

Effects of retronasal smelling, variety and choice on appetite and satiety

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Subject Summary

Completed: 8 control subjects (6 non-exerciser and 2 unmatched)
8 exerciser subjects (from the non-testosterone pool)

Average age: 34 ± 6 years

Subjects undergo:

- 35 combined nasal patency and odorant identification tests (10 tests on BR1 & 2!)
- 7 commercial 'scratch and sniff' smell tests,
- Complete a food acceptability survey for every meal (~300),
- Daily mood and health surveys (~100),
- Dietary Assessment Questionnaire (DAQ)
- Entry survey, and Exit survey

Four principal areas

Nasal Patency

Measure nasal tissue swelling and airflow in BR and compare this to PreBR baseline and PostBR recovery

Ask subjects to self-assess nasal congestion at each test to compare with Astronaut self-assessment

Odorant Identification

Measure subject's ability to recognize odorants obtained from food samples taken from FARU menu and compare this with recognition of food odors not available on FARU

Compare subject assessed ratings of odorant intensity and food liking with nasal airflow measurements to determine effect of fluid shift on smell ability

Four principal areas

Meal acceptability

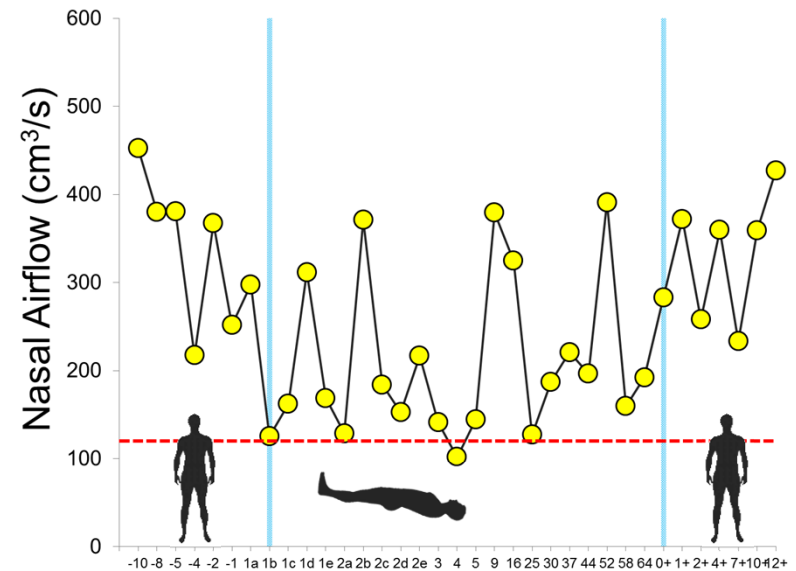
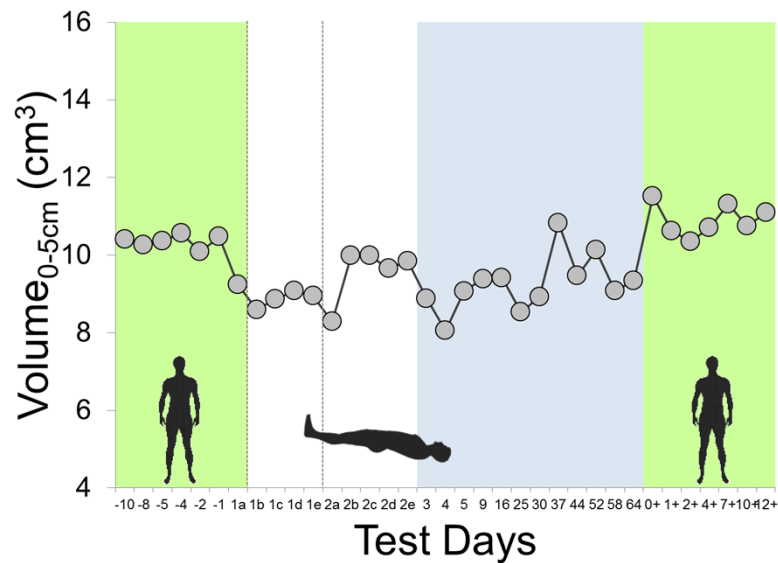
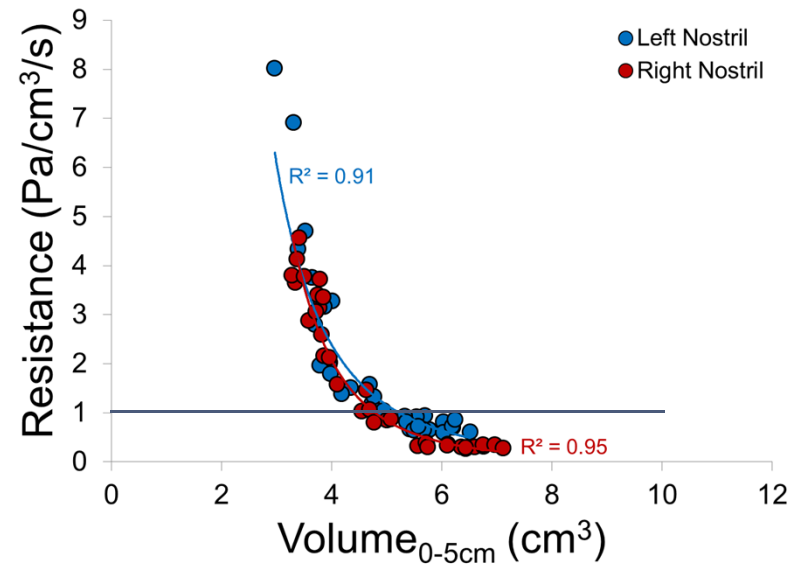
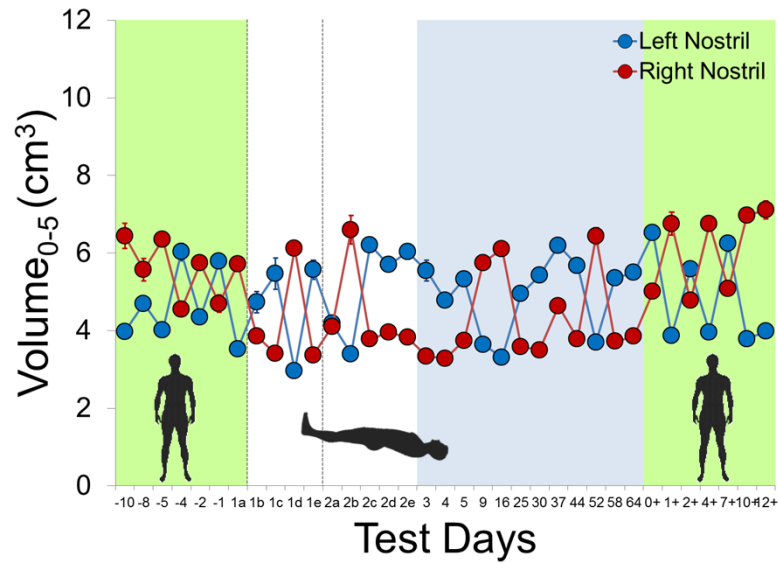
Determine the onset and progression of reported 'menu fatigue' during BR

Determine whether decreased nasal airflow or smell ability are factors in 'menu fatigue'

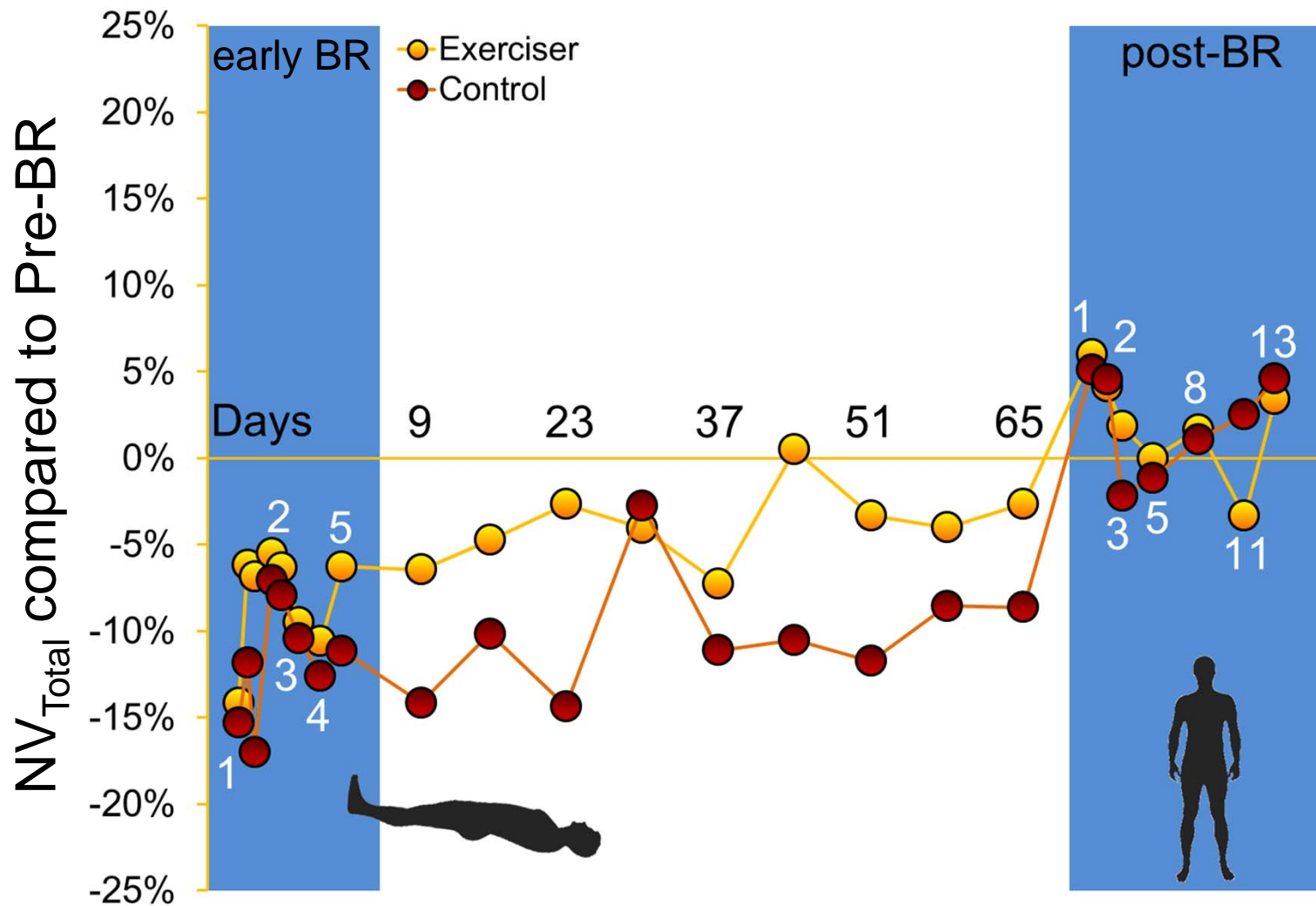
Daily Mood and Health

Record mood changes during study and compare with meal acceptability and smell ability

Nasal volume, nasal cycle, nasal airflow



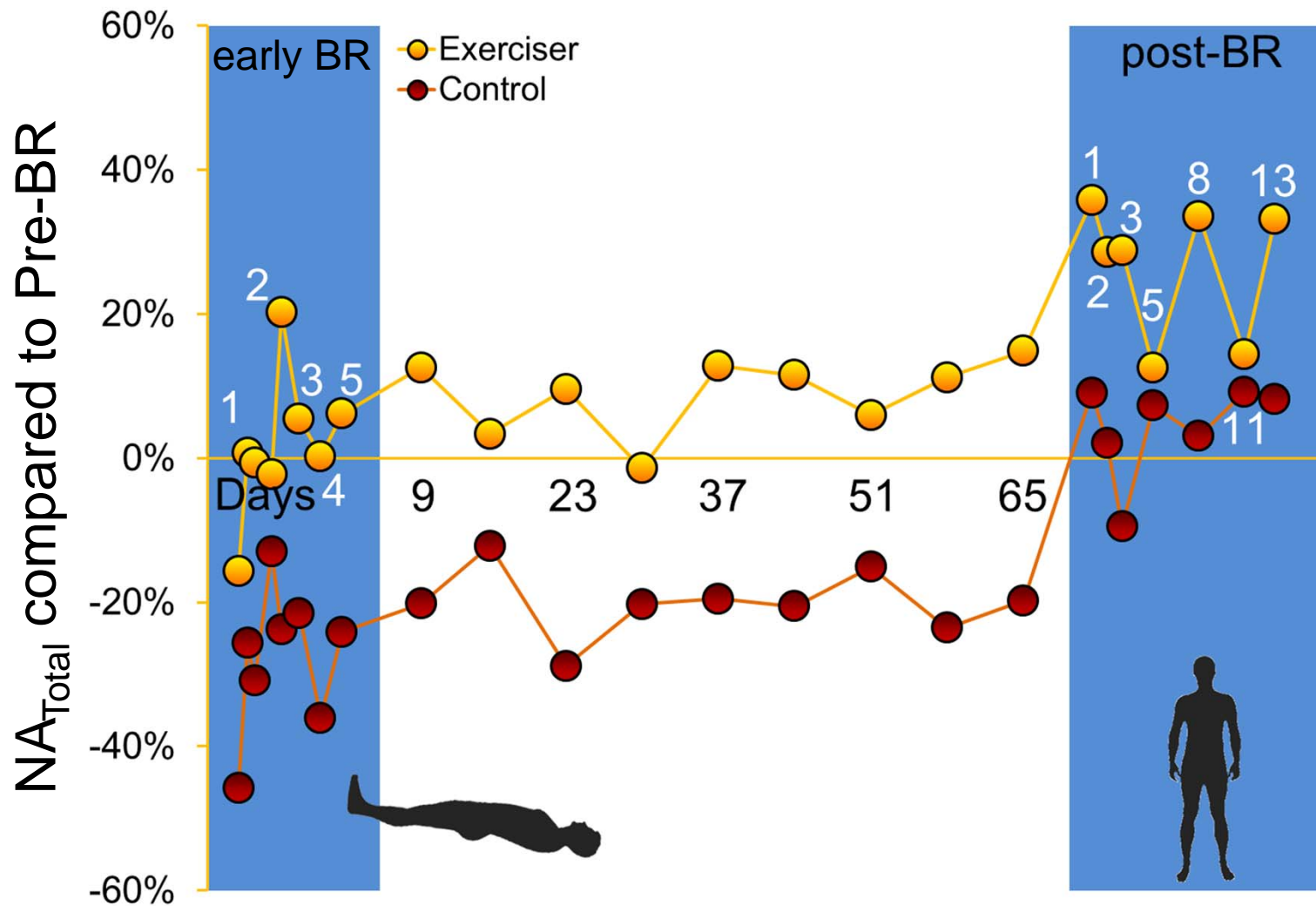
Total Nasal Volume in BR and post-BR Grouped by Control and Exerciser



Control = 8 subjects

Exerciser = 8 subjects

Total Nasal Airflow in BR and post-BR Grouped by Control and Exerciser



Control = 8 subjects

Exerciser = 8 subjects

Self-assessed congestion

Astronauts (60%)



N = 664

Pillownauts (56%)



N = 16

congestion
no congestion

All Pillownauts had measurable nasal congestion!

Odorant Identification (OID)



- 20 odorants are presented at each OID session
- Odorants are drawn from the FARU menu and food sources not present in the FARU
- Odorants are smelt either retronasally or orthonasally or both
- Odorants are repeated 10 times over the course of the study
- Odorants are randomly assigned to each OID session and randomly ordered

Changes in retronasal and orthonasal smell ability

A change in smell ability is measured by tracking subject perception of 35 odorants from admission to the FARU through to dismissal.

The odorants are divided into three categories:

Menu

Apple sauce
Bacon
Cheesecake
Cranberry Sauce
Egg Salad
Mac&Cheese
Mustard
Oatmeal
Orange Juice
Peanut Butter
Potato Chips
Salsa
Salmon Cake
Spaghetti Sauce
Sweet&Sour Sauce

Off-menu

Chipotle
Chocolate
Cilantro
Coffee
Cilantro
Garlic
Gingerbread
Hazelnut
Lime
Olive Oil
Parmesan
Raspberry
Root Beer
Soy Sauce
Vinegar

Calibrates

Banana
Coconut
Flowers
Peppermint
Soap


Assessing retronasal and orthonasal smell ability


After smelling the odorant from the front or back of the nose, subjects rate the character of the smell:


Intensity, Familiarity, Pleasantness, Food or not Food, Like to eat.


And identify the smell from a list of descriptors


TRIAL 1

No odor  Intense odor

Extremely unfamiliar  Extremely familiar

Extremely unpleasant  Extremely pleasant

Definitely not food  Definitely food

Strongly dislike to eat  Strongly like to eat

FINISHED
OK

honey

rubber

olive oil

vanilla

soap

craisins

lavendar

butterscotch

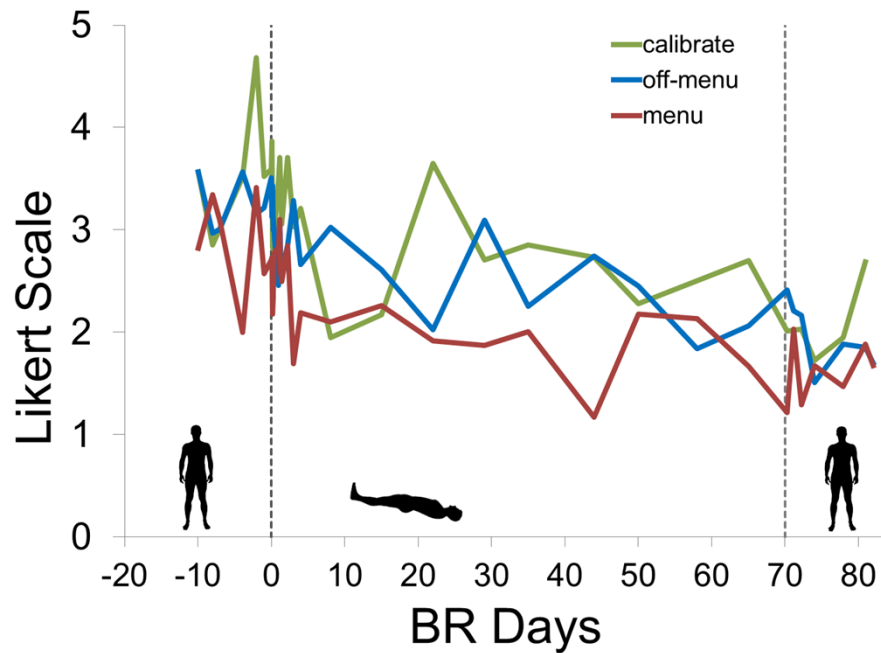
START ID

FINISHED
OK

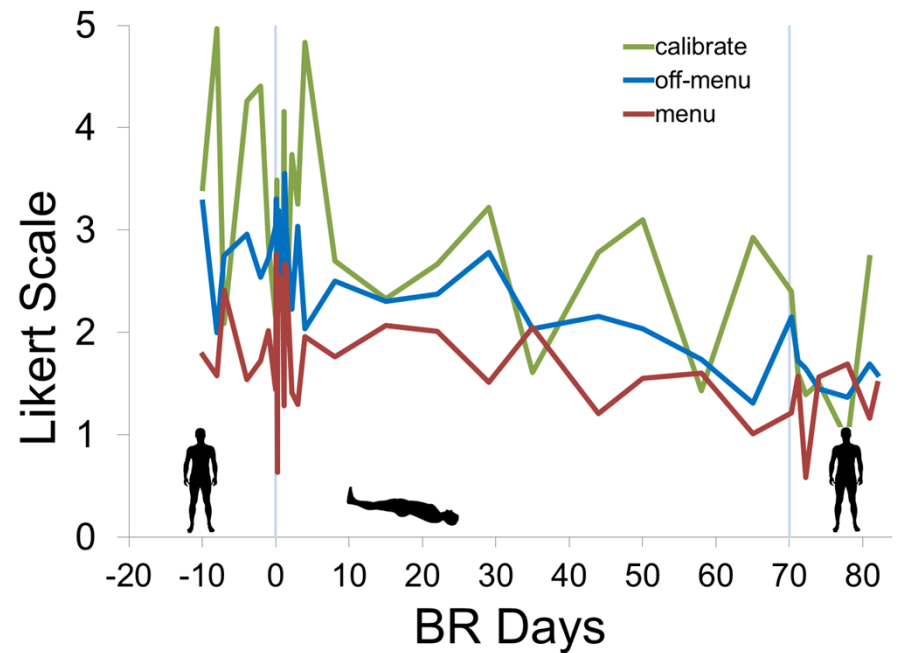
STOP Subject ID: 1111 Test No.: 1

Odorant Identification results

Self-assessed Intensity



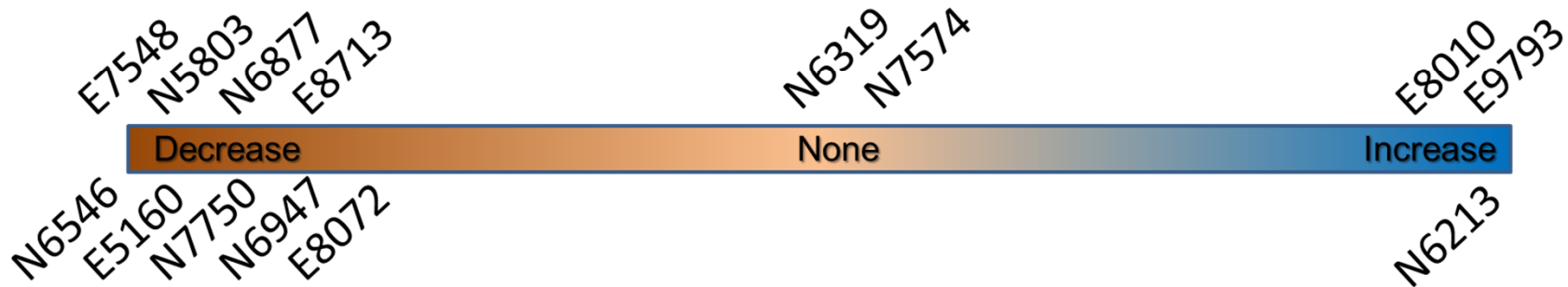
Orthonasal



Retronasal

Odorant Identification results

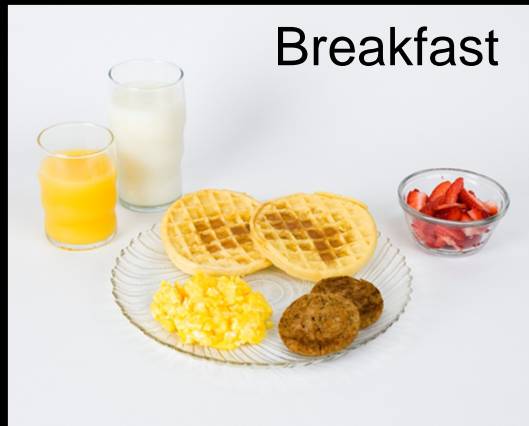
OID Response vs Time



- Only 3 subjects show a slight correlation between change in airflow and odorant intensity
- Have much to do to analyze this data
 - Compare individual odorants in groupings (aromatic, trigeminal, etc.)
 - Compare menu odorants with menu items
 - Determine odorant response in extreme cases: First day of BR, first day of head up, etc.
 - Determine how well subjects identify the odorant and change over time

Menu Fatigue

Tracked using daily meal questionnaires



Breakfast

- Scrambled egg
- Sausage
- Waffle
- Syrup
- Strawberries
- Milk
- Orange juice

Meal items are scored on a Likert scale

Appearance and Acceptability

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|-------------------|-------------------|--------------------|------------------|--------------------------|---------------|-----------------|----------------|----------------|
| Dislike extremely | Dislike very much | Dislike moderately | Dislike slightly | Neither Like nor Dislike | Like Slightly | Like moderately | Like very much | Like extremely |

Interest in Consuming Food

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|-------------------------------|--------------------------|--------------------------------|------------------------------|--|-------------------------------|---------------------------------|---------------------------|--------------------------------|
| Extremely reluctant to eat it | Very reluctant to eat it | Moderately reluctant to eat it | Slightly reluctant to eat it | Neither interested in it nor reluctant | Slightly interested to eat it | Moderately interested to eat it | Very interested to eat it | Extremely interested to eat it |

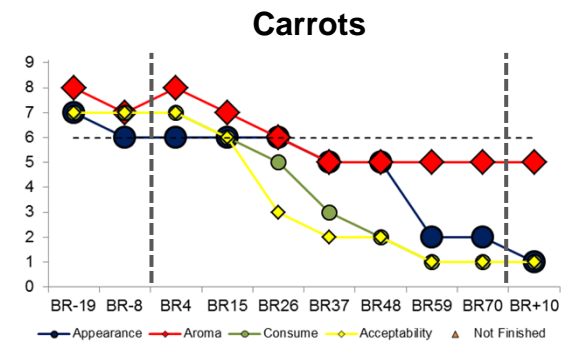
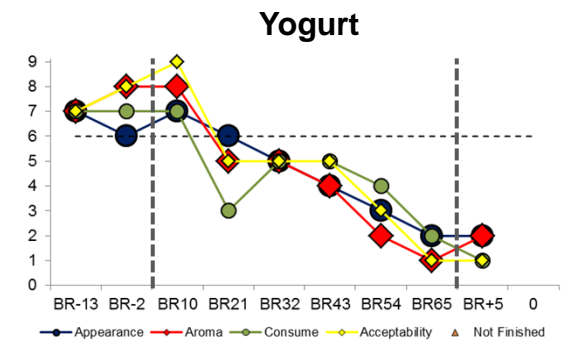
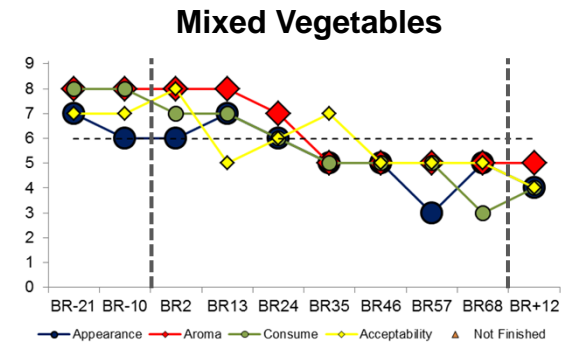
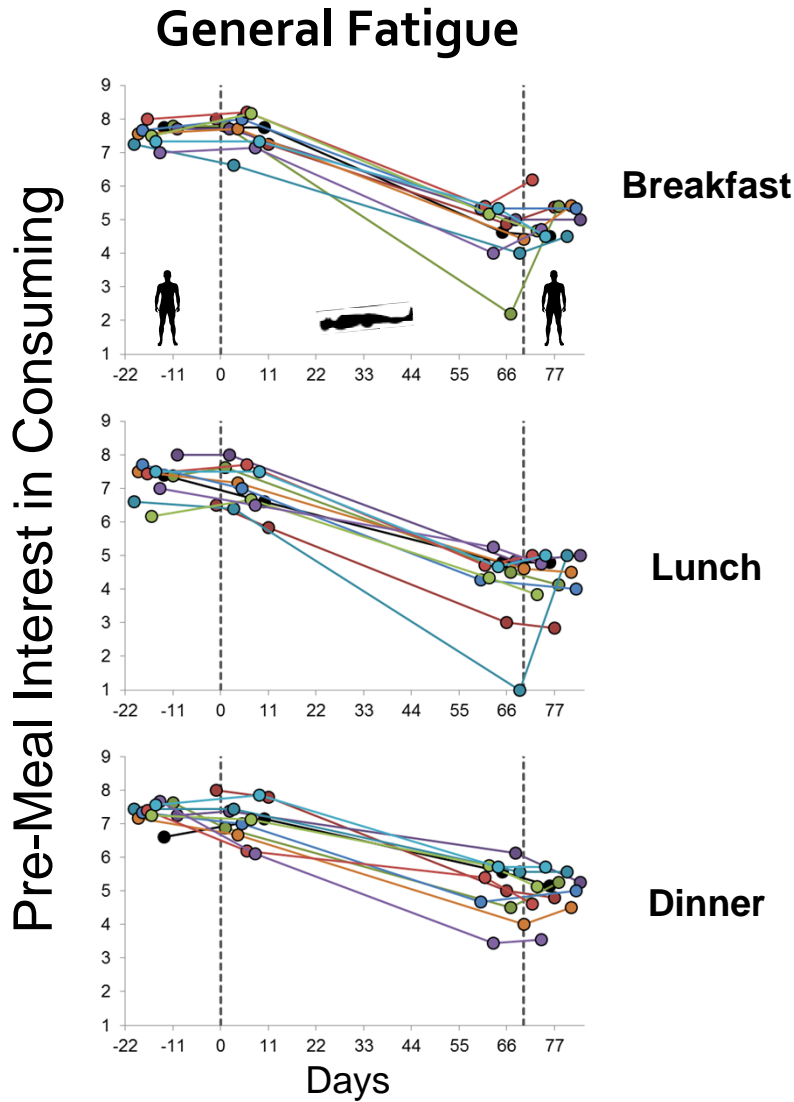
Satiety

| -3 | -2 | -1 | 0 | 1 | 2 | 3 |
|------------------|--------|-------------|-----------------------|----------------|-----------|----------------|
| Extremely hungry | Hungry | Semi-hungry | No particular feeling | Semi-satisfied | Satisfied | Extremely full |

Meals are repeated every 11 days
 During the study, a subject will eat the same meal up to 9 times, with a serving of every meal presented during pre- and post-bed rest.

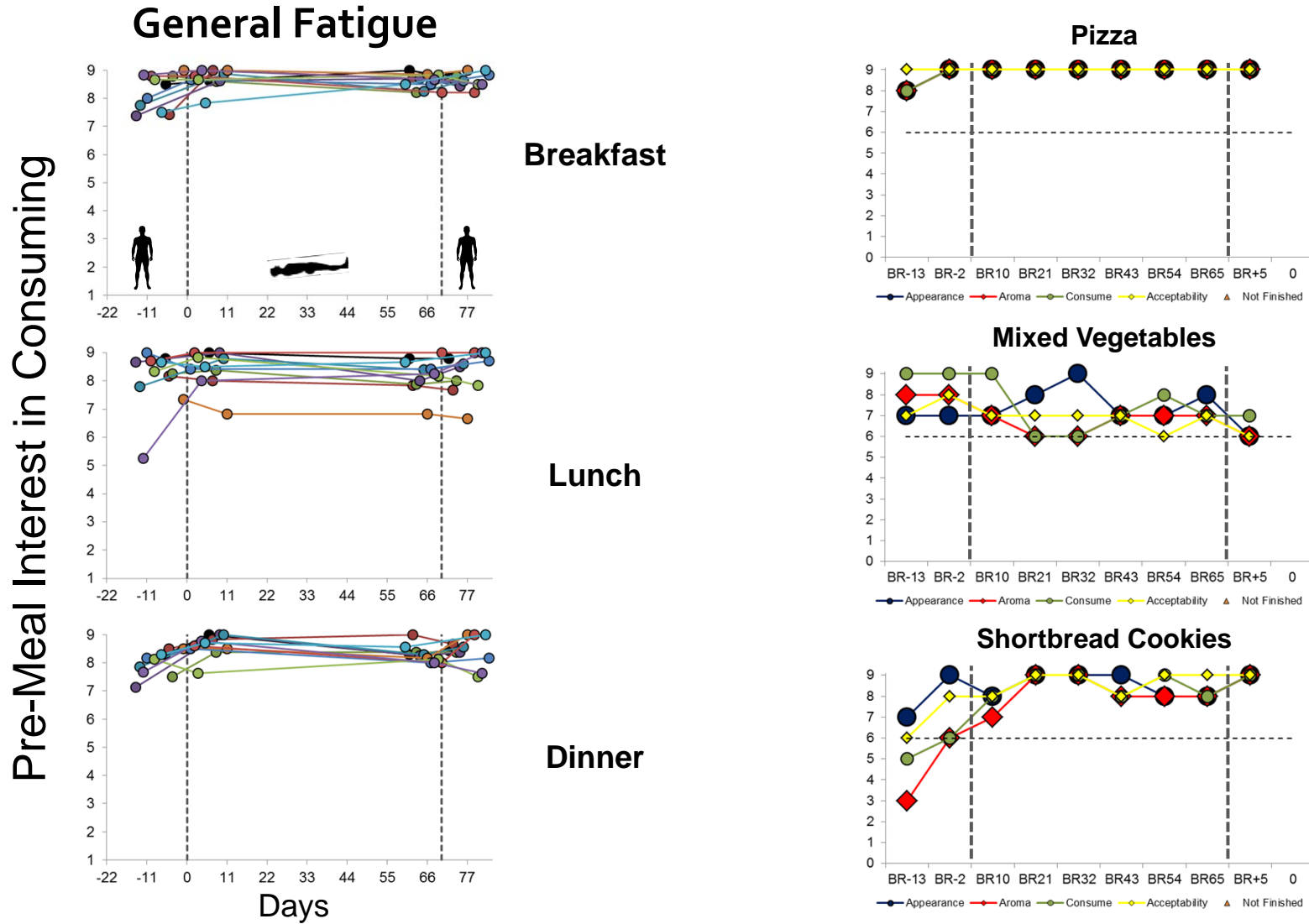
General Menu Fatigue

“Interest in consuming” meals drops by 2 points during the study



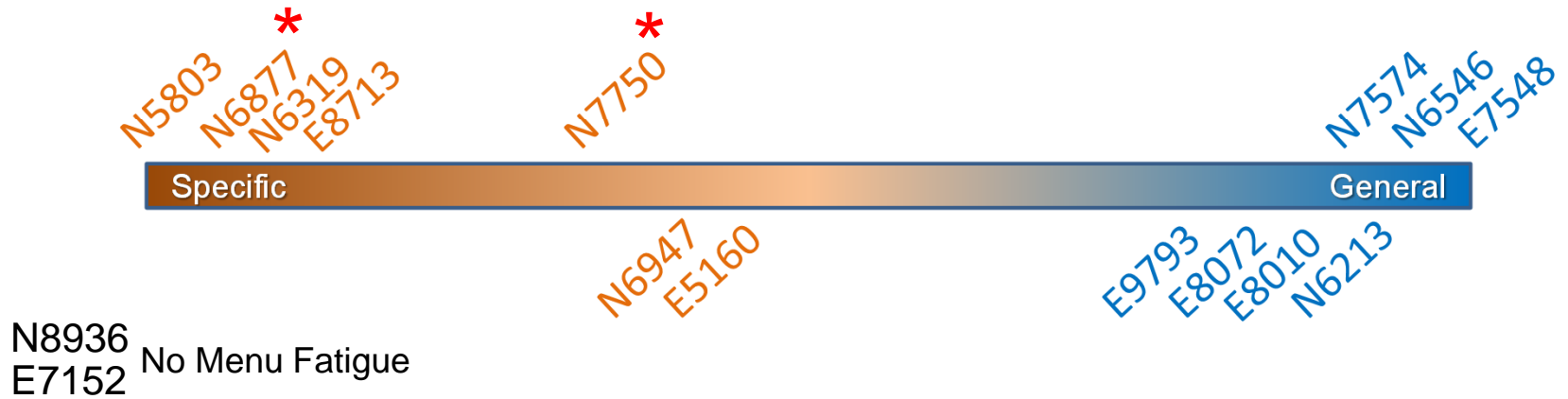
Specific Menu Fatigue

“Interest in Consuming” meal *items* drops by 2 points during the study

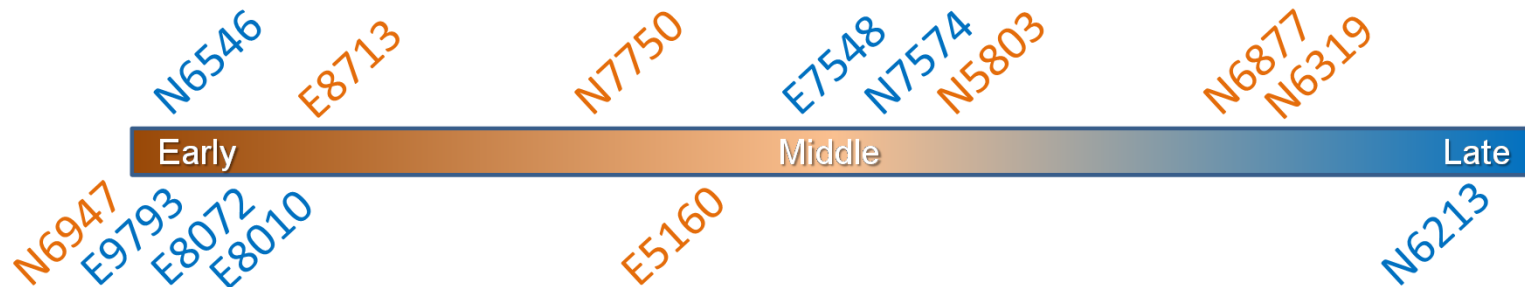


Summary

Menu Fatigue Spectrum of Response



Menu Fatigue Onset



Daily Mood and Health

How you feel right now

Elated/Depressed

Unsure/Confident

Hostile/Agreeable

Composed/Anxious

Confused/Clear-headed

Tired/Energetic

Today's High Point, if any:

Today's Low Point, if any:

Usual State of Health (USH)

7. Unusually healthy and vigorous

6. Somewhat better than usual

5. In typical health for me

4. Not quite 100%

3. Not feeling well, but able to eat my meals and complete tasks

2. Missed test/activity or a meal due to a health issue

1. Need medical care outside of FARU

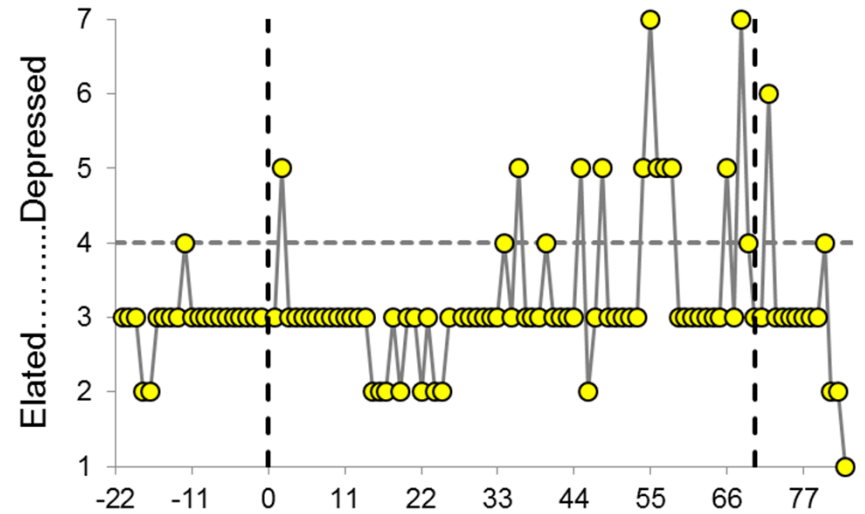
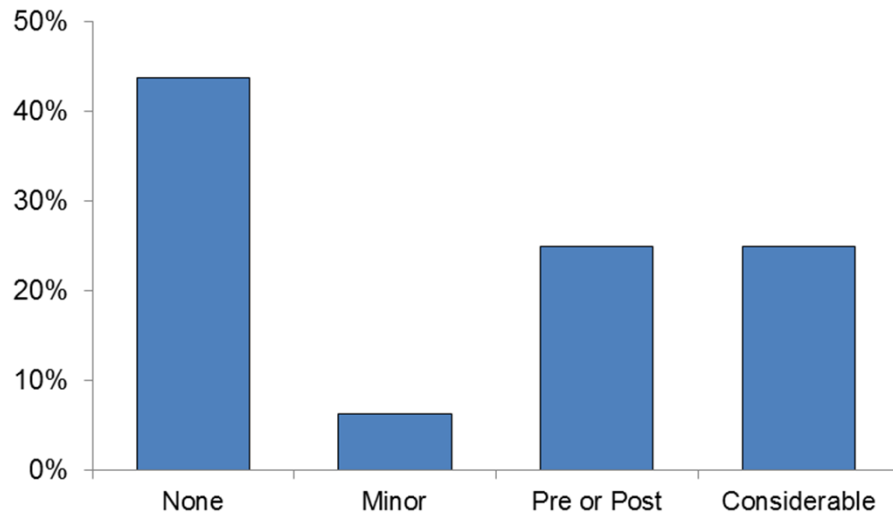
Rated on a scale of 1 - 7

Text description required

Choose one state, if < 5
note symptoms on next page

Daily Mood and Health Results

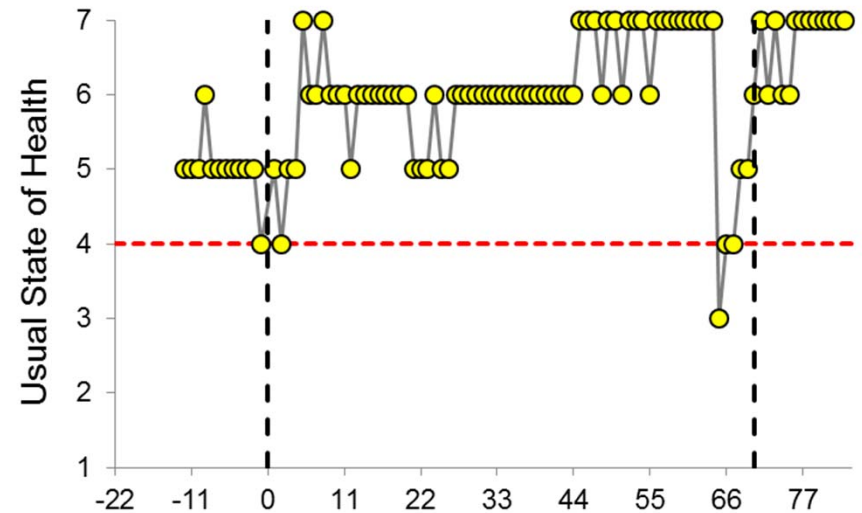
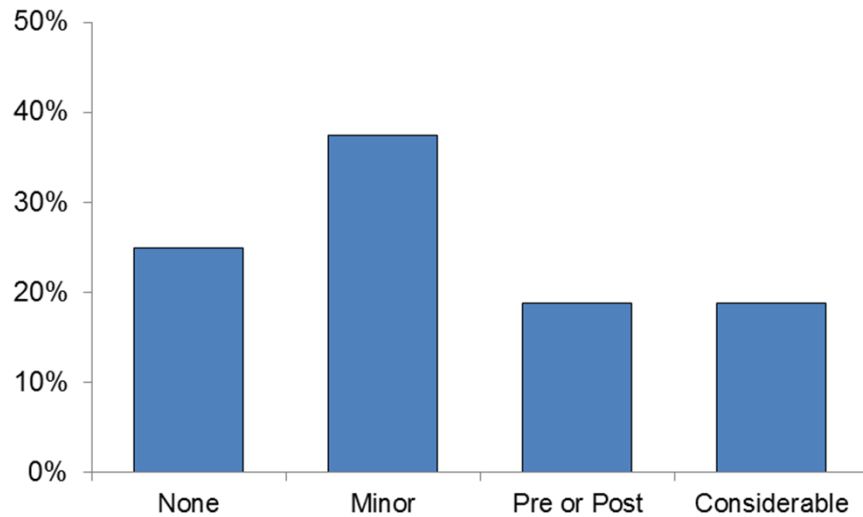
Change of Mood



Most subjects remained in positive mood throughout the study

Daily Mood and Health Results

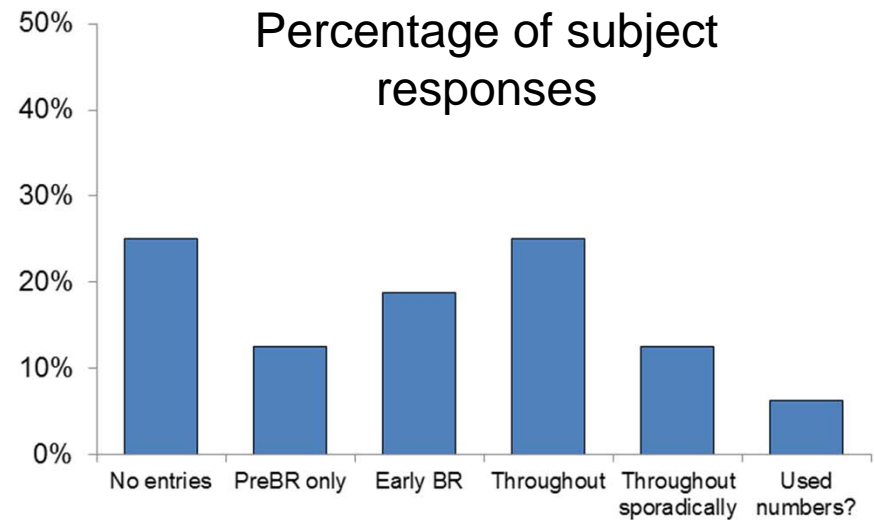
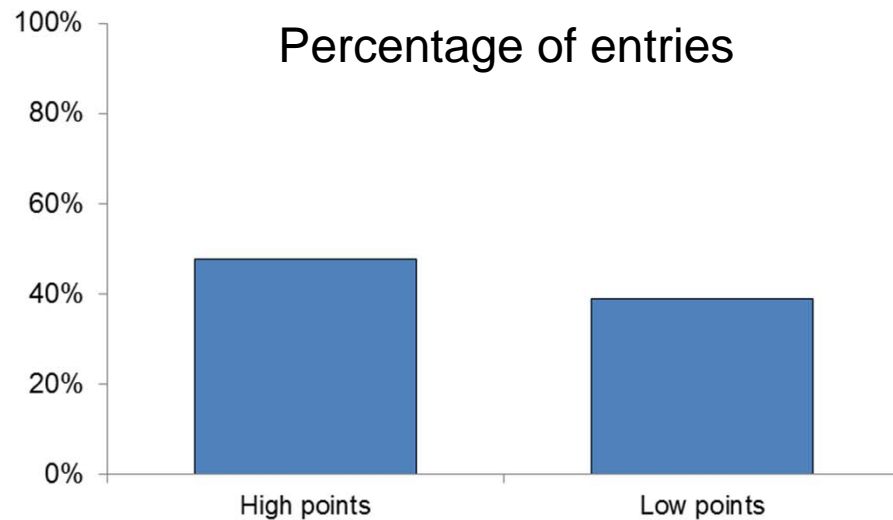
Usual State of Health



Most subjects chose “typical health” (5) throughout the study, and chose “not quite 100%” (4) in the early and post-BR phase

Daily Mood and Health Results

High and Low Points



Low compliance may be due to the phrase “if any”

Daily Mood and Health Results

High points

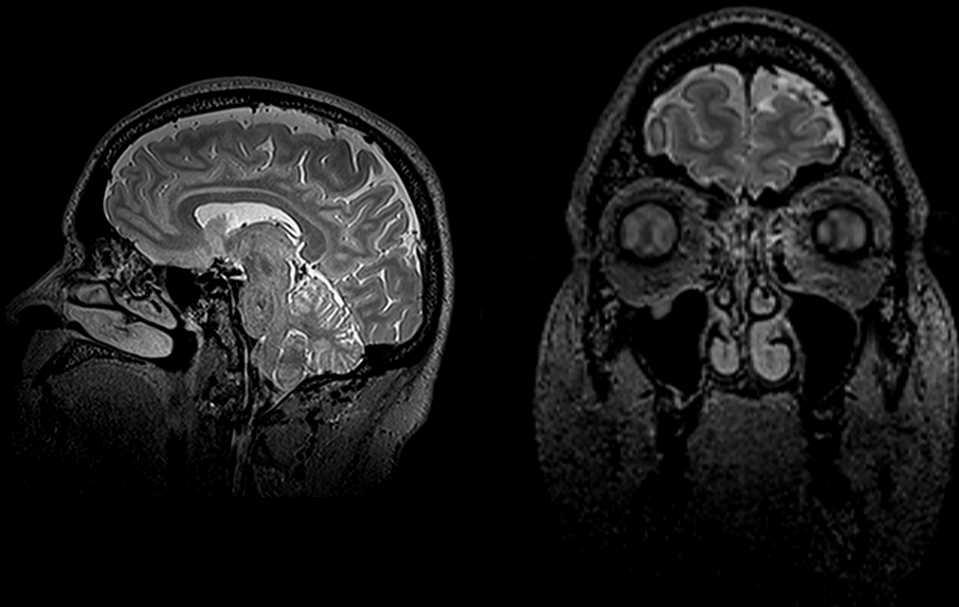
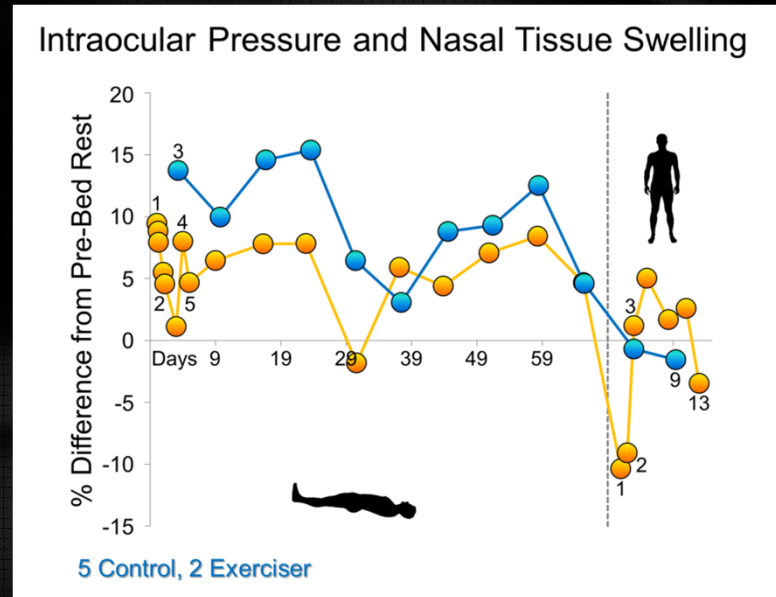
Talking with wife, or family visits
Workouts
Food
Going outside
Massage
Showers
Ice cream
Visitors (astronauts, BBC)
Reconditioning
Getting own room
Social interactions
Birthday
Personal achievements
Specific tests (MRI, FTT, NP/OID)
None

Low points

Biopsy
Muscle soreness
Headache
Food
Irritation with staff
Bad news from outside
Changes in posted schedule
Waking up early
Hunger
Specific tests (MRI, Tilt tests, NP/OID)
None

Data Sharing

Gianmarco Vizzeri
Intraocular pressure
and nasal tissue swelling



Rachael Seidler

Anatomical images of
nasal passages

Data Analysis and Data Sharing

What we have but haven't processed

- **Odorant Identification data**
 - Much to do to understand the response to individual odorants and which parts of this data will benefit food manufacturing for space environments
- **Nasal Patency data**
 - Understanding the deeper nasal response: MRI anatomical data makes this possible.
 - How the nasal response fits into the whole head response to fluid shift (VIIP).

Data Analysis

What we have but haven't processed

- **Menu Fatigue and DMH data**
 - Understanding the factors that precipitate Menu Fatigue: Mood? Physiology? Environment? Can onset be defined?
 - More robust data about mood change would be appreciated

HISEAS Mars Exploration Analog

- **HISEAS data**
 - A crew of six were isolated for four months in 2013
 - We have data on Nasal Patency, Odorant Identification, and Menu acceptability as a control data set for the BR subject data
 - HISEAS offers opportunities for external research projects
 - Currently nearing the end of HISEAS 2 (4 month mission started in April this year), and have an 8 month and 12 month mission funded for 2014 and 2015

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