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MASTERARBEIT

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„Salt taste detection thresholds and pleasantness of test meals varying in salt content after bariatric surgery and weight loss in morbid obese persons “

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Danksagung

„Das eigentliche Studium der Menschheit ist der Mensch.“

Johann Wolfgang von Goethe

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Abbreviations

AFC: alternative forced choice

ASTM: American Society for Testing and Materials

BET: Best-estimate threshold

BMI: body mass index

CD36: Cluster of Differentiation 36

CHC: chronic hepatitis C

CI: confidence interval

ENaC: epithelial sodium channel

GPCRs: G-protein-coupled receptors

HCN: Hyperpolarisation-activated cyclic-nucleotide-gated

ISO: International Organization for Standardization

LA: Linoleic acid

LAGB: laparoscopic adjustable gastric banding

MG: megajoule

MSG: monosodium glutamate

RYGB: Roux-en-Y gastric bypass

SD: Standard Deviation

SDT: salt detection threshold

TBC: taste buds cells

TRCs: taste-receptor cells

VLCD: very low calorie diet

WHO: World Health Organization

1. Abstract

This study examined possible differences in salt taste detection between obese test persons before and after bariatric surgery compared to non-obese individuals.

The salt detection threshold was measured with the 3-alternative forced choice test, including eight ascending concentrations of sodium chloride to assess the sensitivity to saltiness. By evaluating the hedonic liking of five cream soups varying in their salt content the potential liking of salty food has been tested with a 9-point hedonic scale, where test persons had to list their hedonic ratings for five cream soups. Moreover a food questionnaire was assessed to identify the liking and frequency of eating meals with a greater salt content.

For the study 35 obese test persons were recruited from the obesity clinic of the Vienna General Hospital. The patients groups consisted of 13 female and 22 male obese persons with a mean age of 45,40 years and a mean BMI of 43,35 kg/m^2 before bariatric surgery. For the gender and age matched, non-obese control group 30 healthy volunteers, consisting of 16 female and 14 male volunteers with a mean age of 41,03 years and a mean BMI of 23,87 kg/m^2 were recruited from several departments of the Vienna Medical University and other companies. Taste acuity measurements were obtained before and three months after bariatric surgery in patients and only once in the control group.

The results showed no significant differences in the mean salt detection thresholds between obese (Mean ± SD 0,42 ± 0,24g NaCl/L) non-obese individuals (Mean ± SD 0,50 ± 0,44gNaCl/L). Following bariatric surgery, a significant change in the salty taste was observed with a trend toward a decrease in salt detection and recognition thresholds (Mean ± SD 0,66±0,48gNaCl/L). Results of the cream soup likings revealed significant gender specific differences between obese and non-obese test persons; especially the female participants did not like the soups at all. However no significant changes were detectable before and after surgery.

Furthermore no significant differences in the liking and frequency of eating salty meals were found between the obese and lean control group.

The following findings would therefore suggest that bariatric surgery can even worsen the salt detection threshold of patients after bariatric surgery. Furthermore gender should be taken into consideration when conducting a sensory study.

2. Deutsche Übersetzung des Abstracts

Das Ziel dieser Masterarbeit war es, mögliche Unterschiede in der Salzgeschmackserkennung von adipösen Personen vor und nach einer bariatrischen Operation im Vergleich zu einer normalgewichtigen Kontrollgruppe zu untersuchen.

Unter der Annahme, dass übergewichtige Personen eine erhöhte Vorliebe für salzhaltige Speisen aufweisen, wurde mittels 3-alternative forced choice test, welcher aus acht ansteigenden Salzkonzentrationen bestand, die Salzerkennungsschwelle der Probanden eruiert. Um die Beliebtheit von salzhaltigen Speisen zu ermitteln, wurden fünf Rahmsuppen mit unterschiedlichen Salzkonzentrationen mittels einer Neunpunkteskala von den Probanden bewertet. Weiteres wurden die Ernährungsgewohnheiten und die Häufigkeiten von salzhaltigen Speisen und Lebensmitteln mittels eines Ernährungsfragebogens erhoben.

Für die Studie wurden 35 adipöse Testpersonen aus der Adipositas Ambulanz des Allgemeinen Krankenhauses (AKH) Wien rekrutiert. Die Patientengruppe bestand aus 13 weiblichen und 22 männlichen adipösen Testpersonen mit einem durchschnittlichen Alter von 45,40 Jahren und einem durchschnittlichen BMI von 43,35 kg/m^2 vor der Operation. Die auf das Alter und das Geschlecht abgestimmte Kontrollgruppe bestand aus 30 gesunden Probanden, wovon 16 weiblich und 14 männlich waren. Die Kontrollgruppe wies ein durchschnittliches Alter von 41,03 Jahren und einen durchschnittlichen BMI von 23,87 kg/m^2 auf und wurde von verschiedenen Instituten der Medizinischen Universität Wien und anderen Firmen rekrutiert.

Die Ergebnisse der Studie ergaben keine signifikanten Unterschiede zwischen der Salzerkennungsschwelle von adipösen und normalgewichtigen Testpersonen. Signifikant unterschiedliche Ergebnisse in der Salzerkennungsschwelle konnten nach der bariatrischen Operation festgestellt werden, wobei es zu einer verringerten Empfindlichkeit gegenüber dem Salzgeschmack kam. Die Ergebnisse von der Beliebtheit der Rahmsuppe offenbarten signifikant geschlechtsspezifische Unterschiede zwischen adipösen und nicht-adipösen Kontrollpersonen. Vor allem weiblichen Studienteilnehmerinnen schmeckten die Suppen nicht. Unterschiede in der Beliebtheit der Suppen vor und nach dem bariatrischen Eingriff konnten jedoch nicht festgestellt werden. Desweiteren ergab die Auswertung des Ernährungsfragebogens keine Unterschiede in den Essgewohnheiten von übergewichtigen und normalgewichtigen Testpersonen.

Die Ergebnisse der Studie zeigen, dass bariatrische Operationen die Salzerkennungsschwelle verschlechtern können. Desweiteren sollte bei jeder sensorischen Testung der Einfluss des Geschlechts auf die Ergebnisse berücksichtigt werden.

3. Introduction

Reaching epidemic dimensions obesity is the most leading reason of death in adults and children worldwide. The health consequences are diet-related chronic diseases, like type 2 diabetes, cardiovascular disease, stroke and hypertension.

Beside environmental, social and genetic factors, the main cause of obesity is a positive energy balance with an increased consumption of energy dense food, which is high in sugar and fat, in combination with a lack of physical activity. [WHO Fact Sheet Nr 311, 2014]
Furthermore obese people tend to have different taste and smell perceptions, which can influence their choice of food. [Drewnowski 1997]

Former studies especially investigated a change in the sweet taste perception of obese people after bariatric surgery whereas other studies detected a reduction in the bitter taste perception. [Bueter M. et al. 2011; Scruggs DM et al. 1994]

Studies also suggest that people undergoing bariatric surgery complain about side effects like altered taste perception, especially in the sweet and salt taste [Scruggs et al. 1994]. Other studies observed a decreased desire for sweets and fast foods with in turn leads to a lower intake of calories [Pepino et al. 2013]. Some patients developed an aversion of food after bariatric surgery, which in some cases lead to depressions, nutritional deficiencies and despair [Traub Jennifer 2012].

Furthermore several diseases (e.g. type 2 and 1 diabetes, chronic kidney diseases, cirrhosis), drugs and micronutrient deficiencies can influence the human taste. As a consequence qualitative disorders like ageusia, hypogeusia and hypergeusia and quantitative disorders like dysgeusia and phantogeusia occur and lead to the impairment of taste and the loss of appetite. [Daly et al. 2012, Gondivkar et al. 2009, Hummel et al. 2011]

Especially looking at the topic of salt taste and their alterations in obese persons the study results are very inconsistent and rare. In massively obese adolescents and children salt recognition thresholds were lower compared with a lean control group [Pasquet et al. 2007]. Another study showed that overweight women liked the taste of salty food more than normal-weight or obese women, but the converse was true for overweight men [Donaldson et al. 2009]. Only changes in the bitter and sour tastes were found in the study by Simchen et al. and no effects could be observed looking at the salt and sweet taste [Simchen et al. 2006] and Pasquet et al. 2007, was one of the researchers, who was not able to identify a higher sensitivity for the salty and sweet taste in obese persons compared to a non-obese control group [Pasquet et al. 2007].

Most of the available studies are inconsistent in their results and only a small amount of literature, dealing with the specific changes of salty taste in obese persons, is available until now. In the majority of cases most of the studies focused on the changes of the sweet and bitter taste.

Therefore the study aims to analyse the differences in the taste perception of salt of obese persons before and after bariatric surgery in comparison with a non-obese control group.

The next chapters will give an overview of the existing literature dealing with the three topics obesity and their comorbidities, taste perception in general, nutrients which can influence the taste and weight loss-surgeries.

Literature research was operated on www.sciencedirect.com and www.pubmed.com.

3.1 Obesity

Obesity has become a major problem and health risk in our society. The World Health Organisation claimed that the numbers of obese persons doubled since 1980. In 2008 more than 4 billion adults were overweight. 200 million men and 300 million women of these were obese worldwide. [WHO Fact Sheet Nr. 311, 2014]

According to the latest numbers of the Austrian Nutrition Report 2012, "40 percent of Austrian adults aged between 18 and 64 years are overweight (52% of men and 28% of women) and out of this 12 percent are obese (15% of men and 10% of women)". [Elmadfa et al. 2012]

Overweight and obesity is defined by the World Health Organisation as an excessive fat accumulation, which can impair a person's health. [WHO Fact Sheet Nr. 311, 2014]

To measure and classify the level of overweight and obesity the Body Mass Index (BMI) is the most commonly used method. Since 1995 the WHO has accepted the BMI as an appropriate anthropological method. [James W.P.T. 2008]

Adolphe Quetelet was the first person, who described and defined the BMI in the nineteenth century. He stated that the body weight was proportional to the square height in adults and expressed following formula to estimate the BMI. [Romero Corral A. et al. 2008]

$$BMI = \frac{mass(kg)}{(height(m))^2}$$

[Romero Corral A. et al. 2008]

The table below (see Table 1) shows the BMI classification of the WHO. According to this classification table a BMI from 30 upwards implies obesity. Obesity is furthermore dived into three grades, which ranges from class I to class III obesity. [WHO BMI Classification, 2014]

Table 1: BMI Classification (WHO BMI Classification, 2014)

BMI	Classification
< 18.5	underweight
18.5–24.9	normal weight
25.0–29.9	overweight
30.0–34.9	class I obesity
35.0–39.9	class II obesity
≥ 40.0	class III obesity

Factors that can lead to overweight and obesity are wide. It is assumed that an interaction of a positive energy balance over a long time in combination with environmental, social and genetic factors and physical inactivity have an influence on the development of obesity. [Lau et al. 2007]

The mechanization of many jobs and the changes in the mobility of persons, due to a greater offer of transportation options induce a decrease in physical activity during work and leisure activities in private life. [Seidell Jacob C. 2000]

Urbanisation and economic growth promoted a change in the eating behaviours of the population. Nowadays people tend to consume diets high in carbohydrates, fats and sugars more frequent than before. Fast food restaurants, convenience foods and take away meals become more and more popular because of our stressful daily life with no time for cooking. Therefore the combination of fast food consumption, rapid eating and a lack of exercise is one of the main causes for obesity. Apart from that low socioeconomic status, education and income are also discussed as possible reasons. [WHO “Obesity and Overweight” 2003, Seidell Jacob C. 2000, Bellisle et al. 2012]

The study by Drewnowski 2007 pointed out that people with a lower income tend to consume more low cost and low quality foods, like cereals, potatoes and meals with a high fat and sugar content and are frequent fast food users than people with a higher income. He also noted that these people are less physical active and show a higher tendency of becoming obese. [Drewnowski 2007]

In fact obesity can cause many severe health problems, also called no communicable diseases (NCDs), including cardiovascular diseases, cancer, chronic respiratory diseases and diabetes. NCDs are chronic diseases, which have a long duration and slow progression and are not passed from person to person. With an increased BMI the risk of developing NCDS is increased. As a matter of fact this problem is particularly a big burden for the health care systems worldwide. High amounts of money have to be spent for the health costs of these people. [WHO Factsheet Noncommunicable Diseases 2013, Lau et.al. 2007]

3.2 Taste

The human taste, also known under the name gustation, is a very complex sensation and only appears during the intake of food. In humans the gustatory perception is classified into five basic tastes, including sweet, sour, salty, bitter, and umami. [Daly et al. 2012]

Taste and flavour have a strong influence on the acceptance of a food product or ingredient. It is supposed that this reaction is a combination of genetic inheritance, culture, family, environment and in some ways it can also be a survival instinct of humans from former ages.

Foods with a sweet taste are indicating energy-rich foods with a high content of carbohydrates and calories whereas umami is indicating foods rich in proteins and peptides. Furthermore the human aversion against bitter tasting food components can protect the body from eating toxic substances.

[Daly et al. 2012]

Even new-borns are reacting in different ways, when giving them solutions of the five basic tastes (see Figure 1). [Daly et al. 2012, Clark 1998]

Steiner et al. for example examined the facial expressions evoked by different tastes in babies. He was able to show that sweet tasting solutions were very well accepted, which was expressed with a smile and wide open eyes whereas the bitter tasting solution caused a wide open mouth with compressed eyes and the turning of their head. In a further study these behaviour patterns were also detected in non-human primates. [Steiner et al. 2001]

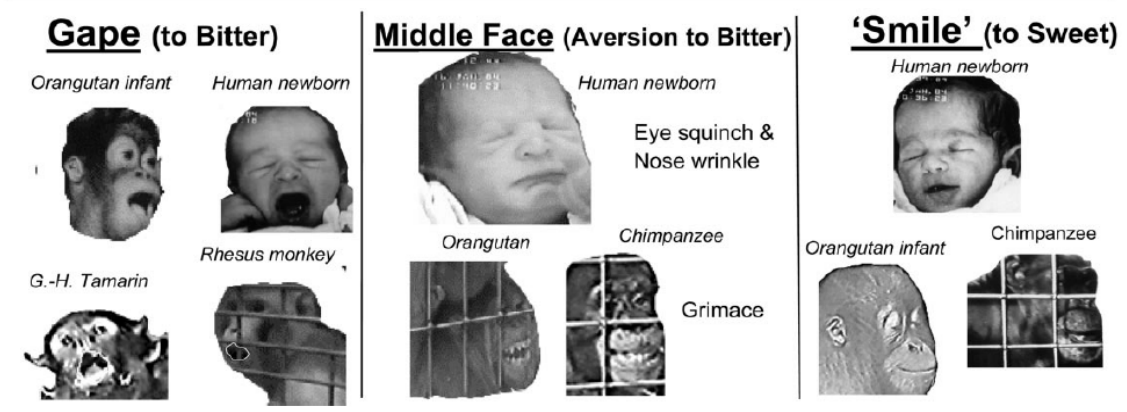


Figure 1: Positive hedonic and aversive components of facial expression to taste [Steiner et al. 2001]

To taste all these flavours, the different substances in the meal have to react chemically with the taste receptor cells, which are centred in the taste buds. A taste bud includes 50-100 taste cells. The taste buds furthermore consists the basal cells, the taste pore, microvillae and gustatory afferent axons (see Figure 2). [Wu et al. 2014]

Taste buds are mainly located in the mouth, in the pharynx and on the tongue, where they are allocated across papillae. [Chandrashekar et al. 2006]

The human tongue possesses four kinds of papillae: fungiform papillae, foliate papillae, circumvallate papillae and filiform papillae.

Fungiform papillae are located on the upper part of the tongue and have a shape like a mushroom. Foliate papillae have a leaf like shape and are located sideways on the back

of the tongue. Circumvallate papillae are based at the back of the tongue and are dome-shaped. These three mentioned papillae are the most important ones, because they contain the taste buds in varying numbers.

The filiform papillae do not contain any taste buds and have therefore no gustatory function. In fact they are responsible for the uneven and rough surface of the tongue. They are distributed all over the tongue, have a shape like a cone and are very small. [Daly et al. 2012]

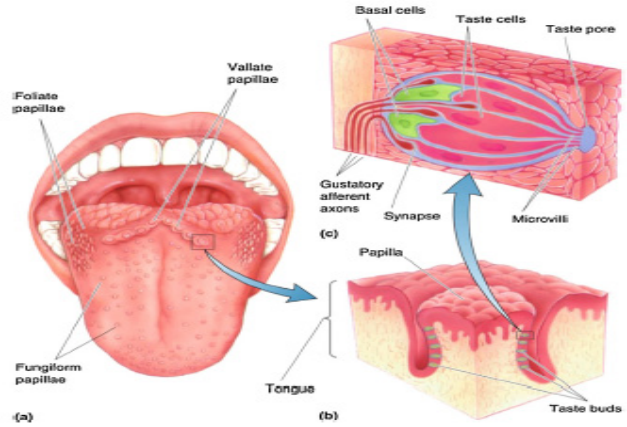


Figure 2: Schematic of the structure and organization of the human tasting sensing system: (a) and the distribution of papillae on the surface of the tongue, (b) the location of the taste buds in a papillae, (c) the structure of the taste bud [Wu et al. 2014]

Gustatory signals are triggered by water-soluble compounds, like sugars, ions or amino acids. These taste agents interact with the apical side of the taste bud so that taste agents, which are dissolved in the saliva, can accumulate in the taste pore. The taste agents are now able to interact with TCR's in the microvillae membrane, which leads to the depolarization of the TCR. As a result neurotransmitter will be released and transmit signals via taste nerves to specific regions of the brain. [Daly et al. 2012, Chaudhari and Roper 2010]

Speaking about coding the different kinds of taste qualities there are two discussed models: the labelled line and across-fibre pattern model.

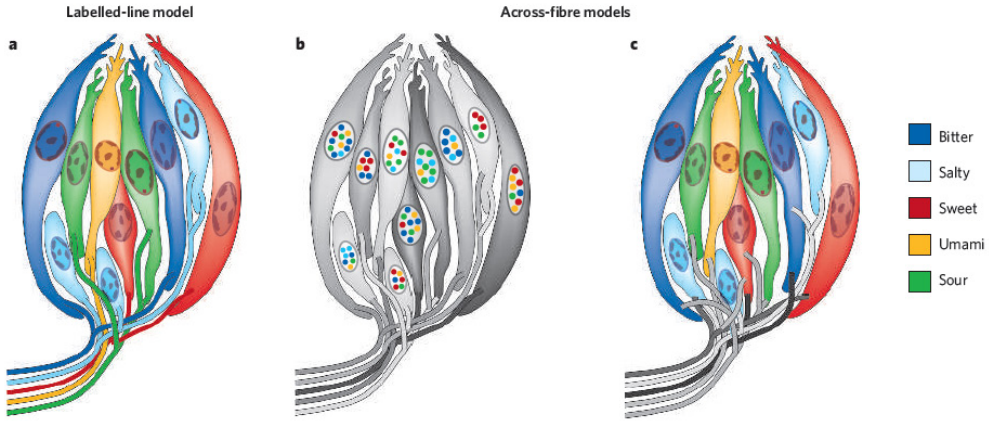


Figure 3: Encoding of taste qualities at the periphery [Chandrashekar et al. 2006]

In the labelled line model (Figure 3.a) taste receptor cells are only responding to one of the four taste modalities (salty, sour, bitter, sweet or umami). This process takes place by innervations of single nerve.

The across fibre pattern model has two approaches. The first approach (Figure 3. b) states that every taste receptor cell is able to respond to each taste modality (salty, sour, bitter, sweet or umami). This effect appears due to the fact that the same afferent fibre transfers the information for more than one taste quality.

The second approach declares (Figure 3.c) that every TCR is only responsible for one taste modality and the information for the taste quality is always transmitted by the same afferent fibre.

[Chandrashekar et al. 2006]

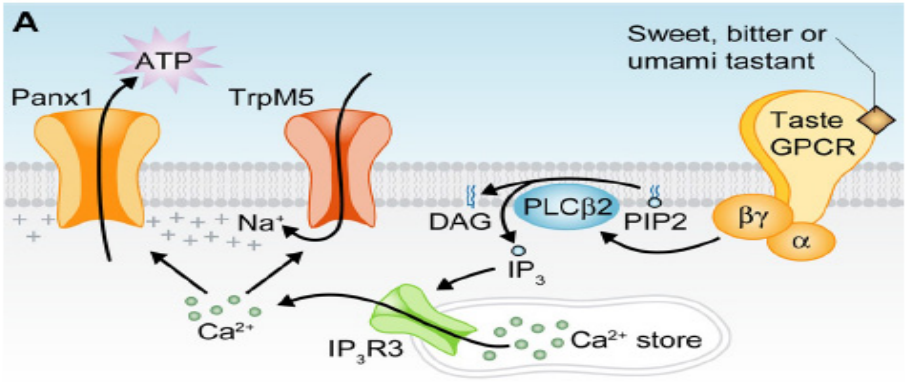


Figure 4: Signal transduction of G-protein coupled taste receptor [Chaudhari 2010]

Sweet, umami and bitter signalling transduction pathways are mediated by G-protein coupled receptors (GPCR'). The basic principle is the same for all three flavours.

The signalling transduction pathway starts with the interaction of a tasting agent with a heterotrimeric G protein complex (see Figure 4). This complex consist a Gα-Gustducin, Gβ and Gγ-subunit, which dissociates into the Gα-fraction and Gβ-Gγ-fraction after the activation by a TCR. The activation of phospholipase Cβ2 through Gβ-Gγ-fraction leads to the production of the two second messengers diacylglycerol (DAG) and inositol-1, 4,5-triphosphate (IP_3). Further IP_3 supports the release of Calcium-ions from the endoplasmic reticulum (ER). Intracellular Calcium levels are increasing and cause the depolarization of the transient receptor potential channel (TRPM 5) and the opening of the non-selective kation-channel. As a result ATP is exhausting and provokes the stimulation of nerves and the secretion of neurotransmitter. [Behrens et al. 2011]

The pathway will always be the same, only the taste receptors differ between the sweet, bitter and umami taste.

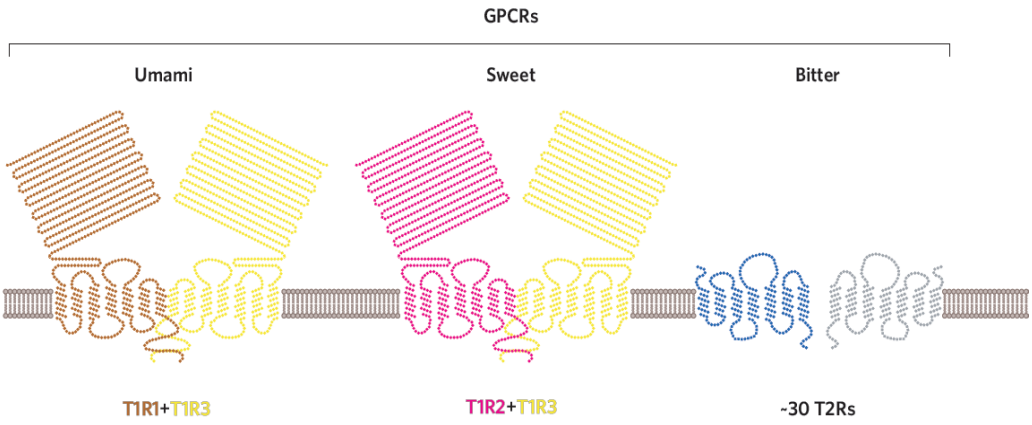


Figure 5: The receptors for umami, sweet and bitter [Chandrashekar et al. 2006]

For example the receptors for sweet and umami belong to the TAS1R family (taste receptor type 1) and are both heterotrimere receptors with different subunits. The sweet taste receptor provides the subunits TAS1R2 and TAS1R3. This receptor is responding to natural sugars, artificial sweeteners, D-amino acids and sweet proteins. The umami like receptor consist the subunits TAS1R1 and TAS1R3. In humans only monosodium glutamate (MSG) and aspartate are able to trigger the umami like taste (see Figure 5).

The taste receptors for bitter belong to the T2Rs-family. More than 30 different taste receptor genes are able to trigger the bitter taste. The bitter tasting compounds differ in their chemical composition and chemical structure, which makes the discrimination between these chemicals difficult. Humans are able to recognize the taste of bitter as unpleasant and sharp, so it prevents us of the ingestion of toxic compounds; however the discrimination between the various substances is limited. On account of this it is an overall believe that the bitter taste is an evolutionary caused defence mechanism.

[Behrens et al. 2011, Chandrashekar et al. 2006, Delay et al. 2012]

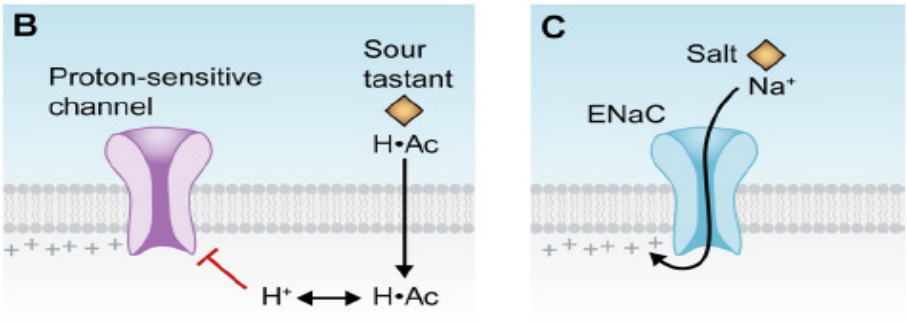


Figure 6: The signalling pathways of sour and [Chaudhari 2010]

The modulation of sour and salt is mainly mediated by the inflow of Na^+ and H^+ ions through membrane channels, which are located on the apical surface of the cell.

There are many mechanism and receptors discussed when talking about the development of the sour taste. Possible mechanisms are acid-sensing ion channels (ASICs), potassium and H^+-guided calcium channels and hyperpolarization-activated cyclic nucleotide-activated (HCN) channels. [Chandrashekar et al. 2006]

Figure 6B shows the permeation of an organic acid (HAC) through the plasma membrane. After passing the membrane, HAC dissociates into H^+ ions and Ac and acidifies the cytosol. The proton sensitive K^+-channel is blocked by H^+ ions, which leads to the depolarization of the cell (see Figure 6B).

Salt taste develops only under the assumption of the dissociation of ions. Both anions and cations are able to produce this taste intensity. Eating salty dishes causes the influx of Na^+ ions through ENaCs and the depolarization of the receptor cell. ENaCs are proteins which are able to produce pores in the surface of the cells. Na^+ therefore can enter the taste receptor cells via these pores and provokes the depolarization of the cell (see Figure 6C).

[Yamamoto and Ishimaru 2013, Delay et al. 2012]

3.2.1. Factors, which influence taste acuity

Several diseases, our environment and genetic factors and can have an influence on the gustatory system with the impairment of taste. This can lead to the loss of appetite, malnutrition, especially in elderly people, weight loss and a reduced life quality.

Two types of taste disorders are known: qualitative and quantitative disorders.

Qualitative disorders include ageusia, hypogeusia and hypergeusia. Ageusia means the absence of taste. Its occurrence is quite rare in people because of the sufficient stimulation of the tongue with gustatory impressions. Hypogeusia is the reduced ability to taste sweet, sour, bitter or salty substances, whereas increased sensitivity of taste is called hypergeusia.

Quantitative disorders include dysgeusia and phantogeusia. Dysgeusia is an impaired taste perception. People suffering of dysgeusia are often complaining that they perceive a metallic or bitter taste when eating a dish. Phantogeusia means the realization of a taste modality when no taste stimulus is current.

[Maheswaran et al. 2014]

Alterations of the human taste can as well be influenced by many drugs, like antihistamines, antibiotics, antidepressants and diuretics (see Figure 7). As a result hypogeusia and dysgeusia is very often diagnosed in people taking these drugs alone or in combination with other medication. Moreover antihypertensive medications like angiotensin-converting enzymes are in discussion of affecting the taste sensitivity. [Daly et al. 2012, Gondivkar et al. 2009, Hummel et al. 2011]

Sulibursk a et al. 2012 pointed out that when taking angiotensin-converting enzymes (ACE 1) in combination with a diuretic and a calcium channel blocker, taste dysfunctions are more likely to occur than in patients not taking any ACE 1's. [Sulibursk a et al. 2012]

Discussed mechanism leading to taste dysfunctions are functional disorders of sensory cells in nerves, deficiencies of vitamins and minerals, like Zinc or Vitamin B12 and an impaired chemoperception. For example low zinc levels are discussed to provoke hypogeusia in people, whereas a zinc supplementation may enhance the taste impairment in patients taking ACE 1's. [Suliburska et al. 2012]

Group	Examples
Antibiotics, Antimycotics	Ampicillin, cefamandole, tetracycline, bleomycin, lincomycin, ethambutol, amphotericin B, griseovulvin, metronidazole, terbinafine
Antiepileptics	Carbamazepine, phenytoin
Antihistamines	Chlorpheniramine, trifluoperazine
Immunosuppressants	Doxorubicin, methotrexate, azathioprine, vincristine
Antirheumatic drugs	Gold, phenylbutazone
Antiseptic agents	Hexetidine
Antithyroid drugs	Thiouracil, methimazole, carbimazole
Corticosteroids	Dexamethasone, hydrocortisone
Diuretics, Antihypertensives	Acetazolamide, amiloride, captopril, diazoxide, diltiazem, enalapril, nifedipine
Antidiabetics	Glipizide, phenformin
Local anaesthetics	Tetracaine, benzocaine, lidocaine
Muscle relaxants, Antiparkinson drugs	Baclofen, chlormezanone, L-DOPA
Psychopharmaceuticals	Amphetamines, psilocybin
Vasodilators	Dipyridamole, nitroglycerin
Other	Allopurinol, colchicine, etidronate, iron, phenindione, lithium

Figure 7: Drugs causing taste disorders [Hummel et al. 2011]

Furthermore systemic disorders such as diabetes mellitus, pernicious anaemia and crohn's disease can as well favour the development of taste dysfunctions. [Maheswaran et al. 2014]

For instance Gondivkar et al. 2009 investigated the gustatory function of patients with type 2 diabetes. Many people with type 2 diabetes suffer from hypogeusia which has an impact on their diet and as a consequence on their glycemic regulation. 40 controlled diabetes mellitus type 2 patients and 40 uncontrolled patients were examined in this study. A whole-mouth above-threshold test was performed. The test contained three cups, one with the test stimuli and two cups with distilled water. The test persons had to identify the quality and intensity of the solutions. The test results revealed hyposensitivity of sweet, sour and salty tastes in diabetic subjects. Furthermore the study results showed that 80% of the uncontrolled and 50% of the controlled diabetic

patients suffered of hypogeusia and six persons of the uncontrolled diabetic patients showed an ageusia to sweet. Referring to these results it can be assumed that the decreased sweet taste sensitivity may result in an increased preference for sweet foods, which can lead to the decline of the hyperglycaemic levels. [Gondivkar et al. 2009]

Similar results were observed in an earlier study by Le Floch et al. 1989, where hypogeusia was detected in patients suffering from diabetes type 1. General taste impairment was found for all four taste modalities in diabetes type 1 patients. In addition peripheral neuropathy was significantly associated with taste dysfunction. [Le Floch et al. 1989]

McMahon et al. 2014 examined taste impairment in patients with chronic kidney diseases (CDK). The recognition for sour, umami and salty was lower in patients with chronic kidney disease compared with a healthy control group. It is presumed that diabetic or uremic neuropathy induces a decrease of fungiform taste buds, which especially has a main influence on the bitter and sweet taste. The lower taste sensitivity for sour stands in close connection with increased levels of bicarbonate ions in the saliva leading to decreased free hydrogen ions. Furthermore zinc deficiencies can also influence the development of taste dysfunctions in chronic kidney disease patients. This assumption is supported by the fact that after the supplementation with zinc, persons showed an improved sensitivity for sweet, salt and bitter. [McMahon et al. 2014]

Limited taste sensitivity of sweet, salty and sour was also apparent in patients with cirrhosis. It is well known that patients with cirrhosis often show a poor nutritional status. Many patients with cirrhosis have low magnesium, zinc, vitamin A and α- and β-carotene concentrations. Particularly serum magnesium was negatively correlated with the detection of salt and the gustatory acuity in patients with cirrhosis. [Madden et al. 1997]

Zinc deficiency can also lead to impaired taste perceptions. Several studies showed that after a supplementation with zinc the gustatory functions and health impairments like dysgeusia could be improved. Furthermore even salt detection thresholds could be

increased after zinc supplementation. [McMahon et al. 2014, Heckmann et al. 2005, Sakai et al. 2002]

In patients undergoing radiotherapy reverse effects could be observed. The study of Najafizade et al. 2013 pointed out that a long term treatment with excessive dosages of zinc can have negative influences on the immune system in cancer patients. It therefore should be kept in mind that when dealing with cancer patients a gently supplementation with zinc would be more beneficial to prevent them of taste alterations. [Najafizade et al. 2013]

Not only low serum zinc levels can have an influence on our gustatory system, also low serotonin and noradrenalin levels can alter the taste perceptions in normal healthy humans. In addition anxious or depressed persons often suffer of an absence of appetite due to a disturbed balance of the neurotransmitter serotonin and noradrenalin. Decreased levels of serotonin and noradrenalin lead to a reduced taste perception of sweet, bitter and sour. [Heath et al. 2005]

Age is another important factor when speaking about taste perception. Becoming older the taste buds decrease and as a result the taste perception is reduced. A significant decline of the salty taste is mostly common in elderly, followed by umami. Furthermore men show a higher decline of their taste sensitivity than women. [Mojet et al. 2001]

Women, independent of age, are more affected of variations of the salt taste during the various phases of menstrual cycle. Verma et al. 2005 stated in their study that this can be associated with the high progesterone and oestrogen levels. In their study women were more annxious for salty popcorn during the luteal phase as during the menstrual phase. [Verma et al. 2005]

These are the most occurring factors, which can influence the human taste. Detailed information about salt and different influences on the salt taste will be discussed in the next chapter.

3.2.2. Obesity and taste

The gustatory and olfactory senses are the most important human senses because of their major role in the enjoyment of food. However gender, age and ethnicity can lead to different perceptions of taste and smell so that not everyone feels the same emotions when eating a dish. Some even believe that obesity plays a very important role in altering the gustatory and olfactory perceptions in people. [Richardson et al. 2004]

The gustatory sensitivity of all four taste qualities were studied in children aged between six and eighteen years in a cross-sectional study. Obese children had difficulties to discriminate the different tastes sweet, sour, bitter and salty whereas this effect was not observed in the non-obese control group. [Overberg et al. 2012]

A similar finding was found in an animal study by Maliphol et al. 2013. Mice were fed a diet with a high fat content to become obese. To see if diet-induced obesity alters the taste preferences a two bottle preference test with five test qualities (acesulfame, sucrose, saccharine, monopotassium glutamate and denatonium) was used. The results revealed that obese mice were less sensitive to the five taste qualities than the normal weight mice. Especially the detection of sucrose and acesulfame was reduced at higher concentrations in obese mice. Therefore the authors concluded that weight gain had an influence on the taste system of obese mice. [Maliphol et al. 2013]

Others as well believe that obesity has an influence not only on the gustatory sense and the taste receptor cells but also on the reward centre and their processes in the brain, which can lead to an enhanced feeling of hunger and as a consequence to an increased food intake. [Berthoud et al. 2012]

Most of the other studies dealing with the topic obesity and changes in taste perceptions had mainly focused on the alteration of the sweet taste.

Drewnowski et al. 2012 stated that the preference for sweet taste is influenced by the experience a baby made. During the period of maximal growth babies often get meals with high contents of sugars, minerals and vitamins, like breast milk and fruits, to keep them growing. Therefore the sweet taste is one of the first flavours perceived by a child. It is possible that foods with a high content of sugar will be more preferred than other things. For example babies, who were fed with sweetened water during their first months of life, had a higher preference for sweet foods in later life and children, who received a sweetened orange flavoured drink during their midmorning snack for eight days were more prone to eat or drink something sweet after the eight days than before. [Drewnowski A. et al. 2012]

Salbe et al. 2004 investigated Pima Indians, who gained weight over the observation period of five years. After the weight gain they showed a higher hedonic response for sweet foods than before. The hedonic responses for solutions with raised sugar content were rated higher than solutions with lower sugar levels. Therefore this study group suggested that the development of obesity is favoured by the increased intake and preference for sweet foods. [Salbe et al. 2004]

A similar result was shown by Schiffman et al. 2000. African Americans, who were more prone to become obese, had a higher demand for eating sweets than normal weight people. According to their findings they also believed that the environment, stress and education level could have an influence on the increased consumption of sweets. [Schiffman et al. 2000]

A relationship between obesity and a high liking for sweets was also shown in the study by Sartor et al. 2011. Obese persons perceived a taste stimulus of sweet and salty less intense than the normal weight control group. The authors concluded that people, who were eating a diet with a high content in sugar and salt, are more prone of preferring such foods compared to others. Another explanation was that the liking for sweet foods increases with the body weight of persons. [Sartor et al. 2011]

However not all of the studies are of the opinion, that obese persons have an altered taste of sweet.
For example Low et al. 2014 stated that obese persons liked sweet foods less because they tasted the sweet taste as less intense and some even felt unpleasant when eating sweet foods compared to normal weight persons. [Low et al. 2014]
This result is in accordance with the review of Grinker 1978, which as well discovered a negatively related liking for sweets in the obese groups in comparison with the normal weight subjects. He even examined that in some studies the liking for the sweet foods was in both groups negatively correlated. [Grinker, 1978]

Fat is another major factor when talking about obesity and taste. Fat is not a taste sense like sugar or salt, it is instead a texture attribute. People are therefore not able to notice a difference when the fat content is changing.
Previous studies showed a link between the consumption of foods with high fat levels and obesity, because obese persons tended to eat high fat meals rather often than normal weight people. Specific reasons for this outcome were satisfaction and happiness after eating high energy foods. However what is still missing on this topic are obvious reasons for the difference in taste preferences of normal weight and obese individuals. [De Graaf 2005]

Studies on salt taste and obesity are very limited and hard to find.
A study of Pasquet et al. 2007 investigated the taste sensitivity and hedonic response in normal weight and obese adolescents with the conclusion that adolescents suffering of obesity responded more sensitive to sucrose and sodium chloride. [Pasquet et al. 2005]
In an earlier study by Warwick et al. 1990 the taste response of fat/sugar mixtures and fat/ salt mixtures were analysed in elderly people and adolescents. High concentrations of the sweet taste stimuli and foods with a mixture of fat and salt were more preferred by the young people. However these findings were not true for the elderly study group. [Warwick et al. 1990]

3.2.3. Taste alterations after bariatric surgery and weight loss

The two most common bariatric operations are Roux-en Y gastric bypass (RYGB) and laparoscopic adjustable gastric banding (LAGB). Under RYGB patients will lose 20-40% of weight. With LAGB people are able to lose 15-30% of weight. Further beneficial effects of such kind of operations are the lower risks for hypertension, dyslipidaemia, sleep apnoea asthma, cardiac dysfunctions and improved psychological wellbeing. [Tadross JW and Le Roux CW, 2009]

However a side effect of these operations is an altered taste perception, especially in sweet taste. In the postoperative phase after bariatric surgery this phenomena could prevent people from overeating. But, if it lasts longer it makes people despair. Furthermore serious nutritional deficiencies and even depressions can occur. [Traub Jennifer 2012]

Tichansky et al. 2006 investigated 127 patients, who underwent RYGB and LAGB. The patients were requested to complete a survey with 23 questions postoperatively, regarding their degree and type of taste changes, food aversions and how their eating habits are influenced since their operation. Most of them indicated an alteration of their taste perception after surgery. Furthermore they declared that they developed an aversion of food or find some food stuffs repulsive. [Tichansky et al. 2006]

In an article published by the journal “Time” Morton et al. 2014 carried out a study with 55 bariatric patients and 33 normal weight persons to measure the five taste qualities before and after surgery. The result showed that 87% of the patients undergoing bariatric surgery complained about altered taste perceptions. As a consequence they ate less and lost more weight compared to patients who did not suffered of altered taste perceptions. Furthermore this study showed that “people had less preference for salty foods”. [Time 2014]

Discussed mechanisms, which may alter taste perceptions, are increased secretion of the gut hormones GLP-1 and PYY as well as decreased levels of ghrelin, an appetite-stimulating hormone, which is secreted in the stomach and small intestine. [Berthoud and Zheng 2013]

Patients undergoing RYGB often suffer of decreased ghrelin levels. Furthermore the gut hormones have large effects on neural circuits. These neural circuits are able to control the food intake through homeostatic and non-homeostatic mechanisms. [Berthoud and Zheng 2013]

The effects of lower ghrelin concentrations and their effects where investigated by Tong et al. 2001. They stated that lower ghrelin levels lead to increased satiety and that "pleasantness ratings for food odours are significantly reduced in satiated humans." [Tong et al. 2011]

Bueter et al. 2011 stated in their study that a decrease of the T1R2 and T1R3 receptors, which are able to bind natural and artificial sweeteners in the mouth and gut, can influence the appetite. Another factor, which can be considered, is leptin. Leptin mainly controls the intake of food and energy exposure. Due to the weight loss and as a consequence decrease in adipose mass, leptin levels are increased and can decrease the responsiveness to sweeteners. [Bueter et al. 2011]

Pepino et al. 2013 found out that after RYGB and LAGB patients showed decreased desire for fast food and sweets and decreased preference for high sucrose concentrations. They assumed that the insulin sensitivity is increased after bariatric surgery and weight loss. Insulin controls the brain dopamine signalling in areas, which in turn regulate appetite and reward. Patients undergoing RYGB no longer liked the taste of sweet foods. However this change of taste could not be observed in patients undergoing LAGB. Therefore they concluded that RYGB is possibly able to decrease the ingestion of sweet foods, which in turn leads to a lower calorie diet. [Pepino et al. 2013]

Scruggs et al. 1994 found no significant differences in taste detection and recognition threshold of the four basic qualities between six obese and non-obese persons before bariatric surgery and therefore concluded that taste acuity was not affected by obesity. However after bariatric surgery sucrose and NaCl detection and recognition thresholds declined in obese test persons. They therefore stated that reasons may involve changes in taste effectors or the rapid loss of weight due to the bariatric surgery. [Scruggs et al 1994]

To what extent the other tastes, like sour and bitter are influenced due to bariatric surgery-induced weight loss, is still unclear.

3.3 Salt

Salt is a very essential part of the human nutrition. Salt consisting of 40% sodium and 60% chloride, is involved in many processes of the human body. For example it is in control of the extracellular volume, keeps up the acid-base balance, the renal function, neural transmission, cardiac output, myocytic contraction and increases the absorption of different nutrients. [Liem et al. 2011]

Furthermore it is one of the most traded commodities in the world and one of the most used products in the food sector. Five hundred years ago Chinese were the first who discovered the use of salt in the preservation of foods. As a result the consumption of highly salted food stuff was increasing and is still increasing all over the world. [He and MacGregor al. 2010, He and Mac Gregor 2009]

In the western countries the average daily intake of salt is between 8 and 15g/d, whereas the WHO is recommending a daily intake of less than 5 g/d. [Siegmund 2013]

The minerals sodium and chloride belongs to the essential minerals and both of them are present in the human body at a concentration of at least 50mg per kg of the body weight. The D-A-CH (Germany, Austria and Switzerland) therefore suggest a guidance level of 550mg sodium/d and 830mg chloride/d for adults. 17mmol sodium and 17mmol chloride are included in one gram of NaCl. To make a calculation the conversion factor of salt therefore is:

$$NaCl\ (g) = Na\ (g) \times 2{,}54$$

$$1g\ NaCl = 0{,}4g\ Na$$

[D-A-CH, 2000]

According to the Austrian Nutrition Report 2012 woman had an estimated daily intake of 7g NaCl/d and men had an estimated daily intake of 10g NaCl/d. In fact 25% of the female population and 36% of men are still exceeding the daily amount of 10g salt per day. [Elmadfa et al. 2012]

Consumption levels of other countries around the world show that the recommended amount of sodium is passing the limit everywhere. In the United States for instance the mean sodium intake is between 8,2 – 9,4g NaCl/d, in the United Kingdom the mean sodium intake is 9,4g NaCl/d and Asian people have even an average daily intake of 12,0g NaCl/d. [Liem et al. 2011]

In the western countries 75% of salt in the human diet is due to the consumption of processed food, like bread, meat, sausages, cheese and because of the increased popularity of out of home eating. 10 – 15% of the salt intake is linked to the way of cooking and 10-12% of salt is naturally occurring as component in different kind of foods (see Figure 8). [Siegmund 2013]

Food item	Description	Sodium content (mg/100 g)
Beef	Topside, roast, lean and fat	48
	Corned beef, canned	950
Bran	Bran, wheat	28
	Bran Flakes	1000
Cheese	Hard, average	620
	Processed	1320
Chick-peas	Dried, boiled in unsalted water	5
	Canned, re-heated, drained	220
Potato	Raw, boiled in unsalted water	9
	Canned, re-heated, drained	250
Peas	Raw, boiled in unsalted water	Trace
	Canned, re-heated, drained	250
Potato	Homemade, fried in blended oil	12
chips	Oven chips, frozen, baked	53
Salmon	Raw, steamed	110
	Canned	570
	Smoked	1880
Sweet corn	On-the-cob, whole, boiled in unsalted water	1
	Kernels, canned, re-heated, drained	270
Tuna	Raw	47
	Canned in oil, drained	290
	Canned in brine, drained	320

Figure 8: Comparison of the sodium content in processed and natural foods [Liem et al. 2011]

The reason why salt is added to different kind of foods is his sensory property which is able to increase saltiness and even sweetness and decreases bitterness. Beside this salt is used for food technology aspects and as a conservation method in the preparation of food, like salting and pickling. The consumption of food is therefore the main source of salt intake in the human population.

The consequence of the increased salt intake is raised blood pressure and thereby enhanced risk of cardiovascular and renal disease. Furthermore a combination of enhanced salt amounts, low fruit and vegetable consumption, obesity, lack of physical exercise and an excessive intake of alcohol encourage the development of high blood pressures in humans too. However there is strong evidence that salt plays the major part in the development of high blood pressure levels.

[He and MacGregor 2010]

He and MacGregor 2010 furthermore described an indirect relationship of salt intake and obesity. This relationship was associated with an enhanced development of renal stones, osteoporosis and stomach cancer. [He and MacGregor 2010]

Eating high amounts of salty foods can decrease the threshold for salt. High salt detection thresholds were mostly found in persons with diabetes, hypertension, elderly and obese ones. [Piovesana et al. 2013]

Studying the relationship between high salt taste sensitivity thresholds, blood pressure and body composition in adolescents was the main target in the study by Kirsten et al. 2014. The threshold for salt was analysed by preparing NaCl solutions in different concentrations, which were applied on the tongue of the test persons. No link between salt taste sensitivity threshold and body composition and systolic blood pressure was found by them. In this context a relationship was only apparent between the diastolic blood pressure and a high salt taste sensitivity threshold. However the scientist noted that it is not possible to conclude from the results of the threshold test on the blood pressure. Further it has to be said that the test persons were adolescents without hypertension and a normal body weight. [Kirsten and Wagner 2014]

Outcomes by Thuesen et al. 2014 though confirm a connection between daily salt intake, blood pressure and obesity. Even blood lipids were affected by obesity and high consumption of salty food. [Thuesen et al. 2014]

In contrast Kim and Lee 2009 were mainly concentrating on the liking and frequent eating of high salt-foods and their effects on salt taste perceptions in schoolchildren. Believing that a frequent consumption of high salt-foods lead to changes in taste perceptions and in consequence to an overconsumption of sodium, they investigated these effects by using a self-administered questionnaire in combination with a salt detection test. Salt threshold was analysed by tasting bean sprout soups followed by a statement of the preferred NaCl concentration in the soup. The results confirm that children, who frequently visit fast food restaurants showed a raised preference for salty soups. [Kim and Lee 2009]

A relationship between obesity and salt taste preferences was studied by Donaldson et al. 2009, where the results showed that overweight women preferred solutions high in salt levels more compared with normal weight individuals. A high preference for salty solutions was also visible for normal weight men. [Donaldson et al. 2009]

The development of obesity is a multifactorial process and taste perception is only a minor part of it. Many studies have investigated the relationship of sweet taste and body mass, however little is known in the field of salt taste, eating behaviour and obesity.

4. Hypotheses and Aims

Since only few studies with inconsistent results examined the effects of salt taste in obese people and changes of the salt taste after bariatric surgery we hypothesized that:

1. the salt taste is modulated after bariatric surgery in patients

2. the salt detection thresholds of obese patients is higher than the salt detection threshold of the lean control group

Accordingly, the aims of this study are to examine:

1. Whether persons suffering from obesity show a different salt taste detection threshold and a diverse preference for salt in test meals compared to healthy persons with a normal BMI.

2. Whether there are differences in the salt taste detection threshold and preference for salt in test meals before and after bariatric surgery and weight loss.

5. Materials and Methods

This chapter gives an overview of the project team, test persons, testing methods, sample preparation and organisational issues, especially the way of working with patients of the Vienna General Hospital and calculation and sensory evaluation methods will be explained.

5.1 Project team

The study has been carried out in cooperation with the supervisor of the master thesis Prof. Dr. Cem Ekmekcioglu of the Medical University in Vienna, in cooperation with Doz. Dr. Karin Schindler of the Vienna Medical University and Assoc.-Prof. Dr. Klaus Dürrschmid of the University of Natural Resources and Life Sciences in Vienna.

Further help and assistance was provided by two surgeons of the Vienna General Hospital, Dr. Gerhard Prager and Dr. Felix Langer, just as Prof. Dr. Bernhard Ludvik, Dr. Renate Kruschitz, Dr. Soheila Shakeri-Leidenmühler, Melanie Walker and Maria Luger all doctors and staff members of the Vienna General Hospital and Vienna Medical University.

Linda Lam, Msc, former nutritional science student of the University of Vienna, was writing the first part of the master thesis with the title "Salt taste detection thresholds and pleasantness of test meals varying in salt content in (morbid) obese persons". She examined the patients before they underwent bariatric surgery and compared this group with respect to differences in salt taste with a normal weight control group. With the help from Prof. Dr. Cem Ekmekcioglu and Assoc.-Prof. Dr. Klaus Dürrschmid she was the one who has built and developed the experimental part of the work. She also recruited most of the patients and carried out the sensory tests with them before undergoing bariatric surgery. Therefore the design and implementation of the sensory tests and the construction of the work has been taken over from Mrs Lam. With the permission of Mrs Lam most of the figures and tables in the following chapters were

also adopted from her work. We were both using the same group of patients and controls.

However in contrast to the Master thesis of Mrs Lam we increased the number of patients and controls, the patients were tested three months after bariatric surgery and the patients and the control group were requested to fill up a questionnaire about their eating behaviours, especially focusing on salty food.

5.2 Test persons

For identification of general differences in salt detection threshold and pleasantness of test meals morbid obese patients, undergoing bariatric surgery were recruited on a voluntary basis at the Vienna General Hospital. Physical examination was performed before and after the bariatric surgery and the health status was documented.
The test took place one day before patients undergo bariatric surgery and 3 months after, when the post control was carried out at the hospital. For making an appointment for the post control patients were asked for their telephone number and were informed about receiving a call one or two months before the post control takes place.

The age- and gender-matched, healthy control persons with a BMI between 18.5 and 27 were participating under volunteer terminations too and recruited from the Institute of Environmental Health and from the Institute of Pathophysiology, both departments of the Vienna Medical University and as well at the company SGS Austria.

The project was improved by the ethics committee of the Medical University of Vienna (EK Nr.: 1193/2013) (see Appendix 10.2).

An informed consent was further received by all participants including all relevant details of the study design and the information that the participation in the study is not associated with any risks and side effects (see Appendix 10.1).
A counselling interview about the advantages of salt reduction for the human health performed by Prof. Dr. Cem Ekmekcioglu was offered to them as a thank-you gift for participating in the study.

5.3 Sensory evaluation

Sensory evaluation is defined as:

"A scientific discipline used to evoke measure, analyse and interpret those responses to products that are perceived by the senses of sight, smell, touch, taste and hearing."
[Stone and Sidel, 1993]

The chosen method for the assessment of the salt taste threshold was the "Standard Practice for Determination of Odor and Taste Thresholds By a Forced-Choice Ascending Concentration Series Method of Limits", which is a standard practice developed by ASTM International. Until 2001 ASTM International was known as the American Society for Testing and Materials (ASTM) and belongs to the fundamentals of sensory. The evaluation standards of ASTM are instrumental in the assessment of consumer products by the use of the human senses, like sight, smell, taste, touch and hearing. A panel of test persons is used and test results are based on their response to the tested products. [ASTM E679-04, 2011]

Different kind of methods can be considered when making a sensory evaluation.

For example the 3 alternative forced choices (3AFC) test is used to identify the threshold of an individual by making an assessment at each concentration step. For our study we used a set consisting of one test sample and two blank samples, where the test person has to select one of the three samples. Further information about this method is described in chapter 3.4. [Peng et al. 2012]

The Cornsweet's Staircase method, also common as up-down technique, is another method of threshold estimation. The staircase method deals with ascending and descending samples, which can be connected to create a run of step intervals so that they visually look like a staircase. The test functions as follows: If the presence of a stimulus, like for example salt, is indicated by the test person, the concentration of the test stimulus will be decreased in the next run. But if the test person is not able to indicate a stimulus, the concentration will be then increased. Usually the first run is discarded and the six subsequent reversals are averaged in order to determine the threshold. [Bartoshuk, 1978]

A disadvantage of this method is the fact that the frequent reversals in the testing lead to an unpredictable duration of the test. Due to the prolonged duration of the test, test persons get tired and their concentration decrease. Failing attention during the test and fatigue can have a great influence on the quality of the results. Therefore it is recommended to use standardized test durations. [Lötsch et al. 2004]

Placing a single drop, consisting either of water or the test solution, on the tongue for three times was the method chosen by Scrugg et al. 1994. Afterwards the test person was asked to make a statement whether there is a difference between the three drops or not. The recognition threshold was defined as the concentration at which the test person correctly detected the taste quality of the stimulus. The disadvantage of this kind of sensory detection method is that only a few taste buds can be stimulated with a single drop. [Scrugg et al 1994]

The method of constant stimuli was used by Bueter et al. 2011 with randomly featured taste stimuli and a set of seven sucrose concentrations. The sucrose concentrations were tested in eight blocks, each of them was composed of seven water samples and seven sucrose samples. The set-up of the eight blocks was in order and without translocation of the samples. Each of the seven sucrose concentrations was presented once within a block. Test persons tried the stimulus in the mouth and expectorated the sample. Then they had to indicate whether the stimulus was water or not. The disadvantage of this method is, as mentioned by the staircase method, the long duration of the test, particularly as this study group was using 112 samples per test person. [Bueter et al. 2011]

After considering all these different kind of evaluation methods and figuring out that the duration of test is one of the most important factors when carrying out an taste threshold evaluation the "Standard Practice for Determination of Odor and Taste Thresholds by a Forced-Choice Ascending Concentration Series Method of Limits" by ASTM was elected as the most appropriate sensory evaluation method for our study.

5.4 Test 1: Assessment of sodium chloride detection

The sodium detection threshold was analysed in 35 obese and 30 non obese test persons, who were representing the control group of the study.

The performance of the detection test took place mainly in the afternoon approximately two hours after lunch at the Vienna General Hospital. A constant room temperature of 21 ± 1 ºC was provided throughout the whole test sessions as well as the test solutions, which were administered at room temperature.

The "Alternative forced-choice test" (AFC), was the chosen testing method for investigating the sodium chloride detection threshold.

Figure 9: 3-ACF test with salt and water stimuli

The ASTM International has defined the ACF test as:

"Alternative food choice (AFC) test, n-method in which 2,3 or more stimuli are presented and assessors are given a criterion by which they are required to select one stimulus. Typical examples include 2-ACF (directional different test) and 3-ACF (selecting the one stimulus among a set of three that differs in a defined attribute)."

[ASTM E253-09, 2009]

In eight blocks eight sodium chloride concentrations (0.003 to 0.034 mol/L, see Table 3) are tested. Each block consist one sodium chloride stimuli (20ml) and two stimuli of distillate water (20ml) in ascending concentrations (see Figure 9 and Figure 10). The test samples were labelled with random three-digit numbers so that they all look the same and the test person was not able to distinguish the salt concentration through their appearance (see Appendix 10.3 and 10.4).

The test begins by tasting the first row of the block consisting of two water cups and one salt cup with the lowest salt concentration of 0.16 g NaCl/L. The test person should take the whole content of the cup into the mouth and wet the oral cavity with the liquid and spit it out again. For the neutralisation of the mouth, a glass of tab water was provided. After each block the study participants have to indicate which of the three samples taste different. Even if no difference is recognizable between the three samples, a choice has to be made and the decision has to be marked on the questionnaire, so that all date can be used for the further analysis. It is further necessary that all participants try all dilutions (eight blocks), even though the correct salt solution has been detected earlier.

Based on the correct/incorrect responses of each test person an individual best-estimated threshold can be calculated for everyone. By deriving a geometrical average of the individual best-estimate thresholds a group threshold can be determined.

Figure 10: 24 samples, each row containing one salt and two water stimuli

Under the supervision of Assoc.-Prof. Dr. Klaus Dürrschmid at the Vienna University of Natural Resources and Life Sciences salt solutions were prepared. On a calibrated scale the sodium chloride amounts (industrial salt NaCl 99%) for 500ml solution were weighed out and filled in 500ml DURAN® laboratory glass bottles. In each bottle distillate water was filled on top and mixed with the salt solution on the bottom (see Table 2).

After each use, the salt solutions were stored in a fridge by +4°C and renewed every six weeks.

Table 2: Preparation of the salt solutions [ISO 3972 Standard]

Dilution	Sodium Chloride concentration		
	ρ [g/l]	[g/500ml]	Mol/L
D1	2	1	0.034
D2	1.4	0.7	0.024
D3	0.98	0.49	0.017
D4	0.69	0.35	0.012
D5	0.48	0.24	0.008
D6	0.34	0.17	0.006
D7	0.24	0.12	0.004
D8	0.16	0.08	0.003

The series of each decision by the panellist was expressed by writing a sequence containing (0) for an incorrect choice or (1) for a correct choice arranged in the order of judgments of ascending concentrations of the salt solution for the data evaluation. The best-estimate threshold concentration is the geometric mean of that concentration at which the last miss (0) occurred and the next higher concentration designated by a (1). [ASTM E679 – 04, 2011]

An example of the calculation for the best-estimated threshold is shown in Table 3.

Table 3: Examples of the best-estimate threshold

Test Persons	**Judgments**								
	NaCl Concentrations increase → [g NaCl/L)]								**Best estimate threshold (BET) [g NaCl/L)]**
	0,16	**0,24**	**0,34**	**0,48**	**0,69**	**0,98**	**1,4**	**2**	
1	0	0	0	0	1	1	1	1	0,58
2	1	0	1	0	0	1	1	1	082
3	0	0	0	1	1	1	1	1	0,40

The calculation was carried out as explained above and all the other values will follow the same formula:

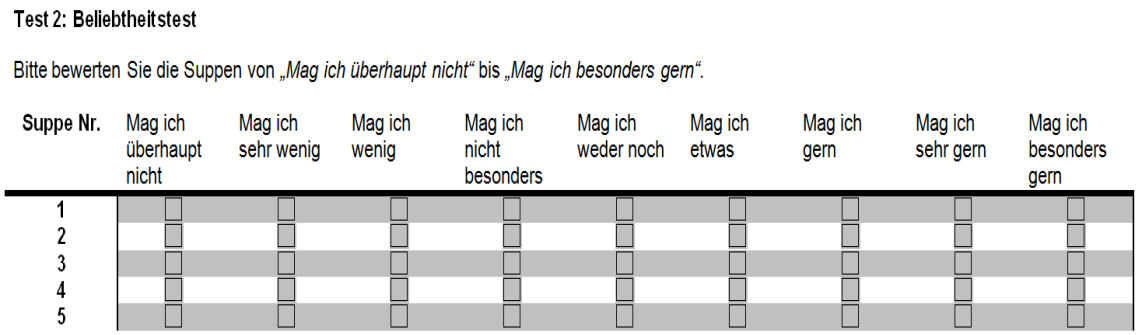
The best-estimate threshold for test person number 1 is: $\sqrt{0.48x0.69} = 0.58$ g NaCl/L

The BET for test person number 2 is: $\sqrt{0.69x0.98} = 0.82$ g NaCl/L

5.5 Test 2: Assessment of preference for different concentrations of salt in soup

A 9-point hedonic scale, which belongs to the acceptance testing methods, was used for the second test of the study, where five cups of creamed soup differing in their salt concentrations are offered to the test persons in ascending concentration levels.

The test persons were asked to rate their personal liking for the different soups on the 9-point hedonic scale. This type of scale is the most used one for measuring food acceptance. Equal intervals from 1 (dislike extremely) to 9 (like extremely) helps to analyse the ratings (see Table 4). Advantages of this scale are the simple understanding of the test method and use of the scale and the simple application, by only making a cross at the right box (see Figure 11).



Test 2: Beliebtheitstest

Bitte bewerten Sie die Suppen von *„Mag ich überhaupt nicht“* bis *„Mag ich besonders gern“*.

Suppe Nr.	Mag ich überhaupt nicht	Mag ich sehr wenig	Mag ich wenig	Mag ich nicht besonders	Mag ich weder noch	Mag ich etwas	Mag ich gern	Mag ich sehr gern	Mag ich besonders gern
1	☐	☐	☐	☐	☐	☐	☐	☐	☐
2	☐	☐	☐	☐	☐	☐	☐	☐	☐
3	☐	☐	☐	☐	☐	☐	☐	☐	☐
4	☐	☐	☐	☐	☐	☐	☐	☐	☐
5	☐	☐	☐	☐	☐	☐	☐	☐	☐

Figure 11: Acceptance test with the 9-point hedonic scale

Table 4: Liking scores for cream soups

9-Point Hedonic Scale		
9	Like Extremely	Liking area
8	Like Very Much	
7	Like Moderately	
6	Like Slightly	
5	Neither Like nor Dislike	Neutral
4	Dislike Slightly	Dislike area
3	Dislike Moderately	
2	Dislike Very Much	
1	Dislike Extremely	

The soups were prepared at the sensory kitchen of the Vienna University of Natural Resources and Life Science, under the supervision of Assoc. Prof. Dr Klaus Dürrschmid The soups were made out of tab water, sour cream, flour and salt in different concentrations (see Table 5).

In a pre-test with 15 randomly selected students from the University of Natural Resources and Life Science the five salt concentrations starting with a concentration of 3.0 g NaCl/L to 9.0 g NaCl/L, the highest salt concentration, was tested to make sure that they are suitable for the study. The chosen concentration step was 1.5 g NaCl/L per step.

Table 5: Salt concentrations in cream soup

Dilution	ρ [g/200ml]	ρ [g/l]	mol/L
1	0.6	3.0	0.051
2	0.9	4.5	0.077
3	1.2	6.0	0.103
4	1.5	7.5	0.128
5	1.8	9.0	0.154

For the production of one litre soup 35g of cake flour (brand “Clever”) and one cup of sour cream (250g, brand “milfina”, 15% fat) were stirred and 250ml of table water were added to the flour-sour cream mixture and mashed together. With the help of a funnel the mixture was filled in a 1L volumetric flask. Residues in the bottle were dissolved with water and transferred into the volumetric flask until all visible residues were removed. The bottle was then filled up with water to the 1L mark and was shaken intensively. Afterwards the content was divided into five 200ml glass bottles. Each of bottles contained a magnetic rod for the magnetic stirrer. The bottles were further closed throughout the entire cooking process to prevent the evaporation of the soup. To avoid agglutination or the burning of the ingredients at the bottom of the bottle due to the boiling by 60 ºC the magnetic stirrer was used (see Figure 12). The different concentrations of salt (brand “Bad Ischler Tafelsalz”) were added after the soup reached the temperature of 60 ºC and the content of the bottles were mixed again.

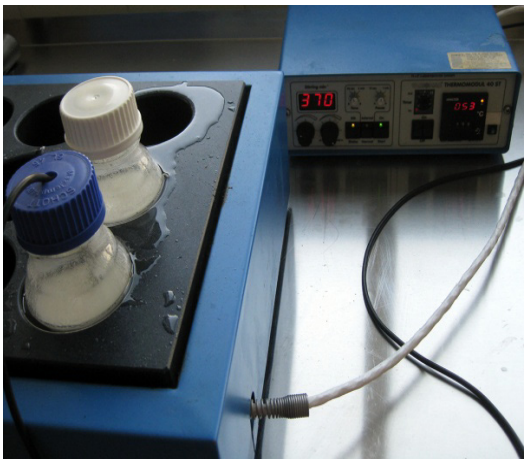


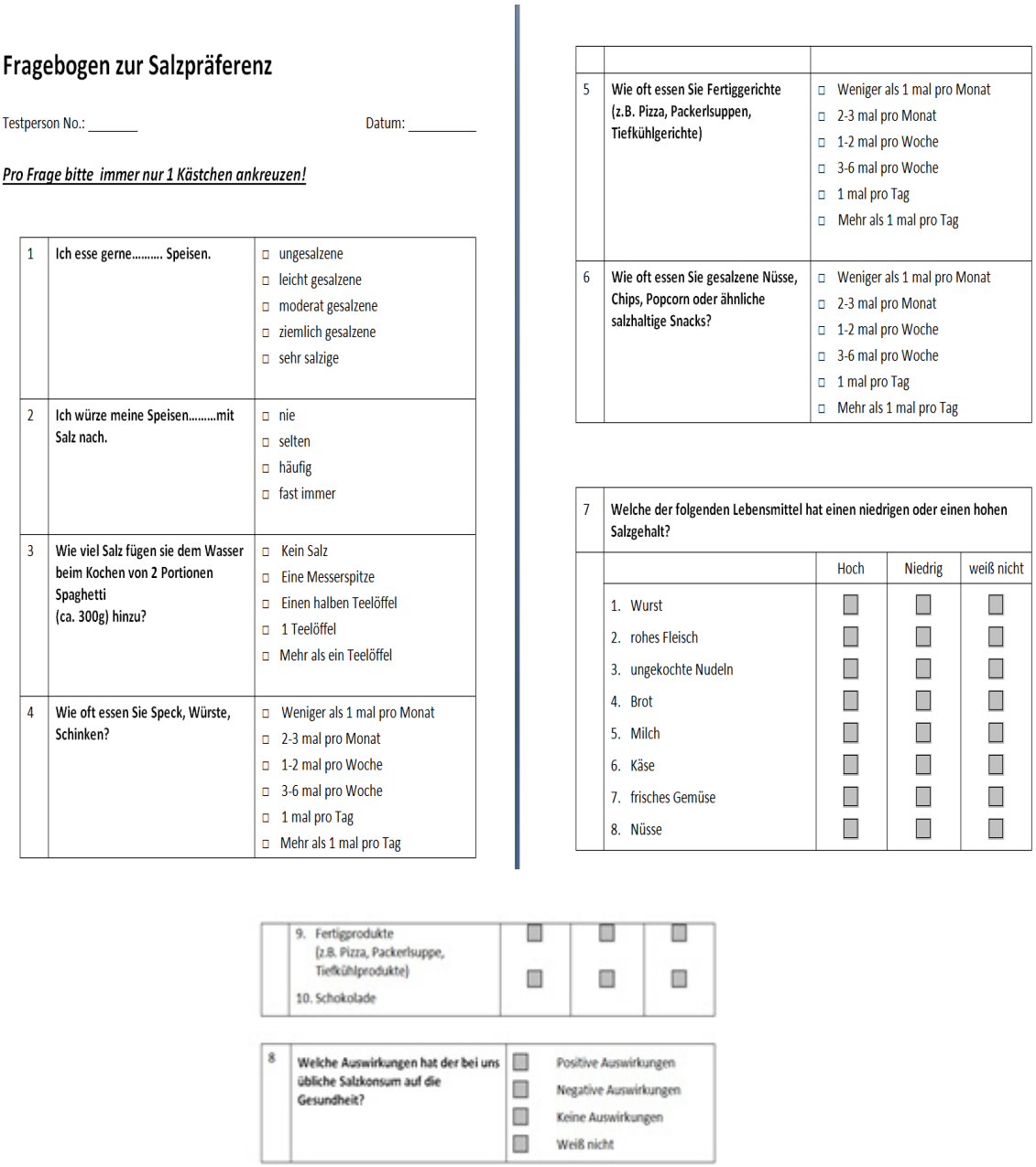
Figure 12: Cream soup preparation

Figure 13: Cream soup filled in cups

After finishing the preparation of the soup, the liquid was filled in 20ml plastic cups (see Figure 13), closed with numbered plastic lids and deep frozen at -20 ºC. When using the soup for the sensory tests, the portioned soups were reheated in a microwave to 50 ºC ± 1 just before testing.

5.6 The Food Questionnaire

Before starting with the sensory testing the patients as well as the control group had to fill up a questionnaire dealing with questions about their preference for salt in foods and their usage of salt in the preparation of meals.



Fragebogen zur Salzpräferenz

Testperson No.: _____ Datum: _____

Pro Frage bitte immer nur 1 Kästchen ankreuzen!

1	Ich esse gerne..... Speisen.	☐ ungesalzene ☐ leicht gesalzene ☐ moderat gesalzene ☐ ziemlich gesalzene ☐ sehr salzige
2	Ich würze meine Speisen.....mit Salz nach.	☐ nie ☐ selten ☐ häufig ☐ fast immer
3	Wie viel Salz fügen sie dem Wasser beim Kochen von 2 Portionen Spaghetti (ca. 300g) hinzu?	☐ Kein Salz ☐ Eine Messerspitze ☐ Einen halben Teelöffel ☐ 1 Teelöffel ☐ Mehr als ein Teelöffel
4	Wie oft essen Sie Speck, Würste, Schinken?	☐ Weniger als 1 mal pro Monat ☐ 2-3 mal pro Monat ☐ 1-2 mal pro Woche ☐ 3-6 mal pro Woche ☐ 1 mal pro Tag ☐ Mehr als 1 mal pro Tag
5	Wie oft essen Sie Fertiggerichte (z.B. Pizza, Packerlsuppen, Tiefkühlgerichte)	☐ Weniger als 1 mal pro Monat ☐ 2-3 mal pro Monat ☐ 1-2 mal pro Woche ☐ 3-6 mal pro Woche ☐ 1 mal pro Tag ☐ Mehr als 1 mal pro Tag
6	Wie oft essen Sie gesalzene Nüsse, Chips, Popcorn oder ähnliche salzhaltige Snacks?	☐ Weniger als 1 mal pro Monat ☐ 2-3 mal pro Monat ☐ 1-2 mal pro Woche ☐ 3-6 mal pro Woche ☐ 1 mal pro Tag ☐ Mehr als 1 mal pro Tag

7	Welche der folgenden Lebensmittel hat einen niedrigen oder einen hohen Salzgehalt?			
		Hoch	Niedrig	weiß nicht
	1. Wurst	☐	☐	☐
	2. rohes Fleisch	☐	☐	☐
	3. ungekochte Nudeln	☐	☐	☐
	4. Brot	☐	☐	☐
	5. Milch	☐	☐	☐
	6. Käse	☐	☐	☐
	7. frisches Gemüse	☐	☐	☐
	8. Nüsse	☐	☐	☐

	9. Fertigprodukte (z.B. Pizza, Packerlsuppe, Tiefkühlprodukte) 10. Schokolade	☐ ☐	☐ ☐	☐ ☐

8	Welche Auswirkungen hat der bei uns übliche Salzkonsum auf die Gesundheit?	☐ Positive Auswirkungen ☐ Negative Auswirkungen ☐ Keine Auswirkungen ☐ Weiß nicht

Figure 14: The food questionnaire for the salt preference

The questionnaire included eight questions, which were given to the controls and patients. The test persons had to make a cross at the response, which applied best to them (see Figure 14).

The questions of the questionnaire were mainly dealing with foods, which are known to have a higher salt content, questions about the handling of salt during the preparation and cooking of food and their general behaviour when it comes to the seasoning of food.

The questions were as follows: I like to eat.... (Unsalted to very salty); I.....add salt on my cooked dishes (never to always); How much salt do you add into water, when cooking two portions of spaghetti (approx. 300g)? How frequently do you eat ham, sausages or bacon? How frequently do you eat convenience products (f.e. pizza, packet soup, deep frozen dishes)? How often do you eat salty nuts, chips, popcorn or similar salty snacks? Which of the listed foods below (sausages, red meat, uncooked spaghettis, bread, milk, cheese, fresh vegetables, nuts, convenience food and chocolate) are high or low in salt? Do you think that dietary negative/positive/no effects on our health?

The questions were taken from various studies that have been dealing with the eating habits of people or the liking and consumption of salty food. Due to the fact that the studies were mostly from non-European countries the questions were modified to Austrians eating habits and conditions. [BDM f. Verbraucherschutz, Ernährung und Landwirtschaft; Hyun et al. 2007; Parmenter K. and Wardle J. 1999; Webster et al. 2010]

At that time the questionnaire was introduced into the study, more than half of the patients already had their first sensory testing. Therefore some of them were asked at the second testing to complete the questionnaire.

5.7 The Test environment

For the design of the test rooms the International Organization for Standardization (ISO) defined engineered standards, which should be taken into account when carrying out a sensory analysis. In their guidelines they stated following norm:

"Conduct sensory evaluation under constant controlled conditions with minimum distractions to reduce the effects psychological factors and physical conditions can have on human judgment." [ISO 8589]

Our study took place at the Vienna General Hospital with obese patients undergoing a gastric bypass surgery (Roux-en-Y or omega loop bypass). Due to the fact that the sensory analysis of the obese patients was conducted on the day of admission to the hospital, around 1-2 hours after lunch (1:00 – 2:00 PM), it was very important to choose a test room as close as possible to the medical station.

The conference room at the control point on level 21 (general surgery department) was selected for the following reasons: It was the closest room to the medical station; there was no disruptive noise present; the room offered a peaceful environment with no potentially distracting stimuli and a constant room temperature of 21 ºC ± 1 was present for all test sessions. Over the whole study duration these mentioned room conditions were always the same. The anteroom of the conference room, which used to be a little kitchen with a microwave, was used for the sample preparation and the heating of the test soups (see Figure 15).

Figure 15: The test room of the Vienna General Hospital

After picking them up from their room at the general surgery station, they were taken to the conference room where the test was conducted. Before starting the sensory assessment of the salt taste an explanation about the purpose of the study was given and the informed consent form had to be signed. Because of the voluntary participation the test persons were allowed to quit the study at any time. Neither health benefits nor risk or side effects were expected from their participation in this study.

Participants for the control group were recruited from the Institute of Environmental Health and from the Institute of Pathophysiology, both of them Departments from the Vienna Medical University as well as at the company SGS Austria. Looking for volunteers between 30 and 65 years, with no health problems, especially no diabetes nor hypertension and without any alterations of the taste sense, e-mails were send out and advertisements were hung up at the Department of Environmental Health, declaring the requirements needed when participating in the study. One hour before the sensory analysis started the test person was requested not to smoke or eat.

The test rooms chosen for the analysis of the control group offered the same testing conditions as the conference room at the Vienna General Hospital. In both cases (Institute of General Environmental Health and as the SGS Austria) the available conference room there was chosen as test room. A close-by kitchen was used in both places for the sample preparation.

5.8 Statistics

The statistical analysis was performed on IBM SPSS 22 Statistics. In all performed statistical analysis a significance level of 5 percent (0,05) is assumed.

In accordance with other studies dealing with a similar topic (see Table 6) a sample size of 65 (35 test persons and 30 controls) was chosen. The sample size was constructed by using the sample size calculator ($p < 0,05$; Power = 0,80; 10% drop out rate). [SISA, 2013]

Table 6: Estimated means and sample size in similar studies

Parameter	Mean group 1, Mean group 2 (unit)	Sigma (SD)	Sample Size	References
Recognition threshold (sucrose)	0.05, 0.03 (mol/L)	0.02	10	Bueter et al., 2011
Recognition threshold (sucrose)	0.047, 0.024 (mol/L)	0.02	14	Burge et al., 1995

Bueter et al. 1995 for example calculated a mean difference of 0.02 mol/L with a SD of 0.02 when investigating differences in sucrose threshold in 10 obese persons before and after Roux-en Y gastric bypass (RYGB). A sample size of 14 was used by Burge et al. 2011. [Bueter et al. 2011, Burge et al. 1995]

Assuming a drop-out rate of 10% and a safety margin, the sample size in our study was set up for 30 per group (35 patients and 30 controls). A higher sample size was chosen to get more representative and accurate statistical results of the population and a higher power increases further the chances to detect differences within a population when differences exist.

For the statistical analysis different parametric and non-parametric tests were performed.

A descriptive data analysis was made to summarize and describe the data of the patients and controls.

Kolmogorov Smirnov test was used to analyse whether the data are normally distributed or not.

Differences in the mean values of estimated thresholds between patients and controls were analysed by an unpaired t-test. A p-value of less than 0.05 was regarded as significant. Also a Mann-Whitney-U-test was performed since the data were not normally distributed.

Soup liking between patients vs. controls were analysed by two methods. First a repeated measures design including gender as a factor was used and differences between the five soups were calculated by contrast analyses. Second a univariate analysis of variance with the weighted mean of the soup liking (soup 1 was weighted with 1 and soup 5 with 5) as the dependent variable, group and sex as factors and age and BMI as covariates.

Gender differences in soup likings were calculated by a univariate analysis of variance with the weighted mean of the soup likings (soup 1 was weighted with 1 and soup 5 with 5) as the dependent variable and group and sex as independent variables (factors). BMI and age were included as covariates.

Differences in soup likings before and after surgery in the patients were analysed by analysis of repeated measures including tests for inner subject contrast to analyse differences between the soups. In separate analyses also age, gender and the difference in BMI (before and after surgery) were included as covariates.

A Pearson correlation analysis was performed to study whether estimated thresholds and soup likings were related to each other.

Gender differences in estimated thresholds in patients and controls were analysed with an unpaired t-test.

6. Results

6.1 Test persons

The test persons were 35 obese patients, of which 22 were female and 12 were male. The mean BMI before the operation was 43,4kg/m^2 (± 5,7 kg/m^2). Three months after the operation the BMI was 34,1kg/m^2 (± 5,1 kg/m^2).

Major comorbidities, which mostly occurred in this group of patients, were hypertension and diabetes. Of the 35 participants, 22 persons were suffering of hypertension and 13 persons had diabetes.

The healthy control group consisted of 30 persons, of which 14 were female and 16 were male. The mean BMI was 23,8kg/m^2 (± 3,4kg/m^2). This group showed no major comorbidities, like hypertension or diabetes (see Table 7).

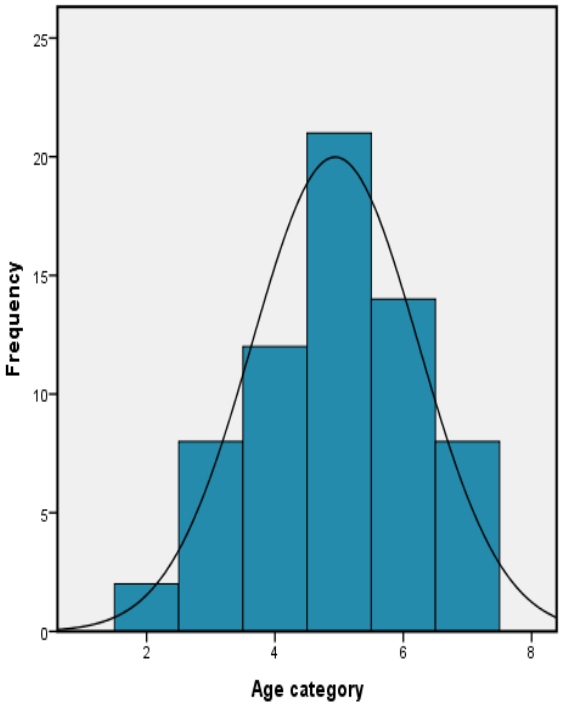
Table 7: Characterization of the control group and the patients (Gender, Age, BMI, Comorbidities)

Group	Gender	Age (years)	BMI before OP [kg/m^2]	BMI after OP [kg/m^2]	Major comorbidities
Controls	Female: 14 Male: 16	Mean±SD:41,0±13,3 Range: 22-63	Mean±SD: 23,8±3,4 Range:16-33		No hypertension, No diabetes
Patients	Female:22 Male: 13	Mean±SD:45,4±11,9 Range: 17 - 67	Mean±SD:43,4±5,7 Range: 30-51	Mean±SD: 34.1±5,1 Range:22-42	Hypertension:22 Diabetes:13

35 obese patients were participating in the study before the bariatric surgery. However of the 35 only 20 test persons (57, 1%) were attending the second test three months after. Patients, who participated in the first test, were already staying at the hospital. Taking part in the study and leaving their room for a few minutes was a good way for them to pass the time. The participation for the second test was much lower, because patients had to come to the hospital.

The age distribution of the test persons and the control group is summarized in the next histograms. For a better representation of age, it was divided in seven age categories as shown in Table 8 and 9 (see Table 8 and Table 9).

Table 8: Age distribution and age categories of all participants of the study (both control group and patients)

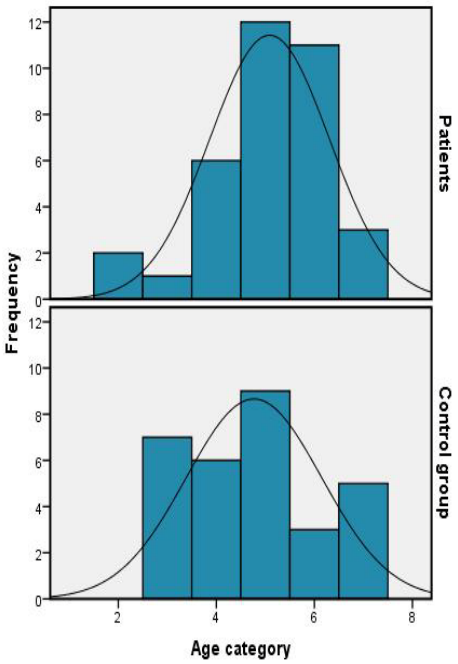


Age category	Age in years	Frequency
1	0-9	0
2	10-19	2
3	20-29	8
4	30-39	12
5	40-49	21
6	50-59	14
7	60-69	8

This diagram shows that most of the participants were 40-49 years old. In the age categories 2 (10-19 years) and 7 (60-69 years) are fewer people compared with the other age categories.

Table 9: Age distribution and age category separated by control group and patients

Age category	Age in years	Frequency Patients	Frequency Control group
1	0-9	0	0
2	10-19	2	0
3	20-29	1	7
4	30-39	6	6
5	40-49	12	9
6	50-59	11	3
7	60-69	3	5



In the histogram of the age distribution separated by patients and controls it is clearly that in both groups most of the people were aged 30-39 (age category 4) and aged 40-49 (age category 5). The control group was consisting of a higher percentage of people aged 20-29 (age category 3) whereas only a very low percentage can be found in the group of patients.

6.2 Salt detection threshold

Descriptive analysis of the data

To point out the most important empiric data a descriptive analyse was executed and revealed that the mean salt detection threshold was **0,49 ± 0,34 g NaCl/L** before the operation and **0,66 ± 0,47 g NaCl/L** three month after. The control group showed a mean (± SD) salt detection threshold of **0,50 ± 044 g NaCl/L** (see Table 10).

Table 10: Descriptive statistic of the data of the control group and patients before and after the operation

Sample	Descriptive statistic		
Controls	**Mean ± SD:** 0,50 ± 0,44 g NaCl/L **Median:** 0,40 g NaCl/L **Minimum:** 0,02 g NaCl/L **Maximum:** 1,67 g NaCl/L **Interquartile range:** 0,69		
Patients		**Before OP**	**After OP**
	Mean ± SD:	0,49 ± 0,34 g NaCl/L	0,66 ± 0,47 g NaCl/L
	Median:	0,40 g NaCl/L	0,58 g NaCl/L
	Minimum:	0,13 g NaCl/L	0,13 g NaCl/L
	Maximum:	1,67 g NaCl/L	1,67 g NaCl/L
	Interquartile range:	0,38	0,95

The two boxplots (see Figure 16 and 17) give a graphical presentation of the results listed in Table 10.

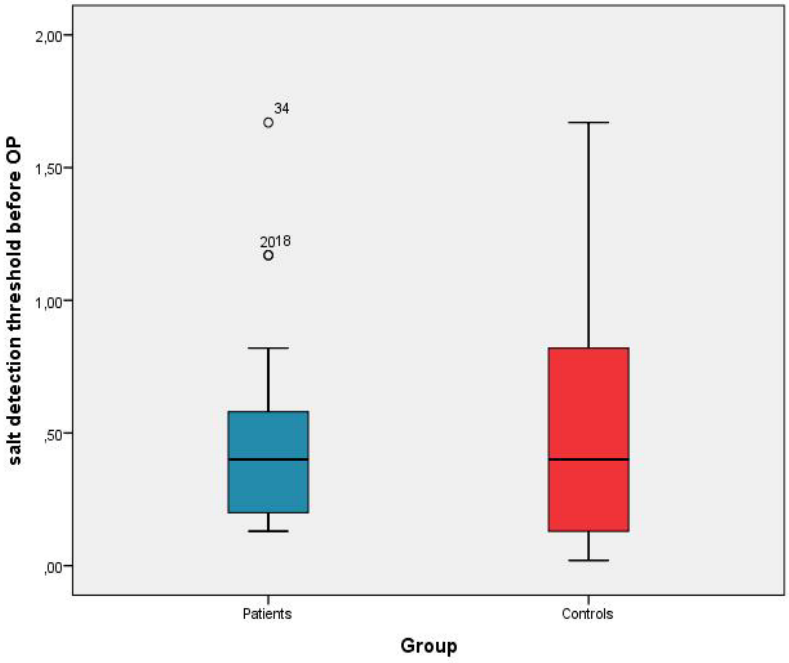


Figure16: Boxplot of salt detection thresholds (g NaCl/L) in the patients and the control group (x-axe: patients and control group, y-axe: salt detection threshold in g NaCl/L)

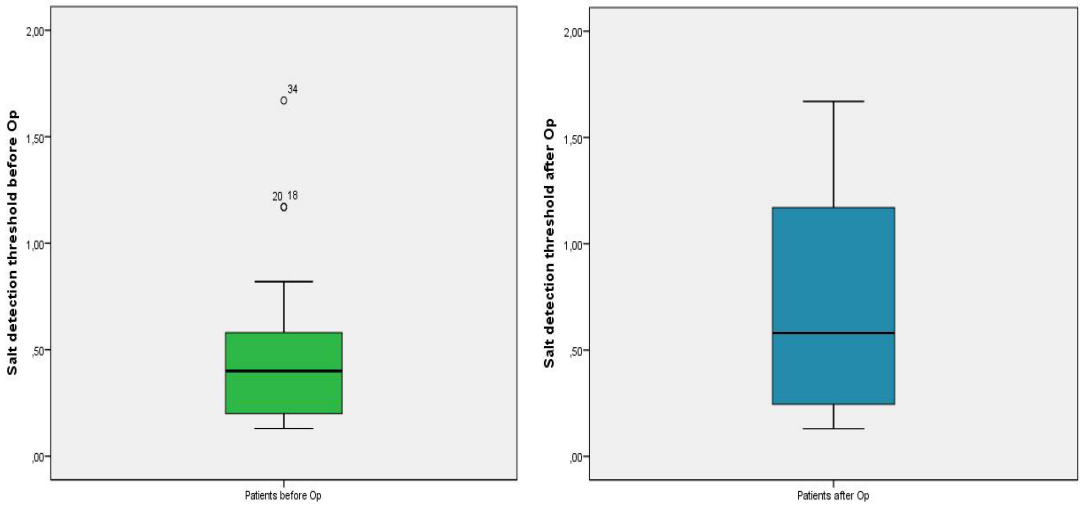


Figure 17: Boxplot of salt detection threshold (g NaCl/L) of the patients before and after the operation (x-axe: patients before and after OP, y-axe: salt detection threshold in g NaCl/L)

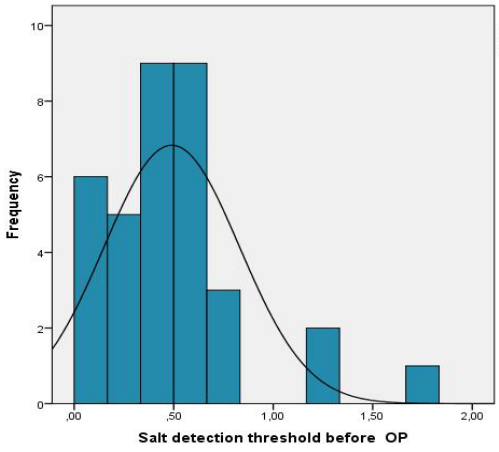
Statistical testing of the salt detection threshold

To figure out, if the data is normal distributed the Kolmogorov Smirnov test was used. The results showed that the estimated thresholds of the patients were not normally distributed, whereas the estimated thresholds of the control group showed a normal distribution (see Table 11 and 12).

A reason for the result in the group of patients could be the relatively low sample size.

Table 11: The distribution of the salt detection threshold (g NaCl/L) of patients before and after the operation

SDT before Op [g NaCl/L]	Frequency	SDT after Op [g NaCl/L]	Frequency
0,13	6	0,13	4
0,20	4	0,20	1
0,29	1	0,29	2
0,40	9	0,40	1
0,58	9	0,58	5
0,82	3	-	-
1,17	2	1,17	6
1,67	1	1,67	1



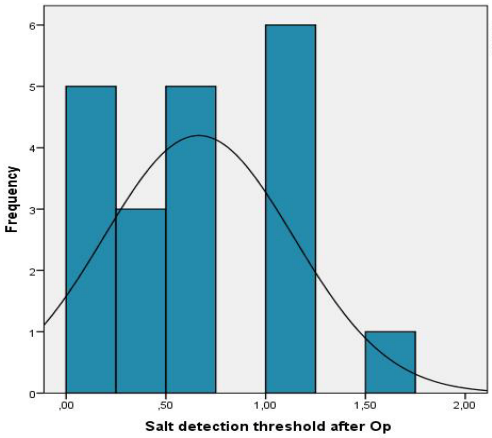
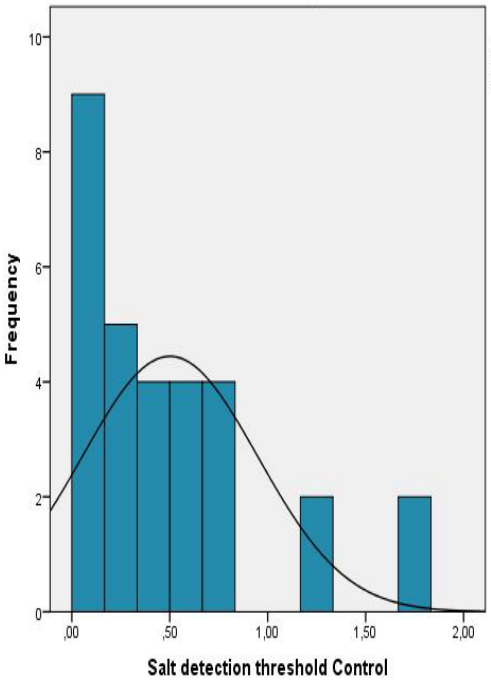


Table 12: Distribution of the salt detection threshold (g NaCl/L) of the control group

SDT Control group [g NaCl/L]	Frequency
0,2	1
0,13	8
0,20	4
0,29	1
0,40	4
0,58	4
0,82	4
1,17	2
1,67	2



Because of the missing normal distribution of the patient's SDT a nonparametric Wilcoxon Signed Rank Test was performed showing a significant difference in the salt detection thresholds of patients before and after surgery **(p = 0,038)**. Also the paired t-test revealed a significant result **(p = 0,026)**. Therefore it can be concluded that bariatric surgeries with accompanying weight loss can even worsen the estimated threshold of people.

The Mann Whitney U Test was further performed to compare the estimated thresholds of the patients and control group. There were no significant differences in the SDT of patients and controls **(p = 0,579)**. Also a t-test for unpaired samples showed no differences in the salt detection thresholds of patients and controls **(p = 0,913)**.

6.2.1 Gender differences in salt detection threshold

Gender differences in the mean salt detection thresholds of patients and controls were tested with t- tests for independent samples.

Results were not significant for men and women in both groups (see Table 13). The mean salt detection thresholds for female and male patients are listed in Table 14.

Table 13: Results of the t-test for independent samples of the mean salt detection thresholds (g NaCl/L) of the control group and the patients

Significance (t-test for independent samples)				
	Total	**Patients before OP**	**Patients after OP**	**Control**
P-Value	0,537	0,366	0,669	0,135

Table 14: Mean salt detection thresholds (g NaCl/l) in female and male patients and controls

Mean (± SD) salt detection threshold (SDT) [g NaCl/L]				
	Total sample	**Patients before OP**	**Patients after OP**	**Control**
Female	0,46±0,36	0,53 ± 0,36	0,63 ± 0,48	0,36±0,35
Male	0,52±0,42	0,42 ±0,29	0,73 ± 0,50	0,61±0,49

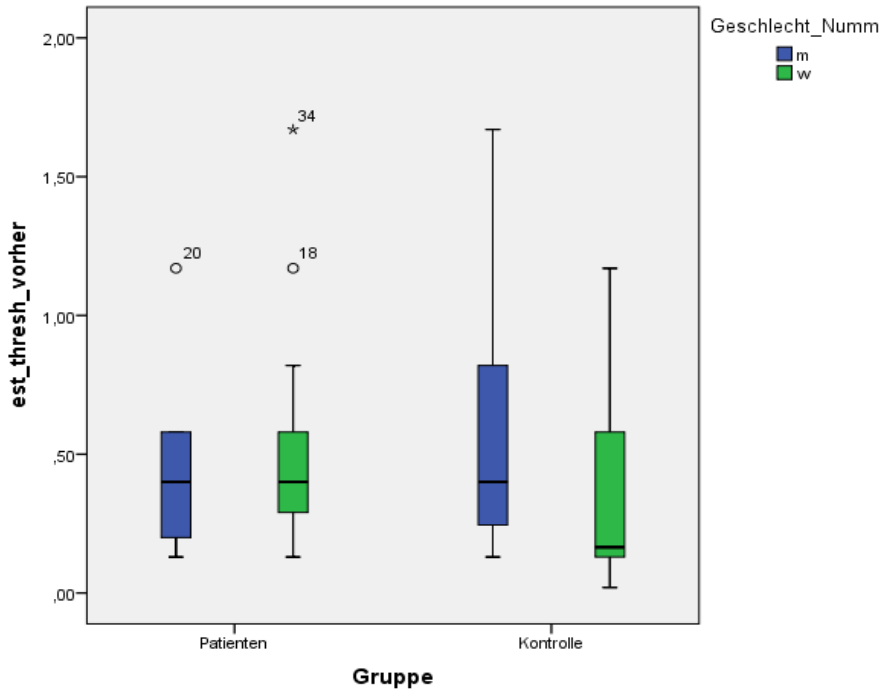


Figure 18: Boxplot of the salt detection thresholds (g NaCl/L) of female and male patients and control (blue boxes: male, green boxes: female)

The Boxplot in Figure 18 shows that the 95% CI of the salt detection threshold (g NaCl/l) is much lower in the female and male control group compared with the group of patients.

6.2.2 Influences of diabetes and hypertension on salt taste detection

There were no significant differences in the salt detection thresholds between patients with or without diabetes or hypertension (see Table 15).

Table 15: Mean salt detection threshold (g NaCl/l) for patients with or without hypertension or diabetes and results for the t-test for independent samples

	Mean SDT (g NaCl/L)		Significance (t-test for independent samples)	
Diseases	**Patients before OP**	**Patients after OP**	**Patients before OP**	**Patients after OP**
Hypertension (n=22)	0,46 ±0,21	0,65±0,39	p = 0,687 f = 0,052	p = 0,939 f = 0,069
No hypertension (n=13)	0,51±0,43	0,67±0,56		
Diabetes (n=13)	0,55±0,24	1,02 ± 0,29	p = 0,479 f = 0,147	p =0,092 f = 0,368
No Diabetes (n=22)	0,46 ± 0,37	0,57 ± 0,47		

These study results lead to the assumption that diabetes 2 and hypertension does not alter the salt taste perception even after bariatric surgery.

6.3 Preference for soups differing in their salt concentrations

Cream soups with five different salt concentrations were used (see Table 6) to test the salt taste. The test persons, patients as well as the control group were requested to state their liking on a 9 point hedonic scale (see Figure 11).

Number 1 was the lowest ranking (Dislike Extremely) and number 9 was the highest possible rating on the scale (Like Extremely). To use the verbal nine point hedonic scale for the statistical analysis, the ratings were registered with the number 1-9.

Descriptive analysis of the soups likings

An overview of the mean liking scores and standard deviations of the five soups of the patients and control group are listed in Table 16.

The results showed that the control group (mean ± SD of 4,27 ± 2,59) liked soup 3 best, whereas patients before the surgery liked soup 4 (mean ± SD of 3,46 ± 2,68) most.

Patients, who participated in the second test liked soup 1 best (mean ± SD of 2,80 ± 1,82). Soup 5, which had the highest concentration of salt, was the one with the lowest liking level in the patients before and after the operation and the control group.

Table 16: Mean liking scores and standard deviations of soup 1-5 in controls and patients before and after OP

Group	Soup 1	Soup 2	Soup 3	Soup 4	Soup 5
Control (n=30)	Mean: 3,67 SD: 2,30	Mean: 4,33 SD: 2,33	Mean: 4,27 SD: 2,59	Mean: 3,47 SD: 2,37	Mean: 3,10 SD: 2,35
Patients before (n=35)	Mean: 2,80 SD: 2,04	Mean:2,83 SD: 2,39	Mean: 2,94 SD: 2,41	Mean: 3,46 SD: 2,68	Mean: 2,91 SD: 2,65
Patients after (n=20)	Mean: 2,80 SD: 1,82	Mean: 2,65 SD: 1,87	Mean: 2,25 SD: 1,86	Mean: 2,40 SD: 2,08	Mean: 2,00 SD: 1,80

The two boxplots (see Figure 19 and 20) give a graphical presentation of the results listed in Table 18.

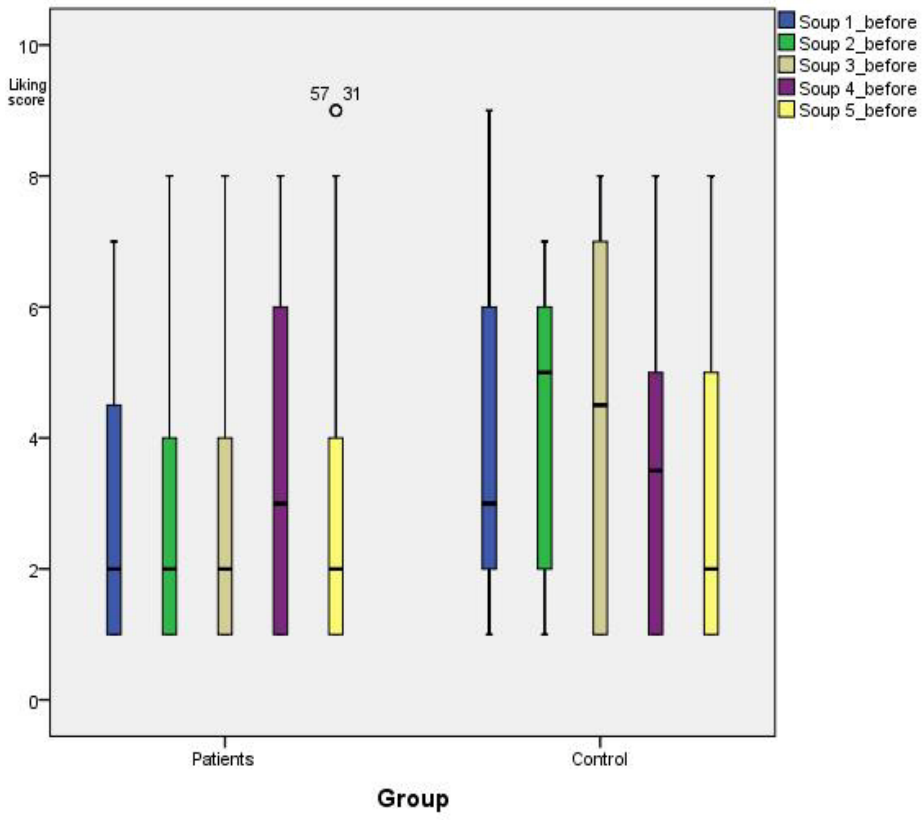


Figure 19: Boxplot of soup 1-5 before bariatric surgery in patients and controls (x-axe: Liking score of the soups, y-axe: soups 1-5 separated in patients and controls)

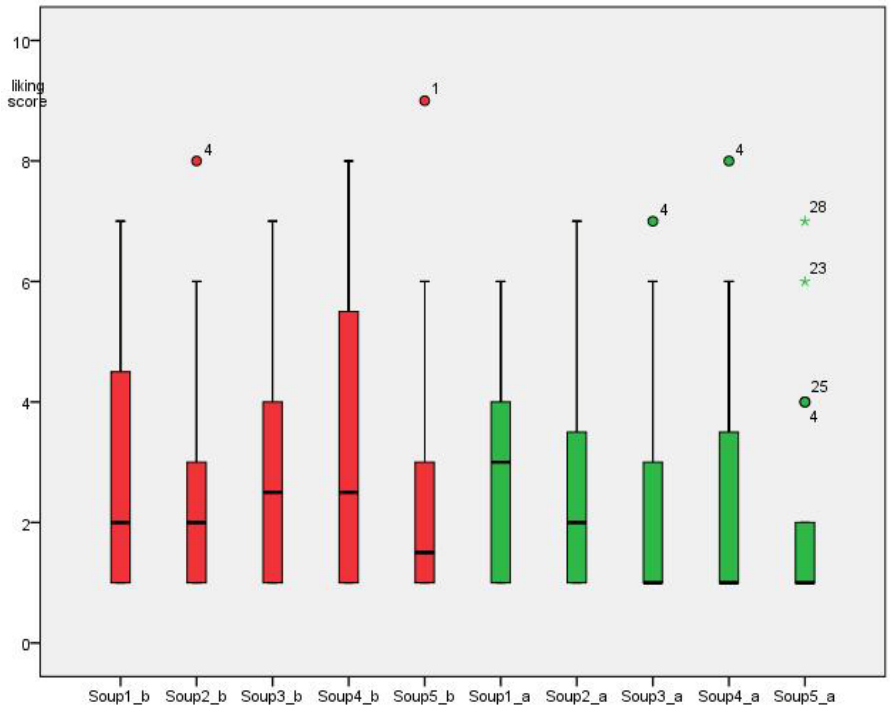


Figure 20: Boxplot of soups 1-5 before and after the operation in patients (x-axe: Liking score of the soups, y-axe: soups 1-5 before and after Op)

Analysis of repeated measures and contrast analysis of the soups before in patients and controls

The analysis of repeated measures showed no differences in the soups. However group specific differences in the soup likings of patients and controls were significant (see Table 17). This effect also occurs if gender is not included as a factor.

Table 17: Results of repeated measures for soups before with patients and controls including gender as factor

Tests der Innersubjekteffekte

Maß: MASS_1

Quelle		Quadratsumme vom Typ III	df	Mittel der Quadrate	F	Sig.
Suppen	Sphärizität angenommen	19,586	4	4,897	2,263	,063
	Greenhouse-Geisser	19,586	3,168	6,183	2,263	,079
	Huynh-Feldt	19,586	3,526	5,555	2,263	,072
	Untergrenze	19,586	1,000	19,586	2,263	,138
Suppen * Gruppe	Sphärizität angenommen	24,767	4	6,192	2,861	,024
	Greenhouse-Geisser	24,767	3,168	7,818	2,861	,035
	Huynh-Feldt	24,767	3,526	7,024	2,861	,030
	Untergrenze	24,767	1,000	24,767	2,861	,096
Suppen * Geschlecht_Numm	Sphärizität angenommen	2,528	4	,632	,292	,883
	Greenhouse-Geisser	2,528	3,168	,798	,292	,842
	Huynh-Feldt	2,528	3,526	,717	,292	,861
	Untergrenze	2,528	1,000	2,528	,292	,591
Suppen * Gruppe * Geschlecht_Numm	Sphärizität angenommen	7,871	4	1,968	,909	,459
	Greenhouse-Geisser	7,871	3,168	2,485	,909	,442
	Huynh-Feldt	7,871	3,526	2,232	,909	,450
	Untergrenze	7,871	1,000	7,871	,909	,344
Fehler(Suppen)	Sphärizität angenommen	528,039	244	2,164		
	Greenhouse-Geisser	528,039	193,239	2,733		
	Huynh-Feldt	528,039	215,080	2,455		
	Untergrenze	528,039	61,000	8,656		

There is also a significant difference of soup 2, 3 and 4 compared to soup 5. Furthermore the liking of soup 2 to soup 5 differs between the groups (see Table 18).

Table 18: Results of the contrast analysis to figure out differences between the soups before in patients and controls (reference is soup 5/level 5)

Tests der Innersubjektkontraste						
Maß: MASS_1						
Quelle	suppen	Quadratsumme vom Typ III	df	Mittel der Quadrate	F	Sig.
suppen	Niveau 1 vs. Niveau 5	4,876	1	4,876	,973	,328
	Niveau 2 vs. Niveau 5	26,411	1	26,411	5,449	,023
	Niveau 3 vs. Niveau 5	27,489	1	27,489	5,004	,029
	Niveau 4 vs. Niveau 5	15,122	1	15,122	5,965	,018
suppen * Gruppe	Niveau 1 vs. Niveau 5	6,521	1	6,521	1,301	,258
	Niveau 2 vs. Niveau 5	23,113	1	23,113	4,769	,033
	Niveau 3 vs. Niveau 5	16,556	1	16,556	3,014	,088
	Niveau 4 vs. Niveau 5	,793	1	,793	,313	,578
suppen * Geschlecht_Numm	Niveau 1 vs. Niveau 5	1,102	1	1,102	,220	,641
	Niveau 2 vs. Niveau 5	,198	1	,198	,041	,841
	Niveau 3 vs. Niveau 5	1,296	1	1,296	,236	,629
	Niveau 4 vs. Niveau 5	,038	1	,038	,015	,903
suppen * Gruppe * Geschlecht_Numm	Niveau 1 vs. Niveau 5	10,357	1	10,357	2,067	,156
	Niveau 2 vs. Niveau 5	12,097	1	12,097	2,496	,119
	Niveau 3 vs. Niveau 5	6,500	1	6,500	1,183	,281
	Niveau 4 vs. Niveau 5	2,929	1	2,929	1,155	,287
Fehler(suppen)	Niveau 1 vs. Niveau 5	305,732	61	5,012		
	Niveau 2 vs. Niveau 5	295,650	61	4,847		
	Niveau 3 vs. Niveau 5	335,064	61	5,493		
	Niveau 4 vs. Niveau 5	154,649	61	2,535		

Table 19: Results of the "Test der Zwischeneffekte" of the soups before in patients and controls

Tests der Zwischensubjekteffekte					
Maß: MASS_1 Transformierte Variable: Mittel					
Quelle	Quadratsumme vom Typ III	df	Mittel der Quadrate	F	Sig.
Konstanter Term	739,826	1	739,826	219,678	,000
Gruppe	3,910	1	3,910	1,161	,285
Geschlecht_Numm	56,306	1	56,306	16,719	,000
Gruppe * Geschlecht_Numm	1,547	1	1,547	,459	,500
Fehler	205,434	61	3,368		

In Table 19 gender specific differences are high significant. The results of the "Test der Zwischeneffekte" show that gender has an influence on the soup likings in both groups.

Analysis of repeated measures and contrast analysis of the soups before vs. after in patients

Table 20: Results of repeated measures design for soups before and after in patients

Tests der Innersubjekteffekte

Maß: MASS_1

Quelle		Quadratsumme vom Typ III	df	Mittel der Quadrate	F	Sig.
op	Sphärizität angenommen	7,220	1	7,220	1,927	,181
	Greenhouse-Geisser	7,220	1,000	7,220	1,927	,181
	Huynh-Feldt	7,220	1,000	7,220	1,927	,181
	Untergrenze	7,220	1,000	7,220	1,927	,181
Fehler(op)	Sphärizität angenommen	71,180	19	3,746		
	Greenhouse-Geisser	71,180	19,000	3,746		
	Huynh-Feldt	71,180	19,000	3,746		
	Untergrenze	71,180	19,000	3,746		
suppe	Sphärizität angenommen	7,930	4	1,983	1,101	,362
	Greenhouse-Geisser	7,930	3,023	2,623	1,101	,357
	Huynh-Feldt	7,930	3,659	2,167	1,101	,361
	Untergrenze	7,930	1,000	7,930	1,101	,307
Fehler(suppe)	Sphärizität angenommen	136,870	76	1,801		
	Greenhouse-Geisser	136,870	57,441	2,383		
	Huynh-Feldt	136,870	69,527	1,969		
	Untergrenze	136,870	19,000	7,204		
op * suppe	Sphärizität angenommen	5,930	4	1,482	,664	,619
	Greenhouse-Geisser	5,930	1,881	3,152	,664	,512
	Huynh-Feldt	5,930	2,081	2,849	,664	,526
	Untergrenze	5,930	1,000	5,930	,664	,425
Fehler(op*suppe)	Sphärizität angenommen	169,670	76	2,233		
	Greenhouse-Geisser	169,670	35,745	4,747		
	Huynh-Feldt	169,670	39,541	4,291		
	Untergrenze	169,670	19,000	8,930		

The repeated measures design revealed that the operation (op) had no effects on soup likings and there were no differences found in the soups (Suppe) (see Table 20).

Table 21: Results of the contrast analysis to figure out differences between the soups before and after in patients

Tests der Innersubjektkontraste							
Maß: MASS_1							
Quelle	op	suppe	Quadratsumme vom Typ III	df	Mittel der Quadrate	F	Sig.
op	Linear		1,444	1	1,444	1,927	,181
Fehler(op)	Linear		14,236	19	,749		
suppe		Niveau 1 vs. Niveau 5	12,100	1	12,100	3,436	,079
		Niveau 2 vs. Niveau 5	4,225	1	4,225	1,211	,285
		Niveau 3 vs. Niveau 5	3,025	1	3,025	,584	,454
		Niveau 4 vs. Niveau 5	11,025	1	11,025	5,175	,035
Fehler(suppe)		Niveau 1 vs. Niveau 5	66,900	19	3,521		
		Niveau 2 vs. Niveau 5	66,275	19	3,488		
		Niveau 3 vs. Niveau 5	98,475	19	5,183		
		Niveau 4 vs. Niveau 5	40,475	19	2,130		
op * suppe	Linear	Niveau 1 vs. Niveau 5	2,500	1	2,500	,408	,531
		Niveau 2 vs. Niveau 5	4,225	1	4,225	,514	,482
		Niveau 3 vs. Niveau 5	,025	1	,025	,006	,939
		Niveau 4 vs. Niveau 5	,625	1	,625	,305	,587
Fehler(op*suppe)	Linear	Niveau 1 vs. Niveau 5	116,500	19	6,132		
		Niveau 2 vs. Niveau 5	156,275	19	8,225		
		Niveau 3 vs. Niveau 5	79,475	19	4,183		
		Niveau 4 vs. Niveau 5	38,875	19	2,046		

The contrast analysis however showed that soups 4 and 5 were statistical different (see Table 21).

However when covariates like age, sex and BMI_difference were considered the significant effect between soup 4 and 5 abolishes (see Table 22).

Table 22: Results of the repeated measures design with age, gender and BMI_difference as covariates

Tests der Innersubjektkontraste							
Maß: MASS_1							
Quelle	Operation	Suppen	Quadratsumme vom Typ III	df	Mittel der Quadrate	F	Sig.
Operation	Linear		1,665	1	1,665	2,153	,162
Operation * Alter	Linear		,479	1	,479	,619	,443
Operation * Geschlecht_Numm	Linear		1,487	1	1,487	1,922	,185
Operation * BMI_diff	Linear		,492	1	,492	,637	,437
Fehler(Operation)	Linear		12,375	16	,773		
Suppen		Niveau 1 vs. Niveau 5	1,453	1	1,453	,461	,507
		Niveau 2 vs. Niveau 5	,167	1	,167	,050	,826
		Niveau 3 vs. Niveau 5	1,653	1	1,653	,328	,575
		Niveau 4 vs. Niveau 5	2,875	1	2,875	1,335	,265
Suppen * Alter		Niveau 1 vs. Niveau 5	9,262	1	9,262	2,940	,106
		Niveau 2 vs. Niveau 5	9,021	1	9,021	2,686	,121
		Niveau 3 vs. Niveau 5	2,473	1	2,473	,491	,493
		Niveau 4 vs. Niveau 5	,528	1	,528	,245	,627
Suppen * Geschlecht_Numm		Niveau 1 vs. Niveau 5	1,739	1	1,739	,552	,468
		Niveau 2 vs. Niveau 5	1,210	1	1,210	,360	,557
		Niveau 3 vs. Niveau 5	,315	1	,315	,063	,806
		Niveau 4 vs. Niveau 5	,068	1	,068	,031	,862
Suppen * BMI_diff		Niveau 1 vs. Niveau 5	,319	1	,319	,101	,754
		Niveau 2 vs. Niveau 5	,203	1	,203	,060	,809
		Niveau 3 vs. Niveau 5	8,744	1	8,744	1,737	,206
		Niveau 4 vs. Niveau 5	4,714	1	4,714	2,190	,158
Fehler(Suppen)		Niveau 1 vs. Niveau 5	50,401	16	3,150		
		Niveau 2 vs. Niveau 5	53,732	16	3,358		
		Niveau 3 vs. Niveau 5	80,539	16	5,034		
		Niveau 4 vs. Niveau 5	34,451	16	2,153		
Operation * Suppen	Linear	Niveau 1 vs. Niveau 5	,409	1	,409	,059	,811
		Niveau 2 vs. Niveau 5	,110	1	,110	,012	,916
		Niveau 3 vs. Niveau 5	1,417	1	1,417	,311	,585
		Niveau 4 vs. Niveau 5	,024	1	,024	,012	,914
Operation * Suppen * Alter	Linear	Niveau 1 vs. Niveau 5	,662	1	,662	,095	,761
		Niveau 2 vs. Niveau 5	,209	1	,209	,022	,884
		Niveau 3 vs. Niveau 5	2,326	1	2,326	,510	,485
		Niveau 4 vs. Niveau 5	,283	1	,283	,145	,708
Operation * Suppen * Geschlecht_Numm	Linear	Niveau 1 vs. Niveau 5	2,816	1	2,816	,406	,533
		Niveau 2 vs. Niveau 5	,555	1	,555	,058	,812
		Niveau 3 vs. Niveau 5	,882	1	,882	,194	,666
		Niveau 4 vs. Niveau 5	4,202	1	4,202	2,159	,161
Operation * Suppen * BMI_diff	Linear	Niveau 1 vs. Niveau 5	,200	1	,200	,029	,867
		Niveau 2 vs. Niveau 5	1,395	1	1,395	,147	,707
		Niveau 3 vs. Niveau 5	3,077	1	3,077	,675	,423
		Niveau 4 vs. Niveau 5	1,011	1	1,011	,519	,482
Fehler(Operation*Suppen)	Linear	Niveau 1 vs. Niveau 5	110,879	16	6,930		
		Niveau 2 vs. Niveau 5	152,101	16	9,506		
		Niveau 3 vs. Niveau 5	72,913	16	4,557		
		Niveau 4 vs. Niveau 5	31,143	16	1,946		

Correlation analysis of the SDT of the soups before and after in patients and controls

Table 23: Results of the bivariate correlation of the SDT before and after with the cream soups before and after for controls and patients

SDT	Soup 1	Soup 2	Soup 3	Soup 4	Soup 5
Before Patients and Control	Pearson:-0,053 p = 0,672	Pearson:-0,034 p = 0,786	Pearson:-0,055 p = 0,664	Pearson:-0,132 p = 0,293	Pearson:0,185 p = 0,141
Before Control	Pearson:-0,069 p = 0,719	Pearson:-0,012 p = 0,951	Pearson:0,127 p = 0,502	Pearson:0,249 p = 0,184	Pearson:0,214 p = 0,257
Before Patients	Pearson:-0,044 p = 0,804	Pearson:-0,073 p = 0,678	Pearson:-0,036 p = 0,837	Pearson:-0,021 p =0,903	Pearson:0,162 p = 0,352
After Patients	Pearson: -0,298 p = 0,201	Pearson:-0,027 p = 0,910	Pearson:-0,000 p = 1,000	Pearson:-0,028 p = 0,907	Pearson:0,016 p = 0,500

The Pearson correlation revealed no correlation of the estimated thresholds before with the soups before and also afterwards no correlation existed between the SDT and the soups for patients. Patients and controls as well as the control group alone revealed no correlation of the estimated thresholds and the soups before (see Table 23).

6.3.1. Gender differences in cream soup likings

Descriptive Analysis of the cream soups

Table 24: Mean Liking Scores and SD of soup 1-5 of female and male test persons (total sample, control group and patients)

Group	Soup 1	Soup 2	Soup 3	Soup 4	Soup 5
Total Sample					
Female (n=36)	Mean*: 2.44 SD: 1,98	Mean: 2,56 SD: 2,13	Mean: 2,53 SD: 1,99	Mean: 2,64 SD: 2,11	Mean: 2,19 SD: 2,01
Male (n=29)	Mean: 4,14 SD: 1,98	Mean: 4,72 SD: 2,36	Mean: 4,83 SD: 2,66	Mean: 4,48 SD: 2,65	Mean: 4,00 SD: 2,71
Control					
Female (n=14)	Mean: 2,79 SD: 2,29	Mean: 3,29 SD: 2,30	Mean: 5,38 SD: 2,63	Mean: 2,21 SD: 1,67	Mean: 1,64 SD: 1,01
Male (n=16)	Mean: 4,44 SD: 2,09	Mean: 5,25 SD: 2,02	Mean: 3,00 SD: 2,32	Mean: 4,56 SD: 2,39	Mean: 4,38 SD: 2,47
Patients before					
Female (n=22)	Mean: 2,23 SD: 1,78	Mean: 2,09 SD: 1,92	Mean: 2,23 SD: 1,74	Mean: 2,91 SD: 2,35	Mean: 2.55 SD: 2,41
Male (n=13)	Mean: 3,77 SD: 2,17	Mean: 4,08 SD: 2,67	Mean: 4,15 SD: 2,94	Mean: 4,38 SD: 3,04	Mean: 3,54 SD: 3,02
Patients after					
Female (n=14)	Mean: 2,86 SD: 1,51	Mean: 2,36 SD: 1,39	Mean: 2,14 SD: 1,83	Mean: 2,43 SD: 2,14	Mean: 1,64 SD: 1,01
Male (n=6)	Mean: 2,67 SD: 2,58	Mean: 3,33 SD: 2,73	Mean: 2,50 SD: 2,07	Mean: 2,33 SD: 2,17	Mean: 2,83 SD: 2,86

Table 24 illustrates the mean liking scores and SD of the female and male test persons (total sample, patients and control group). Mean liking scores of male participants, whether patients or controls are higher than the female ones (see Table 24).

The Boxplots in Figure 21 and 22 illustrate the likings scores of the cream soups (y-axes) of the female and male group (x-axes) of patients and controls. In the two Boxplots it is quite clear that the female population had significant lower liking ratings for all the five cream soups.

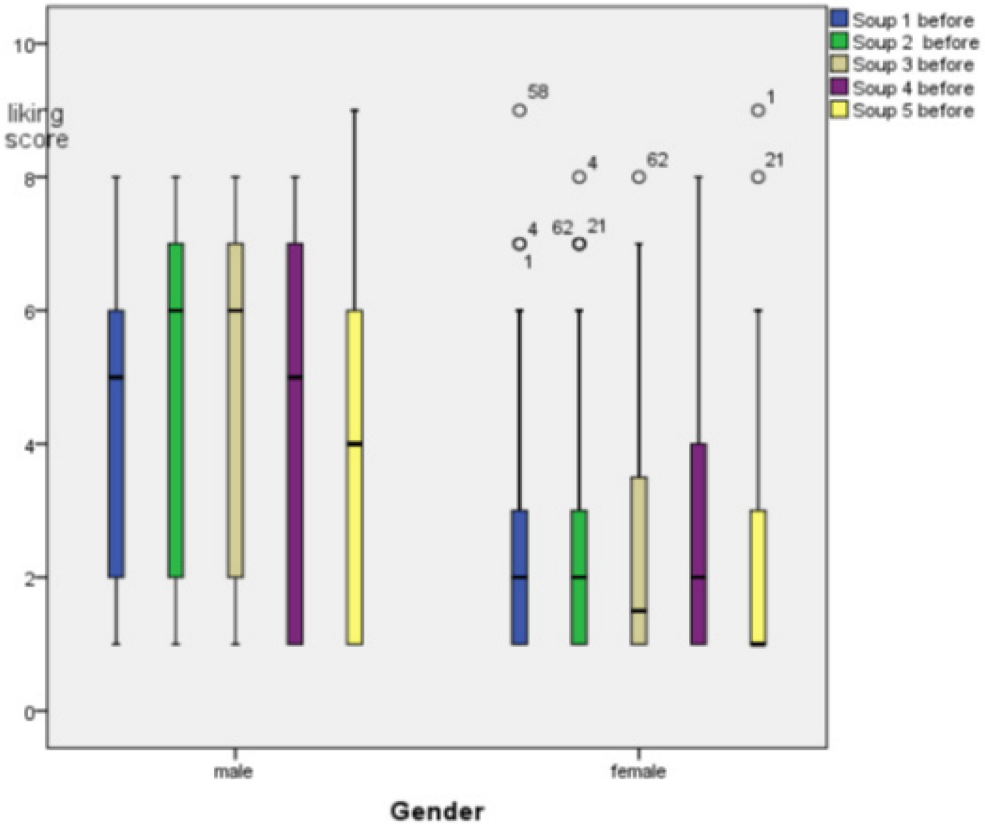


Figure 21: Boxplot illustration of female and male group in patients before operation and the control group and the soup liking scores (x-axes: male, female; y-axes: liking score (1-9))

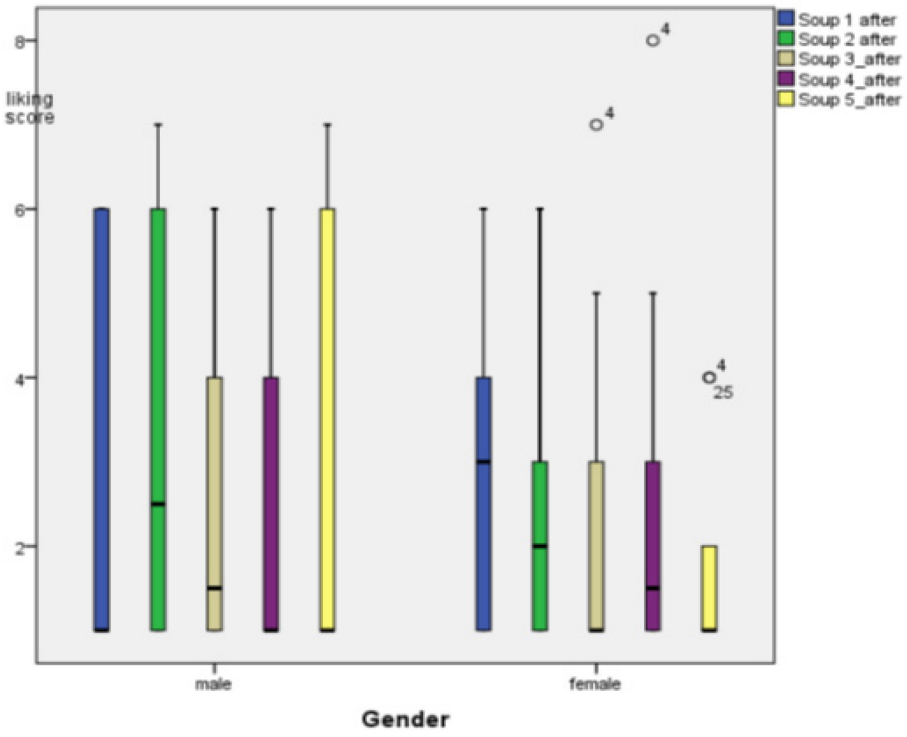


Figure 22: Boxplot illustration of female and male group in patients after operation and control group and the soup liking scores (x-axes: male, female; y-axes: liking score (1-9))

Univariate Analysis of Variance of soups before in patients and controls

With an univariate analysis of variance (ANOVA) using weighted average of soups before (WM_Suppe_vorher) as dependent, group and sex as independent variable and age and BMI_before as covariates in men and women of patients and controls the results showed no group specific differences. Gender specific differences however were highly significant (see Table 25), suggesting that females did not like the soups.

Table 25: Results of the ANOVA with WM_Suppe as dependent variable, group and sex as independent variable and age and BMI_before as covariates in the total sample

Tests der Zwischensubjekteffekte					
Abhängige Variable: WM_Suppen_v					
Quelle	Quadratsumme vom Typ III	df	Mittel der Quadrate	F	Sig.
Korrigiertes Modell	73,720[a]	5	14,744	3,871	,004
Konstanter Term	30,194	1	30,194	7,927	,007
BMI_vor	3,035	1	3,035	,797	,376
Alter	5,689	1	5,689	1,494	,227
Gruppe	1,621	1	1,621	,426	,517
Geschlecht_Numm	64,120	1	64,120	16,834	,000
Gruppe * Geschlecht_Numm	4,843	1	4,843	1,271	,264
Fehler	224,725	59	3,809		
Gesamt	1013,573	65			
Korrigierte Gesamtvariation	298,445	64			

a. R-Quadrat = ,247 (korrigiertes R-Quadrat = ,183)

6.4 Food Questionnaire

In Table 26 mean values, standard deviations and the results of the t-test for unpaired samples and Mann Whitney U Test are listed.

Table 26: Mean value and SD and results of the t-test for unpaired samples and the non-parametric Mann Whitney U Test (patients and controls included) for the questions (1-7.10)

Questions	Mean Value	Standard Deviation (SD)	Significance t-test for unpaired samples	Significance Mann Whitney U Test
1. Ich esse gerne ….Speisen	2,84	0,81	0,818	0,699
2. Ich würze meine Speisen …mit Salz nach	1,95	0,61	0,378	0,381
3. Wie viel Salz fügen Sie dem Wasser beim Kochen von 2 Portionen Spaghetti (ca.300g) hinzu?	3,14	0,89	0,667	0,850
4. Wie oft essen Sie Speck, Würste, Schinken?	2,79	1,32	0,698	0,655
5. Wie oft essen Sie Fertiggerichte (z.b. Pizza, Packerlsuppe, Tiefkühlgerichte)	1,91	0,75	0,531	0,670

6. Wie oft essen Sie gesalzene Nüsse, Chips, Popcorn oder ähnliche salzhaltige Snacks?	1,93	0,98	0,781	0,611
7. Welche der folgenden Lebensmittel hat einen niedrigen oder hohen Salzgehalt?				
7.1.Wurst	1,12	0,49	0,243	0,279
7.2.Käse	1,95	0,43	0,209	0,206
7.3.ungekochte Nudeln	2,00	0,53	0,561	0,348
7.4.Brot	1,56	0,57	0,092	0,096
7.5. Milch	2,19	0,39	0,114	0,113
7.6. Käse	1,72	0,70	0,827	0,661
7.7. frisches Gemüse	2,05	0,37	0,144	0,150
7.8. Nüsse	**1,37**	**0,58**	**0,001**	**0,001**
7.9. Fertigprodukte (z.b. Pizza, Packerlsuppe, Tiefkühlprodukte)	**1,37**	**0,65**	**0,003**	**0,000**
7.10 Schokolade	2,09	0,57	0,052	0,054

Only question 7.8 and 7.9 showed significant results of patients and controls (p-value 0,001 and 0,003). All the other results were not significant at all and showed no differences in the liking of salty food of patients and controls.

7. Discussion

The present study demonstrates that no significant differences in the salt detection thresholds of patients and controls and no differences in the salt detection thresholds of women and men were found. A significant decrease was shown in the salt detection thresholds of patients after bariatric surgery. This leads to the conclusion that bariatric surgery can even worsen salt detection thresholds of patients. Moreover there were no differences in the salt detection thresholds between patients with or without diabetes and hypertension.

Group specific differences of patients and controls were significant and gender specific differences were high significant looking at the rating of the soup likings of the five cream soups. However the bariatric operation of the patients had no effect on their soup liking at all and there was also no significant correlation of the salt detection thresholds and the five soups before and after operation.

The Food Questionnaire revealed no differences in the liking of salty food of patients and controls.

The hypothesis of this study that salt taste detection may differ between the obese patients and the lean control group could not be confirmed in this study. Salt taste and taste in general is influenced by many factors such as genetic variations, diseases, drugs, environmental influences and age.

However our present results are in accordance with previous study results, who investigated the four general taste response thresholds.

The study of Simchen et al. 2006 for example showed that there were no significant differences in salty and sweet taste perceptions. In their study differences were only significant in bitter and sour tastes of test persons and an impaired taste was also found in adults older than 65. Furthermore a strong effect of age and gender on the salt taste was observed. They observed a lower taste and odour perception in males and a decreased texture perception and chewing efficiency in the older participants. Therefore

they came to the conclusion that the gustatory abilities of humans decrease with increasing age and are higher in female than in males. [Simchen et al. 2006]

In the study of Pasquet et al. 2007 the results revealed significant lower recognition thresholds for sucrose and sodium chloride in obese adolescents compared to the lean control group. [Pasquet et al. 2007]

The study of Donaldson et al. 2009 on the other hand showed that overweight women liked the taste of salty foods more compared to the normal weight group; however the converse assumption was true for the male control group. [Donaldson et al. 2009]

Possible explanations for those different findings could be the use of different sensory evaluation methods or the fact that the observed test persons were mostly adolescents or elderly participants whereas the test persons of our study consisted of adults with a mean age of 45,4 years in the group of patients and 41 years in the control group.

Gender specific differences of the salt detection thresholds, like in the study of Donaldson et al. 2009 and Simchen et al. 2006, were not significant in the patients and control group of our study. Because of the very similar mean salt detection thresholds of men and women it can be assumed that both genders tend to have common salt taste acuities. [Donaldson et al. 2009, Simchen et al. 2006]

The second hypothesis of this study assumed that salt taste is modulated after bariatric surgery in patients. Although there were significant differences in the salt detection thresholds of patients before and after bariatric surgery, the results revealed an increase of the salt detection thresholds after surgery instead a decrease, which leads to the assumption that bariatric surgery can even worsen salt detection thresholds of patients.

Because of the fact that this is one of the first studies, which is focusing on alterations of the salt taste in patients before and after bariatric surgery it is very difficult to find studies to compare the outcomes, because most of the existing studies were only focusing on changes of the sweet taste after bariatric surgery.

For example Miras and le Roux 2010 showed an increase of the sweet taste, which lead to an increased intensity when eating sweet meals and consuming sweet foods were perceived as less pleasant after bariatric surgery. [Miras and le Roux 2010]

Also Bueter et al. 2011 investigated changes of the sweet taste perception in patients after gastric bypass surgeries. They found out that patients were able to detected lower concentrations of sucrose after the operation then before, however there were no differences in the hedonic ratings of sucrose solutions by patients after surgery compared to the sensory testing before. [Bueter et al. 2011]

To our knowledge the only study, investigating a decrease of the salt detection threshold after bariatric surgery was the study of Scruggs et al. 1994. However the findings of Scruggs et al. 1994 are not in accordance to our findings. Our results revealed that participants of the second test were not able to detect salt at lower concentrations. A possible reason for the contrary findings may be the method of sensory measurement. Scruggs et al. 1994 placed a single drop of water or salt for three times on the tongue of the patients. This method stimulates only a limited number of taste buds on the tongue. In our study the alternative food choice (AFC) test was used, consisting of eight cups of sodium chloride concentrations and water. The test persons were requested to take the whole content of the cup into the mouth, so that all taste buds of the mouth and tongue were stimulated with the test solution. Furthermore there were also other determinates, which were different like the age category of the test persons, the sample size, the follow up (3 months) and most of our patients were suffering of hypertension or diabetes. [Scruggs et al 1994]

Although similar studies used lower sample sizes [Scruggs et al 1994, Bueter et al.2011 and Burge et al. 1993] compared to our study, the low participation in the second sensory test of the study (only 20 out of 35 patients were attending the test) may hide potential relations between the weight loss after bariatric surgery and the salt taste acuity of the patients.

A reason for the low participation of the second test was the fact that the patients had to come to the hospital to take part in the test. Compared to the first test, where the patients were already staying at the hospital, waiting for their operation on the next day, and coming to the hospital for the second sensory test was very annoying for some of them.

Although it was the overall believe that all the patients had to come to the hospital for their medical check-up after three months of the bariatric surgery, some of the patients visited Prof. Langer or Prof. Prager at their private ordination and were not eager to come to the hospital only for the test. Therefore most of them were not able to take part in the second test.

To get to know the date of their medical check-up at the hospital, patients were informed to receive a phone call two months after their operation. Although all of them were willing to receive the phone call some of the patients were not reachable by phone at all. They were either not responding to the phone calls or the voice mails, which were left for them or even told us a wrong phone number. Some of them even arranged an appointment for the second test in the General Hospital, but in the end they did not show up to the appointed date and when trying to call them on their phone they did not answer the calls.

Therefore it can be assumed that the results of the salt detection thresholds of patients before and after would maybe differ when all of the patients would have been participated in the second test.

Although there were no significant differences in the salt detection thresholds between patients with or without diabetes or hypertension, these comorbidities such as medical treatments and age can act as a cofounder in this study.

Also the aging process of humans can influence the gustatory sensation, as shown in the study of Simchen et al. 2006. [Simchen et al. 2006]

A decline in taste sensitivity mostly occurs after the age of 60 years. Especially the salt and bitter taste is more affected of age than the sweet and sour taste. Increased drug consumption in the elderly population also influences the gustatory function of humans. Drug related quantitative and qualitative gustatory disorders are the result of a longer treatment with different kind of medications.

Earlier studies focusing on the salt taste sensitivity and thresholds between hypertensive and normotensive persons found differences between the two groups. For example Fallis et al. 1962 showed a decreased ability to recognize the taste of salt in hypertensive persons and therefore concluded that hypertensive persons consume more salt and salty foods because of their impaired salt taste, whereas Henkin 1974 found no

differences in the salt taste of hypertensive and normotensive persons. [Fallis et al. 1962; Henkin RI 1974]

Moskowitz and Abramson et al. 1976 examined the saltiness of salted soups using 10 point hedonic scale and showed that hypertensive persons perceived high salt concentrations less intense compared with the control group. [Moskowitz and Abramson 1976]

Gondivkar et al. 1989 revealed hyposensitivity of sweet, sour and salty tastes in persons with diabetes type 2. Similar findings were found by le Floch et al. 1989 were all four taste modalities were decreased in patients with type 1 diabetes. [Gondivkar et al. 2009, Le Floch et al. 1989]

The results of the ratings of the soup likings revealed significant group specific and gender specific differences of patients and controls.

The mean scores of the soups showed that Soup 4 was most preferred by patients before the operation and soup 5 was the one, which was getting the lowest ranking. Three months after the operation soup 1 had the highest mean liking score of all the five soups, which can be partly related to nausea and a loss of appetite after bariatric surgery.

The control group preferred soup 3 most and soup 5 least. This result is not surprising either, because of the assumption that normal weight persons prefer foods with a lower salt content more.

The bariatric operation of the patients showed no significant effect on the soup liking at all and no correlation was found between the estimated thresholds and the five soups in the group of patients.

One important cofounder in the soup liking ratings, which should be taken into consideration, was the willingness of the test persons to participate in this study. The reason why the control group showed better acceptance values of the soups compared to the patients is that they were very interested in the sensory test and were very pleased to

take part in the study. Many of them wanted to get more knowledge about their sense of taste when eating salty food and were very interested in their results after the sensory testing. Although they were all participating on a voluntary basis the group of patients were not that enthusiastic about testing different kind of salt concentrations. It seemed that they just participated in the study to pass by the time during their stay at the hospital. The low interest of the patients was confirmed when they had to come to the second test. Therefore only 20 patients were participating in the second test and most of them rated all the soups with 1 because of their physical discomfort.

A reason for the high significant gender specific differences in the cream soup likings between women and men can be due to the fact that women tend to have a lower intake of milk and milk products than men.

Klesges et al. 1999 assumed that men and boys drink more milk compared with women and girls. They therefore investigated the average milk and milk products consumption of four young men and women with a questionnaire. Their results revealed that half of the test persons reported to consume less than 1 milk product per day. Milk intake was higher in men than in women and test persons, who experienced gastric distress after consuming milk or milk products showed also a lower consumption of such products. Most of the persons, who experienced gastric distress, were women. [Klesges et al. 1999]

Marques-Vidal et al. 2006 studied the relationship between milk intake and body mass index in men and women and found out that the prevalence for milk consumption increased with a decreased BMI in men and women. Furthermore a comparison between normal weight and obese individuals showed that obese men reported a lower daily consumption of milk than normal weight subjects. In women, normal weight persons had a higher consumption of milk than overweight or obese subjects. [Marques-Vidal et al. 2006]

Liebmann et al. 2003 observed gender differences in adults, who participated on a food frequency survey. Here women also reported lower intakes and a lower frequency of milk consumption compared to men. Furthermore twenty-one percent of female participants reported that they never consume milk compared to 14% of men. The data

of this study suggested that the diets of female persons were more nutrient-dense, with the exception of milk derived calcium due to the fact that women also reported higher intakes in fruits and vegetables. [Liebmann et al. 2003]

Although these studies are in accordance with our study results, no studies about different likings of dietary products of obese persons compared to normal weight were found. To assess the possible reasons for the distinctions in the liking of the test soups between men and women further investigations are required.

Because of the assumption that obese individuals tend to have a higher consumption of salty foods and snacks we wanted to measure the eating behaviour of salty foods of test persons with a food questionnaire.

Compared with the study of Deglaire et al. 2015, where differences in the salt liking of obese persons compared to non-obese participants were found, our results revealed only significant differences of question 7.8 and 7.9 of patients and controls. All the other questions were not significant at all and showed no differences in the liking of salty foods of patients and controls. [Deglaire et al. 2015]

8. Conclusion

In conclusion salt detection thresholds were found to increase significantly in patients after bariatric surgery. Therefore it can be assumed that the salt taste can be even worsened after surgery.

Although there is the overall believe that obese persons are more prone of eating salty snacks and foods, no changes of the salt detection thresholds between the obese and normal weight individuals were found and gender specific differences were also not significant.

Diabetes and hypertension had no influence on the salt detection thresholds of patients; however limitations of this study are that the medical treatment of the patients and also the socioeconomic and educational status were not recorded at the time of the examination which could be an additional cofounder it.

The association between the ratings of soup likings before surgery differed according to gender in both groups. This highlights the need to consider gender and the different liking of dietary products in men and women, when studying such associations.

Our findings are relevant, as it showed the need to consider the influence of sensory liking of salt in the management and prevention of obesity. Further research to evaluate the effect of taste on food intake in obese individuals and the influence of gender on taste is indicated.

9. References

ASTM. Standard Practice for Determination of Odor and Taste Thresholds by a Forced-Choice Ascending Concentration Series Method of Limits. E679-04 (2011), Volume 15.08

ASTM International. 2009. Standard Terminology Relating to Sensory Evaluations of Materials and Products, E253-09a. ASTM International, West Conshohocken, PA. E253-09a

Bartoshuk LM. The psychophysics of taste. Am J Clin Nutr. 1978 Jun; 31(6):1068-77

Behrens Maik and Meyerhof Wolfgang. Gustatory and extra gustatory functions of mammalian taste receptors. Physiology & Behaviour 105 (2011) 4-13

Bellisle F, Drewnowski A, Anderson GH, Westerterp-Plantenga M, Martin CK. Sweetness, satiation and satiety. J Nutr. 2012 Jun; 142(6):1149S-54S. doi: 10.3945/jn.111.149583. Epub 2012 May 9.

Berthoud Hans-Rudolf and Huiyuan Zheng. Modulation of taste responsiveness and food preference by obesity and weight loss. Physiol Behav. 2012 November 5; 107(4):527-532.doi:10.1016

Bueter M, Miras AD, Chichger H, Fenske W, Ghatei MA, Bloom SR, Unwin RJ, Lutz TA, Spector AC, le Roux CW. Alterations of sucrose preference after Roux-en-Y gastric bypass. Physiol Behav. 2011 Oct 24; 104(5):709-21. Epub 2011 Jul 30.

Bundesministerium für Verbraucherschutz, Ernährung und Landwirtschaft. Fragebogen Nationale Verzehrsstudie II „Was esse ich“, die bundesweite Erhebung zur Ernährung von Jugendlichen und Erwachsenen.

Burge JC, Schaumburg JZ, Choban PS, Di Silvestro RA, Flancbaum L. Changes in patients' taste acuity after Roux-en-Y gastric bypass for clinically severe obesity. J Am Diet Assoc. 1995 Jun;95(6):666-70.

Chandrasekhar Jayaram, Hoon Mark A., Ryba Nicholas J.P. and Zuker Charles S. The receptors and cells for mammalian taste. Nature Vol 444, 16 November 2006, doi: 10.1038/nature05401

Chaudhari Nirupa and Roper Stephen D. The cell biology of taste. Journal of cell biology 2010, Vol 190, No 3, 285-296

Clark Jane E. Taste and Flavour: their importance in food choice and acceptance. Proceedings of the Nutrition Society 1998, 57, 639-643

Daly B.P., Daly M.P., Minniti N. and Daly J.M. Sense of Taste (Effect on Behavior). Elsevier 2012, Pages 373–378 from the book Encyclopedia of Human Behavior (second Edition)

De Graaf. Sensory responses, food intake and obesity. In: Mela D, editor. Food, Diet and Obesity. Cambridge: Woodhead Publishing Ltd; 2005. pp. 137–159.

Deglaire A, Mejean C, Castetbon K, Kesse-Guyot E, Urbano Ch, Hercberg S and Schlich P. Development of a questionnaire to assay recalled liking for salt, sweet and fat. Food Quality and preferences 23 (2012); 110-124

Deglaire A, Mejean C, Castetbon K, Kesse-Guyot E, Hercberg S. and Schlich P. Associations between weight status and liking scores or sweet, salt and fat according to the gender in adults (The Nutrinet-Sante study). European Journal of Clinical Nutrition (2015) 69,40-46

DGE, D-A-CH-Referenzwerte für die Nährstoffzufuhr. Umschau Verlag, Sulzbach, 2008, in the text [D-A-CH, 2000]

Donaldson LF, Bennett L, Baic S, Melichar JK. Taste and weight: is there a link? Am J Clin Nutr. 2009 Sep;90(3):800S-803S. Epub 2009 Jul 1.

Drewnowski A. Taste preferences and food intake. 1997, Annu Rev Nutr 17, 237–253.

Drewnowski Adam. The real contribution of added sugars and fats to obesity. 2007, Epidemiologic Reviews 29 (1): 160-171

Drewnowski Adam, Mennella Julie A, Johnson Susan L and Bellisle France. Sweetness and Food Preference. The Journal of Nutrition 2012, May 9, doi: 10.3945

Elmadfa I et al. Österreichischer Ernährungsbericht 2012. 1. Auflage, Wien, 2012.

Fallis N, Lasagna L, Tetreault L. Gustatory thresholds in patients with hypertension. Nature 196:74, 1962

Gondivkar SM, Indurkar A, Degwekar S, Bhowate R. Evaluation of gustatory function in patients with diabetes mellitus type 2. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2009 Dec; 108(6):876-80.

Grinker Joel PhD, Obesity and sweet taste. The American Journal of Clinical Nutrition 31, June 1978, pp. 1078-1087

He Feng J, MacGregor Graham A. Reducing Population Salt Intake Worldwide: From Evidence to Implementation. Progress in Cardiovascular Diseases 52 (2010) 363-382

He F, MacGregor G. A comprehensive review on salt and health and current experience of worldwide salt reduction programmes. J. Hum. Hypertens. 2009, 23, 363–384.

Heath TP, Melichar JK, Nutt DJ, Donaldson LF. Human taste thresholds are modulated by serotonin and noradrenaline. J Neurosci 2006; 26: 12664-71

Heckmann S.M, Hujoel P, Habiger S, Friess W, Wichmann M, Heckmann J.G, Hummel T. Zinc Gluconate in the Treatment of Dysgeusia – randomized clinical trial. Journal of dental research, January 2005, vol 84, no 1, 35-38

Henkin RI. Salt taste in patients with essential hypertension due to hyperaldosteronism. J. Chronic Dis. 1974, 27:235-44

Hummel Thomas, Landis Basile N, Hüttenbrink Karl-Bernd. Smell and taste disorders. GMS Curr Top Otorhinolaryngol Head Neck Surg. 2011; 10: Doc 04

Hyn Ju Kim Msc, Hee Young Paik ScD, Sim Yeol Lee PhD, Jae Eun Shim PhD and Young Sik Kim MD PhD. Salt use behaviours are related to urinary sodium excretion in normotensive Korean adults. Asia Pac J Clin Nutr 2007; 16 (1): 122-128

ISO 3972, International Standard, Sensory analysis — Methodology — Method of investigating sensitivity of taste, Third edition 2011-10-15 Reference number ISO 3972:2011

ISO 8589 – Sensory Analysis – General Guidance for the Design of Test Rooms, 2011

James W.P.T. The epidemiology of obesity: the size of the problem. Journal of Internal Medicine 2008, 263; 366-352

Khobragade RS, Wakode SL, Kale AH. Physiological taste threshold in type 1 diabetes mellitus. Indian J Physiol Pharmacol. 2012 Jan-Mar; 56(1):42-7.

Kim GH and Lee HM. Frequent consumption of certain fast foods may be associated with an enhanced preference for salt taste. J. Human Nutr. Diet 2009, Oct 22 (5): 475-80

Kirsten Vanessa Ramos and Wagner Mario Bernardes. Salt taste sensitivity threshold in adolescents: are there any relationships with body composition and blood pressure levels? Appetite 81 (2014) 89-92

Klesges Robert C. PhD, Harmon-Clayton Karen MS, Ward Kenneth D. PhD, Kaufman Elizabeth M. MS, Haddock Keith C. PhD, Talcott Wayne G. PhD, Lando Harry A. PhD. Predictors of milk consumption in a population of 17 to 35 year old military personnel. Journal of the American Dietetic Association, July 1999 Volume 99, Number 7

Lau DC, Douketis JD, Morrison KM, Hramiak IM, Sharma AM, Ur E (April 2007). 2006 Canadian clinical practice guidelines on the management and prevention of obesity in adults and children summary. CMAJ. 2007 April 10; 176(8): S1–S13. Doi: 10.1503/cmaj.061409

Le Floch Jean Pierre, MD, Le Livre Gilles, MD, Sadoun Jacky, MD, Perlemuter Leon, MD, Peynegre Roger, MD, Hazard Jean. Taste impairment and related factors in type 1 diabetes. Diabetes Care March 1989, Vol 12, No 3, 173-178

Liebman M, Pelican S, Moore SA, Holmes B, Wardlaw MK, Melcher LM, Liddil AC, Paul LC, Dunnagan T, Haynes GW. Dietary intake, eating behaviour and physical activity-related determinants of high body mass index in rural communities in Wyoming, Montana and Idaho. Int J Obes Relat Metab Disord. 2003 Jun; 27 (6): 648-92

Liem DG, Miremadi F, Keast RS. Reducing sodium in foods: the effect on flavor. Nutrients 2011 Jun; 3(6):694-711. Epub 2011 Jun 20. Review

Low Yu Qing, Lacy Kathleen and Russell Keast. The role of sweet taste in satiation and satiety. Nutrients 2014, Sep 6(9):6431-6450

Lötsch J, Lange C, Hummel T. A simple and reliable method for clinical assessment of odor thresholds. Chem Senses. 2004 May; 29 (4):311-7

Madden AM, Bradbury W, Morgan MY. Taste perception in cirrhosis: It's relationship to circulating micronutrients and food preferences. Hepatology 1997 Jul., 26 (1): 48-8

Maheswaran T, Abikshyeet P, Sitra G, Gokulanathan S, Vaithiyanadane V, Jeelani S. Gustatory dysfunction. J Pharm Bioallied sci. Jul. 2014; 6 (Suppl 1): S30-33

Maliphol Amanda B, Garth Deborah J, Medler Kathryn F. Diet-Induced Obesity Reduces the Responsiveness of the Peripheral Taste Receptor Cells. November 13, 2013, PLOS One 8(11): e79403, doi: 10.1371

Marques-Vidal P, Goncalves A and Dias CM. Milk intake is inversely related to obesity in men and young women: data from the Portuguese Health Interview Survey 1998-1999. International Journal of Obesity (2006) 30, 88-93

McMahon Emma J, Campbell Katrina L, Bauer Judith D. Taste perception in kidney disease and relationship to dietary sodium intake. Appetite 83 (2014) 236-241

Miras Alexander D., le Roux Coul W. Bariatric surgery and taste: novel mechanism of weight loss. Curr Opin Gastroenterol. 2012 Mar 26 (2): 140-5.doi

Mojet Joe, Christ-Hazelhof Elly and Heidema Johannes. Taste Perception with Age: Generic or Specific Losses in Threshold Sensitivity to the Five Basic Tastes? Chem. Senses 26:845-860, 2001

Moskowitz H.R. and Abramson R. Altered taste preference in obese and renal patients. Paper presented to the Eastern Psychological Association Meeting New York, April 1976.

Najafizade Nadia , Hemati Simin , Gookizade Abbas , Berjis Nezameddin , Hashemi Mostafa , Vejdani Soheil , Ghannadi Alireza , Shahsanaee Armindokht ,and Arbab Nafise. Preventive effects of zinc sulfate on taste alterations in patients under irradiation for head and neck cancers: A randomized placebo-controlled trial. J res Med Sci. Feb 2013; 18 (2): 123-126

Overberg Johanna, Hummel Thomas, Krude Heiko, Wiegand Susanna. Differences in taste sensitivity between obese and non-obese children and adolescents. Arch Dis Child 2012; 97:1048-1052 doi: 10.1136

Parmenter K, Wardle J. Development of a general nutrition knowledge questionnaire for adults. European Journal of Clinical Nutrition 1999; 53, 298-308

Pasquet P, Frelut ML, Simmen B, Hladik CM, Monneuse MO. Taste perception in massively obese and in non-obese adolescents. Int J Pediatr Obes 2007; 2:242–8.

Peng Mei, Jaeger Sara R., Hautus Michael J. Determining odor thresholds: Incorporating a method-independent definition into the implementation of ASTM E679. Food Quality and Preferences 25 (2012) 95-104

Pepino Marta Yanina, Bradley David, Eagon Christopher, Sullivan Shelby, Abumrad Nada A., Klein Samuel. Changes in Taste Perception and Eating Behaviour after Bariatric-Surgery-Induced Weight Loss in Women. Obesity 19, 2013

Piovesana de Moura Paula, Sampaio de Lemos Karina and Gallani Maria Cecilia B.J. Association between Taste Sensitivity and Self-Reported and Objective Measures of Salt Intake among Hypertensive and Normotensive Individuals. ISRN Nutrition Volume 2013, Article ID 301213, 7 pages

Richardson BE, Vander Woude EA, Sudan R, Thompson JS, Leopold DA. (2004) Altered olfactory acuity in the morbidly obese. Obes Surg. 2004 Aug; 14(7):967-9

Romero-Corral A, VK Somers, J Sierra-Johnson, RJ Thomas, ML Collazo-Clavell, J Korinek, TG Allison, JA Batsis, FH Sert-Kuniyoshi,F Lopez-Jimenez. Accuracy of body mass index in diagnosing obesity in the adult general population. International Journal of Obesity 2008, 32:959–966

Salbe Arline D, DelParigi Angelo, Pratley Richard E, Drewnowski Adam and Tataranni P. Antonio. Taste preferences and body weight changes in an obesity-prone population. Am J Clin Nutr 2004, 79:372-8

Sakai Fumitake, Yoshida Shinya, Endo Sohei, Tomita Hiroshi. Double-blind Placebo-controlled Trial of Zinc Picolinate for Taste Disorders. Acta Oto-laryngologica, 2002, Vol 122, No 4: pages 129-133

Sartor Francesco, Donaldson Lucy F., Markland David A., Loveday Helina, Jackson Matthew J., Kubis Hans-Peter. Taste perception and implicit attitude toward sweet related to body mass indix and soft drink supplementation. Appetite 57 (2011) 237-246

Scruggs DM, Buffington C, Cowan GS Jr. Taste Acuity of the Morbidly Obese before and after gastric bypass surgery. Obesity Surgery, 1994, Volume 4, 24-28

Schiffman Susan S, Brevick Graham G. PhD, Sattely-Miller Elizabeth A. BA and Peterson-Dancy Measha MD. Elevated and Sustained Desire for Sweet Taste in African-Americans: A Potential Factor in the Development of Obesity. Nutrition 16:886-893, 2000

Seidell Jacob C. Obesity, insulin resistance and diabetes – a worldwide epidemic, British Journal of Nutrition 2000, 83, Suppl. 1, S5-S8

Siegmund Barbara. Sensorik und Lebensmitteltechnologie: Salzreduktion-Möglichkeiten und Grenzen. Journal für Ernährungsmedizin 2013; 15 (1) 24-27

Simchen U, Koebnick C, Hoyer S, Issanchou S, Zunft HJ. Odour and taste sensitivity is associated with body weight and extent of misreporting of body weight. Eur J Clin Nutr 2006; 60:698–705.

SISA Simple Interactive Statistical Analysis, Sample Size Calculation, Internet: http://www.quantitativeskills.com/sisa/calculations/sampshlp.htm (accessed: 12.12.2014)

Steiner Jacob E, Glaser Dieter, Hawilo Maria E, Berridge Kent C. Comparative expression of hedonic impact: affective reactions to taste by human infants and other primates. Neuroscience and Biobehavioral Reviews 25 (2001) 53-74

Stone, H and Sidel, JL. 1993. Sensory Evaluation Practices. 2nd ed. Academic Press: San Diego.

Suliburska Joanna, Duda Grazyna and Pupek-Musialik. The Influence Of Hypotensive Drugs On The Taste Sensitivity In Patients With Primary Hypertension. Acta Poloniae Pharmaceutican Drug Research, Vol. 69 No. 1 pp. 121n127, 2012

Tadross JA and le Roux CW. The mechanisms of weight loss after bariatric surgery. International Journal of Obesity (2009) 33, 28-32

Thuesen BH, Toft U, Buhelt LP, Linneburg A, Friedrich N, Nauck M, Wallaschofsko H, Jorgensen T. Estimated dialy salt intake in relation to blood pressure and blood lipids: the role of obesity. Eur J. Prev Cardiol 2014, Oktober 3

Tichansky DS, Boughter Jr JD, Madan AK. Taste change after laparoscopic Roux-en Y gastric bypass and laparoscopic adjustable gastric banding. Surg Obs Relt Dis 2006; 2:440-444

Time, Internet: http://time.com/3556309/obesity-taste-buds-weight-loss/, 2014 (Current: 9.12.2014)

Tong J, Mannea E, Aime P, Pfluger Paul T., Yi Chun-Xia, Castaneda Tamara R., Davis Harold W., Ren Xueying, Pixley Sarah, Benoit Stephen, Julliard Karyne, Woods Stephen C., Horvath Tamas L., Sleeman Mark M., D'Alessio David, Obici Silvana, Frank Robert, and Tschöp Matthias H. Ghrelin enhances olfactory sensitivity and exploratory sniffing in rodents and humans. Journal of Neuroscience, 2011; 31(15):5841-5846

Traub Jennifer RD. CNSC, Nutritional Considerations in Bariatric Patient, Bariatric Time, 2012; 9(5):14-15

Verma Punam, Mahajan Krishna K., Mittal Sunita and Ghildiyal Archna. Salt preference across different phases of menstrual cycle. Indian J. Physiol Pharmacol 2005; 49 (1): 99-102

Warwick ZS, Schiffman SS Sensory evaluations of fat-sucrose and fat-salt mixtures: relationship to age and weight status. Physiol. Behav. 1990 Nov, 48(5):633-6

Webster Jacqueline L MA, Li Nicole PhD, Dunford Elizabeth K MPH, Nowson Caryl A PhD, Neal Bruce C PhD. Consumer awareness and self-reported behaviours related to salt consumption in Austrialia. Asia Pac J. Clin Nutr 2010; 19 (4); 550-554

WHO: World Health Organization, BMI Classification, Internet: http://apps.who.int/bmi/index.jsp?introPage=intro_3.html, 2014 (Current: 18.09.2014)

WHO: World Health Organization, Obesity and overweight, Fact sheet N°311, Updated August 2014, Internet: http://www.who.int/mediacentre/factsheets/fs311/en/

WHO: World Health Organization, Factsheet "Noncommunicable diseases", 2013, Internet: http://www.who.int/mediacentre/factsheets/fs355/en/, 2013 (Current: 18.09.2014)

WHO: World Health Organization "Obesity and Overweight" 2003, Internet: http://www.who.int/dietphysicalactivity/media/en/gsfs_obesity.pdf, 2003 (Current: 18.09.2014)

Wu Chunsheng, Du Liping, Zou Ling, Zhao Luhang, Huang Liquan, Ping Wang. Recent advances in taste cell- and receptor-based biosensors. Sensors and Actuators B201 (2014) 75-85

Yamamoto Kumuri and Ishimaru Yoshiro. Oral and extra-oral taste perception. Seminar in Cell & Developmental Biology 24 (2013) 240-246

10. Appendix

10.1. Teilnehmerinformation und Einwilligungserklärung

Teilnehmerinformation und Einwilligungserklärung
zur Teilnahme an der klinischen Studie

„Salzerkennungsschwelle und Geschmacksempfindung bei einer Testmahlzeit mit unterschiedlicher Salzkonzentration bei fettleibigen PatientInnen vor und nach einer Magenbypass-Operation“

Sehr geehrte Teilnehmerin, sehr geehrter Teilnehmer!

Wir laden Sie ein an der oben genannten klinischen Studie teilzunehmen. Die Aufklärung darüber erfolgt in einem ausführlichen ärztlichen Gespräch.

Ihre Teilnahme an dieser Studie erfolgt freiwillig. Sie können jederzeit ohne Angabe von Gründen aus der Studie ausscheiden. Die Ablehnung der Teilnahme oder ein vorzeitiges Ausscheiden aus dieser Studie hat keine nachteiligen Folgen für Ihre medizinische Betreuung.

Klinische Studien sind notwendig, um verlässliche neue medizinische Forschungsergebnisse zu gewinnen. Unverzichtbare Voraussetzung für die Durchführung einer klinischen Studie ist jedoch, dass Sie Ihr Einverständnis zur Teilnahme an dieser klinischen Studie schriftlich erklären. Bitte lesen Sie den folgenden Text als Ergänzung zum Informationsgespräch mit Ihrem Arzt sorgfältig durch und zögern Sie nicht Fragen zu stellen.

Bitte unterschreiben Sie die Einwilligungserklärung nur

- wenn Sie Art und Ablauf der klinischen Studie vollständig verstanden haben,
- wenn Sie bereit sind, der Teilnahme zuzustimmen und

- wenn Sie sich über Ihre Rechte als Teilnehmer an dieser klinischen Studie im Klaren sind.

Zu dieser klinischen Studie, sowie zur Teilnehmerinformation und Einwilligungserklärung wurde von der zuständigen Ethikkommission eine befürwortende Stellungnahme abgegeben.

Was ist der Zweck der klinischen Studie?

Der Zweck dieser klinischen Studie ist es, mögliche Unterschiede in der Salzerkennungsschwelle sowie im Salzgeschmack einer Testmahlzeit zu ermitteln. In die Studie eingeschlossen werden adipöse PatientInnen, die einen Magenbypass erhalten. Als Kontrolle dienen normalgewichtige Versuchspersonen. Es soll festgestellt werden, ob sich der Salzgeschmack und die Salzerkennungsschwelle durch einen Magenbypass mit anschließender Gewichtsabnahme verbessert bzw. verändert. Eine hohe Salzerkennungsschwelle begünstigt die vermehrte Zufuhr von Kochsalz und den damit verbundenen Risiken, v.a. dem Risiko an Bluthochdruck zu erkranken. Bluthochdruck ist ein wichtiger Risikofaktor für Herzkreislauferkrankungen, insbesondere für Schlaganfall und Herzinfarkt.

Wie läuft die klinische Studie ab?

Diese klinische Studie wird im Allgemeinen Krankenhaus der Stadt Wien stattfinden. Es werden insgesamt etwa 36 Personen daran teilnehmen.

Sie werden in einem gewissen Zeitrahmen 3 identische, sensorische Tests zur Erkennung der Salzkonzentrationsschwelle und zusätzlich Tests zur Ermittlung der am schmackhaftesten empfundenen Salzkonzentration in einer Testmahlzeit (Suppe) durchführen. Außerdem bitten wir Sie auch einen kurzen Fragebogen zur Salzpräferenz auszufüllen.

Der Test wird 1 Woche vor, sowie 3 Monate nach der bariatrischen Operation durchgeführt. Die normalgewichtigen Personen, die als Kontrolle dienen, werden einmalig getestet.
Der Test für die Salzkonzentrationsschwelle findet morgens statt. Ihnen werden 8

mal 3 Becher angeboten, wobei Sie jedes Mal jeweils 2 Becher eine Wasserlösung und 1 Becher eine Salzlösung, mit unterschiedlichen Salzkonzentrationen, erhalten. Sie müssen sich dann entscheiden, bei welcher der 3 Becher es sich um die Salzlösung handelt und dies auf einem Testformular ankreuzen.
Beim Test für die Vorlieben von verschiedenen Salzkonzentrationen in einer Suppe werden Ihnen 5 Suppenproben angeboten, wobei Sie den Geschmack bzw. das Gefallen an der Suppe auf einem Fragebogen mit einer Skala von 1 („schmeckt mir überhaupt nicht“) bis 9 („schmeckt mir sehr gut“) angeben müssen.

Der Fragebogen zur Salzpräferenz sollte bitte nach dem Geschmackstest ausgefüllt werden. Er beinhaltet 8 Fragen, in denen Sie vor allem nach Ihrer Vorliebe für salzhaltige Speisen und Ihre Kenntnis zu Salz in Lebensmitteln gefragt werden.

Worin liegt der Nutzen einer Teilnahme an der Klinischen Studie?

Es ist nicht zu erwarten, dass Sie aus Ihrer Teilnahme an dieser klinischen Studie gesundheitlichen Nutzen ziehen werden. Jedoch können Sie durch Ihre Teilnahme zur wissenschaftlichen Bereicherung beitragen und das Verständnis zur Salzproblematik verbessern. Auf persönlichen Wunsch können Sie am Ende der Studie, nach der Auswertung der Ergebnisse, ein Aufklärungsgespräch über die Salzproblematik erhalten.

Gibt es Risiken und Nebenwirkungen?

Es bestehen für Sie keinerlei Risiken und Nebenwirkungen.

In welcher Weise werden die im Rahmen dieser klinischen Studien gesammelten Daten verwendet?

Die Weitergabe der Daten erfolgt ausschließlich zu statistischen Zwecken und Sie werden darin ausnahmslos nicht namentlich genannt. Auch in etwaigen

Veröffentlichungen der Daten dieser klinischen Studie werden Sie nicht namentlich genannt.

Entstehen für die Teilnehmer Kosten? Gibt es einen Kostenersatz oder eine Vergütung?

Durch Ihre Teilnahme an dieser klinischen Studie entstehen für Sie keine zusätzlichen Kosten.

Möglichkeit zur Diskussion weiterer Fragen

Für weitere Fragen im Zusammenhang mit dieser klinischen Studie stehen Ihnen Ihr Prüfarzt und seine Mitarbeiter gern zur Verfügung. Auch Fragen, die Ihre Rechte als PatientIn und TeilnehmerIn an dieser klinischen Studie betreffen, werden Ihnen gerne beantwortet.

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Ständig erreichbar unter: 40160-34927

Linda Lam, Bakk.rer.nat
E-mail: linda_lam@gmx.at

Einwilligungserklärung

Name der Patientin/des Patienten in Druckbuchstaben:

.....

Geb.Datum: ..... Code:.....

Ich erkläre mich bereit, an der klinischen Studie „Salzerkennungsschwelle und Beliebtheit verschiedener Salzkonzentrationen“ teilzunehmen.

Ich bin von Herrn/Frau_____ausführlich und verständlich über mögliche Belastungen und Risiken, sowie über Wesen, Bedeutung und Tragweite der klinischen Studie, sich für mich daraus ergebenden Anforderungen aufgeklärt worden. Ich habe darüber hinaus den Text dieser Patientenaufklärung und Einwilligungserklärung, die insgesamt 4 Seiten umfaßt gelesen. Aufgetretene Fragen wurden mir vom Prüfarzt verständlich und genügend beantwortet. Ich hatte ausreichend Zeit, mich zu entscheiden. Ich habe derzeit keine weiteren Fragen.

Ich werde den ärztlichen Anordnungen, die für die Durchführung der klinischen Studie erforderlich sind, Folge leisten, behalte mir jedoch das Recht vor, meine freiwillige Mitwirkung jederzeit zu beenden, ohne dass mir daraus Nachteile für meine weitere medizinische Betreuung entstehen.

Ich bin zugleich damit einverstanden, dass meine im Rahmen dieser klinischen Studie ermittelten Daten aufgezeichnet werden. Um die Richtigkeit der Datenaufzeichnung zu überprüfen, dürfen Beauftragte des Auftraggebers und der zuständigen Behörden beim Prüfarzt Einblick in meine personenbezogenen Krankheitsdaten nehmen.

Beim Umgang mit den Daten werden die Bestimmungen des Datenschutzgesetzes beachtet.

Eine Kopie dieser Teilnehmerinformation und Einwilligungserklärung habe ich erhalten. Das Original verbleibt beim Prüfarzt.

.....

(Datum und Unterschrift der Teilnehmerin/des Teilnehmers)

.....

(Datum, Name und Unterschrift des verantwortlichen Arztes)

10.2 Antrag Ethikkommission

ethik kommission
Medizinische Universität Wien

Borschkegasse 8b/6
A-1090 Wien, Austria

T +43 1 40 400 - 2147, 2244
F +43 1 40 400 - 1690
ethik-kom@meduniwien.ac.at
ethikkommission.meduniwien.ac.at

Votum:

EK Nr: 1193/2013
Projekttitel: Salzerkennungsschwelle und Geschmacksempfindung bei einer Testmahlzeit mit unterschiedlicher Salzkonzentration bei fettleibigen PatientInnen vor und nach einer Magenbypass-Operation und Gewichtsverlust
Antragsteller/in: Frau Linda Lam
Institution: Medizinische Universität Wien
Sponsor: Medizinische Universität Wien

Teilnehmende Prüfzentren:

Ethik-Kommission	Prüfzentrum	Prüfärztin/arzt
Ethikkommission der Medizinischen Universität Wien	Medizinische Universität Wien	Herr Ao. Univ. Prof. Dr. med Cem Ekmekcioglu

Die Stellungnahme der Ethik-Kommission erfolgt aufgrund folgender eingereichter Unterlagen:

Dokument	Name	Version	Datum
Lebenslauf (CV)	Lebenslauf Prof. Cem Ekmekcioglu	1.0	01.04.2013
Sonstige	Rekrutierung_Flyer_salz_v1.1	1.1	03.06.2013
	Teilnehmerinformation-Lam-Ekmekcioglu-Ethik_v1.1	1.1	21.05.2013
	Publikationsliste Prof. Cem Ekmekcioglu	1.0	01.04.2013
	Verfplichtungserklärung	1.0	26.03.2013
Stellungnahme zum Gutachten	Aenderungen zu Votumskommentaren	1.0	21.05.2013
Studienprotokoll (Prüfplan)	Projektantrag-Lam-Ekmekcioglu-Ethik_v1.2_aenderungen	1.2	03.06.2013

Die Kommission fasst folgenden Beschluss (mit X markiert):

☒	Es besteht kein Einwand gegen die Durchführung der Studie.

Ergänzende Kommentare der Sitzung am 07.05.2013:
Zum Prüfplan:
Die primäre Hypothese der Studie ist, dass sich die Salzerkennungsschwelle und die Geschmacksempfindung bei einer Testmahlzeit mit unterschiedlicher Salzkonzentration bei fettleibigen Patienten nach einer Magenbypass-Operation verändert.
Es stellt sich die Frage nach der Relevanz der Kontrollgruppe: Was kann die gesunde Kontrollgruppe zur Beantwortung der Frage beitragen?
Die Ethik-Kommission ersucht um Stellungnahme.

Seite 7: "Additionally salt consumption will be assessed with a 7day food record and evaluated with the "nuts" database".
Die Ethik-Kommission ersucht um Details oder eine Referenz zur "nuts" database.

Angaben zum Nutzen/Risiko fehlen und sind nachzureichen.

Zum Antrag:
Punkt 7.15: Angaben zur Fallzahlberechnung sind vorzulegen. Die Angabe, dass vergleichbare Studien signifikante Ergebnisse bei ähnlicher Probandenanzahl haben, ist nicht ausreichend.
Punkt 11: Es wurden 6 Teilnehmer angegeben, laut Protokoll sollen aber 36 Teilnehmer eingeschlossen werden. Die Ethik-Kommission ersucht um Vereinheitlichung.
Punkt 12: Die Antragstellerin Linda Lam ist nicht bei den verantwortlichen Mitarbeitern an der Studie angeführt, dies ist zu ergänzen.

Zur Teilnehmerinformation:
Das Dokument sollte als "Teilnehmerinformation", nicht als "Patienteninformation" betitelt werden.
Da Patienten und Probanden nicht von der Studienteilnahme profitieren, ist eine finanzielle Entschädigung vorzusehen.

Zur Versicherung: nicht erforderlich

Andere:
Die normalgewichtigen Kontrollpersonen müssen auf objektive, neutrale Weise rekrutiert werden, z.B. durch Aushänge oder Flyer. Die Texte zur Rekrutierung sind der Ethikkommission vorzulegen.
Das unterschriebene Antragsformular ist nachzureichen.

Die Ethik-Kommission ersucht die Antragsteller, bei der Wiedervorlage von geänderten Unterlagen ein Exemplar mit hervorgehobenen Änderungen beizulegen.

Ergänzende Kommentare:
Nachtrag vom 4. Juni 2013:
Die Antragsteller legen am 03.06.2013 überarbeitete Unterlagen vor, die von der Ethik-Kommission akzeptiert werden. Das unterschriebene Antragsformular wurde nachgereicht.

Die aktuelle Mitgliederliste der Ethik-Kommission ist unter der Adresse http://ethikkommission.meduniwien.ac.at/ethik-kommission/mitglieder/ abrufbar. Mitglieder der Ethik-Kommission, die für diesen Tagesordnungspunkt als befangen anzusehen waren und daher laut Geschäftsordnung an der Entscheidungsfindung/Abstimmung nicht teilgenommen haben: Herr Thomas Waldhör, Frau Dr. med. Kathryn Hoffmann

ACHTUNG: Unter Berücksichtigung der "ICH-Guideline for Good Clinical Practice" gilt dieser Beschluss **ein Jahr ab Datum der Ausstellung**. Gegebenenfalls hat der Antragsteller eine Verlängerung der Gültigkeit rechtzeitig zu beantragen.

Dieses Votum ist für berechtigte Benutzer/innen in digitaler Form unter der Adresse https://ekmeduniwien.at/vote/2668/download/ abrufbar.

Signaturwert	TC/jpnnZrfH+gIx4jOuHMjDyCwgS4P+s7O7sTSC4HcBHImwSb7F+3WEun/1JoRnfRvrojIuGlMX9rk9egj6aFw==	
SIGNATURINFORMATIONEN	Unterzeichner	Dr. Ernst Singer
	Aussteller-Zertifikat	CN=a-sign-Premium-Sig-02,OU=a-sign-Premium-Sig-02,O=A-Trust Ges. f. Sicherheitssysteme im elektr. Datenverkehr GmbH,C=AT
	Serien-Nr.	456499
	Methode	urn:pdfsigfilter:bka.gv.at:binaer:v1.1.0
	Parameter	etsi-moc-1.1@9bbb3cd
Prüfinformation	Informationen zur Prüfung der elektronischen Signatur und des Ausdrucks finden Sie unter: http://www.signaturpruefung.gv.at	
Datum/Zeit-UTC	2013-06-07T13:29:52Z	

193/2013] Neue Meldungsantwort.

Betreff: [ECS 1193/2013] Neue Meldungsantwort.
Von: Ethik-Kommission <ecs-1e94e54c90eb4297b148a076455fd8ef@ekmeduniwien.at>
Datum: 03.10.2013 09:27
An: cem.ekmekcioglu@meduniwien.ac.at

Sehr geehrter Herr Ao.Univ. Prof. Cem Ekmekcioglu!

Antwort auf Amendment für 1193/2013 (https://ekmeduniwien.at/notification/2964/)

- 1193/2013: https://ekmeduniwien.at/core/submission/1307/

vom 30.09.2013.

Eingereicht von: Frau Linda Lam

Die Kommission stimmt der vorgeschlagenen Protokolländerung zu.

Mit freundlichen Grüßen,

das Team der Ethik-Kommission

10.3 Fragebogen Salzerkennung und Beliebtheitstest

Salzstudie

Testperson Nr.: ____________ Datum: ___________

Liebe/r Teilnehmer/in!

Test 1: Salzerkennung
Bitte identifizieren Sie die salzhaltige Probe!

1.	☐ 664	☐ 176	☐ 324
2.	☐ 312	☐ 445	☐ 237
3.	☐ 313	☐ 867	☐ 874
4.	☐ 573	☐ 149	☐ 443
5.	☐ 929	☐ 615	☐ 570
6.	☐ 630	☐ 767	☐ 485
7.	☐ 677	☐ 294	☐ 766
8.	☐ 180	☐ 890	☐ 358

Test 2: Beliebtheitstest

Bitte bewerten Sie die Suppen von *„Mag ich überhaupt nicht“* bis *„Mag ich besonders gern“*.

Suppe Nr.	Mag ich überhaupt nicht	Mag ich sehr wenig	Mag ich wenig	Mag ich nicht besonders	Mag ich weder noch	Mag ich etwas	Mag ich gern	Mag ich sehr gern	Mag ich besonders gern
1	☐	☐	☐	☐	☐	☐	☐	☐	☐
2	☐	☐	☐	☐	☐	☐	☐	☐	☐
3	☐	☐	☐	☐	☐	☐	☐	☐	☐
4	☐	☐	☐	☐	☐	☐	☐	☐	☐
5	☐	☐	☐	☐	☐	☐	☐	☐	☐

Vielen Dank für die Teilnahme!

10.4 Fragebogen zur Salzpräferenz

Testperson No.: _____ Datum: _____

Pro Frage bitte immer nur 1 Kästchen ankreuzen!

1	**Ich esse gerne……. Speisen.**	□ ungesalzene □ leicht gesalzene □ moderat gesalzene □ ziemlich gesalzene □ sehr salzige
2	**Ich würze meine Speisen……mit Salz nach.**	□ nie □ selten □ häufig □ fast immer
3	**Wie viel Salz fügen sie dem Wasser beim Kochen von 2 Portionen Spaghetti (ca. 300g) hinzu?**	□ Kein Salz □ Eine Messerspitze □ Einen halben Teelöffel □ 1 Teelöffel □ Mehr als ein Teelöffel
4	**Wie oft essen Sie Speck, Würste, Schinken?**	□ Weniger als 1 mal pro Monat □ 2-3 mal pro Monat □ 1-2 mal pro Woche □ 3-6 mal pro Woche □ 1 mal pro Tag □ Mehr als 1 mal pro Tag
5	**Wie oft essen Sie Fertiggerichte (z.B. Pizza, Packerlsuppen, Tiefkühlgerichte)**	□ Weniger als 1 mal pro Monat □ 2-3 mal pro Monat □ 1-2 mal pro Woche □ 3-6 mal pro Woche □ 1 mal pro Tag □ Mehr als 1 mal pro Tag
6	**Wie oft essen Sie gesalzene Nüsse, Chips, Popcorn oder ähnliche salzhaltige Snacks?**	□ Weniger als 1 mal pro Monat □ 2-3 mal pro Monat □ 1-2 mal pro Woche □ 3-6 mal pro Woche □ 1 mal pro Tag □ Mehr als 1 mal pro Tag

7	**Welche der folgenden Lebensmittel hat einen niedrigen oder einen hohen Salzgehalt?**			
		Hoch	Niedrig	weiß nicht
	1. Wurst	☐	☐	☐
	2. rohes Fleisch	☐	☐	☐
	3. ungekochte Nudeln	☐	☐	☐
	4. Brot	☐	☐	☐
	5. Milch	☐	☐	☐
	6. Käse	☐	☐	☐
	7. frisches Gemüse	☐	☐	☐
	8. Nüsse	☐	☐	☐
	9. Fertigprodukte (z.B. Pizza, Packerlsuppe, Tiefkühlprodukte)	☐	☐	☐
	10. Schokolade	☐	☐	☐

8	**Welche Auswirkungen hat der bei uns übliche Salzkonsum auf die Gesundheit?**	☐ Positive Auswirkungen ☐ Negative Auswirkungen ☐ Keine Auswirkungen ☐ Weiß nicht

10.5 Curriculum Vitae

Persönliche Daten

Name	Julia Maedge (geb. Petzenka)
E-Mail	julia@maedge.eu
Geburtsdatum	09.07.1988
Staatsangehörigkeit	Österreich

Arbeits- und Berufserfahrung

Datum (von – bis)	01.08.2006 – 31.8.2006
Arbeitgeber	Hanusch Krankenhaus
Branche	Verwaltung
Beruf / Funktion	Ferialpraktikantin
Tätigkeiten / Zuständigkeiten	Sekretariat Gynäkologie
Datum (von – bis)	01.07.2007 – 31.08.2007 &
	01.07.2008 – 31.08.2008
Arbeitgeber	Hanusch Krankenhaus
Branche	Pflegedienst
Beruf / Funktion	Pflegehelferin auf der Internen (Herzabteilung)
Tätigkeiten / Zuständigkeiten	Betreuung der Patienten

Datum (von-bis)	01.03.2010 – 01.07.2014
Arbeitgeber	SGS Austria Controll-Co Ges.m.b.H
Branche	Biokontrollstelle
Job	studentischer Mitarbeiterin
Tätigkeiten/Zuständigkeiten	Administration von Bio-Verarbeitungs- und Gentechnikfrei Kontrollen, Schulungskontrollen bei Bio-Verarbeitungsbetrieben, Vorbereitung von Zertifikaten, Briefen und Rechnungen, Dokumentenmanagment und Datenbankpflege
Sonstige Arbeitserfahrung	Nachhilfeunterricht in Englisch für Unterstufenklassen während der Gymnasialzeit Wöchentliche Kinderbetreuung auf privater Basis

Schul- und Berufsbildung

Datum (von-bis)	01.10.2012- heute
Name der Bildungseinrichtung	Universität Wien Institut für Ernährungswissenschaften
Studium	Master of food quality and safety
Abschluss	Master of Science
Thema der Masterarbeit	"Salt taste detection thresholds and pleasantness of test meals varying in salt content in (morbid) obese patients after bariatric surgery and weight loss", Betreuer: Ao. Univ. Prof. Dr. med. Cem Ekmekcioglu

Datum	10/2006 – 10/2012
Name der Bildungseinrichtung	Universität Wien Institut für Ernährungswissenschaften
Studium	Bachelor in Ernährungswissenschaften
Abschluss	Bachelor of Science (Bakk. rer. nat.)
Thema der Bachelorarbeit	"Antioxidants and their impact on the nutrition of athletes", Betreuer: O. Univ.-Prof. Dr. Hans Goldenberg

Datum (von – bis)	09/1998 – 06/2006
Name der Bildungseinrichtung	Wirtschaftskundliches Bundesrealgymnasium, Kleine Sperlgasse 2a, 1020 Wien
Formaler Abschluss	AHS – Matura

Datum (von – bis)	09/1994 – 06/1998
Name der Bildungseinrichtung	PVS St. Elisabeth, Leopoldgasse 1a, 1020 Wien

Zusatzqualifikationen und Besonderheiten

Fremdsprachen	Englisch (fließend in Wort und Schrift) 2 Jahre Wahlfach Business Englisch (2003-2005) Latein (Maturaniveau) Grundkenntnisse in Spanisch, Französisch
EDV-Kenntnisse	Ausgezeichnete Kenntnisse in: Word Gute Kenntnisse in: Outlook, Power Point, Excel

Besonderheiten:	Teamfähig, zuverlässig, kommunikativ
Sonstiges	Führerschein B, Erste Hilfe Kurs, 2 jähriger Kurs in Mediation
Freizeitinteressen	Lesen, Skifahren, Klavier spielen, Oper, klassische Konzerte, Eislaufen, Tanzen

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Status: März 2015