Changes in the implicit and explicit evaluation of food features with age

Theoretical background

Food is one of the most salient and rewarding stimuli in the human environment and several food choices are daily influenced by factors such as palatability and healthiness[1], dietary habits[2], *and* hunger level[3].

According to the *Reflective-Impulsive Model*[4] (proposed for explaining behavioral decision regulation), two systems can guide eating behaviour: a) the *impulsive system* guiding approach/avoidance to food based on taste, palatability or the reward by ingesting it; b) the *reflective system* personally shaped and considering the long-term health food-related consequences. Explicit and implicit measures can predict participants' food choices, dissociating, for example, the implicit positive evaluations of high-energy/palatable foods in restrained eaters[2,3] and the explicit negative ones[1,5]. The lack of inhibitory control allows the impulsive system to dominate the reflective one[4] and modulate the reward-involved regions activated by, for example, high-calorie food: medial prefrontal (PFC, elaborating food healthiness[1]), anterior cingulate and orbitofrontal (OFC; reflecting the expected pleasantness of the food) cortices [7,8].

The studies above examined food processing in young adults, but less is known about how the elderly process such cognitive features, except for food intake anomalies in neurodegenerative diseases: frontotemporal dementia patients cannot control food intake (they eat indiscriminately when food is present but do not seek it[9]), and Alzheimer's patients do not recognize food or swallow inedible items.

Aims and Hypotheses

This study will investigate whether (i) implicit and explicit healthiness/palatability food evaluations change with age; ii) these changes are related to inhibitory control.

Given the role of the dorsolateral and ventromedial PFC in cognitive control and the rewarding value assigned to stimuli, changes are expected in food choices based on taste (palatability) and healthiness. As unsuccessful controllers[3], older adults should prefer tasty foods, although unhealthy, both implicitly and explicitly, due to natural depletion in the PFC with aging[10] bringing a disequilibrium between cognitive control and reward sensitivity. Indeed, a reduction in control resources leads participants to be driven by the impulsive system in an implicit task, but long-term health concerns regarding foods and their quality should affect the explicit evaluations[4].

Methods

Participants

Hundred healthy participants (aged 20-30 and 65-75 years) will be recruited. Considering an effect size Cohen's d=.53[11], and a between-subjects design, the sample would achieve a power of .84 (with α= .05 one-tail).

Exclusion criteria: neurological or psychiatric disease, subjective report of odour loss or medication intake affecting cognitive function and appetite.

Tools

Self-report questionnaire: participants report age, gender, height and weight (to calculate body mass index, BMI), hunger level (on a 9-points scale), hours from the last meal, dietary habits (e.g., omnivore, vegetarian), dietary restrictions based on medical (e.g., gluten allergies), ethical or religious reasons, and perceived olfactory and gustatory skills.

Stimulus set: Food pictures selected from FRIDA[12], divided into Natural vs Processed food and balanced according to caloric value (high vs low).

Food stimuli rating: Valence (How negative/positive is the food in the picture?), Palatability/hedonic value (How pleasant do you think it is to taste a bite of the food in the picture?), Healthiness (How healthy is the food represented in the picture?), Wanting (How much do you desire at this moment the food depicted in the picture?) will be rated on a 9-points scale.

Implicit Association Test (IAT): it tests automatic/implicit responses to stimuli while performing a double categorization task[13]. Reaction times (RTs) reflect the easiness/difficulty to do the task in the stimulus-positive vs stimulus-negative associations.

Go-nogo task: it evaluates inhibitory control and measures the error rate in making a "go" response on "no-go" trials. Fewer errors link to better inhibitory control.

MOCA[14] will be used with old participants to exclude cognitive decline.

Procedure

First, participants will fill out the Self-report questionnaire (the older participants also MOCA). Second, they will rate each food picture in terms of Valence, Palatability, Healthiness, and Wanting. Then, they will do two IATs (Natural Food-IAT and Processed Food-IAT in counterbalanced order) and complete a GO-Nogo task at last.

The entire procedure will take about 40 min.

Statistical analyses

Linear Mixed Models (LMM) will analyse the dependent variables IAT's RTs and explicit ratings with random intercepts for participants and images.

A first model on IAT's RTs includes caloric value (high vs low), and congruency (low-positive vs high-negative) in interaction. A second model includes food type (Natural vs Processed) and congruency (natural-positive vs processed-negative) in interaction. Participant-related factors (hunger level; age group- young adults vs. old adults; inhibitory control) or the explicit rating (e.g., healthiness, palatability) are added to the model in a stepwise manner to select the ones to include in a final model with the significant factors.

Separate LMMs for Valence, Palatability, Wanting and Healthiness will be run on picture rating (dependent variable) with fixed effects (caloric value, type of food), and covariates (BMI, inhibitory control, age group and hunger level).

Commitment to request ethical approval

The protocol will be submitted to the Ethics Committee of Bologna University for approval.

Expected results and Implications

Assuming a lack of inhibitory control in the old but not the young adults (allowing the impulsive system to take over the reflective one[4]), a stronger dissociation between explicit and implicit measures is expected in the old related to healthiness and palatability. The type of food (processed vs natural and low vs high calories) should further modulate evaluations both implicitly and explicitly. Natural food should be greatly associated with healthiness and transformed foods to hedonic value in explicit measures in participants with preserved inhibitory control. At the implicit level, a stronger association with positivity for processed than natural food in participants with good inhibitory control, but explicit and implicit measures should converge in participants with lower inhibitory control (the elderly) with a positive correlation with caloric value.

These results will help understand if behavioral anomalies emerge in the elderly based on voluntary and explicit control in the intake and evaluation of food or if such anomalies are already present at an implicit level and go to undermine the reward values of food stimuli (especially appetizing and high-calorie ones), against healthiness. These data can help develop novel behaviour change strategies and inform nutrition research and practices.

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References

1. Hare, T. A., Malmaud, J., Rangel, A. (2011). Focusing attention on the health aspects of foods changes value signals in vmPFC and improves dietary choice. *Journal of neuroscience*, *31*, 11077-11087.
2. Houben, K., Roefs, A., Jansen, A. (2010). Guilty pleasures. Implicit preferences for high calorie food in restrained eating. *Appetite*, *55*, 18-24.
3. Hoefling, A., Strack, F. (2008). The tempting effect of forbidden foods. High calorie content evokes conflicting implicit and explicit evaluations in restrained eaters. *Appetite*, *51*, 681-689.
4. Strack, F., Deutsch, R. (2004). Reflective and impulsive determinants of social behavior. *Personality and social psychology review*, *8*, 220-247.
5. Richetin, J., Perugini, M., Prestwich, A., O'Gorman, R. (2007). The IAT as a predictor of food choice: The case of fruits versus snacks. *International Journal of Psychology*, *42*, 166-173.
6. Czyzewska, M., Graham, R. (2008). Implicit and explicit attitudes to high-and low-calorie food in females with different BMI status. *Eating behaviors*, *9*, 303-312.
7. Plassmann, H., O'Doherty, J., Rangel, A. (2010). Appetitive and aversive goal values are encoded in the medial orbitofrontal cortex at the time of decision making. *Journal of neuroscience*, *30*, 10799-10808.
8. Bartholdy, S., Dalton, B., O'Daly, O., Campbell, I., Schmidt, U. (2016). A systematic review of the relationship between eating, weight and inhibitory control using the stop signal task. *Neuroscience & Biobehavioral Reviews*, *64*, 35-62.
9. Neary, D., Snowden, J., Gustafson, et al. (1998). Frontotemporal lobar degeneration: a consensus on clinical diagnostic criteria. *Neurology*, *51*, 1546-1554.
10. Eldaief, M. C., McMains, S., Hutchison, R., Halko, M., Pascual-Leone, A. (2017). Reconfiguration of intrinsic functional coupling patterns following circumscribed network lesions. *Cerebral cortex*, *27*, 2894-2910.
11. Rumiati, R. I., Foroni, F., Pergola, G., Rossi, P., Silveri, M. C. (2016). Lexical-semantic deficits in processing food and non-food items. *Brain and cognition*, *110*, 120-130.
12. Foroni, F., Pergola, G., Argiris, G., Rumiati, R. I. (2013). The FoodCast research image database (FRIDa). *Frontiers in human neuroscience*, *7*, 51.
13. Greenwald, A. G., McGhee, D., Schwartz, J. (1998). Measuring individual differences in implicit cognition: the implicit association test. *Journal of personality and social psychology*, *74*, 1464.
14. Santangelo, G., Siciliano, M., Pedone, R., et al. (2015). Normative data for the Montreal Cognitive Assessment in an Italian population sample. *Neurological Sciences*, *36*(4), 585-591.

Project activities

- Task preparation
- Ethical clearance
- Partnerships creation with associations and Third-age universities (UNI3) and recruitment
- Experimental protocol administration
- Continuous data monitoring and analysis
- Drafting scientific paper/conference abstract
- Writing the final report

Training activities

- Deepening the explicit and implicit paradigms for studying food
- Deepening the statistical analysis
- Supervision for scientific writing (papers and conference abstracts)

Timing of activities

	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12
Ethical Clearance												
Experimental task preparation												
Participant recruitment and creation of partnerships with associations and UNI3												
Experimental protocol administration												
Continuous data monitoring, cleaning and analysis												
Drafting scientific paper/conference abstract												
Writing the final report												

Feasibility

The project contains a food evaluation protocol already used in literature and stimuli selected from an available database. The main risk is insufficient participant recruitment in person in the lab. If necessary, participants will also be recruited online (using Qualtrics and Jatos platforms) and agreements with associations will be signed to help preventing the risk of participant withdrawal.

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