Measuring and Validating the Subjective Effects of Foods on Mood and Mental Performance

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Overview

• **Effects of food on mental performance**
  – How to select suitable tests for nutrient intervention studies

• **Effects of food on subjective performance and mood**
  – How to capture subjective performance and mood in nutrient intervention studies
What is Cognitive Performance?

• Perception, understanding & action

• Complex tasks – operating machinery, driving, learning, making decisions

• Evolved to give us control over the environment

• We are all using our cognitive abilities all the time
Motivation
Subjective Performance

Factors affecting the nutrition - behaviour/cognition relationship

Cognitive performance
- Executive Function
- Memory – verbal/spatial
- Attention
- Psychomotor
- Perception
- Language

Physical well-being
- Expectancy/Placebo Effects

Mood
- Improvement to real world performance?
Markers of cognitive function: Criteria for validation and considerations for nutrition research

- Tests commonly in use and their state of validation;
- Mechanisms of action for the cognitive domains related to the specific markers or tests;
- Application of the measures to studies of nutrition, and intervention trials;
- Guidance related to how the criteria for validation can be applied to select the most suitable markers for a nutritional intervention study of effects on cognition.
• tests that can be used in experimental trials valid, reliable & sensitive measures of cognitive function
• can act as valid surrogates/(bio) markers of neural processes underlying major domains of cognition.
Memory is comprised of a number of stages:

- a) encoding or learning
- b) short and long-term storage
- c) recognition, retrieval or recall (cued or free)

Memory types

- Non-declarative – implicit learning that is not verbalised, eg. riding a bicycle
- Declarative – put into words
  - a) short-term working memory
  - b) long-term memory for events
  - c) prospective eg. for future appointments
  - d) semantic memory for concepts and language
Methodological considerations for nutritional intervention studies

Product to be tested

- Target population
  - Age groups, Specific conditions/diseases
- Anticipated effect
  - (earlier studies, neurobiology, hypotheses)

- Test difficulty
  - appropriate for population/age
- Test characteristics
  - sensitivity to change/reliability
- Cognitive domains
  - appropriate for expected effect, & interactions

- Test battery selection

- Study sample size
  - Adequately powered to prove null hypothesis

- Surrogate markers
  - eg. Brain volume change

- Safety and serious adverse events

- Primary and secondary outcomes

- Biological outcomes of nutritional intervention:
  - increase in blood levels of nutritional target or decrease disease agent

- Claims for efficacy to EFSA/FDA of specific benefits

Adapted from Benton, Klaus, Schmitt

- Appropriate test selection
- managing performance variability
- ensuring meaningful interpretation of results
### Significant effects of selected nutritional interventions on tests of cognitive domains/number of tests applied

<table>
<thead>
<tr>
<th>Cognitive Domain</th>
<th>Isoflavones</th>
<th>Polyphenols</th>
<th>B Vitamins</th>
<th>N-3 Fatty Acids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immediate verbal memory</td>
<td>3/15</td>
<td>2/7</td>
<td>3/7</td>
<td>0/3</td>
</tr>
<tr>
<td>Delayed verbal memory</td>
<td>0/9</td>
<td>0/4</td>
<td>2/2</td>
<td>1/3</td>
</tr>
<tr>
<td>Immediate spatial memory</td>
<td>4/15</td>
<td>4/8</td>
<td>1/1</td>
<td>½</td>
</tr>
<tr>
<td>Delayed spatial memory</td>
<td>3/4</td>
<td>0/1</td>
<td>-</td>
<td>1/1</td>
</tr>
<tr>
<td>Executive Function</td>
<td>10/30</td>
<td>0/3</td>
<td>4/6</td>
<td>0/3</td>
</tr>
<tr>
<td>Working memory</td>
<td>1/8</td>
<td>1/5</td>
<td>0/2</td>
<td>2/6</td>
</tr>
<tr>
<td>Attention/info processing</td>
<td>3/12</td>
<td>2/15</td>
<td>1/4</td>
<td>0/9</td>
</tr>
<tr>
<td>Global (adult)</td>
<td>-</td>
<td>-</td>
<td>3/7</td>
<td>0/2</td>
</tr>
<tr>
<td>Global (child)</td>
<td>0/4</td>
<td>-</td>
<td>2/2</td>
<td>1/1</td>
</tr>
<tr>
<td>Psychomotor</td>
<td>1/3</td>
<td>-</td>
<td>-</td>
<td>0/1</td>
</tr>
</tbody>
</table>
Few effects of these nutrients on various cognitive domains

• Quite sparse amount of research using cognitive outcomes
• Poor choice of tests?
• Tests not sensitive
• No real effect of intervention
• Intervention inadequate to exert cognitive effects - too short/low dose
• Inappropriate sample (too healthy/young etc)
Criteria

1. **Analytical Aspects**
   - accurate, standardized, & robust methodology
   - good sensitivity & specificity
   - construct validity & retest reliability
   - Norms/CIs for target populations.

2. **Causal relationship**
   - between the marker and outcome - health/disease state.
   - correlate with endpoint & with changes in it, & be relevant to the outcome.
   - Biological plausibility required even if the detailed mechanism of action of the marker is not fully understood.

3. **Nutritional status or studies**
   - marker (i.e. cognitive test score) should show a response to dietary or nutritional intervention or lifestyle changes.
Innovation & future development of markers of cognitive function

• validation of the marker for new population is required - cant just assume findings observed in one population are applicable to any other population

• novel tests or markers should be evaluated against norms relating to age, education and gender of established tests or against ‘gold standards’ (such as diagnosis or diagnostic criteria) to assess their validity
Measuring effects of nutrients on subjective mental performance & MOOD

Impetus:

- Subjective experience is a component of EFSA evaluation for health claims on psychological function.
- Objective measures considered “gold standard”
- Subjective experiences are important & may enrich objective data
Examining techniques for measuring the effects of nutrients on subjective performance and mood state,
Mark Hamer, Louise Dye, Marie E. Latulippe, Siobhan Mitchell, Sophie Layé, Caroline Saunders, Neil Boyle & John Sijben

1) To evaluate methods to measure subjective mental performance and mood
2) Examine validity of existing measures & the relationship between subjective & objective measures
3) What constitutes a meaningful effect - how do standardized questionnaires translate into everyday life?
How objective is objective?

- false dichotomy
- self-rating/self-reported measures of mood, hunger, etc. = subjective measures
- cognitive behaviour (reaction time, number of words recalled) & physiological variables (salivary cortisol concentration, blood pressure, heart rate variability) = objective measures
Definition & measurement of subjective mood state

• Cognitive performance = objective measure
• Self-reports of performance/mood = subjective measures
• Mood can be consistently measured
  – Protracted, generalised mood
  – Transient mood state
• Measures can be sensitive to nutrient intervention

Scholey et al, 213, J Psychopharm
New methods of monitoring mood

Ecological momentary assessment

- Experience sampling
- Mobile technology
- New statistical approach

Validated against CV biomarkers e.g. SBP
Sensitive to nutrient effects
e.g. Multivitamin increased alertness over 4 weeks.

via cellphone
Expectancy & Placebo effects

- Placebo effects - influence physiological response
- Expectancy - anticipation of results
- Neuroimaging - frontal/prefrontal activation:
  - Processing of expectation & executive function
- Can also influence performance on objective cognitive tests

Strategies:
- Blind participants & experimenters to hypotheses under test
- Assess effectiveness of blinding via debriefing
- Objective measures don’t necessarily avoid these effects

Measures of subjective state are no less objective than measures of overt behaviour and physiological state
Recommendations:

- Use methods/measurement intervals which may more realistically capture transient states e.g. EMA
- Use measures sufficiently sensitive to detect effects of a nutritional manipulation
- Evaluate magnitude and meaningfulness of changes demonstrated e.g. comparison with effects induced by drugs/alcohol or circadian fluctuations in mood
- Consider the possibility that subjective and objective measures may show different temporal profiles/dose effects. Acute on chronic studies - insight
- Be aware of possible expectancy of placebo effects
- Select well-matched placebos/debrief checks
- Demonstrate biological plausibility to link effects of specific nutrients to subjective mood states and behaviour.
Thank you