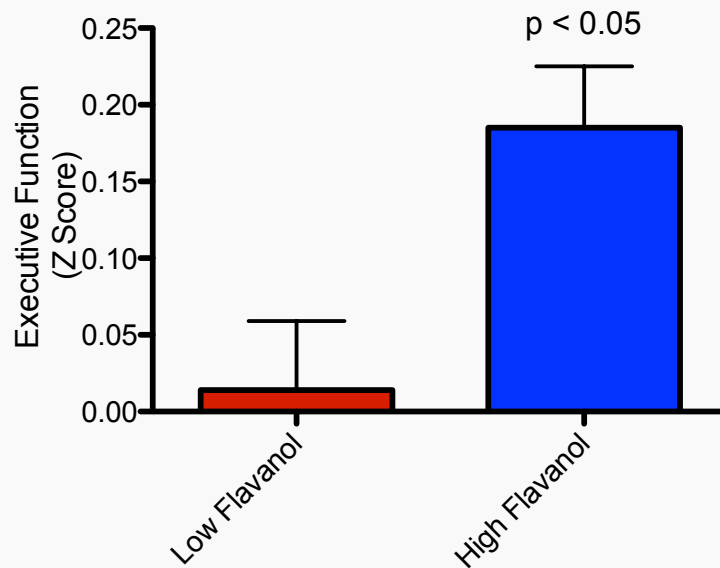
Acute intervention:
0-2 h

	High CF product	Low CF Product
Packet code	252	639
Packet size, g	30	30
mg Cocoa Flavanols (DP 1-10)	494	29
epicatechin, mg	89	3
catechin, mg	21	3
dimers-decamers, mg	384	20
Calories	113	112
Total fat, g	1	1
Saturated fat, g	1	1
Cholesterol, mg	5	5
Sodium, mg	197	204
Total Carbohydrates, g	16	16
Dietary Fiber, g	3	4
Sugars, g	10	9
Protein, g	9	9
Caffeine, mg	15	17
Theobromine, mg	185	176
Potassium, mg	507	573
Calcium, mg	243	225
Iron, mg	2	4
Phosphorus, mg	272	247
Magnesium, mg	82	74
Zinc, mg	1	1
Copper, mg	0	0
Manganese, mg	0	0

Cocoa flavanol intervention acutely (2h) improves executive function and episodic memory

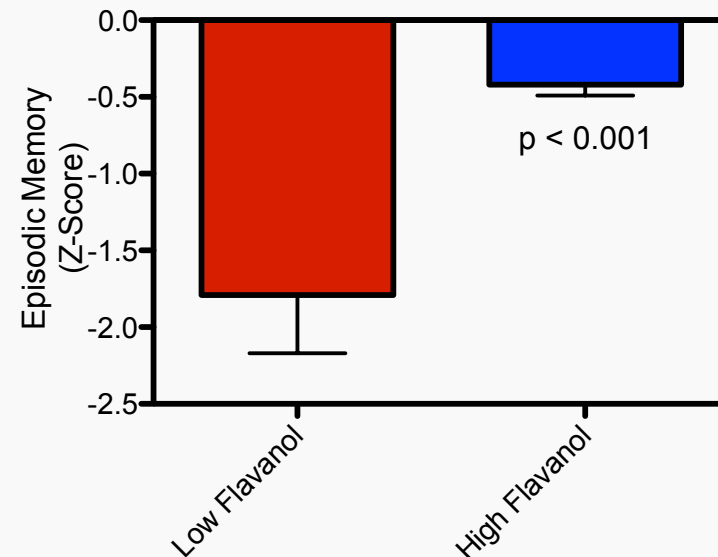
Executive Function

z-score from 5 tests

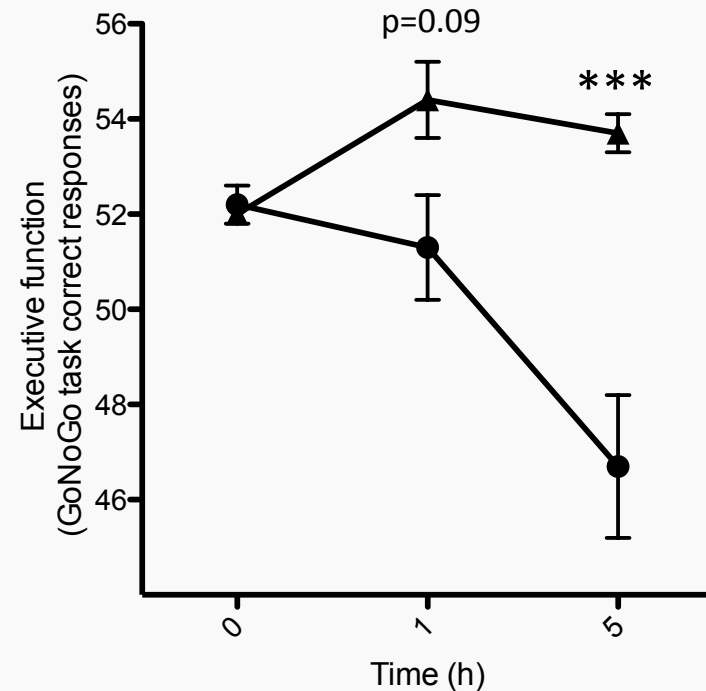
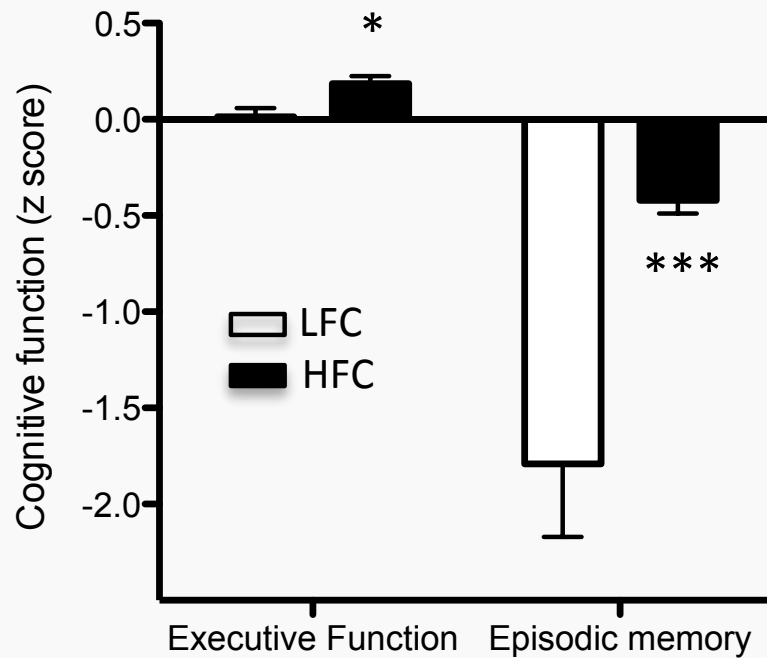


Episodic memory

z-score from 4 tests

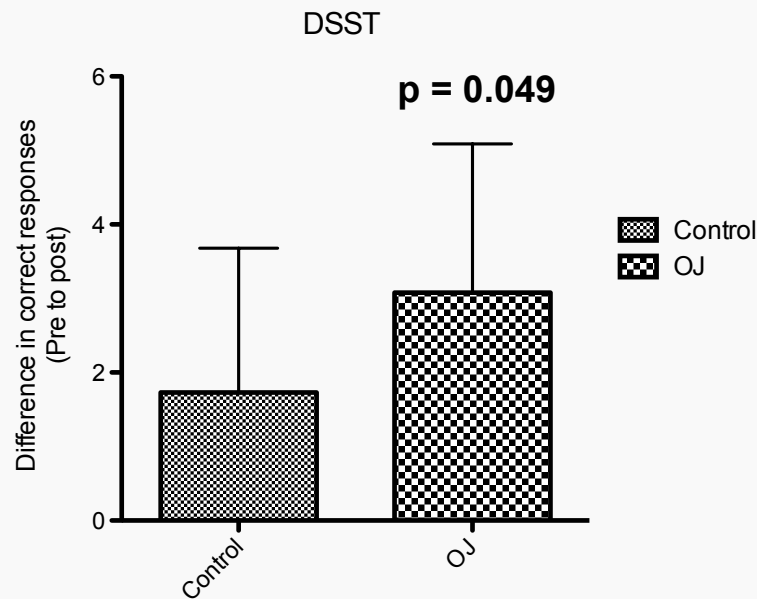


Cocoa (flavanol) and berry (anthocyanin) intervention acutely improves human executive function and episodic memory

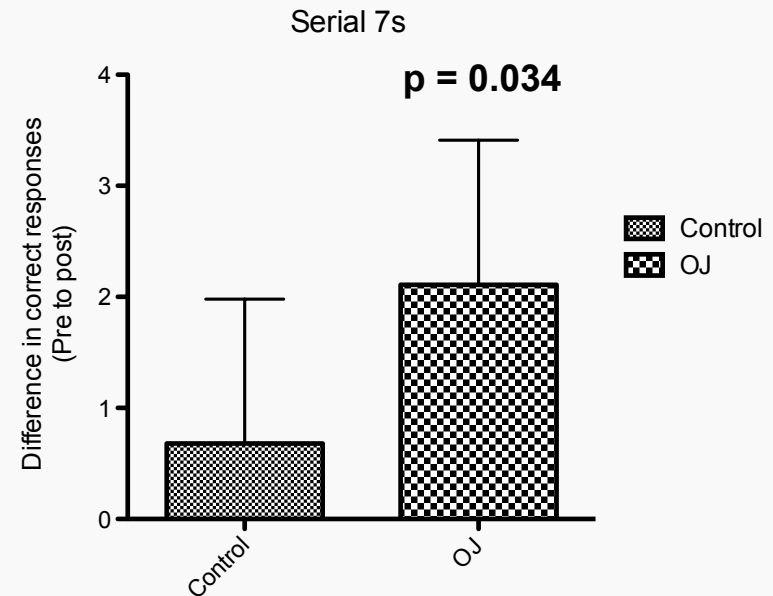


Chronic improvements in cognitive function following OJ (250 ml/day for 8 weeks)

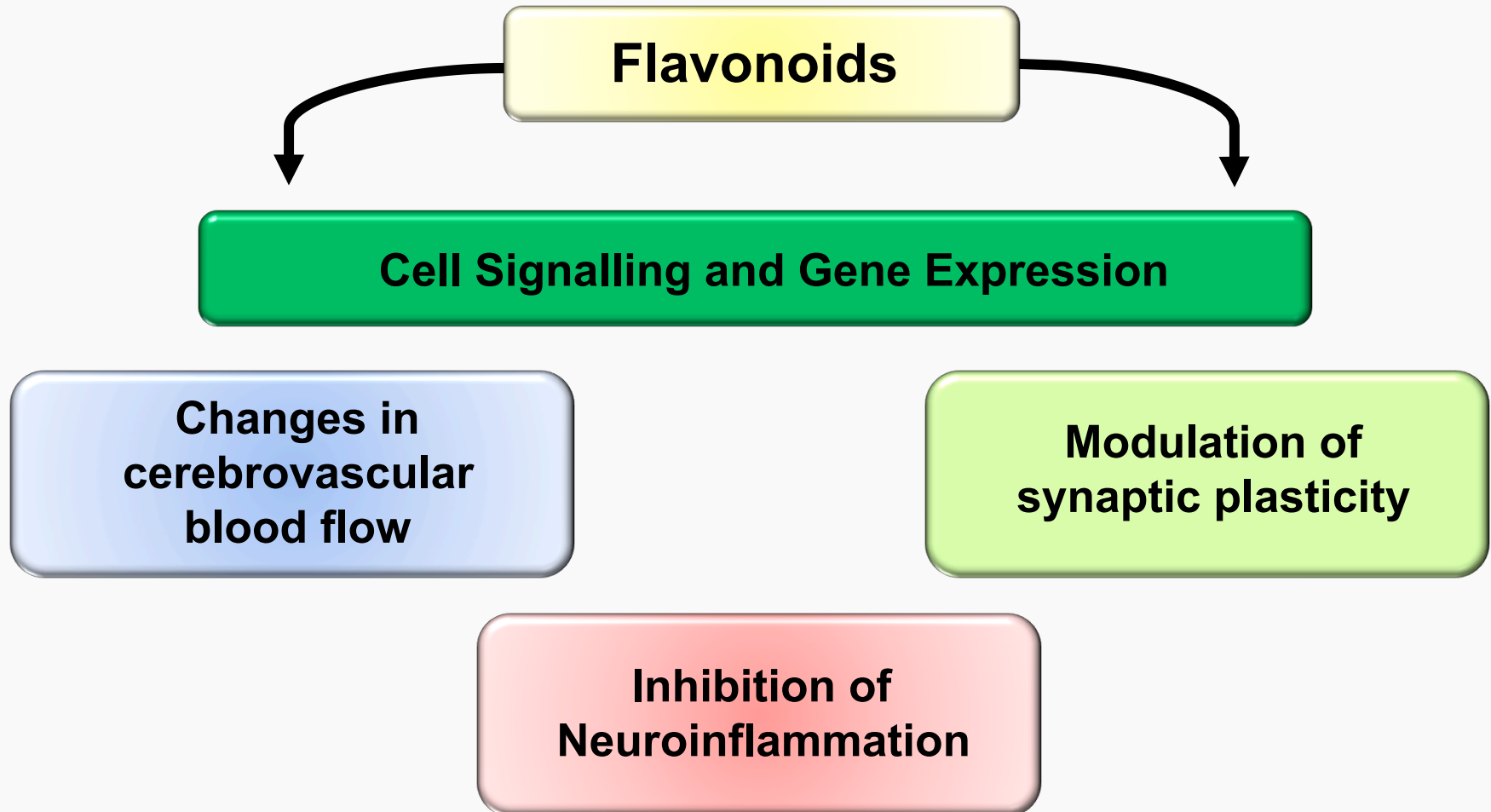
Executive Function/Attention



Working memory



How do they exert such actions in the brain?

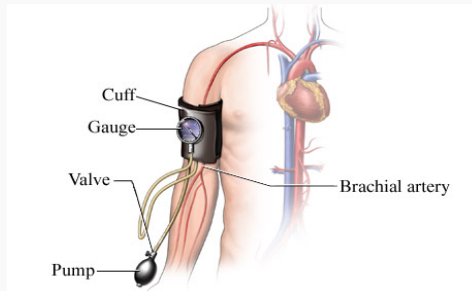
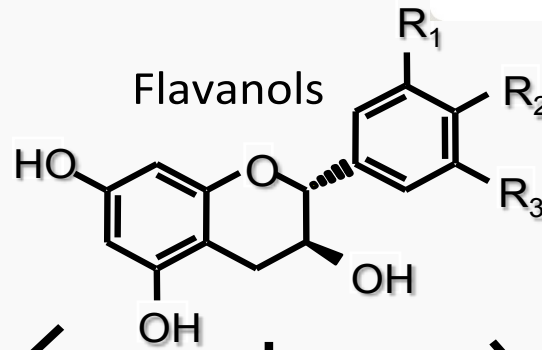


Blueberry?

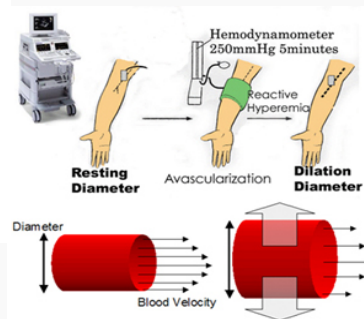
Cocoa



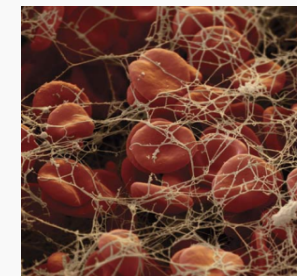
Tea



**Lower
Blood Pressure**



Improved Vascular Function

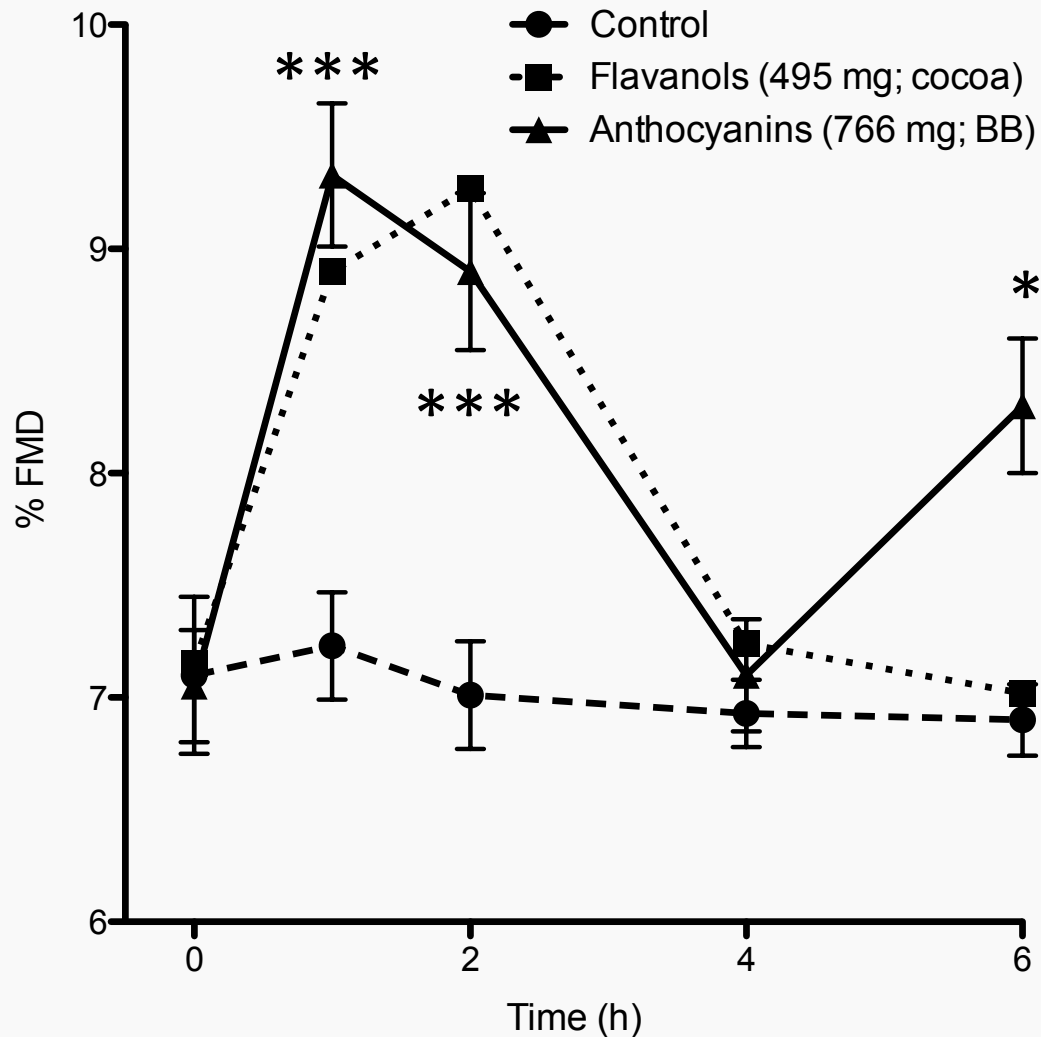


**Decreased
Blood Clotting**

Reduced Risk of Cardiovascular Disease

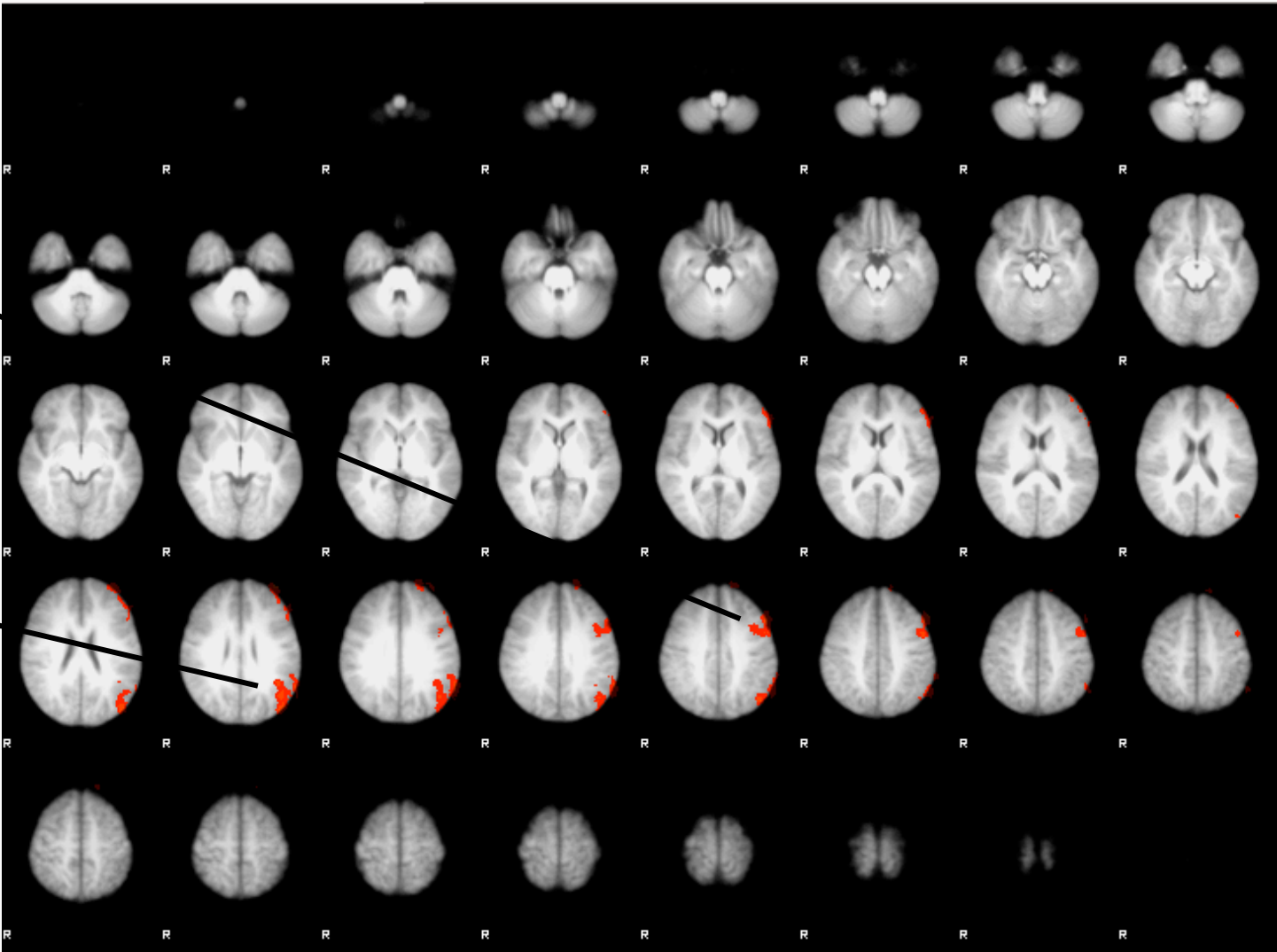
Flavanols and anthocyanins induce peripheral blood flow

C



Time-series analysis on resting state ASL data

- cocoa vs. control intervention (axial slices)

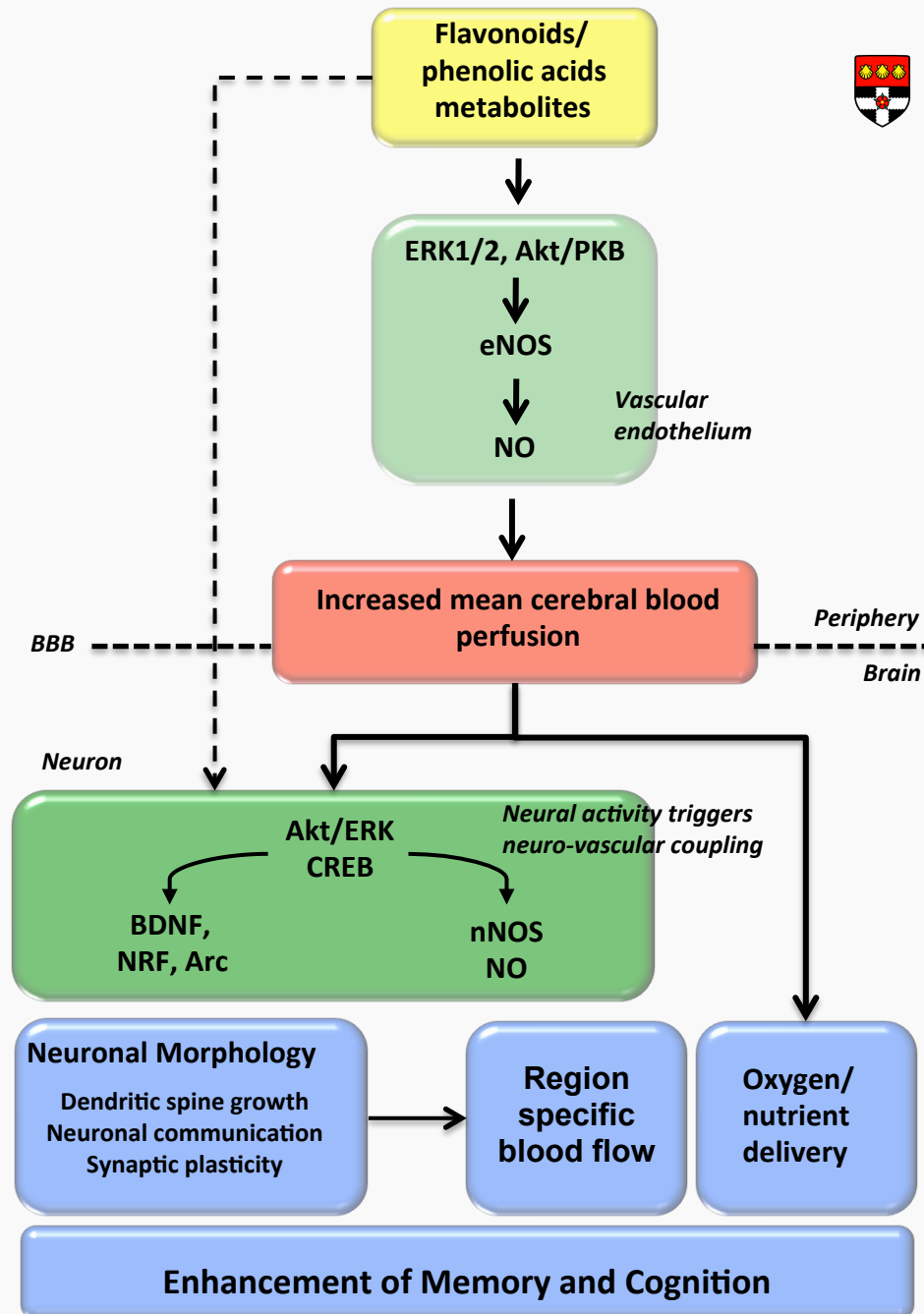


Middle frontal
gyrus

Pre-central
gyrus

Lateral occipital
cortex

Mechanisms of action



Benefits and novelty

- Will yield mechanistic insights into flavonoid-induced improvements on cognition.
- Will yield a mechanistic understanding of both short- and longer-term effects of flavonoids on cognition.
- Will fulfil the Bradford-Hill criteria for causation, satisfying consistency, specificity, temporality, and plausibility (mechanistic) factors, necessary to provide adequate evidence of a causal relationship between intervention.

Industry relevance

- Flavanols and anthocyanins are found in a wide array of sustainable, UK based crops, notably apples, pears, blackcurrants, raspberries and juices derived from these.
- Requirement for novel approaches designed to improve cognitive health has never been greater given the increased incidence of age-related cognitive decline and concomitant neuropsychological disorders.

