HOW EMOTIONS AND SOCIAL INTERACTION AFFECT OUR FOOD EXPERIENCE

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I declare that my PhD thesis has been amended to address all the Referee's comments.

DEDICATION

I would like to dedicate my Ph.D. thesis to my family
who have always supported me with love.

Abstract

The initial intent of this research was to understand whether there were possible interferences between the perception – the sensorial response of the individual when approaching food – and the effective, objective quality of the food.

Our aim was to investigate whether, at the moment a person is about to experience food, some external factor might influence the individual's subsequent choice of food.

We also wondered whether external factors might render a dish more or less appetizing.

Initially we thought about investigating "external factors" such as changes of (exclusively) visual sensory aspects that would directly influence the appeal of food, such as color or size.

Later, and during the course of our research, we decided to change our approach and investigate whether there might also be factors unrelated to the food that influence the perception of taste and the subsequent desirability of the food.

For a given food, just before its consumption, we asked ourselves which environmental, external human factors might affect the internal subjective representation sufficiently to change the entire food experience.

Our approach did not take into consideration a human environment where there was consumption of food, which has already been extensively investigated in numerous studies, but only the interference of the mere sight of an emotion relayed by others' facial expressions.

This research hypothesis is based on the concept of *heterosis*.

We are interested in the method by which to approach a path of heterosis of scientific thought. Starting from the genetic concept of "hybrid vigor", we asked ourselves about the power of a multidisciplinary approach among different scientific disciplines, especially between food science and technology (presence of food), neuroscience (recent discoveries in the field of mirror neurons) and behavioral psychology (changes in food choice).

In the field of genetics, heterosis refers to crossbreeding between unrelated individuals.

The term heterosis is synonymous with interspecific hybridization, and is the opposite of inbreeding: in the scientific field, according to our approach and idea for the thesis, inbreeding signifies continuing to investigate within the same field of study, without any aperture towards

other disciplines, or at least without assessing whether there might be possible interactions of an interdisciplinary nature.

The population (gene pool) deriving from heterosis is a genotype which increases the frequency of heterozygosity, which means an increase in the number of loci with different alleles for the gene for the same character.

This involves the generation of advantages that improve the fertility and genetics of the species.

On the contrary, inbreeding increases the homozygosity, i.e. the presence of identical alleles at the same locus, and this is to the detriment of future genetic improvement.

Heterosis is associated with the observed phenomenon known as hybrid vigor, in which the individual is the product of the coupling characteristics of a particularly vigorous phenotype: for example, there is an increase in stature, enhanced fertility, and a stronger resistance to disease.

On the other hand, in the case of inbreeding one finds inbreeding depression, in which, among other things, there is an increase in the frequency of genetic diseases and a reduction of vigor and stature.

The parallelism that we assumed in the scientific disciplines sees, in the field of interdisciplinary studies, a multiplier effect of discoveries and insights to the benefit of specific individual fields of research.

The hybridization of different fields of science can generate new and unexplored fields of research, which may (this is our hypothesis) lead to new disciplines that are the result of the hybridization of such fields.

For example: intelligent eating might be a wide new field of research involving neuroscience, psychology, medicine and food science and technology.

The *underlying* theme of this thesis project, supported by comprehensive bibliographic database, is clearly of a hybrid nature, also in the formulation and planning of behavioral experiments.

We followed the exploration of such hybridization of science fields without ever going into the specifics of one or the other discipline, but trying to maintain its cross-cutting nature.

It is our hope that new fields of research, and even new branches of studies, might result from the heterosis of scientific disciplines, and this effort is intended to be a modest, experimental

start whose ambition is to inspire a future in which every field of science has an internal development, specific and specialized, and one or more parallel multidisciplinary developments, each with a precise logic for the development and evolution of the holistic understanding of man.

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CONTENTS

Chapter 1: General introduction

1. General Introduction

1.1 Why emotions and food?

Food [in Italian language *alimenti*, from the Latin *alimentum*, deriving from the verb *alere*, to "nourish"] (Source Treccani) are substances which, introduced into an organism, make up for its expenditure of life force (energy), providing the materials for restoration, those needed for possible growth and the materials (proteins, fats, carbohydrates, vitamins, minerals) that are essential to the normal course of basic functions for the individual and for the species.

This definition is focused on the physical properties of the food, and assumes that, once the material and organoleptic qualities of the food have been determined, it may or may not provide the correct energy intake for human needs.

The question we asked ourselves is: are there external factors, not necessarily related to the food, which affect the desirability and subsequent food intake by humans?

It is true that there are foods that naturally stimulate the brain mechanisms of reward, such as pizza (Beaver et al, 2006), which we used in our experiments to start with an "attractive" food; we wanted to see whether there were other factors, of a different nature from the food itself, which might make it even more attractive.

We know that sight is a main sensor in the first approach to food, and therefore factors such as color and size exert a fundamental role in the recognition by humans of how good the food is. Previous studies investigates how eating is not only triggered by hunger but also by the sight of foods: viewing appetizing foods alone can induce food craving and eating (see Passamonti et al, 2009.

We wanted to go beyond just the appearance of the food, involving the human environment, both internal (i.e. the feelings evoked in the subject) and external (the presence of external human influences).

We wondered whether emotions, for example, might affect the level of consumption of food or whether only the senses of sight, taste, smell or feel are a determining factor.

We started from the premise that food intake in humans is not automatic, but is also mediated by experience and habit.

The latter is influenced by a number of factors relating to the psychology of the individual and his/her basic emotional state, or also by the emotional states in which the subject finds himself/herself at the moment.

We conducted our research based on the assumption that food intake is linked to the psycho-physiological state of the subject, and indeed we have attempted to (timidly) investigate the idea that the emotional state itself may be the result of the intake of certain foods.

Numerous studies address the relationship between emotions, mood and food, eating disorders (Willner et al, 1998; Christensen, L., 2001; Chua et al, 2004; Wallis et al, 2009; Hepworth et al, 2010; Loxton et al, 2011) in relation to emotional mechanisms such as the sense of motivation and reward (Davis et al, 2004), or stress (Greeno & Wing, 1994).

In our thesis project, great importance is attached to the concept of emotional eating, as a cue for investigating the factors of emotional interaction between individuals that influenced the eating experience.

Emotional eating is a risk factor for eating disorders (Eldredge and Agras, 1996 and Rich et al., 2009).

It has also been linked with obesity, possibly because overweight people have difficulty differentiating between hunger signals and the physical experience of negative emotions (Striegel-Moore, Morrison, & Schreiber, 1999).

From these studies it is clear that emotions and eating behavior are linked.

Overweight individuals who are more prone to unhappy feelings were found to be more susceptible to eating temptations within an environment characterized by negative affect (Jansen, Havermans, Nederkoorn, & Roefs, 2008).

Almost always, emotional experiences, prior or subsequent to any food intake, are present in studies and research related to eating disorders.

Studies examining participants in weight reduction programs have found that mild, moderate, and severely obese women increased their food intake in response to a variety of negative emotions such as anxiety, depression and anger (Ganley, 1989; Arnow et al., 1992; Steptoe et al., 1998).

Over-eating in response to negative emotions has been found to occur in both obese and normal weight women.

Previous studies found that meals eaten in positive and negative moods were significantly larger than meals eaten in a neutral mood; moods and social context functioned additively to increase to the risk of over-eating (Patel & Schlundt, 2001).

For many years the relationship between emotions and food intake has been the subject of study, not only from the point of view of quality but also quantity.

In fact, higher food consumption was reported during boredom, depression, and fatigue, and lower food intake was reported during fear, tension, and pain.

Compared with low arousal states, high arousal states were seen as inhibiting food consumption (Desmet & Schifferstein, 2008).

Meals eaten with other people were significantly larger than meals eaten alone.

This is also supported by Ramathan & McGill (2007): going through an experience with someone else may feel different from consuming alone.

In our view, the fields of food research should focus more attention on the internal factors that influence food intake, first of all on the emotional state of the subject, and then on the mechanisms of motivation/reward present in the brain, which lead to the consumption of foods with effects on mood change on the chemical level (Avena and Bocarslay, 2012).

In particular, it would be interesting to investigate the influence of other factors in the emotional variability of the observers, to determine whether not only internal emotions, but also the emotions observed in the human environment, might have a bearing on the approach to food; and this is the field on which our research is based.

Studies carried out on "social relations and food" bring to light the existence of factors influencing the food experience in the presence of other people, and that is what we decided to focus on.

As Piccinni states (2012), Sigmund Freud was the first to state that our consciousness illuminates only a part of the mind; the rest of our inner life takes place unconsciously. According to Freud, the majority of our activities, decisions, beliefs and behavior are affected by contents of the mind that do not appear in our consciousness and which, in other words, we are not able to see clearly.

Even in the field of cognitive choices, our brain operates with unconscious and often automated functioning, depending on the stimuli mediated by previous experiences.

So why not investigate this world, which is frequently overlooked by traditional scientific research (based on experiments that often artificially induce moods in the subjects of their

experiments during food intake), and introduce the concept of "external factors" which might exercise a conditioning effect on the consumption of food in a way that is not initially linked to the food experience?

As claimed by Patel and Schlundt (2001), studies that have looked at the relationship between positive mood and food intakes have found conflicting results.

For example, some researchers have found no association between over-eating and positive moods (Schmitz, 1996; Davis et al., 1985; Lowe & Fisher, 1983) whereas others have found that positive mood is related to over-eating in social situations (Schlundt et al., 1988).

As there are various relations of cause and effect between psychological states, experiences and a broad spectrum of eating behaviors (Rozin, 1998), as well as hormonal causes (Rozin et al, 1991), we asked ourselves whether or not there might also be effects of an unconscious nature, not immediately or consciously perceived by the subjects, on eating behavior.

On the basis of these data, we wanted to add to the range of hypotheses that might somehow link the emotions felt by the subjects to a rise or fall in their propensity to consume food, setting up a behavioral experiment to this end.

We wanted to discover whether or not emotional states, even if not associated with the food, might affect its desirability.

The innovative aspect with respect to previous studies lies in the introduction of a previously-induced emotional stimulus which is not directly connected to the eating experience.

We started from the conviction that the mere sight of a different person's face with an emotional value might affect people in their desire for food, even though that person's face was not directly linked to the action of consuming the food.

And this is precisely the innovative idea on which we wanted to focus: the effect of the mere sight of the emotions shown by another person's face during the approach to food; we wanted to see whether this might be the beginning of a new approach to research and scientific experimentation.

Our intention was to move away from previous experiments (like Patel and Schlundt), in which subjects were asked to keep a food diary where they annotated the quantity and quality of the food and their moods.

We also wanted to depart from previous evidence, such as “exposure to food advertising, which typically depicts people enjoying food, increases food consumption relative to a non-exposure condition (Halford et al., 2004).

We wanted to use recent neuroscientific findings in the field of mirror neurons, and try to find a direct cause-and-effect relationship between the sight of other people's emotions and the immediate approach to food.

Without straying into the field of subliminal marketing (e.g. food advertising – the term “subliminal” refers to those sensations that occur below the level of consciousness, too weak to be felt, but sufficient, according to some, to influence the unconscious and hence behavior), we wanted to focus on neuroscientific findings which have demonstrated the existence, first in certain species of monkeys, and later in humans, of mental processes by which individuals would tend to unconsciously imitate and feel (at a potential level, via the activation of specific areas of the brain) the same emotions they observed in other individuals (Iacoboni, 2009).

We began with the concept of unconscious imitation, to see whether somehow a social environment exhibiting a certain emotional quality might or might not influence the approach of the subjects to food; we then measured the difference between the presence of the observed emotional quality and motor acts lacking emotional quality (but related to food), to see whether the influence was the same or if there were any differences.

Previous studies have already addressed the issue of food consumption in social settings and demonstrated that food consumption increases in the presence of others, irrespective of whether the meal is eaten with friends, family or strangers (De Castro & Brewer, 1991; De Castro, 1994; Clendennen et al, 1994).

A facilitator effect on the amount of food eaten is the result of the so-called "social facilitation effect". People eat more when in company (Piccinni, 2012).

These fascinating hypotheses have guided our scientific curiosity and have been a leitmotiv for the entire duration of our investigation.

What we therefore focused on is the attention to the factors external to the eating experience, such as the surrounding human environment, but considering a major difference from previous approaches, based on recent discoveries in neuroscience: the emotions associated with the food experience were not internally induced by cognitive stimuli (experiential or associative or created especially for experimental purposes) but were induced, probably at a subconscious level, by the mere sight of the emotions shown by other the facial expressions of other persons, as a result of the activation of visuo-motor neural circuits.

Mirror neurons are especially active in the stimulation of brain areas of the insula, as regards the emotion of disgust, which is directly linked to food (Phillips et al, 1997).

Previous authoritative studies have evaluated the effect of the sight of disgusted faces (during the action of eating, see chapter 2) on the level of the observers' food intake, noting a strong link, as expected, between the loss of appetite and the observation of another's disgust.

Moreover, disgust is one of the most ancient emotions, and has contributed to the evolution of the species: disgust is a social message that people give to others, and indicates that a food which engenders disgust is not a healthy food for others.

This has significant implications in terms of social evolution: a person who eats food that has gone bad and shows his disgust, perhaps by 'turning up his nose' (Ekman, 2008), will have harmed only himself, while those around him, who have observed his disgust, will be able to avoid making the same mistake.

In the course of an experiment conducted by means of nuclear magnetic resonance imaging, Singer, Seymour and colleagues (2004) found that the same areas involved in the experiences of disgust and pain are also activated by the sympathetic reaction to the pain of others.

Witnessing the pain experienced by another person is in some way equivalent, neurologically speaking, to experiencing the pain in person (Holley, 2004), just as the sight of an expression of disgust leads to a feeling of disgust.

In this research project, we wondered whether there were any links between food intake and other emotions, such as happiness and anger, which are not directly related to the eating experience.

If disgust and pain activate the same neural circuits in others, is that true also for anger?

Does an angry face produce effects similar to a disgusted one, leading one to shun a food?

Given that disgust causes a reduced propensity in others to consume the food that provokes disgust, we wanted to investigate if at the same time the sight of other expressions of emotion might influence the desirability of our food, and to what extent.

And again, if disgust can exert a preventive influence on the choice and consumption of food, does that hold true for happiness as well?

Furthermore, when we choose a food, are we more conditioned by the emotional stimuli (the view of others' emotions) or by the motor stimuli (an individual who is eating) associated with it?

And to what extent?

These and other questions have guided these three years of research, aimed at supporting the argument that we need the synergies of a multidisciplinary approach to the study of eating behaviors that leads to an approach in experimentation embracing various specializations. This also takes us on a path that allows us to approach the behavioral aspects related to nutrition more objectively.

The emphasis on diet and healthy nutrition has been growing, but what focus has the influence of our surrounding human environment received?

We believe that greater attention should be paid to behavior in the places where food is consumed, and in this study we wanted to support the reasons for this belief.

1.2 Is it a free choice? First deepening.

Pursuant to Regulation (EC) No. 178/2002 of the European Parliament and of the Council dated 28 January 2002, which lays down the general principles and requirements of legislation governing foodstuffs, "the European Food Safety Authority is established and procedures in matters of food safety are set out".

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[1] Source Regulation (UE) n. 1169/2011 of European Parlament and European Counsil of 25 october 2011

Our research was stimulated by the last part of this Regulation, with particular reference to the concept of informed choice and the absence of practices that might mislead the consumer.

Choice (in the field of food, too), is a "free act of will by which subjects, given several proposals and possibilities, manifest a preference for one (or more than one) deeming it better, more suitable or convenient than the other, on the basis of objective criteria or personal judgment, or at times on the basis of impulse." (Source Treccani).

We asked ourselves whether or not there were "non-evaluable" impulses or ones that are not open to conscious interpretation which might influence the subjects in their food choices.

Starting from the concept already proposed by Berthoz (2003), perception, not only in the realm of food and drink, is never just pure contemplation, but a call to action.

From this very important point, we started to ask ourselves questions.

Researchers (Cabanac, 1971) have long confirmed the intuitions of common sense and found that the intensity of the pleasure given by a certain kind of food is subject to strong variations, depending on the level of the hunger, or simply of the appetite, of the subject.

We thought that not only the level of hunger or appetite influenced the level of desirability of food, but that a major role was perhaps played by behavior and emotional value.

And we thought that this might alter the intensity of the pleasure of food, perhaps pre-emptively, increasing the consumer's susceptibility to selection, and subsequent consumption.

Individuals are influenced by emotions, and these lead to behavioral changes in other individuals, also in subsequent actions that are not linked to the emotion itself.

This assumption is supported by the concept of priming, upon which we based our first behavioral experiment: a primary (emotional) stimulus leading to subsequent behavioral changes.

Happiness, for example, which is strongly linked to states of pleasure, might in our opinion be linked to the choice and successive consumption of food.

Influential authors (Holley, 2006) claim to have found, in this specific field of food, a close link between pleasure and the desire to consume food, i.e. the impulse to perform one of the actions that allow us to live our biological life.

If we presume that the search for hedonistic pleasure goes hand-in-hand with the desire to increase the consumption of food, might it be that external factors that generate pleasure or happiness may predispose people to greater appetite than others such as anger?

We focused on the pleasure and anger expressed by others, as if somehow these might influence the observer's susceptibility to food consumption.

The data we collected in our behavioral experiments supported our thesis, and the effects on eating behavior may be very far-reaching and start a debate among scientists.

Let us consider the problem of obesity and food intake in the presence of emotions expressed by other individuals and therefore shared with the observer: can a human environment, through the mere sight of emotions, awake emotion mechanisms that influence the subsequent eating behavior?

Another important topic on which we focused is the specific field of negative emotions, again from the point of view of observing (or listening to) the emotions of others.

We live in an society that is increasingly "contaminated" by the sharing, through mass media, of events depicting violence against other individuals.

We wondered how this might affect eating behavior, as mass media are now present in almost all social contexts and therefore also in the context of food consumption (think TV sets in restaurants, or simply the average family watching the news during meals).

There are previous studies which address the issue of the use of negative terms in advertising in connection with the consumption of food (Pettigrew et al, 2012).

The presence of very high percentages of negative terms used in the advertising of foodstuffs has been observed, in a country such as Australia, where almost two-thirds of adults and a quarter of children are overweight or obese (Australian Bureau of Statistics, 2008).

We asked ourselves about the state of mind that is portrayed in the media, particularly the one associated with negative emotions, and how it can affect the food experience.

Previous studies have observed people who eat while watching television.

Whether there is a person chatting with us at our table, or our attention is turned to the television screen, we will be distracted from satiety signals and, since no signal will warn us that we need to stop eating, we will continue to do so and therefore we will eat more food than we need.

The effect of these types of distractions on the hunger/satiety balance was also found in an experiment (Brunstrom & Mitchell, 2006) on children playing on a computer while eating.

Compared to children who were not engaged in other tasks, the ones who were distracted by their activity on the PC or Playstation tended to eat more.

Other studies have shown that children are very vulnerable to the impact of external stimuli (Anschutz et al, 2010) because their inhibitory system is not yet fully mature.

Commercial messages that advertise food and drink are overabundant and may, as claimed by Piccinni (2012), direct younger children towards the consumption of any delicacy available regardless of the brand.

Piccinni shows also that children are highly susceptible to advertising, and this increases their propensity to food intake.

A study conducted on 1192 children aged 8 to 16 (Hare-Bruun, 2011) has shown that watching television for more than one hour a day was associated, both for boys and girls, with unhealthy foods and changes in eating habits.

The longer children watched television, the poorer the quality of their food preferences and their eating habits.

But besides this general dynamic, can we assume a direct influence of negative news on our approach to food?

Can a television news broadcast that describes negative situations or emotions affect not only the mood of those watching, but also their propensity to food?

Can these negative influences also affect digestion enough to even cause eating dysfunctions in individuals?

For these questions we have not been able to find answers, although our visit to the University of Ljubljana provided many ideas and our second experiment triggered numerous possible insights into the perceived difference between emotional stimuli and motor stimuli in association with food.

Regarding the stimuli that affect people's choice of food, in our second experiment we have considered that, in addition to the outward appearance of the foods, the context in which they are displayed plays a prominent role.

Is a context that stimulates emotions better or worse than a context that expresses only motor actions associated with the consumption of food?

These questions moved us to start our two experiments, with the idea of measuring, as far as possible, the influence that factors such as emotions (seen in other people) and motor acts related to food, might have on the propensity to consume food.

The experiments we conducted did not consider the eating of food from the quantitative standpoint, but were limited to the preceding step, which involves the desirability, the desire to purchase, the approach to food.

1.3 First approach and experiment

In our first experiment, which is described in the second chapter, we created the conditions for measuring the effect of emotions seen in others, unrelated to the food experience, on the subsequent food choice.

Many previous experiments focused on the influence of the emotions of others when food is consumed.

It had never been thought pertinent to evaluate the influence on the approach to food of the mere sight of a person's face expressing emotion through facial expression.

Ramanathan and McGill (2007) deal with the observation of aspects of mimicry and emotional contagion: one person smiles at something in the experience, which causes the second person first to mimic that smile and then to feel a bit happier.

This greater happiness leads to a more positive evaluation of subsequent components of the experience.

In our experiment, we wanted to measure this impact by simply relying on the priming effect exerted by the sight of a smiling or angry or neutral face, without that emotion being consciously transferred to or generated in the observer.

We did not assess whether the observer did or did not produce the emotion observed, but limited our observation to the effect on food desirability: the results were significant.

Our intention was to find an immediate and unconscious effect on the desirability of the food and to measure its significance.

We formed a research team to conduct experiment 1 (Dr. Cinzia di Dio, of the University of Milan, Dr. Fabrizio Fasano, University of Parma) under the supervision of Prof. Alessandro Sensidoni (University of Udine), with consulting by Prof. Giacomo Rizzolatti (University of Parma).

The team was created with the intention of garnering support from experts in the field of neuroscience who might have a critical role verifying the quality of the first experiment, since it was our intention to conduct research in a way that might, in the near future, be easily verifiable through the use of equipment directly related to the field of neuroscience, such as functional magnetic resonance imaging (fMRI).

1.4 Second experiment

On the assumption that *empathy is implemented by a simulation of the mental states of other people* (Iacoboni, 2009), we tried to understand whether this mechanism might be sufficiently powerful to influence the approach to a food that stimulates the brain reward circuits.

We wanted to know whether the sight of a happy face (represented in a drawing of a waiter with a happy face) might evoke in the observer a mimic that stimulated reward mechanisms which might in turn lead him/her to choose that food instead of others that presented motor stimuli or no stimuli at all.

We wanted to investigate in this direction because, within the wide range of products offered (for example) in supermarkets, the package almost always presents a picture of the food it contains, but without other types of stimuli with “human” presence.

After collating the results of the first experiment, we wondered whether combining images of the food itself with other, human-related stimuli, such as gestures or emotions, might be useful in food marketing.

On the basis of studies conducted on mirror neurons, we created a motor stimulus and an emotional stimulus to be associated to the image of the food.

We collated the results from the behavioral experiment conducted on volunteers, and our two experiments have proven consistent with our hypothesis, supporting the intent of our research.

1.5 References

Anschutz, D.J. et al (2010). Maternal encouragement to be thin moderates the effect of commercials on children's snack food intake. *Appetite*, 55 (1):117-123.

Arnow, G., Kenardy, J. & Agras, W. S. (1992). Binge eating among the obese: a descriptive study. *Journal of Behavioral Medicine* 15, 155-170.

Australian Bureau of Statistics, Canberra (2007). Catalog No. 4364.0.

Avena, N. M., Bocarsly, M. E. (2012). Dysregulation of brain reward systems in eating disorders: neurochemical information from animal models of binge eating, bulimia nervosa, and anorexia nervosa. *Neuropharmacology*, 63 (1), pp. 87–96

Berthoz, A. (2003). La décision. Odile Jacob, Paris

Beaver, J. D., Lawrence, A. D., van Ditzhuijzen, J, Davis, M. H., Woods, A., & Calder, A. J. (2006). Individual differences in reward drive predict neural responses to images of food. *The journal of neuroscience*. 26(19):5160-5166.

Brunstrom, J. M., & Mitchell, G. L. (2006). Effects of distraction on the development of satiety. *British Journal of Nutrition*, 96 (4): 761-769.

Cabanac, M. (1971). Physiological role of pleasure. *Science*, 173, 1103-1107.

Christensen, L. (2001). The effect of food intake on mood. *Clinical Nutrition*, Volume 20, Supplement 1, June 2001, Pages 161–166

Chua, J. L., Touyz, S., & Hill, A. J. (2004). Negative mood-induced overeating in obese binge eaters: an experimental study. *International Journal of Obesity and Related Metabolic Disorders*, 28(4), 606–610.

Clendenen, V. I., Herman, P. C. & Polivy, J. (1994). Social facilitation of eating among friends and strangers. *Appetite* 23, 1-13.

Davis, R., Freeman, R. J. & Solyom, L. (1985). Modd and food: an analysis of bulimic episodes. *Journal of Psychiatric Research* 19, 331-335.

Davis, C., Strachan, S., & Berkson, M. (2004). Sensitivity to reward: implications for overeating and overweight. *Appetite*, 42, 131-138.

De Castro, J. M. (1994). Family and friends produce greater social facilitation of food intake than other companions. *Physiology and Behavior* 56, 445-455.

De Castro, J. M. & Brewer, E. M. (1991). The amount eaten in meals by humans is a power function of the number of people present. *Physiology and Behavior* 51, 121-125.

Desmet, P. M. A., & Schifferstein, H. N. J. (2008). Sources of positive and negative emotions in food experience. *Appetite* 50, 290-301.

Ekman, P. (2008). Te lo leggo in faccia. Riconoscere le emozioni anche quando sono nascoste, *Amrita Editore*, 2008. ISBN 978-88-89-38219-6.

Eldredge, K. L., & Agras W. S. (1996). Weight and shape overconcern and emotional eating in binge eating disorder. *International Journal of Eating Disorders*, 19 (1), pp. 73–82.

Ganley, R. M. (1989). Emotions and eating in obesity: a review of the literature. *International Journal of Eating* Disorders 8, 343±361.

Greeno, G. G., & Wing, R. R. (1994). Stress-induced eating. *Psychological Bulletin*, 115, 444–464.

Halford,J. C. G., Gillespie, J., Brown, V., Pontin, E. E., & Dovey, T. M. (2004). Effect of television advertisements for foods on food consumption in children. *Appetite*, 42, pp. 221–225.

Hare-Bruun, H. et al (2011). Television viewing, food preferences and food habits among children: a prospective epidemiological study. *BMC Public Health*, may 13; 11:311.

Iacoboni, M. (2009). Imitation, empathy, and mirror neurons. *Annual Review of Psychology* 60:653–670.

Jansen, A., Havermans, R., Nederkoorn, C., & Roefs, A. (2008). Jolly fat or sad fat? Subtyping non-eating disordered overweight and obesity along an affect dimension. *Appetite*, 51, pp. 635–640.

Lowe, M. R. & Fisher, E. B. (1983). Emotional reactivity, emotional eating, and obesity: a naturalistic study. *Journal of Behavioral Medicine* 6, 135-149.

Loxton, N. J., Dawe, S., Cahill, A. (2011). Does negative mood drive the urge to eat? The contribution of negative mood, exposure to food cues and eating style. *Appetite* 56, 368-374.

Passamonti, L., Rowe, B. J., Schwarzbauer, C., Ewbank, M. P., Von dem Hagen, E., and Calder, A.J. (2009). Personality predicts the Brain's response to viewing appetizing foods: the neural basis of a risk factor for overeating. *The Journal of Neuroscience*, 29 (1):43–51.

Patel, K. A., & Schlundt, D. G. (2001). Impact of moods and social context on eating behavior. *Appetite*, 36, 111-118.

Pettigrew, S., Roberts, M., Chapman, K., Quester, P., & Miller, C. (2012). The use of negative themes in television food advertising. *Appetite*, vol 58, pp 496-503.

Phillips, M. L., Young, A.W., Senior, C., Brammer, M., Andrew, C., Calder, A., Bullmore, E. T., Perrett, D. I., Rowland, D., Williams, S. C., Gray G. A., & Davids, A. S. (1997). A specific neural substrate for perceiving facial expressions of disgust. *Nature*, 389, pages 495-498.

Piccinni, A. (2012). Drogati di cibo. Giunti Editore, Firenze.

Ramanathan, S., & McGill, A. L. (2007). Consuming with Others: Social Influences on Moment-to Moment and Retrospective Evaluations of an Experience. Journal of consumer research, Vol 34, pp 506-524.

Ricca, V., Castellini, G, Lo Sauro, C., Ravaldi, C., Lapi, F., Mannucci, E., Rotella, C. M. & Faravelli, C. (2009). Correlations between binge eating and emotional eating in a sample of overweight subjects. *Appetite*, 53, pp. 418–421.

Rozin, P., Levin, E., & Stoess, C. (1991). Chocolate craving and liking. *Appetite*, 17, pages 199-212.

Rozin, P. (1998). Towards a psychology of Food Choice. *Institute Danone*, Bruxelles.

Schmitz, B. A. (1996). The relationship between affect and binge eating. Dissertation Abstracts International: Section B: *The Sciences and Engineering* 56, 7055.

Singer, T., Seymour, B., O'Doherty, J., Kaube, H., Dolan, R. J., & Frith, C. D. (2004). Empathy for pain involves the affective but not sensory components of pain. *Science*, 303, pages 1157-1162.

Steptoe, A., Lipsey, Z. & Wardle, J. (1998). Stress, hassles and variations in alcohol consumption, food choice and physical exercise: a diary study. *British Journal of Health Psychology* 3, 51-63.

Striegel-Moore, R. H., Morrison, J. A., & Schreiber, G. (1999). Emotion-induced eating and sucrose intake in children: The NHLBI growth and health study. *International Journal of Eating Disorders*, 25, pp. 389–398.

Yeomans, M. R., & Coughlan, E. (2009). Mood-induced eating. Interactive effects of restraint and tendency to overeat. *Appetite*, 52(2), 290–298.

Wallis, D. J., & Hetherington, M. M. (2009). Emotions and eating. Self-reported and experimentally induced changes in food intake under stress. *Appetite*, 52(2), 355– 362.

Willner, P., Benton, D., Brown, E., Cheeta, S., Davies, G., Morgan, J., et al. (1998). Depression increases craving for sweet rewards in animal and human models of depression and craving. *Psychopharmacology*, 136, 272–283.

Chapter 2: first experiment. Is food desirability affected by social interactions?

2. First experiment. Is food desirability affected by social interaction?

2.1 Genesis

In this experiment, we decided to evaluate the effect of the sight of other people's facial expressions on subjects faced with food.

To be more certain of the result, we also included a variable: the color of the food. Our aim was to measure the effect of the sight of another person's face on the desirability of the food, given the same changes in the food color, starting from previous studies that have shown that a lower color temperature (of the food) induces a perception of poor palatability.

Our goal is considered achieved when, even with changes in food color, the influence of the sight of other people's emotions maintained its effect in terms of altering the desirability of the food.

We considered the concept of the desirability of the food rather than the simple "liking" type pleasure: the level of desirability was desumed from the question that we asked our subjects: "How much would you like to eat this?", since this question expresses a "wanting" type of desirability (Berridge, 1996), and therefore a pleasure attributed to a potential later consumption.

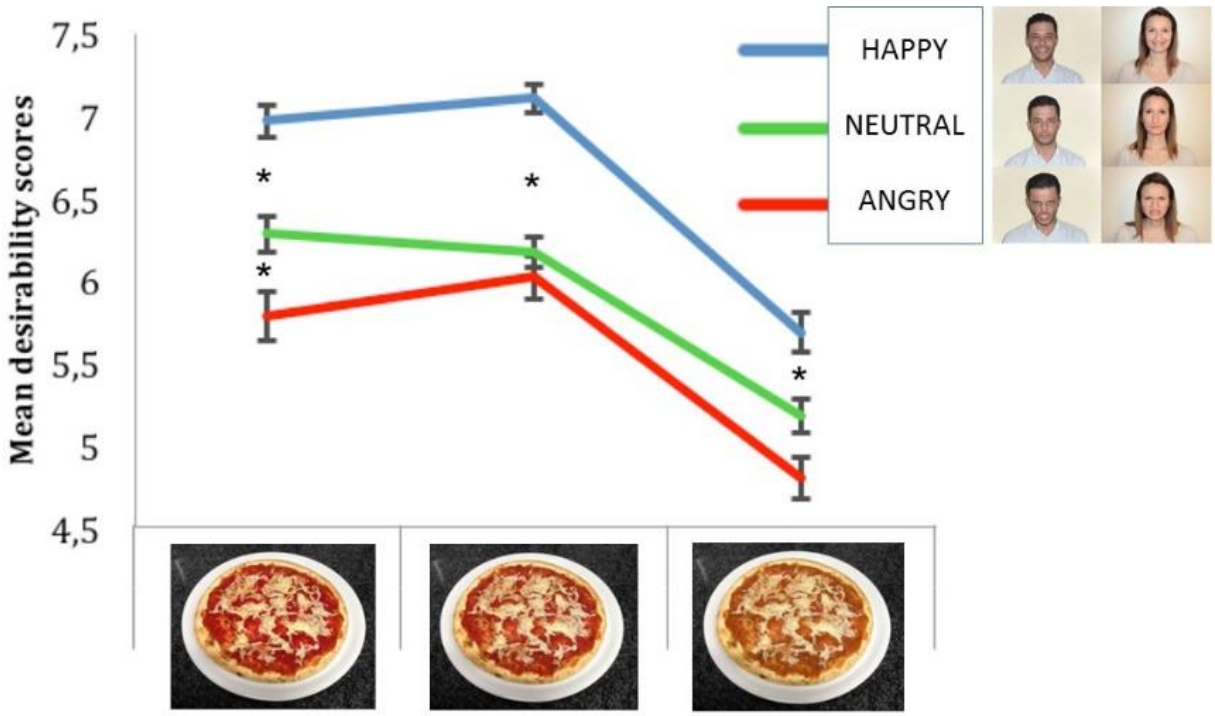
This experiment, initially designed by Matteo Rizzato (University of Udine), Prof. Alessandro Sensidoni (University of Udine), Fabrizio Fasano (University of Parma, and Neurocomm Srl) and Cinzia Di Dio (University of Milan), was integrated by important contributions by Prof. Gabriella Gilli (University of Milan), and Prof. Antonella Marchetti (University of Milan). The processing of data for statistical analysis was carried out with the support of Dr. Cinzia Di Dio.

Highlights

- This study investigates the effect of an emotional context on food desirability
- Happiness, anger and a neutral facial expression denoted the emotional context
- Happiness exerted a positive effect comparable to a no-(emotional) context condition
- Anger, selected as a food-unrelated emotion, showed a negative effect on desirability
- Also the neutral expression evoked negative influential effects on desirability

Keywords: Emotion, Faces, Food, Food Desirability, Anger, Happiness, Social context.

Grafic Abstract



2.2 Abstract

The experience of food can be affected by visual perception and the context in which food is presented. In this study, we investigated the effect of specific emotional contexts on food desirability.

To this purpose, we selected a highly familiar Italian food, Pizza Margherita, whose sauce color was digitally manipulated to create different desirability levels.

The participants rated the pizza desirability on the basis of its visual features alone (no-context condition) and, most critically, after viewing images representing facial expressions of happiness, anger and neutrality.

Anger was selected, as opposed to disgust, as a food-unrelated emotion to assess whether influential effects on food desirability evoked by the observed individual's emotion state needs to be necessarily related to the eating context.

Confirming previous results, we found an effect of the social context (facial expressions) on food desirability.

Similarly to the no-context condition, happiness evoked the highest desirability ratings for all items compared to neutral and angry expressions, whereas the neutral and angry faces negatively affected food desirability relative to no-context and happy face conditions.

These findings show that happiness is commensurate with a situation in which food is presented alone, suggesting that approach to food in healthy individuals is intrinsically related to positive emotions.

Additionally, we show that food perception can be also affected by emotions, which are not necessarily related to food, but which nevertheless frame food delivery.

We argue that this emotion-related effect may be grounded on resonance 'mirror' mechanisms allowing people to spontaneously tune to others' emotions.

2.3 Introduction

The way we experience food is influenced by all five senses (Brody, 2012). However, eating behavior is not characterized only by the perceptual qualities of a given food, but also by cognitive and emotional factors.

Flavor, for example, is shown to be the result of the multisensory integration of olfactory, tactile and taste impressions, which will vary from individual to individual based on past experiences as well as on the emotional state of the eater (Smith, 2012).

Various studies have shown that the relationship between eating and emotion varies according to the particular characteristics of the individual and to his/her emotional state like, for example, anxiety, anger, joy, depression, sadness and other emotions (e.g., Canetti et al, 2002).

Similarly, Macht (2008) maintains that the amount of food intake is largely influenced by change of emotions.

Emotional eating is typically defined as eating in response to negative emotions (e.g., Arnow, Kenardy, & Agras, 1995; Van Strien et al., 1986) and this is due to factors, such as one's intent to alleviate negative emotional states (Macht & Simons, 2011).

High food consumption was reported during boredom, depression and fatigue and low food intake was reported during fear, tension and pain (Mehrabian, 1980).

However, Evers et al. (2013) showed that also positive emotions can elicit food intake.

Their study revealed that positive emotions evoked by the vision of a brief film caused a higher snack intake during a taste test.

Positive emotions are often associated with high appetite levels (Mehrabian & Riccioni, 1986) and with a greater tendency to consume healthy foods, as opposed to junk food during negative emotions (Lyman, 1982).

Additionally, it was shown that people tend to eat larger amounts of a less hedonic product (like raisins) when they are in a happy state than when they are in a sad state (Garg, Wansink & Inman, 2007).

Our perception of the sensory world is therefore constantly modulated by our psychological and emotional state as well as by the environment surrounding us (Fontanini & Katz, 2009).

Health related contextual factors can also impact eating behavior.

For example, the desire to eat decreased when an obese person was observed, independently of the observer's facial expression.

In contrast, the desire to eat increased when a subject of normal weight was observed by a person exhibiting a facial expression of pleasure (Barthomeuf, Rousset, & Droit-Volet, 2010).

The effect of external factors, such as the environment or other persons present, seems to be crucial for how we experience food (Jang, King, & Prinyawiwatkul, 2014).

It was shown, for example, that socializing can influence the volume of food consumption (Wansink, 2004).

Barthomeuf and colleagues (2009) carried out a study to test if pleasure, neutrality and disgust expressed by other individuals on a photograph could affect the desire to eat liked or disliked foods.

In this study they tested 44 subjects viewing photographs of people while eating different types of food and showed that the effect of the presence of an eater, and of emotions expressed by this eater, depended on the food category.

The desire to eat was higher when foods were presented alone than with an eater expressing neutral emotions.

When the eater expressed pleasure, the desire to eat liked foods did not significantly increase while it increased for disliked foods.

In contrast, when the eater expressed disgust, the desire to eat liked foods significantly decreased while had no effect on the desire for disliked foods.

These results suggest that attending to others' emotions may affect food desirability.

This social effect on one's emotions can be explained in terms of the commonly accepted existence of a mirror mechanism.

Humans possess six basic emotions, namely happiness, surprise, fear, sadness, anger, and disgust combined with contempt, although the list has been expanded later (Ekman, 1999).

As in the theories of embodied emotions (Wicker et al., 2003; Bersalou et al., 2003; Niedenthal et al., 2005), the perception of emotions expressed by other people's faces leads to a comprehension of the emotional state in the observer via an automatic imitation of the facial expressions (Adolphs et al., 2000; see also Dimberg, 1982, 1990).

This 'resonance' between individuals (empathy) may be grounded on the existence of mirror mechanisms (Rizzolatti et al., 1988, 1999; Rizzolatti & Craighero, 2004) that are considered the neural basis of intersubjectivity (Gallese, 2001).

Through the mirror systems, perception of actions and emotions in others overlaps with the same neural mechanisms in the beholder when actively executing the same actions or feeling

the same emotions (e.g., Di Pellegrino et al., 1992; Fadiga et al., 1995; Iacoboni et al., 2005; Gallese, 2006; Sato & Yoshikawa, 2006).

In this study, we aimed at exploring how a perceived emotion can influence food experience.

In particular, a behavioral experiment was carried out to assess whether the mere sight of other people's emotions, shown by their facial expressions, exerts a significant influence in the level of predisposition to food consumption (desirability) independently of the initial emotional state of the observing subject.

For this purpose, we manipulated food desirability by changing the visual features of the presented stimulus and, more specifically, its color.

As a stimulus, we selected a typical and well-known Italian food, Pizza Margherita, commonly recognized as desirable.

We assessed its desirability when presented alone (no-context condition) and observed changes in its desirability level when embedded in a social emotional context.

The social context condition was created by introducing, prior to the food target presentation, a male or female face expressing happiness, anger and neutrality.

Differently from previous studies (e.g., Barthomeuf et al., 2009) that used images of people in the act of eating, we presented the emotional stimulus prior to food observation to evaluate if observation of others' emotions alone (and not emotion in association with eating) exerts effects on food perception.

Additionally, we used facial expressions, whose emotions are not necessarily linked to the eating experience as in the case, for example, of disgust.

This was done to assess whether, generally, food perception is affected by the receiver's current emotion state. Nevertheless, we chose some emotions (happiness and anger) that, at a probabilistic level (because more frequent), could ease the emotional response of the viewers, as opposed to emotions such as sadness and fear (Macht, 1999; Scherer, Wallbott, & Summerfield, 1986).

2.4 Materials and Methods

2.4.1 Participants

Thirty-three (33) volunteers, aged between 20 and 31 years, 18 male and 15 female, participated to this study.

None of the participants had celiac disease nor intolerance to the components of the presented food stimuli.

This study was approved by the University of Udine Ethics Committee.

2.4.2 Stimuli

A typical Italian food, Pizza Margherita, was selected as food model to our purpose.

Pizza Margherita has a widespread approval rating in the Italian population and is considered a 'familiar' food.

Images of Pizza Margherita were supplied by Roncadin S.p.A. (Meduno, Pn, Italy).

Different degrees of desirability were created by digitally manipulating the sauce color.

More specifically, we varied the red color coordinate (light red -30, standard red 00, bright red +30) using the Photoshop software function (Image, adjustments, selective color, reds, and varying magenta levels -30 and +30; see Fig.1).

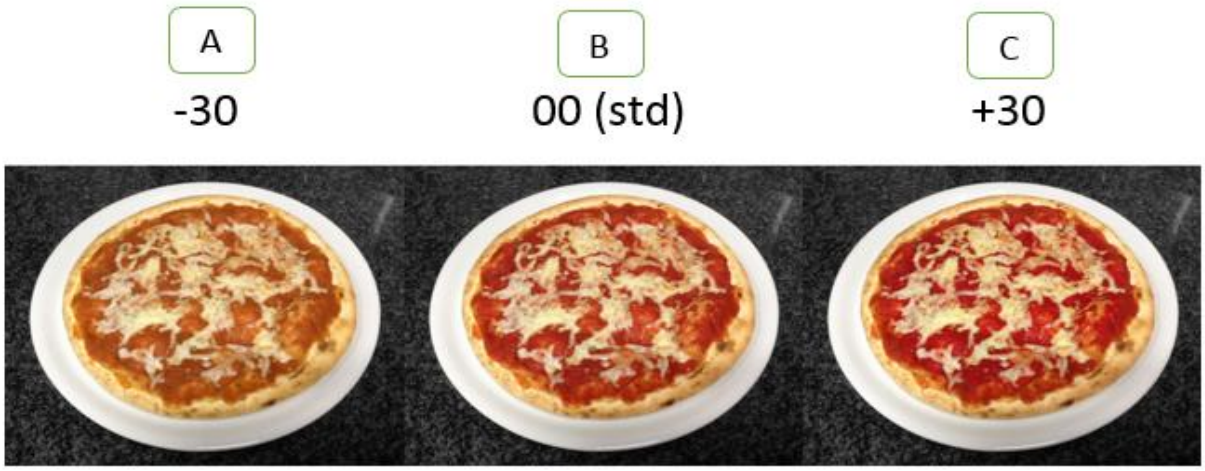


Figure 1: Images of three Pizza types used on our experiment. A) light red -30; B) standard red 00; C) bright red +30.

Using the same stimulus in different visual variances allowed us to control for homogeneity of responses due to differences in the visual composition of food.

The emotional stimulus (facial expression) represented a male or female face expressing either a neutral, happy, or angry emotion.

Happy and angry face expressions were selected among six possible emotions according to Ekman's categorization: sadness, anger, surprise, fear, disgust and contempt, happiness (1999). In total, 6 emotional stimuli were used (2 gender x 3 emotions; Fig. 2).

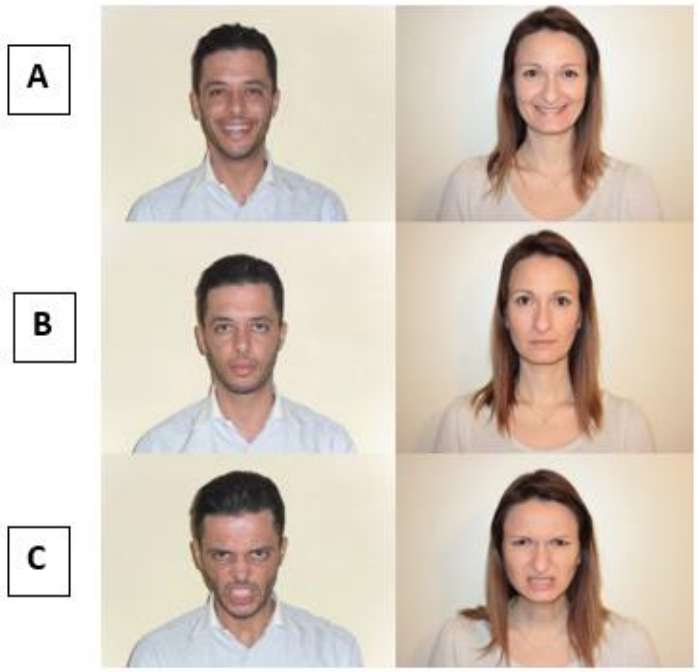


Figure 2: Images of six facial expressions used on our experiment. A) Happy expressions; B) Neutral expressions; C) Angry expressions.

To increase the ecological power of the observed effects, all participants (males and females) were equally presented with both face genders.

To support that the effect of the social stimuli on food desirability was independent of whether a female or male participant observed a female or male face, a supplementary analysis including the participants gender as a between-subjects factor showed no significant interaction effect between participants' gender and and the gender of the presented face (see Results below).

To validate the stimuli used (stimulus validation), after the experimental session, in which we required participants to express a desirability judgment on the food images, the subjects had to evaluate which emotion they had recognized in the images among the following: happiness, neutrality, anger, disgust, euphoria, surprise, sadness.

The results showed that all facial expressions were correctly judged, each one significantly falling into the expected category (happy, neutral, angry; see Fig 3 and Table 2 for statistical details).

Figure 3: Categorization of the participants' judgments of the facial emotions (happy, neutral, angry) for the female and male's face. The figure shows that all facial expressions were correctly identified.

Additionally, we carried out a repeated measures GLM analysis on response times with facial expressions (happy, neutral, angry) and actor's gender (female, male) as within subjects factors and subject's gender as a between groups factor.

This analysis was carried out accounting for the stimuli correctly judged.

The results showed that there was no significant difference when evaluating the three emotions for either the female or male's face.

No differences were further found as a function of the subject's gender indicating that all emotional stimuli were recognized with equal ease.

2.4.3 Apparatus and Procedure

We created a software, called “Progetto Udine Parma”, using php programming language which stores the information it receives from the interaction among users on a “mysql” database.
The system runs on a server with “Ubuntu” OS, whereas web pages were realized in html language.
The stimuli were portrayed using Ipad digital camera (Apple, inc).
We created 9 video clips (stored encrypted on YouTube online streaming service) with random combinations of pairs of images with the emotional and food stimuli representing the 3 different facial expressions (happy, neutral and angry) in association with the 3 versions of Pizza images (bright red, natural and light red).
These clips were presented 4 times each, twice portraying a male actor, and twice a female actor (for a total of 36 clips).
Multiple responses to the same item were required to spread out possible noise sources associated with, for instance, context effects (i.e., preceding stimuli), hence providing consolidated responses for each given stimulus and emotion.
Stimulus randomization across participants accounted for possible boredom effects due to task performance.
Three video clips were created only with food images (3 versions of pizza) and presented 4 times each, for a total of 12 presentations.
Face expressions shown on the 36 videos were presented for 250 ms followed by a food image presented for 1750 ms (priming effect).
After each of the 48 clips, a question mark appeared prompting the subjects’ response to the food stimulus.
The subjects had to indicate their predisposition to eat the food (desirability score) on a scale ranging from 1 (not at all) to 10 (very much) answering to the question “how much would you like to eat it?”.
The participants’ ratings and response times were recorded.

2.4.4 Statistical analysis

Repeated measures GLM (General Linear Models) analyses were carried out to test the effects of interests.

The between subjects factors were: 4 emotional conditions (baseline – no context -, happy, neutral, angry); 3 pizza variations (bright red – BR, standard red – SR, light red – LR).

The between group factor was the participants gender.

In a supplementary analysis, we added the gender of the emotional stimulus (emotional expressions of the female and male actors) as a within factor variable to assess whether there was an interaction effect between participants' gender and the gender of the observed emotional stimulus.

In this analysis, the baseline condition (no context) was removed.

The dependent variables were the subjects' ratings of desirability and response time (RT) in seconds.

The Greenhouse-Gaisser correction was applied when the sphericity assumption was violated ($p>.05$). The Bonferroni correction was used for post-hoc multiple comparisons.

The dependent variables were the subjects' evaluation of the food stimuli on a scale from 1 to 10 (see Methods) and response time (RT) in seconds.

The Greenhouse-Gaisser correction was applied when the sphericity assumption was violated ($p>.05$). The Bonferroni correction was used for post-hoc multiple comparisons.

2.5 Results

2.5.1 Effect of facial expressions on pizza desirability: SCORES

Within this analysis, we tested the effect of facial expressions (happy, neutral, angry) and no-context condition on pizza desirability for the three pizza variations (BR, SR, LR) also as a function of the actor's gender.

The results showed a main effect of pizza variation ($F_{(2,62)}$=24.88, p<.0001; partial-η^2=.45; δ=1), with standard and bright red color pizzas evoking higher desirability scores compared to light red pizza (SR>LR: p<.0001, 95% C.I. .66, 1.92; BR>LR: p<.0001, 95% C.I. .66, 1.87). No differences were observed between standard and bright red pizzas (p>.05).

The results also showed a main effect of facial expression on pizza desirability ($F_{(3,93)}$=19.65, p<.001; partial-η^2=.39; δ=1), with pizzas primed by a happy expression being evaluated as more desirable than pizzas presented with a neutral or angry facial expression (happy> neutral: p<.0001, 95% C.I. .34, 1.07; happy>angry: p<.0001, 95% C.I. .37, 1.71).

No differences were observed between the no-context condition and happy facial expressions. As shown in Fig. 4, pizzas primed by an angry facial expression evoked the lowest desirability scores.

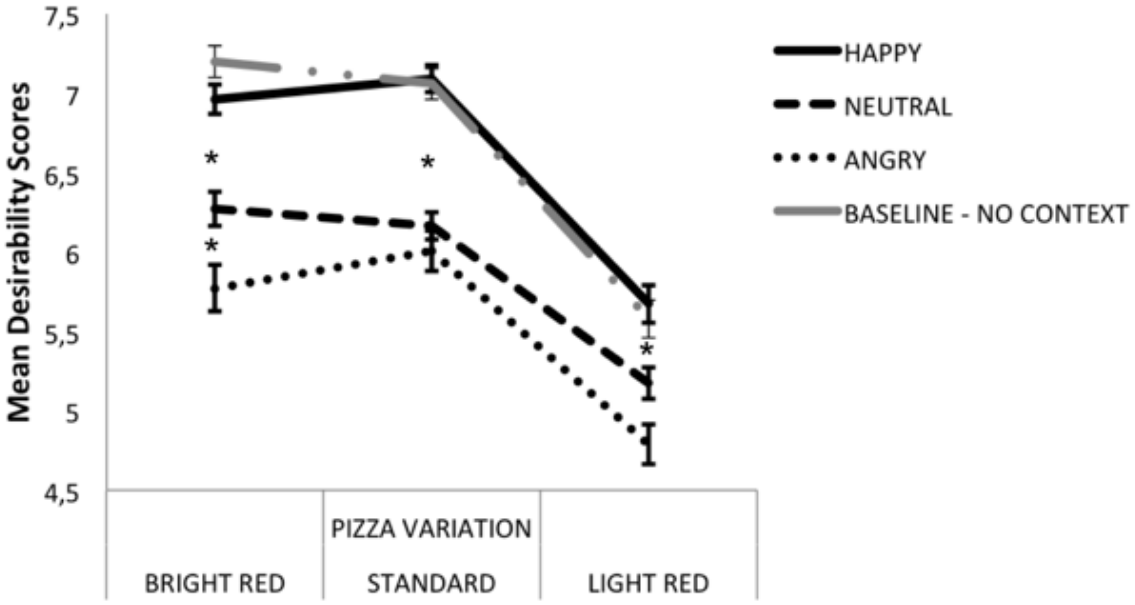


Figure 4: Mean desirability scores as a function of pizza variation (bright red, standard red, light red sauce) when presented with no-context and when primed by the emotional expressions (happy, neutral, angry). Bars represent the Standard Error of the mean. (*) indicates significance (p<.005) between levels of pizza variation.

A significant interaction pizza variation*facial expression was also found ($F_{(6,186)}$=4.64, p=.001; partial-η^2=.13; δ=99).

Post hoc paired sample tests showed that, whereas for SR and LR pizzas, no differences in desirability were observed between neutral and angry facial expression, for BR pizzas the desirability scores significantly decreased at every level of facial expression (happy>neutral>angry; see Fig. 4 and Table 1 for statistical details).

Table 1

Pair Differences

Comparisons (facial expr_pizza color)	Mean	Std Error	t	df
H_B - N_B	0.69	0.16	4.23	32
H_B - A_B	1.19	0.25	4.72	32
N_B - A_B	0.50	0.18	2.85	32
H_S - N_S	0.92	0.14	6.62	32
H_S - A_S	1.08	0.24	4.60	32
N_S - A_S	0.16	0.15	1.07	32
H_L - N_L	0.50	0.14	3.47	32
H_L - A_L	0.89	0.25	3.49	32
N_L - A_L	0.39	0.17	2.30	32

Table 1: Statistics for paired sample analyses testing for the interaction effect between pizza type and facial expression. H_B=happy_bright; H_S=happy_standard; H_L=happy_light; N_B=neutral_bright; N_S= neutral_standard; N_L= neutral_light; A_B=angry_bright; A_S= angry_standard; A_L= angry_light. The critical p for this tests = .005 Bonferroni corrected. As far as face gender associated with the facial expressions is concerned, there is no difference in desirability scores if the expression that primes the pizzas is associated with a female or male face (p>.05).

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No significant effects were observed as a function of the subject's gender (p>.05).

The supplementary analysis, where we added the gender of the actors portraying the emotional stimuli as a within factor variable, therefore, removing the no-context condition from the model,

revealed no significant interactions between participants' gender and the gender of the observed emotional stimulus ($F_{1,31}$=1.78, p>.05).

Table 2: Categorization of judgments for the Female's and Male's facial expressions (frequencies out of 33 total cases). % Correct: percent correct judgments; % Related: percent of emotion evaluation related to the target expression (e.g., anger, disgust; happy, euphoria); % Total: sum of % Correct and % Related judgments. The table shows that all facial expressions significantly fell in the correct emotion category. The statistics was carried out on the % correct judgments.

	FEMALE			MALE		
	HAPPY	**NEUTRAL**	**ANGRY**	**HAPPY**	**NEUTRAL**	**ANGRY**
HAPPY	**29**	1	0	**31**	0	0
NEUTRAL	0	**32**	0	0	**28**	0
ANGRY	0	0	**24**	0	0	**32**
Others						
DISGUST	0	0	9	0	0	0
EUPHORIA	3	0	0	1	0	1
SURPRISE	1	0	0	1	2	0
SAD	0	0	0	0	3	0
% Correct	**88*** **	**97****	**73***	**94*** **	**85*** **	**97****
% Related	9	0	27	3	0	0
% TOTAL	**97**	**97**	**100**	**97**	**85**	**97**

*** Binomial Test test sign. P<.0001**

**** Binomial Test test sign. P<.01**

***** Chi² test sign. P<.0001**

2.5.2 Effect of facial expression on pizza desirability: response time

In general, there were no differences in response time to the food stimuli as a function of facial expression or face gender (p>.05). However, Figure 5 shows an interaction trend between face gender and facial expression. When pizzas were preceded by a neutral facial expression, subjects tended to provide a slower desirability evaluation when the emotional expression belonged to the male than to the female face. Whereas, when pizzas were preceded by an angry facial expression, the female face tended to trigger slower responses than the male face. Failure

to reach significance (F(2,64)=3.11, p>.07 Greenhouse-Geisser corrected) was possibly due to the great variance associated with the ratings for the male's neutral expression and the female's angry expression, as shown by the bars representing the standard error of the mean displayed in Figure 5.

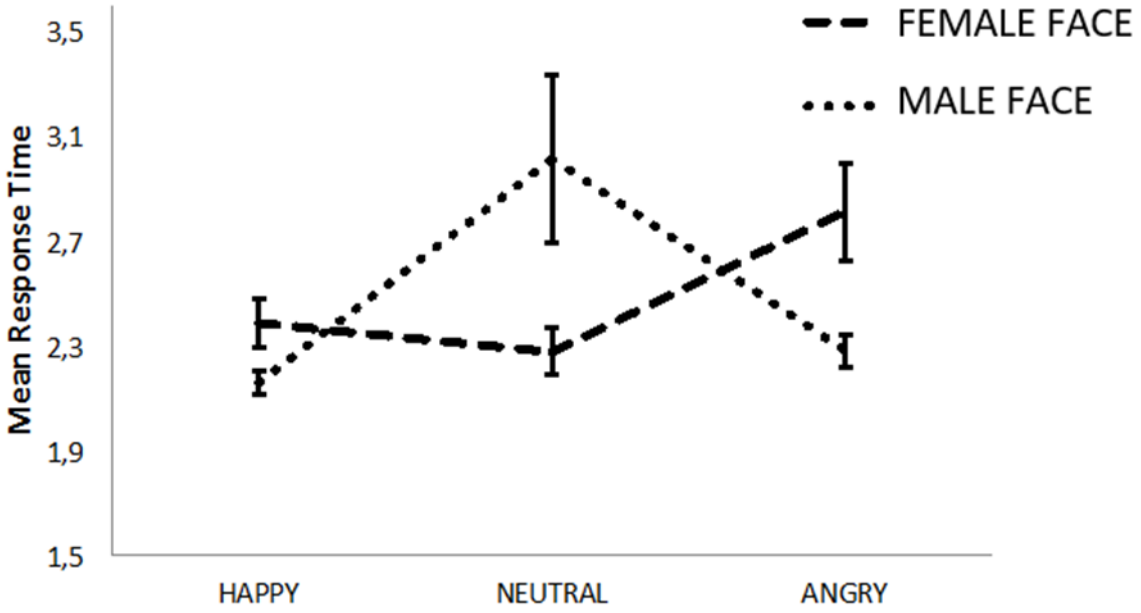

Figure 5: mean response times as a function of the 3 emotional expressions (happy, neutral, angry) for the female facial expression (dashed line) and the male facial expression (dotted line). Bars represent the Standard Error of the mean.

2.6 Discussion

In the present study we explored if an emotional context can affect food desirability by presenting subjects with images of different pizza variations (whose sauce color was manipulated with the intent to create different desirability values) primed by facial expressions of happiness and anger (plus a neutral expression).

Overall, the present results showed that, when presented alone (no-context condition), light red color effectively diminished the pizza desirability value, supporting the view that diminished gamma colors are typically associated with the decomposition process of food.

Opposite, increasing the red color brightness in our study had no significant effect on the pizza appeal in contrast with the idea that high chromatic food color is associated with food preference (Sun-Man Lee et al., 2013).

It would be interesting to research whether there is also a limit in artificially increasing the color, beyond which food is considered by the observer too bright and therefore unacceptable. In general, these results confirm previous findings showing that food selection is primarily guided by the visual system (Van del Laan et al., 2011) and that color can be a decisive element as an indicator for food evaluation and selection (Abdullah et al., 2004; Afshari-Jouybari & Farahnaky, 2011).

Crucial to this study was to observe differences in food desirability when embedded within an emotional context (facial expression).

The results showed that the desirability scores for the 3 pizza variations significantly decreased, compared to no-context condition, when presented in association with both a neutral and angry facial expression, whereas happy facial expressions exerted no effect on food desirability compared to no-context condition.

In fact, pizzas primed by a happy face received virtually identical scores to those recorded for the no-context condition.

The first point raised by our data regards the, so judged, neutral expressions.

The results show that a neutral expression, identified as such also by the participants of this study, is still able to convey an emotional meaning, at least when associated with a food item.

In fact, when primed by the neutral expression, all pizza variations underwent a significant decrease in desirability.

Most likely, food presentation, when associated with an emotion, requires this emotion to be overly positive at least to maintain the desirability aspect it conveys through its visual appearance.

This idea is supported by our results showing that happy faces, among the three tested emotions, evoked the highest ratings for all pizza variations.

This is in line with the idea that people, who are in a state of joy, undergo a positive food experience (e.g., Macht, 1999) and with our proposition that, in healthy individuals, food presentation is intrinsically related to a positive emotion.

The second point raised by the present data is that the happy facial expression, although scoring significantly higher compared to the other two emotions independently of the pizza variation, did not evoke greater desirability scores compared to the no-context condition.

This result only partially supports what previously found (e.g., Barthomeuf et al., 2009, 2010; see also, Evers et al., 2013).

In Barthomeuf et al's (2009) work the expression of pleasure enhanced food desirability for disliked foods with respect to food presentation alone.

In our study, the happy face did not increase the desirability value ascribed to the less desired food (LR) with respect to the no-context condition.

These results need not to be regarded in opposition.

Our results support the idea that not even a happy face is able to affect food perception when the visual features of the presented food convey poor quality.

Most likely, since our color manipulation was possibly associated with food degradation, and not only with food disliking as in Barthomeuf et al., the stimulus became more resistant to external influence.

On the contrary, the negative emotion and even the neutral facial expression worked as reinforcers of perception formation based on the visual features alone.

In fact, when presented in association with neutral and angry facial expressions, the less desired item further diminished its desirability level.

The last, but certainly not least, point highlighted by the present concerns the effect elicited by the expression of anger, which had a significant negative effect on food desirability for all 3 pizza variations compared to the no-context and happy emotional context conditions.

This result shows that emotional effects on food desirability can be evoked also by emotions that are not strictly related to eating, as in the case of disgust, a visceral emotion that, from Darwin onward, has been regarded as basically about rejecting foods (for a review, see Haidt, McCauley, & Rozin, 1994; see also, Wicker et al., 2003; Barthomeuf et al., 2009).

Additionally, the interesting interaction between emotions and pizza variation showed that, within the emotional contextual frame, SR and LR foods received similar ratings when presented with neutral and angry faces, whereas only bright red sauce pizza was significantly affected by all emotion expressions.

Since bright and standard red pizzas were judged equally desirable in the no-context condition, this interaction suggests that there is some intrinsic difference between the stimuli, which makes them more (in the case of BR) or less (in the case of SR) easily influenced by external factors.

One of such intrinsic properties may relate to the consolidated value ascribed to foods by experience.

That is, SR represents the common type of pizza, well known and actually experienced by the Italian population, whereas BR was judged desirable based on visual features alone, since people have no actual experience of it.

Prior experience would then make SR pizza more resistant to external effects and, in contrast, BR pizza more susceptible to the negative emotional effect evoked by anger.

This aspect is of particular importance when considering conditions in which individuals approach unknown food.

Let's think of, for example, situations where children are presented with new foods.

If food is delivered in association with a negative emotion state, independently of whether this emotion directly targets the food, its perceived desirability is already compromised.

This is most critical in light of psychological investigations carried out on Italian preschoolers showing that anger rather than sadness is a typical reaction to perceived negative events (Tiberi & Pedrabissi, 1988; see also, Gilli et al., 2001; Gilli, Marchetti & Rosini, 2001).

Education on food behavior is of extreme importance from very early in childhood. Educational practices addressed to young children are in fact centered on food-related behavior, a theme that, from an evolutionary perspective, is of extreme importance since it relates to our ability to recognize what is good or bad for our health.

This focused attention on food behavior and education affects also the maturation of mental abilities in children, as predicated by the Theory of Mind (e.g., Perner & Wimmer, 1985) and, in particular, of those related to food, which manifest themselves precociously with respect to evolutionary less relevant subjects.

Emotions, such as sadness or fear, ‘‘rabbia’’ or rage, are the most frequent negative emotions observed among Italian children in interaction with family and friends (Marchetti, 1993).

The emotional context, which may not be related to food but in which food is embedded, becomes in this respect vital for the formation of a first food impression and, possibly, subsequent food experience and behavior.

The phenomenon according to which the mere sight of a facial expression, even in a photograph, significantly modified food desirability ratings in the present study strongly suggests that the observer’s mood was somehow affected by the observed emotion and that this change influenced, in turn, perception.

In light of the recent neurophysiolgical discoveries, it is plausible to ascribe this phenomenon to an “emotional resonance”, which would be grounded on the existence of mirror mechanisms (for a review see Gallese & Sinigaglia, 2011).

During facial emotion processing, mirror neurons may provide an internal simulation of the observed motor behavior (i.e., facial expression) that evokes a similar emotion in the observer (Gallese, 2006).

Sato (2006) suggested that the mirror neuron system may play an important role in facial mimicry, eliciting a subject’s facial reactions to another individual’s facial movements.

Wicker et al. (2003) also found that observing the expression of disgust in others activates the same brain areas involved in the feeling of disgust in the observer.

Additionally, Lenzi (Lenzi et al., 2008) found that imitating the joyous expression of an infant greatly activates limbic and temporal areas, which are associated with emotion processing.

The data from our study are congruent with these observations and suggest an empathic resonance effect in the observing individuals that is evoked by other people's facial expression. This is most likely the reason that people who see positive expressions in others in a food consumption context are predisposed to larger food intakes; the same principle would apply also to the expression of negative emotions with respect to food rejection.

2.7 Concluding Remarks

The results of this study support the idea that social emotional factors may influence our perception of food through an emotional resonance triggered by the sight of different facial expressions (happy, neutral and angry).

We suggest that this phenomenon is physiologically grounded on the existence of a mirror mechanism, through which the motor pattern characterizing the observed facial expression would translate in the same motor pattern in the observer and, ultimately, in the corresponding emotion.

Crucially, this emotional rebound does not necessarily require a strict association with the food context, whereby an observer views somebody in the act of eating with a disgusted face, but may be elicited by more general food-unrelated modifications of the observer's emotion, which ultimately affect food perception.

However, our data also show that not all emotions exert the same effect on food perception. The type of emotion perceived and the intrinsic properties of the food stimulus (e.g., past experiences with that particular food or perceptual visual properties cuing its edibility) may play different roles on food perception and, possibly, eating behavior.

More generally, the present data suggest that the quality of the emotions expressed have to be considered both in the food marketing industry as well as in restaurants and other places where food is consumed, since they could enhance the pleasantness or unpleasantness of food.

2.8 Limitation and outlook

In the present study we used only one type of food (pizza).

This choice was based on the assumption that pizza is very much consumed, hence well known and experienced, within the Italian population (hence by our sample subjects).

Systematic changes to this stimulus features allowed us to control for cognitive biasing factors concerning, for example, familiarity, as well as perceptual biasing factors, such as food shape, composition, etc.

Alternatively, in future developments of the present experimental idea, a large variety of food can be used, allowing for a more powerful generalization of our results.

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Is food desirability affected by social interaction?

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2.9 Selected References

Abdullah, M. Z., Guan, L. C., Lim, K. C., & Karim, A. A. (2004). The applications of computer vision system and tomographic radar imaging for assessing physical properties of food. *Journal of Food Engineering, 61 (1)*, 125–135.

Adolphs, R., Damasio, H., Tranel, D., Cooper, G., & Damasio, A. R. (2000). A role for somatosensory cortices in the visual recognition of emotion revealed by three dimensional lesion mapping. *Journal of Neuroscience*, *20*, 2683–2690.

Afshari-Jouybari, H., & Farahnaky, A. (2011). Evaluation of Photoshop software potential for food colorimetry. *Journal of Food Engineering*, *106 (2)*, 170–175.

Arnow, B., Kenardy, J., & Agras, W. S. (1995). The emotional eating scale. The development of a measure to assess coping with negative affect by eating. *International Journal of Eating Disorders*, *18*, 79–90.

Barthomeuf, L., Rousset S., & Droit-Volet, S. (2009). Emotion and food. Do the emotions expressed on other people's faces affect the desire to eat liked and disliked food products? *Appetite*, 52, 27-33

Barthomeuf, L., Rousset, S., & Droit-Volet, S. (2010). The desire to eat in the presence of obese or normal-weight eaters as a function of their emotional facial expression. *Obesity*, *18*, 719-724

Barsalou, L., Nidenthal, P., Barbey, K., & Ruppert, J. (2003). Social embodiment. In Ross, B. H. (Ed.). *Psychology of Learning and Motivation, 43, 2003, Pages 43-92*.

Brody, H. (2012). Editorial: taste. *Nature*, 486(7403), S1.

Canetti, L., Bachar, E., & Berry, E. M. (2002). Food and emotion. *Behavioural Processes*, *60*, 157-164.

Dimberg, U. (1982). Facial reactions to facial expressions. *Psychophysiology*, *19*, 643–647.

Dimberg, U. (1990). Facial electromyography and emotional reactions. *Psychophysiology*, *27*, 481–494.

Di Pellegrino, G., Fadiga, L., Fogassi, L., Gallese, V., & Rizzolatti, G. (1992). Understanding motor events: A neurophysiological study. *Experimental Brain Research*, *91*, 176–180.

Ekman, P. (1999). Basic emotions. Sussex, UK: John Wiley & Sons.

Enticott, P. G, Johnston, P. J., Herring, S. E., Hoy, K. E., & Fitzgerald, P. B. (2008). Mirror neuron activation is associated with facial emotion processing. *Neuropsychologia*, *46*, 2851-2854.

Evers, C., Adriaanse, M., de Ridder, D. T. D., & de Witt Huberts, J. C. (2013). Good mood food. Positive emotion as a neglected trigger for food intake. *Appetite*, 68, 1-7.

Fadiga, L., Fogassi, L., Pavesi, G., & Rizzolatti, G. (1995). Motor facilitation during action observation: A magnetic stimulation study. *Journal of Neurophysiology*, *73*, 2608–2611.

Fontanini, A., Katz, D. B. (2009). Behavioral modulation of gustatory cortical activity. *Annals of the New York Academy of Sciences*, 1170, 403–406.

Gallese, V., Fadiga, L., Fogassi, L., & Rizzolatti, G. (1996). Action recognition in the premotor cortex. *Brain* 119: 593-609.

Gallese, V. (2001) La molteplicità condivisa. Ipotesi: dai neuroni specchio all'empatia. *Journal of Consciousness Studies,* 8, 33-50.

Gallese, V. (2003). The roots of empathy: The shared manifold hypothesis and the neural basis of intersubjectivity. *Psychopathology*, *36*, 171–180.

Gallese, V. (2006) Intentional attunement: A neuromphysiological perspective on social cognition. *Brain Research Cognitive Brain Res*earch, 1079, 15-24.

Gallese, V., & Sinigaglia, C. (2011). What is so special about embodied simulation? *Trends in Cognitive Sciences*, 15: 512-519

Garg, N., Wansink, B., & Inman, T. J. (2007). The influence of Incidental Affect on Consumers' Food Intake. *Journal of Marketing*, 71 (1), 194-206.

Gilli, G., Siegal, M., Marchetti, A., & Peterson, C.C. (2001). Children's incipient ability to distinguish mistakes from lies: An Italian investigation *International Journal of Behavioral Development, 25 (1)*, 88-92.

Gilli, G., Marchetti, A., & Rosini, S. (2001). *Storie illustrate di famiglia, Psicologia clinica dello Sviluppo, 1*, 133-140.

Haidt, J., McCauley, C., & Rozin, P. (1994). Individual Differences in Sensitivity to Disgust: A scale sampling seven domains of disgust elicitors. *Personality and Individual Differences*, 16, 701-713. DOI: 10.1016/0191-8869(94)90212-7

Iacoboni, M., Molnar-Szakacs, I., Gallese, V., Buccino, G., Mazziotta, J. C., & Rizzolatti, G. (2005). Grasping the intentions of others with one's ownmirror neuron system. *Plos Biology*, *3*, e79.

Jang, Y., King, J. M., & Prinyawiwatkul, W. (2014). A review of measurement and relationship between food, eating behavior and emotion. *Trends in food science & technology*, *36*, 15-28.

Lee, S.-M., Lee, K.-T., Lee, S.-H., (2013) Origin of human colour preference for food, *Journal of Food Engineering*, 119, 508-515.

Lenzi, D., Trentini, C., Pantano, P., Macaluso, E., Iacoboni, M., Lenzi, G. I., & Ammaniti, M. (2008). Neural basis of maternal communication and emotional expression processing during infant preverbal stage. *Cerebral Cortex May*, 19, 1124-1133, doi:10.1093/cercor/bhn153

Lyman, B., 1982. The nutritional values and food group characteristics of food preferred during various emotions. *Journal of Psychology*, 112, 121-127.

Macht, M. (1999). Characteristics of eating in anger, fear, sadness and joy. *Appetite*, 33, 129-139.

Macht, M., & Simons, G. (2000). Emotions and eating in everyday life. *Appetite*, 35, 65-71.

Macht, M. (2008). How emotions affect eating: a five-way model. *Appetite*, 50, 1e11.

Macht, M., & Simons, G. (2011). Emotional eating. In I. Nyklic. N, A. Vingerhoets, &M. Zeelenberg (Eds.), *Emotion regulation and well-being* (pp. 281–295). New York: Springer.

Marchetti, A. (1993). *Emotional experience, labeling and social sharing of emotions*. Paper presented at the Symposium on Labeling and social sharing of emotions. Xth General Meeting of the European Association of Experimental Social Psychology, Lisbon.

Mehrabian, A. (1980). Basic Dimensions for a General Psychological Theory. Oelschlager, Gunn & Hain, Cambridge.

Niedenthal, P. M. (2007). Embodying emotion. *Science*, 316, 1002–1005.

Niedenthal, P. M., Barsalou, L., Winkielman, P., Krauth-Gruber, S., & Ric, F. (2005). Embodiment in attitudes, social perception and emotion. *Personality and Social Psychology Review*, *9*, 184–211.

Perner, J., & Wimmer, H. (1985). "John thinks that Mary thinks that…" attribution of second-order beliefs by 5-to 10-year-old children. Journal of experimental child psychology, 39, 437-471.

Rizzolatti, G., Camarda, R., Fogassi, L., Gentilucci, M., Luppino, G., & Matelli, M. (1988). Functional organization of inferior area 6 in the macaque monkey. II. Area F5 and the control of distal movements. In *Experimental Brain Res*earch, 71, 491-507.

Rizzolatti, G., Fadiga, L., Fogassi, L., & Gallese, V. (1999). Resonance behaviors and mirror neurons. *Archives Italiennes de Biologie*, *137*, pp. 83-99.

Rizzolatti, G., & Craighero, L. (2004). The mirror neuron system. *Annual Reviews of Neuroscience*, *27*, pp. 169-192.

Rizzolatti, G., Fadiga, L., Gallese, V., & Fogassi, L. (1996). Premotor cortex and the recognition of motor actions. *Cognitive Brain Res*earch, 3, 131-141.

Rizzolatti, G., & Sinigaglia, C. (2006). So quel che fai, *Raffaello Cortina Editore*, Milano.

Sato, W., & Yoshikawa, S. (2006). Spontaneous facial mimicry in response to dynamic facial expressions. *Cognition, 104*, 1-18

Scherer, K. R., Wallbott, H. G., & Summerfield, A. B. (1986). Experiencing emotion: A crosscultural study. Cambridge: Cambridge University Press.

Smith, B. (2012). Perspective: complexities of flavour. *Nature*, 486(7403), S6.

Tiberi, E., & Pedrabissi, L. (1988). *Caratteristiche emozionali degli italiani. Ricerca empirica sulla frequenza delle emozioni di base nella popolazione italiana*. Milan: Giuffre`.

Van Strien, T., Rookus, M. A., Bergers, G. P., Frijters, J. E., & Defares, P. B., (1986). Life Events, emotional eating and change in body mass index. *International Journal of Obesity*, 10(1), 29-35

Van der Laan, L. N., de Ridder, D. T. D., Viergever, M. A., & Smeets, P. A. M. (2011). The first taste is always with the eyes: A meta-analysis on the neural correlates of processing visual food cues. *NeuroImage*, 55(1), 296–303.

Wansink, B. (2004). Environmental Factors that Increase the Food Intake and Consumption Volume of Unknowing Consumers. *Annual Review of Nutrition*, 24, 455–479.

Wicker, B., Keysers, C., Plailly, J., Royet, J. P., Gallese, V., & Rizzolatti, G. (2003). Both of us disgusted in my Insula: the common neural basis of seeing and feeling disgust. *Neuron*, 40, 655–664, October 30.

Willson, M. F., Whelan, C. J. (1990). The evolution of fruit color in fleshy-fruited plants. *The American Naturalist,* 136 (6), 790–809.

Chapter 3: emotions or motor stimuli associated with food images? How they influence the choice of food compared to the mere image of food.

3. Emotions or motor stimuli associated with food images? How they influence the choice of food compared to the mere image of food.

3.1 Abstract

Following the well-known studies of mirror neurons in monkeys, and consistent with the fields of research that this thesis project wanted to develop, a further field of investigation that we wanted to consider was the comparison between emotional stimuli and motor stimuli.

Given that studies on mirror neurons have found that brain activation involves the motor area and therefore, assuming that for humans the functioning is the same, the subjects become active when they see other people perform actions that they know; we wanted to investigate whether this motor activation might be more or less important than the activation exerted by the sight of an emotion expressed by another person's facial reaction to the same food stimulus.

The intention of this investigation is to evaluate the perceived difference between different stimuli referred to the same food (in this case a box of Pizza Margherita), and in particular to understand, at the level of the consumers' choices, whether these stimuli might to some extent influence the propensity to purchase.

It not being our intention to carry out a pure neuroscience experiment using machines for functional magnetic resonance imaging (fMRI), we chose to organize a simple but direct behavioral experiment that would provide a useful guideline for subsequent, more detailed experiments.

We prepared three kinds of packages of Pizza Margherita (a regular one, one with the presence of an emotional stimulus, and one with a motor stimulus) and we asked the subjects which was their potential choice of purchase.

3.2 Introduction

Recent studies of the activation of mirror neurons in the F5 brain area in monkeys suggest that the discharge of F5 mirror neurons is influenced by the information on the value that the object targeted by the motor act has for the observer.

This information may help the observer to interpret the action meaning (Caggiano et al, 2012). The possibility of a mirror system in humans (Fadiga et al, 1995; Grafton et al, 1996; Rizzolatti et al, 1996), leads us to use behavioral experiments to investigate whether scientific measurements using advanced tools are consistent with a basic behavioral response.

People map an observed action onto their own motor representation of that action, enabling them to immediately understand what another individual is doing (Rizzolatti et al, 2001).

There is evidence, both at the neuronal and behavioral level, that motor processes involve motor representations of the outcomes to which actions are directed (Jeannerod, 2006; Rizzolatti et al, 2008).

Functional properties of the mirror mechanism clearly indicate that observing someone else performing a given action recruits the very motor representations, which are involved in the execution of that action and ground its outcome-directedness.

The mirror mechanism transforms the sensory representation of an action into the motor representation of that action, and also this sensory-motor transformation selectively occurs at the level of the outcome-directedness shared by the actively executed and the observed action. (Sinigaglia, 2013).

The neural correlates of the vitality of human actions have been recently discovered (Di Cesare et al, 2015). "Vitality" is a term that describes the style with which motor actions are performed (e.g. rude, gentle, etc.).

They represent one characterizing element of conscious and unconscious bodily communication.

They found that there is a common-specific activation of the dorsocentral sector of the insula in addition to the parietofrontal network that is typically active during arm movements production and observation.

Thus, the dorsocentral part of the insula seems to represent a fundamental and previously unsuspected node that modulates the cortical motor circuits, allowing individuals to express their vitality forms and understand those of others.

Behavioral mimicry refers to a process in which a person unwittingly imitates the behavior of another person.

Research has shown that individuals automatically mimic many aspects of the people with whom they interact, including their postures, gestures, mannerisms, and speech accents (Lakin et al, 2003).

As far as the relationship with food is concerned, previous studies suggest that a person's motivation to eat and the quantity, frequency, and choice of food intake are affected by variables not necessarily directly related to his or her physiological needs or the nutritive value of the food (Booth, 1994).

We wanted to investigate what these variables were, and in particular the possible influence of the sight of other people's emotions, and the sight of gestures (mimicry) linked to the food experience.

This mimicry is assumed to occur because of the tight neural link between perception and action (Dijksterhuis and Bargh, 2001; Iacoboni et al, 1999).

That is, perceiving another person's movements activates one's own motor system for that same movement (Knoblich & Sebanz, 2001), which in turn increases the likelihood and ease of initiating a matched action (Brass & Prinz, 2001).

In the domain of eating, seeing another person taking a bite might trigger a similar response in the perceiver, i.e. taking a bite as well.

In the light of this discovery, we thought that the mere sight of "eating" actions was more attractive than the sight of emotions to consumers about to select food.

Stel and Vonk (2010) showed that people who were instructed to mimic an interaction partner reported more positive feelings for this partner and towards the quality of the interaction.

Both mimicking and being mimicked induces preference for a target.

The chameleon effect refers to nonconscious mimicry of the postures, mannerisms, facial expressions, and other behaviors of one's interaction partners, such that one's behavior passively and unintentionally changes to match that of others in one's current social environment (Chartrand & Bargh, 1999).

Individuals high in cognitive empathy exhibit more behavioral mimicry (Chartrand & Bargh, 1999) whereas individuals high in affective empathy exhibit more facial mimicry (Sonnby-Borgstrom, 2002).

The mere perception of another's behavior automatically increases the likelihood of engaging in that behavior oneself (Bargh, Chen & Burrows, 2996).

During many situations, consumers might not speak with each other, but they may nevertheless sense the reactions of their companions, as body postures, facial expressions, and gestures may communicate feelings such as interest, boredom, sadness, or amusement.

As a consequence of this nonverbal communication, consumers may come to feel in sync with their companions in the shared experience or vastly out of step.

Further, this awareness of others' feelings may come to color consumers' reactions as the experience unfolds, heightening or dampening their enjoyment.

Thus, going through an experience with someone else may feel different from consuming alone (Ramanathan and McGill, 2007).

During our experimentation we were intrigued by the aspect linked to the chameleon effect, because we assumed that the sight of a gesture such as bringing pizza to the mouth (during the act of eating) might generate an activation of the motor areas and therefore be more conditioning compared to an emotion (happiness) that is not necessarily related to food.

In the previous experiment, we saw how happiness is an emotion that, compared to a neutral face or an angry face, can have a positive influence on the desirability of the food.

This does not mean that actions relating to food, but emotionless, cannot exert a conditioning effect on the approach to food.

Among the studies on mimicry and behavioral imitation there is one in which the women subjected to experiment were more likely to take a bite of their meal in congruence with their eating companion rather than eating at their own pace (Hermans et al, 2012).

Added to this, sharing the experience with another person may cause the consumer's moment-to-moment evaluation to become more like that of the other person, through processes of emotional contagion.

A number of researchers have studied how the attractiveness of sales operators might influence clients' satisfaction with products.

They found that when the salesperson was less attractive and engaged in the opposite gestures as the customer, it corresponded with substantially lower customer service ratings and a tendency to not wish to return to the store (Kulesza et al, 2014).

It is generally acknowledged that human eating behavior, which is influenced by cues from foods, the body, and the social and physical environment, is affected by and associated with emotions (Desmet & Schifferstein, 2008).

Social psychology has begun to examine how people may influence each others' feelings in their joint interactions (Gump and Kulik 1997; Hatfield, Cacioppo, and Rapson 1994; Howard and Gengler 2001).

A common finding in this research is that people's expressions of emotions may rub off on each other so that people acting together come to catch each others' moods, eventually even moving up and down together in a shared emotional rhythm (McGrath and Kelly 1986; Neumann and Strack, 2000; Totterdell et al. 1998).

This emotional contagion and entrainment of mood has been traced to mimicry of behavior, which can cause people to adopt the emotion associated with facial expressions and mannerisms that they have mimicked (Hatfield, Cacioppo, and Rapson, 1992).

For example, people smile in response to smiles, which in turn may lead to shared feelings of happiness (as just seen in Ramanathan & McGill, 2007).

And what if this meant that simply seeing a person eating (without emotions) can induce the same gesture or exert a certain attraction to the food?

The result is a state of rapport, which is characterized by agreement and mutual interest that arises through convergence or synchrony of nonverbal expressive behavior (Bernieri, Reznick, and Rosenthal 1988; Drolet and Morris 2000; Tickle-Degnen and Rosenthal 1990).

It is generally suggested that advertisers attempt to generate positive emotional reactions in the audience because this can improve mood, enhance recall, and yield more positive product evaluations (Bagozzi et al., 1999, Mai and Schoeller, 2009 and Poels and Dewitte, 2006).

Emotions have a biological role in food motivation through complex processes that take place in the brain (Kringelbach, 2004).

Certain emotional states can suppress food consumption (e.g. fear) while others are associated with higher levels of consumption of varying types (e.g. anger is related to impulsive eating and joy with hedonic eating) (Canetti et al., 2002 and Macht, 1999, see chapter 2).

We previously saw that emotional eating constitutes a means by which individuals attempt to regulate their mood, such as by distracting themselves from problems (Macht, 2008, see chapter 2).

People both mimic and are mimicked in nearly every social interaction, though neither the mimicker nor the mimicked are generally aware of its occurrence.

Tanner and Chartrand (2005) reported a study in which participants mimicked by a confederate during the presentation of a product consumed more of the product and had higher stated intentions of buying it than those who were not mimicked.

This "chameleon effect" may lead to emotional contagion in which moods transfer between people (Hatfield et al. 1994; Neumann and Strack 2000).

Behaviors such as facial expressions may reflect underlying feelings, but processes of afferent feedback may also cause people who are mimicking behaviors to adopt the corresponding underlying affective state.

That is, moods may cause expressions, but expressions may also cause moods.

Friedman and Riggio (1981) found, for example, that sitting facing another person for a few minutes may cause the mood of the less expressive person to become more like the mood of the more expressive person.

Observing another person's expressions may also lead to contagion of emotion through conscious processes.

Observation of another person's pleasure or displeasure with an experience may provide information about the nature and quality of an experience, causing people to adjust their own expressions and feelings.

We thought that this kind of effect might be induced by the sight of a person smiling, in this case in a context directly attributable to food, such as a waiter in a restaurant.

People mimic what they observe in others, including facial expressions, emotions, behavioral movements, and verbal patterns (Duffy and Chartrand, 2015).

Mimicry also facilitates empathy, with research showing that mimicry decreases racial bias (Inzlicht et al, 2012), reduces victim blaming (Stel et al, 2012), increases affective responses to seeing someone in pain (De Coster et al, 2013), and strengthens men's belief in a just world (Stel et al, 2013).

Furthermore, mimicry also increases trust in both children (Over et al, 2013) and adults (Gueguen et al, 2012; Verberne et al, 2013).

All these effects exerted by emotions may be valid reasons to believe that the “emotional” base of a face might be more powerful than a simple motor act, but during our experiments (Chapter 2) we saw that emotions associated with food did not "boost" the consumption of food, but, on the contrary, limited its attractiveness (apart from the sight of the happy face). We thought it was reasonable, after the first experiment, to look for confirmation that emotions effectively exert a contaminating effect on the objective assessment of the food, and then assume that the consumption of food in an environment free from external elements of distraction might be preferable.

3.3 Material and methods

3.3.1 Partecipants

172 volunteers, aged between 20 and 63 years, 74 male and 98 female, participated to this study. This study was approved by the University of Udine Ethics Committee.

3.3.2 Stimuli

We used three different packages of Pizza Margherita, an existing one provided by Roncadin SpA (Meduno, Pordenone) and two more that we created by changing its base image.

Figure 1. «Control». Normal Pizza Margherita package used actually for market.

The standard pizza is that in Fig. 1, which was our control image. From this, using Photoshop, we created two other versions, which we called "emo" and "motor".

The emotional image of Fig. 2 was created by adding the image of a smiling waiter to the box.

Figure 2. «Emo». Package with emotional stimuli.

We chose the waiter because it represents a subject directly linked with the food experience, in particular the consumption of pizza.

The image of the waiter, which was specially created by a professional graphic designer (Federico Cecchin) according to our instructions, was meant to clearly represent the traits of happiness.

To build the image, in particular the details of his facial expression, we used Duchenne and Ekman's categorizations and studies (Duchenne, 1862; Ekman et al, 1982, 1990, 2003) so that it could not be mistaken for any emotion except happiness. Recent research indicates that facial mimicry helps people distinguish between true and false smiles (Krumhuber et al, 2014).

We chose happiness because it was consistent with our first experiment, in which we found that happiness is the emotion that, compared to the others (neutral and angry) maintained food desirability unaltered compared to control trials which lacked emotional images.

As seen in previous research (Kulesza et al, 2014), the effect of the imitation of gestures of others is important in selling products, but attractiveness, too, has a strong influence.

This is why we chose an emotional drawing and not an actual photograph, to avoid, as far as possible, the "sexual attraction" effect, which would have caused misunderstandings in the results.

The experiments in emotional contagion carried out by Ramanathan and McGill (2007) led us to choose the creation of the emotional image of a smiling waiter, in order to generate the same emotional baseline in the observer and to see whether this can cause him/her to change his/her choice of product.

As for the third type of image, the "motor" (Fig. 3), we created an image that was totally evocative of an act related to food, in particular to the specific act of eating.

Figure 3. «Motor». Package with subject eating pizza.

The image had to be "clean", totally free of any emotional connotation.

We chose an image (Fotolia.com), cut it out and adapted it to the package used for the experiment.

It presented neither any character attributable to the sex of the subject (no eyes nor hair were depicted) nor any form of attractiveness.

Our intent was to create an unequivocal motor image, relying on the fact that previous studies on the activation of mirror neurons are concentrated in the motor areas of the brain.

3.3.3 Apparatus and procedures

We created a software, called "Project Udine Parma", using php programming language which stores the information it receives from the interaction among users on a "mysql" database.

The system runs on a server with "Ubuntu" OS, whereas web pages are realized in html language.

We created a web page in which the three different packages were (randomly) displayed and presented with the question "which one would you buy?" in order to understand the choice expressed by the interviewees.

We collected data on preferences and response times.

3.4 Results and discussion

We thought that, by inducing an imitation effect in individuals, we might observe some preference for the package depicting the same movements that he would make when eating. Our intention was to test whether the mechanism of imitation was somehow responsible for an increase of choice in the purchase of food.

The hypothesis was that the action observed (the act of eating, the "motor" hypothesis) would attract the subject more than seeing an emotion, and that this would lead to an increase in the attractiveness of the food depicted.

The results we obtained were in line with our expectations, and are presented in Fig. 4.

The emotional image was chosen by only 5.23% of the subjects, equally distributed between males and females.

Package type	N.	[%]	T (s)	Age (medium)	Women	Men
Emo	9	5,23	12,30	30,56	5	4
Motor	36	20,93	15,59	33,11	19	17
Standard	127	73,84	16,12	30,71	74	53
Tot	172	100,00	14,67		98	74
				Percentuale:	56,98	43,02

Figure 4: results.

The aspect that really requires examination – which attracted our attention and leads to a number of reflections – is that the package most frequently chosen was the one lacking in any emotional or motor stimuli.

At this point, a twofold discussion is necessary: the preferences expressed by the subjects and the relationship between emotional and motor images.

As for the former, it is evident that the vast majority of subjects (Fig. 5) chose the pizza without stimuli.

A counter-deductive approach is needed to assess these results.

They are in line with the previous experiment, in which emotions are a sort of "contamination" (when related to food) towards which people are not greatly attracted.

In Chapter 2 we saw how the image of happiness did not produce a greater effect on the desirability of the food than the image of food without other stimuli (baseline), while all the other emotions caused a collapse of desirability.

The data collected in this second experiment lead us to think that most people actually prefer the food presented alone, without any "distracting" element. Indeed, the presence of a "social" context is a “contaminant” that people do not like.

It would be interesting to use this data as a basis for further experiments concerning the effect of emotions on the choice and consumption of food.

If further studies confirm this trend, one might conclude that for proper food intake the environment must be as "free" as possible of emotions or elements that might create them. This might confirm that the objectivity of sensory analysis of food by humans can be obtained only in contexts which are free of social or emotional stimuli of any kind.

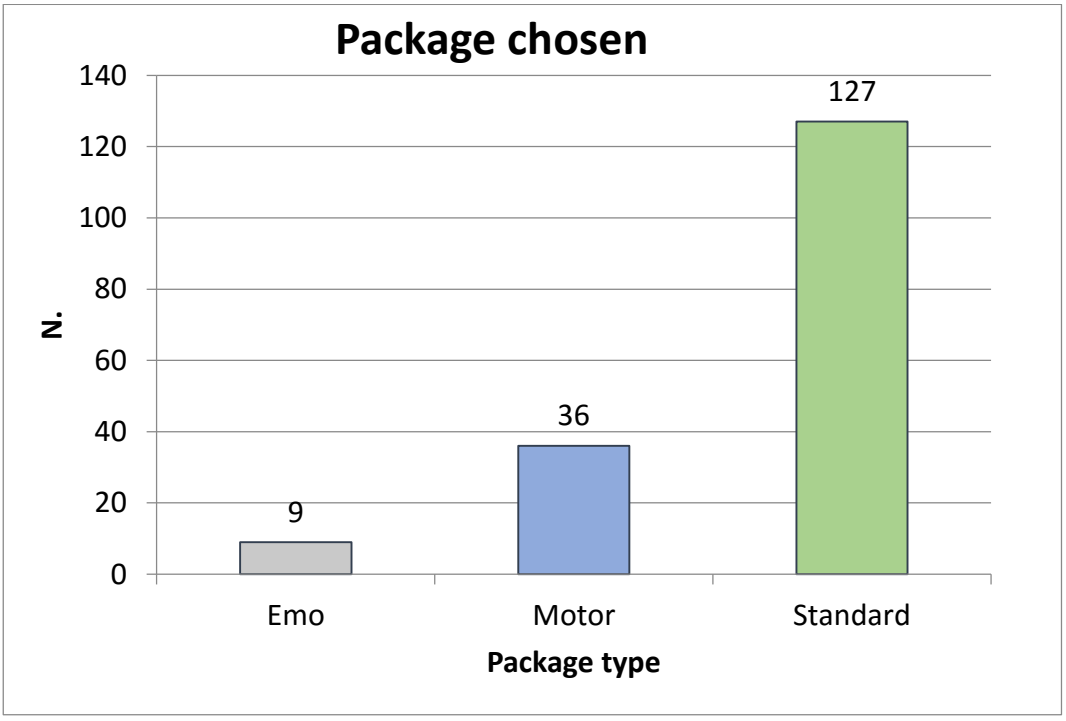

Figure 5: types of package chosen.

The latter consideration concerns the relationship between emotional stimulus and motor stimulus.

The percentage of subjects who chose the "emotional" package (5.23%, Fig. 6) was lower than that of the "motor" package (20.93%).

This leads us to think in the same direction: emotions entail a "burden" that involves a decrease in the appeal of the food, even in a social context in which people eat without sharing emotions.

The discussion of these results might suggest that, in a social context of food consumption, it is preferable that the subjects limit themselves to the consumption of food rather than the exchange of "emotions", because this might affect the desirability (and choice) of foods.

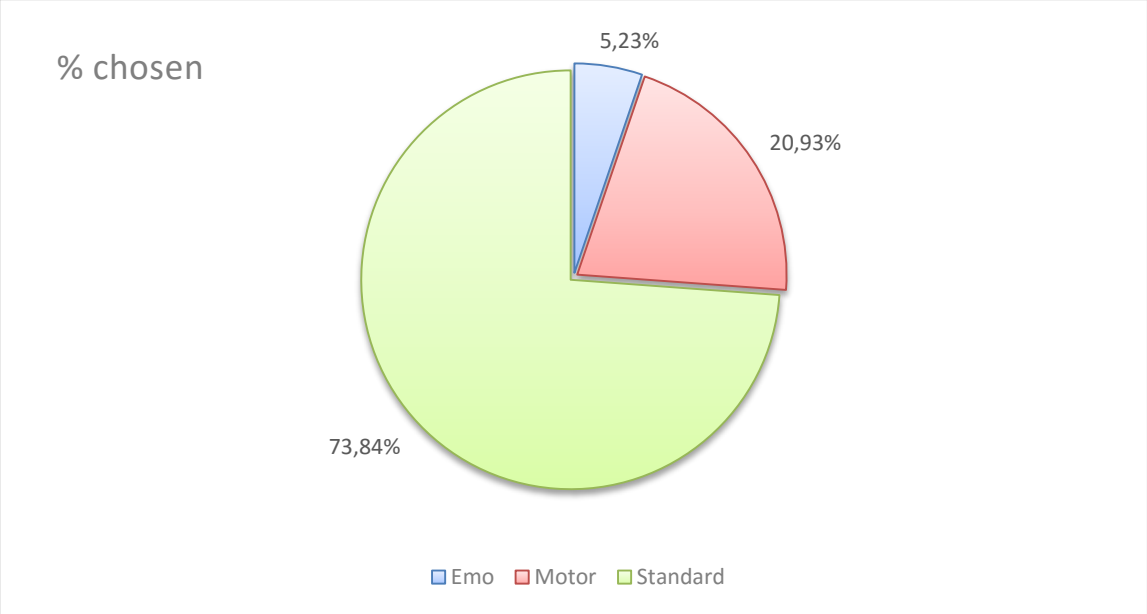

Figure 6: percentage of package chosen.

As for gender differences, there were no significant differences between the choice made by men or women (Fig. 7).

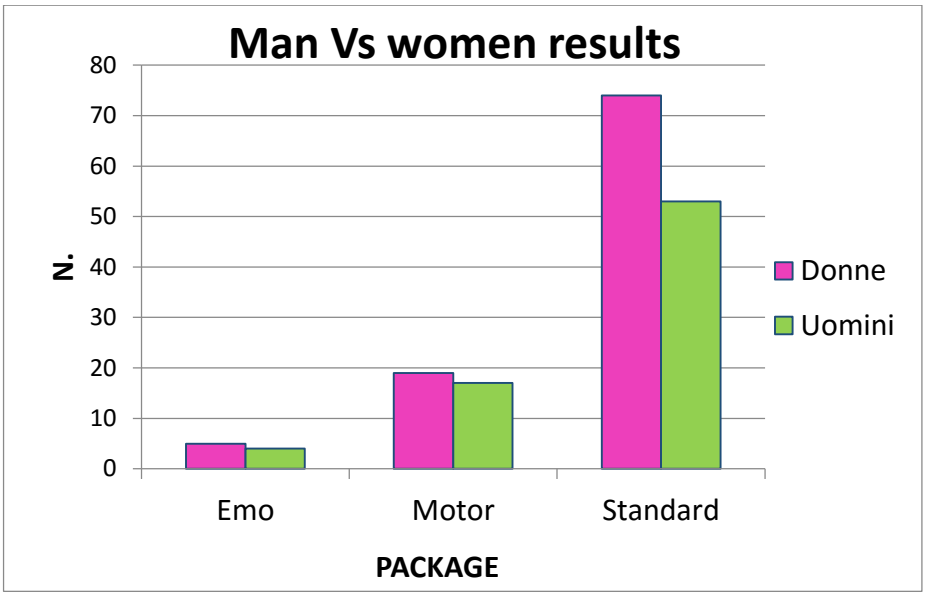

Figure 7: results, man and women.

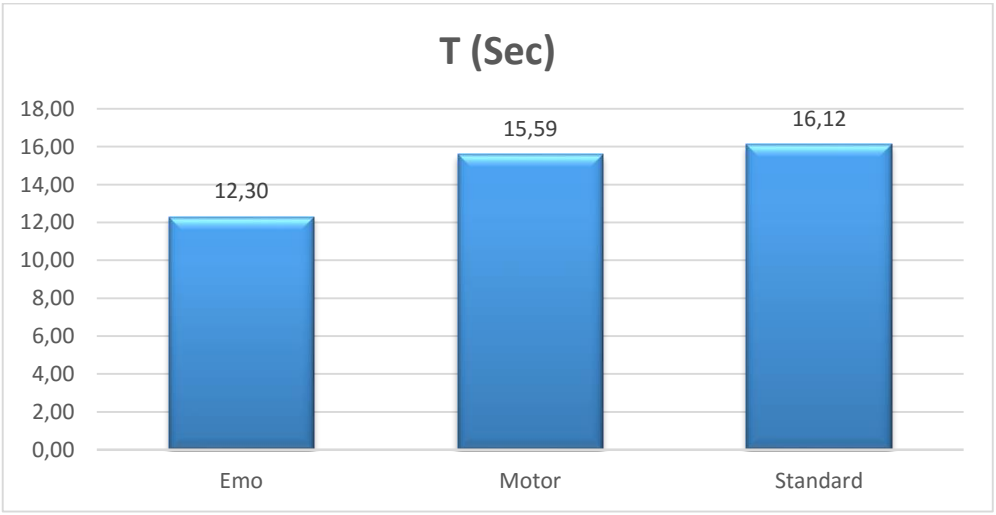

Figure 8: time of response.

Interestingly, the higher response times (as see in Fig. 8) referred to the standard image, while less time was spent in the choice of the emotional image.

The data relative to the response times may lead us to assume that the more rapid choice of the "emotional" package was made as an emotional rather than a food choice.

Thus we can state – following the counter-deductive reasoning of our discussion – that it was almost a choice of "distance" from the food, compared to choices specifically related to the food, such as the motor package and the one devoid of stimuli.
But this is merely a deduction that requires confirmation by means of further and more extensive experiments.

3.5 Conclusions

The intention of our second experiment was to confirm what was already known to researchers, and specifically that emotions exert an effect on the relationship with food.

This effect also conditioned our two experimental research projects.

What emerged from this experiment is that facial expressions, in particular motor actions, generate some form of appeal on the viewer which is greater than that generated by the sight of emotions.

The food is chosen more easily if there are no other external stimuli, emotional or motor.

This is probably congruent with the fact that the vast majority of food products on the market can be found in packages free of images other than photographs or representations of the food product itself.

There are interesting prospects for research.

One direction would be to use the instrument of the eye tracking, to see whether the human eyes dwell longer on the emotional or motor images or seek the underlying image of the food.

This would confirm the tendency to prefer pictures of food with no other stimuli.

The preference for the motor image compared to the emotional one allows for considerations in marketing, where the responses on other products can be explored: for example soft drinks depicted while being drunk, rather than the static image of the drink itself.

Interesting developments can be investigated with regard to the consumption of food in the sport: an increasing number of people participate in physical exercise and then the demand of sports food is also growing (see Fangrong, 2015) , and future researchers could focus on this field too.

In any case, further investigation at the neurological level is necessary to understand whether or not these first insights can be confirmed.

Further research should be conducted using Functional Magnetic Resonance Imaging (fMRI) to understand the neural correlates of the different images and the possible involvement of the brain insula.

3.6 Limitations

In this research we limited ourselves to considering only one type of food, the pizza, and only one type of emotion (happiness).

Interesting developments can arise in further research based on tests in different foods and emotions.

This test doesn't consider the food intake of subjects: it would be interesting to investigate the amount of food consumed in environments where you look at other people eat compared to environments where there are smiling people but not intent on eating.

3.7 References

Bagozzi, R. P., Gopinath, M., & Nyer, P.U. (1999). The role of emotions in marketing. *Journal of the Academy of Marketing Science*, 27 (2), pp. 184–206.

Bargh, J.A., Chen, M., & Burrows, L. (1996). Automaticity of social be- havior: Direct effects of trait construct and stereotype priming on ac- tion. *Journal of Personality and Social Psychology*, 71, 230-244.

Bernieri, F. J., Reznick S.J., & Rosenthal R. (1988). Synchrony, Pseudosynchrony, and Dissynchrony: Measuring the Entrainment Process in Mother-Child Interactions. *Journal of Personality and Social Psychology*, 54 (February), 243–53.

Booth, D. A. (1994). Psychology of nutrition. London: Taylor & Francis.

Brass, M., Bekkering, H., & Prinz, W. (2001). Movement observation affects movement execution in a simple response task. *Acta Psychologica* 106: 3–22.

Brooks B. G. & Kulik, J. A. (1997). Stress, Affiliation, and Emotional Contagion. *Journal of Personality and Social Psychology*, 72 (2), 305–19.

Caggiano, V., Fogassi, L., Rizzolatti, G., Casile, A., Giese, M., e Thier, P. (2012). Mirror neurons encode the subjective value of an observed action, *PNAS*, vol 109, 11848–11853, doi: 10.1073/pnas.1205553109.

Chartrand, T. L., Bargh, J. A. (1999). The chameleon effect: the perception-behavior link and social interaction. *Journal of Personality and Social Psychology*, Vol 76(6), 893-910.

De Coster, L., Verschuere, B., & Goubert L. (2013). I suffer more from your pain when you act like me: being imitated enhances affective responses to seeing someone else in pain. Cognitive, Affective and Behavioral Neuroscience, 13, pp. 519–532.

Desmet, P. M. A., & Schifferstein, H. N. J. (2008). Sources of positive and negative emotions in food experience. *Appetite*, 50. Pages 290-301.

Di Cesare, G., Di Dio, C., Marchi, M., Rizzolatti, G. (2015). Expressing our internal states and understanding those of others. *PNAS*, doi:10.1073/pnas.1512133112.

Dijksterhuis, A., & Bargh, J. A. (2001). The perception-behavior expressway: Automatic effects of social perception and social behavior. In Zanna M. ed. *Advances in experimental social psychology*. New York: Academic Press. Pp 1–40.

Drolet, A. L. & Morris M. W. (2000). Rapport in Conflict Resolution: Accounting for How Face-to-Face Contact Fosters Mutual Cooperation in Mixed-Motive Conflicts. *Journal of Experimental Social Psychology*, 36 (1), 26–50.

Duchenne, G. B. (1862). The mechanism of human facial expression. R.A. Cuthbertson (Ed.) Cambridge University Press, New York

Duffy, K., Chartrand, T. (2015). Mimicry: causes and consequences. Current opinion in behavioral sciences. Volume 3, June 2015, Pages 112–116

Ekman, P., Davidson R. J., Friesen W. V. (1990). The Duchenne smile: emotional expression and brain physiology: II. *Journal of Personal Social Psychology*, 58 (1990), pp. 342–353

Ekman, P., Friesen W. V. (1982). Felt, flase and miserable smiles. *Journal Nonverbal Behavior*, 6 (1982), pp. 238–252.

Ekman, P. (2003). Darwin, deception, and facial expression. *Ann. N Y Acad. Sci*, 1000 (2003), pp. 205–221

Fadiga, L., Fogassi, L., Pavesi, G., Rizzolatti, G. (1995). Motor facilitation during action observation: a magnetic stimulation study, *Journal of Neurophysiology*, 73, 2608–2611.

Fangrong, Wu (2015). Analysis on the Impact Factors of Consumers' Purchase Intention of Sports Food. *Advance Journal of Food Science and Technology*, Vol. 8(9), pp.642-645.

Friedman, H. S. & Riggio R. E. (1981). Effect of Individual Differences in Non-verbal Expressiveness on Transmission of Emotion. *Journal of Nonverbal Behavior*, 6 (2), 96–104.

Grafton, S.T., Arbib, M. A., Fadiga, L., Rizzolatti, G. (1996). Localization of grasp representations in humans by PET. 2. Observation compared with imagination, *Experimental Brain Research* 112. 103–111.

Gueguen, N., Martin, A., Meineri, S., & Simon, J. (2012). Using mimicry to elicit answers to intimate questions in survey research. *Field methods*, 25, pp. 47–57.

Hatfield, E., Cacioppo, J. T., & Rapson, R. L. (1992). Primitive Emotional Contagion. *Emotion and Social Behavior*, ed. Margaret S. Clark, Thousand Oaks, CA: Sage, 151–77.

Hatfield, E., Cacioppo J. T., & Rapson, R. L. (1994), Emotional Contagion. New York: *Cambridge University Press*.

Hermans R. C. J., Lichtwarck-Aschoff, A., Bevelander, K. E., Herman, C. P., Larsen, J. K., & Engels, R. C. M. E. (2012). Mimicry of Food Intake: The Dynamic Interplay between Eating Companions. *PLoS ONE* 7(2): e31027. doi:10.1371/journal.pone.0031027

Howard, D. J., & Gengler, C. E. (2001). Emotional Contagion Effects on Product Attitudes. *Journal of Consumer Research*, 28 (September), pp.189–201.

Iacoboni, M., Woods, R. P., Brass, M., Bekkering, H., & Mazziotta, J. C. (1999). Cortical mechanisms of human imitation. *Science* 286: 2526–2528.

Inzlicht, M., Gutsell, J.N., & Legault, L. (2012). Mimicry reduces racial prejudice. Journal of Experimental Social Psychology, 48 (2012), pp. 361–365.

Jeannerod, M. (2006). Motor cognition, in: What Actions Tell to the Self, *Oxford University Press.*

Knoblich, G., & Sebanz, N. (2006). The social nature of perception and action. *Current Directions in Psychological Science,* 15: 99–104.

Krumhuber, E. G., Likowski, K. U., & Weyers, P. (2014). Facial mimicry of spontaneous and deliberate Duchenne and Non Duchenne Smiles. *Journal of Nonverbal Behavior*. Vol. 38, Issue 1, pages 1.11.

Kringelbach, M. L. (2004). Food for thought: Hedonic experience beyond homeostasis in the human brain. *Neuroscience*, 126, pp. 807–819

Kulesza, W., Szypowska, Z., Jarman, M. S., Dolinski, D. (2014). *Attractive Chameleons Sell: The Mimicry-Attractiveness Link.* Psychology & Marketing, Vol.31(7), pp.549-561.

Lakin, J. L., Jefferis, V. E., Cheng, C. M., & Chartrand, T. L. (2003). The Chameleon effect as social glue: evidence for the evolutionary significance of nonconscious mimicry. *Journal of Nonverbal Behaviour*, 27: 145–162.

Mai L.-W., & Schoeller, G. (2009). Emotions, attitudes and memorability associated with TV commercials. *Journal of Targeting, Measurement and Analysis for Marketing*, 17 (1), pp. 55–63.

McGrath, J. E. & Kelly, J. R. (1986). Time and Human Interaction: Toward a Social Psychology of Time, *New York: Guilford*.

Neumann, Roland and Fritz Strack (2000). Mood Contagion: The Automatic Transfer of Mood between Persons. *Journal of Personality and Social Psychology*, 79 (2), 211–23.

Over, H., Carpenter, M., Spears, R., & Gattis, M. (2013). Children selectively trust individuals who have imitated them. *Social Development*, 22, pp. 215–224.

Poels, K., & Dewitte, S. (2006). How to capture the heart? Reviewing 20 years of emotion measurement in advertising. *Journal of Advertising Research*, doi:10.2501/S0021849906060041.

Ramanathan, S., McGill, A. L. (2007). Consuming with Others: Social Influences on Moment-to-Moment and Retrospective Evaluations of an Experience. Journal of Consumer Research. DOI: http://dx.doi.org/10.1086/520074 506-524.

Rizzolatti, G., Fadiga, L., Matelli, M., Bettinardi, V., Paulesu, E., Perani, D., Fazio, F. (1996). Localization of grasp representation in humans by PET: observation versus execution, *Experimental Brain Research* 11 246–252.

Rizzolatti, G., Fogassi, L., Gallese, V. (2001). Neurophysiological mechanisms underlying the understanding and imitation of action, *Nature Reviews. Neuroscience* 2, 661–670.

Rizzolatti, G., Sinigaglia, C. (2008). Mirrors in the brain, in: How Our Minds ShareActions Emotions and Experience, *Oxford University Press.*

Sinigaglia, C. (2013). What type of action understanding is subserved by mirror neurons? *Neuroscience Letters*, Volume 540, Pages 59–61.

Sonnby-Borgström, M. (2002). Automatic mimicry reactions as related to differences in emotional empathy. *Scandinavian Journal of Psychology*, 43, pp. 433–443.

Stel, M., Vonk, R. (2010). Mimicry in social interaction: benefits for mimickers, mimickees, and their interaction. *British Journal of Psychology*, 101 (Pt 2) (2010), pp. 311–323.

Stel, M., van den Bos, K., & Bal, M. (2012). On mimicry and the psychology of the belief in a just world: imitating the behaviors of others reduces the blaming of innocent victims. *Social Justice Research*, 25, pp. 14–24.

Stel, M., van den Bos, K., Sim, S., & Rispens, S. (2013). Mimicry and just world beliefs: mimicking makes men view the world as more personally just. *British Journal of Social Psychology*, 52, pp. 397–411.

Tanner, R., & Chartrand T. L. (2005). The Convincing Chameleon: Impact of Mimicry on Persuasion. *Working paper, Fuqua School of Business*, Duke University.

Tickle-Degnen, L. & Rosenthal R. (1990). The Nature of Rapport and Its Nonverbal Correlates. *Psychological Inquiry*, 1 (4), 285–93.

Totterdell, P., Kellett, S., Teuchmann, K., and Briner, R. B. (1998). Evidence of Mood Linkage in Work Groups. *Journal of Personality and Social Psychology*, 74 (6), 1504–15.

Verberne, F.M.F., Ham, J., Ponnada, A., & Midden, C.J.H. (2013). Trusting Digital Chameleons: The Effect of Mimicry by a Virtual Social Agent on User Trust. *PERSUASIVE 2013*, Sydney, NSW, Australia. Conference paper, Volume 7822 LNCS, Pages 234-245

Chapter 4: Exchange experience in Biotechnical Faculty University of Ljubljana , Slovenia

4. Exchange experience at University of Ljubljana, Slovenia, Biotechnical Faculty

4.1 Introduction

The aim of the visit to the Department of Food Science at the University of Ljubljana was to obtain information about the relationship between emotions and food, trying to determine whether studies or research projects dedicated to the investigation of these multidisciplinary issues had been carried out.

In addition, the visit was meant as an exchange of information with Slovenian colleagues to inform them about our recent experiments and see whether there might be room for cooperation in future experiments and research.

Our intention was to determine whether it was possible to establish a permanent cooperation with the Slovenian department with which to leverage each other's experience and begin a thorough research into the effects of human behavior in relation to the approach to food.

In particular, during meetings organized by Prof. Marjan Simcic and held at the Department of Udine, we discussed whether or not to adopt a multidisciplinary approach involving behavioral psychology, aiming at investigating possible links between the mere sight of violent behavior and our physical reactions during digestion.

One example would be the opportunity of investigating what happens to the digestive process (starting from food intake) during media exposure to news of a violent nature or images depicting violence against human beings.

We believe that these are extremely significant research fields, and it is necessary to support the creation of international teams involving various scientific areas in order to carry out research in these directions.

Another field of investigation discussed with Prof. Simcic in the preliminary meetings was to verify whether it might be possible to carry out experiments designed to identify the existence, in the muscles and the brain, of a system of involuntary recognition of adulterated foods.

Assuming that the agricultural and food industry are increasingly oriented towards the creation of safe food, for which they use substances with a certain level of toxicity, our intent was to discuss and understand whether man might somehow manage to detect, at an unconscious level (e.g. epidermal), the presence or absence of high levels of substances used to ensure food safety but which might be harmful to health.

4.2 Experience in Ljubljana

4.2.1 Food Safety and food Quality

While visiting the Department of Food Science and Technology of the University of Ljubljana, I attended the National Seminar on Food Safety together with Prof. Marjan Simcic, Professor of Nutrition (7 April 2015, photo 1).

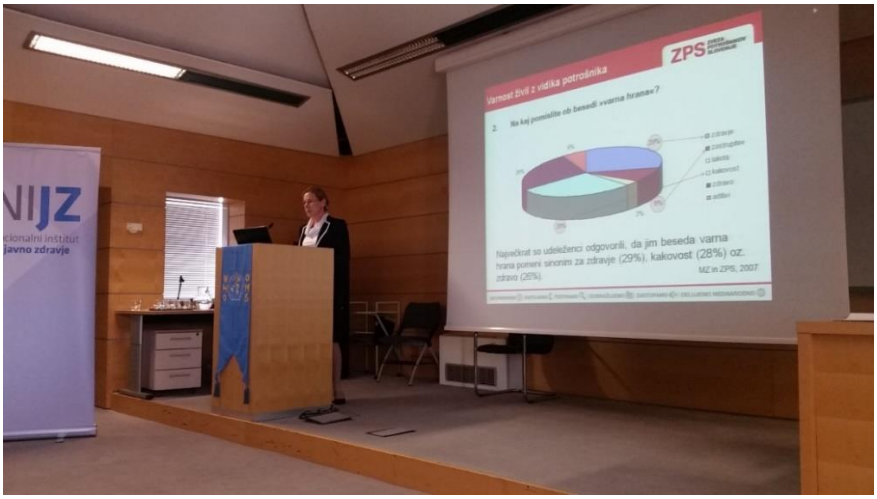

Fig. 1: Seminar on “Food Safety and Quality from customer’s point of view”, April 7, 2015, Ljubljana, address by Dr. Zontar.

Of particular interest was the address by Dr. Tanja Pajk Zontar concerning issues relating to chemicals used in agriculture which might be harmful to humans if present in high quantities.

In further meetings with Dr. Tanja Pajk Zontar, we discussed the perception of food quality according to European directives and the need to shift the focus from food safety to food quality.

The aim is to improve the quality of consumers' lives, since higher-quality food ensures better nutritional properties compared to food for which only the achievement of the strictest safety criteria were considered.

We also discussed the issue of the consumer's perception of the use of technology to improve the characteristics of food, with reference to their publications on this topic (Boel Nielsen et al, 2009).

We discussed the possibility of carrying out experiments to evaluate the ability of humans to unconsciously detect the danger of technological agents added to food to improve its safety, but we found many obstacles in the organization of potential experiments, due to the difficulty of exposing individuals to harmful substances without generating objective repercussions on their health and the need to comply with the code of ethics for scientific experiments.

After much debate, Professor Marjan Simcic suggested a possible solution: to perform this experiment in collaboration with the University of Slovenia, ensuring that all the rules of ethical human experimentation can be followed; today we are planning its future feasibility.

We believe that investigating the ability of humans to self-regulate on food, by exploiting their innate ability of sensory detection, is an area of research that is required in the field of food science and nutrition.

4.2.2 From the Selfish Gene to Emotions

Together with Prof. Simcic, we discussed about the possible interactions between food, emotions and human behavior.

Dawkins' theory argues that, in order to survive, humans develop a kind of "genetics for survival".

Up until the 1960s, over-nutrition was considered by western nutritionists as a way to ensure survival.

Eating all that appeared on the table and was displayed during convivial occasions – lunch, dinner or breakfast – took on the meaning of "material" or "fuel" needed for our reproduction. So, for many years, eating as much as possible was considered important.

Today, the availability and presence of food has substantially increased, due to higher levels of production, to the extent that in certain sectors there is overproduction.

Therefore, while in the past the problem was represented by insufficient availability of food, which led to the tendency to hyper-nutrition, currently western populations are exposed not only to an excess of food but also to industrially-processed foods, which contain more calories, and people's propensity to traditionally "eating everything that is on the table" might lead to an eating behavior that may lead to excess weight.

According to Prof. Simcic, the selfish gene theories in relation to food (Ostan, Poljšak Simcic, and Tijskens, 2010), apply to eating styles and dietary choices.

According to the research we carried out in the first experiment, we found a potential meeting-point with the theory related to the over-nutrition of the selfish gene.

It might be that the "happy" facial expression leads to a perception of health in others and the attractiveness of this condition might affect the desirability of the food.

The mechanism would seem to be that of identifying with a model of health seen in other people, and this might lead to higher food consumption.

An example is when people come together and, in the pleasure of a convivial atmosphere, eat increased quantities of food.

This is in line with our data.

So the smiling face would comply with the standards of health that the selfish gene would like to achive, and is consistent with the assumptions of Holley (2006) mentioned in the introduction.

It would be interesting to see whether the marketing of fast food, which often evokes joy and fun, aims at increasing the level of desirability of the food through the stimulation of moods of joy and happiness (however objectively identifiable by smiles), as is assumed in this thesis.

In our first experiment, we found that, among the emotions that are not directly related to food, happiness is the one that best maintains the desirability of the food we are presented with.

4.2.3 Violence and digestion

As for our intention of investigating the effect of exposure to violent acts in the media upon the digestive process, our visit to Ljubljana Children's Hospital was very productive.

Indeed, the effect of negative television images on nutrition was discussed with Prof. Dr. Rok Orel, Director of the gastroenterology department of the Faculty of Medicine of Ljubljana, Pediatric Hospital.

The idea was to assess an expert's opinion on the relationship between negative news (especially exposure to violent images or videos) and food intake.

A previous study investigated the effect of the emotional content of television news programs on mood state and the catastrophizing of personal worries.

Three groups were shown 14 min. TV news bulletins that were edited to display either positive, neutral or negative-valenced material.

Participants who watched the negatively-valenced bulletin showed increases in both anxious and sad mood, and also showed a significant increase in the tendency to catastrophize a personal worry (Johnston and Davey, 1997).

For our research it was our intention to obtain information from Prof. Rok Orel about the possibility of demonstrating experimentally that there are internal reactions in the subjects during the ingestion of food when exposed to the mere sight (or hearing) of negative news, and especially of violent acts.

We expected to find a correlation between the watching of violence and some kind of change in the quality of digestion (e.g. a slowdown, or block).

This might be an element of novelty in eating behavior, as millions of people daily eat in an environment (both domestic and non-domestic) replete with references to violence, either explicitly verbalized in a news program, or present in the environment where the food is consumed (e.g. at a restaurant where owners or waiters are rude or simply in a hurry).

Previous studies have addressed the relationship between food intake and exposure to the use of video games in adolescents: they found that heart rate, systolic and diastolic blood pressures, sympathetic tone, and mental workload were significantly higher during the video game play condition than during the resting condition.

The increase in food intake associated with video game play was observed without increased sensations of hunger and was not compensated for during the rest of the day (Chaput et al, 2011).

The basic idea is that emotions can influence the approach to food to such a degree that it becomes necessary to associate a new behavioral paradigm to food intake.

Prof. Rok Orel found these considerations interesting and, in particular, he noted the difficulties of conducting experiments on individuals.

He informed us of the possibility of filming what occurs during digestion (through special ingestible capsules, which have already been tested), and even of withdrawing the gastric fluid to analyze it.

There are practical limits deriving from these analyses, and these relate to two aspects:

a) digestion (and therefore the passage into the stomach and intestine of such capsules) occurs very rapidly compared to the "chemical reaction" (the production of cortisol) which may be caused by the sight of violent facts, thus presenting objective physical limits;

b) there are too many chemicals in the intestinal material and it would be virtually impossible to "isolate" the chemical production generated by the external influence, from the chemicals necessary for normal digestion.

The solutions envisaged, which might be used in future research and experiments based on our assumptions, are:

a) the use of a videocamera to measure any changes in intestinal motility (food transit time) as a result of exposure to violence, compared to digestion without these stimuli;

b) the use of milk, to avoid the complexities that other types of solid food can generate at a chemical level: probably with milk, which can be considered as a liquid food, it is easier to detect subsequent chemical productions related to a response to external stimuli.

We spoke with Natasa Fidler Mis, food technologist at the Pediatric Hospital in Ljubljana, on the issue of simple sugars in our nutrition, and with PhD student Eugen Benedik.

Interesting points of development in research might concern whether or not there should be vending machines for snacks inside hospital wards.

We discussed the possibility of including distributors of healthy food instead of the current distributors of coffee and snacks.

Interesting future developments in research concerning eating behavior were discussed with Prof. Janez Hribar,

Director of the Department of Food Science. We talked about the organization of research and nutrition education in Slovenia.

We also discussed the possibility of developing multidisciplinary research, including projects focused on neuroscience and the relationship between emotions and food.

In particular, we discussed how to implement magnetic resonance investigation using the tool of functional magnetic resonance imaging (fMRI).

We met Dr. Mojca Gabrijelcic, of the National Institute of Health (NIJZ) of the Slovenian Ministry of Health, and reported our findings about the relationship between emotions and food.

4.3 Conclusions and future prospects.

The experience in Slovenia clarified a number of points that characterized these three years of study and research.

In particular, researchers and professors showed great interest in the topic of "emotions and food", especially the effects that emotions can exert on the food experience.

All the participants agreed that there is currently a limited number of studies of the direct effects on individuals of the negative emotions expressed by other people.

We are certain about the internal effect of these emotions on food intake (when they are felt directly by the parties), but the unconscious contaminating effect of the mere sight of a person's face as it expresses positive or negative emotions is not yet sufficiently clear to the scientific community.

We have attempted to provide further evidence which will assist us in conducting our research.

The data collected confirmed our hypothesis and increased our desire for scientific investigation on the issues put forward in this thesis.

These data support the idea that new fields of research should be investigated using scientific hybridization, the intersection between several areas of science (as suggested by Wilson, 2013), in particular behavioral psychology, food science and neuroscience.

Ample opportunities for development are suggested by the exploration of the effects that the sight or hearing of violence exert on individuals approaching food.

We believe this is an essential and compelling field of research that should not be neglected, as a response to social needs dictated by the desire of improving the collective welfare.

4.4 Selected References

Ostan, I., Poljsˇak, B., Simcˇicˇ, M., Tijskens, L. M. M., (2010). Appetite for the selfish gene. *Appetite*, 54, 442–449.

Boel Nielsen, H., Sonne, A.M., Grunert, K.G., Banati, D., Pollak-Toth, A., Lakner, Z., Veflen Olsen, N., Pajk Zontar, T., Peterman, M., (2009). Consumer perception of the use of high-pressure processing and pulsed electric field technologies in food production. *Appetite*, 52, Issue 1, 115–126.

Chaput J. P., Visby, T., Nyby, S., Klingenberg, L., Gregersen, N. T., Tremblay, A., Astrup, A., and Sjo¨din, A. (2011). Video game playing increases food intake in adolescents: a randomized crossover study. *American Journal of Clinic Nutrition*, vol. 93 no. 6 1196-1203

Holley, A. (2006). Le cerveau gourmand. *Les editions Odile Jacob*, Paris.

Johnston, W. M., & Davey G. C. L. (1997). The psychological impact o fnegative TV news bulletins: the catastrophizing of personal worries. *British Journal of Psychology*, 88, pages 85-91.

Wilson, E. O. (2013). Letters to a young scientist. *W. W. Norton & Company*, inc.

Chapter 5: Conclusions and prospects

5. Conclusions and prospects

5.1 Conclusions of Thesis

For the past three years we have focused our research on the possible external factors that might influence the subjective perception of food quality.

We thought that there might be a gap between the actual quality of the food and the subject's perception of it, and that the this perception might somehow be contaminated, conditioned, and made less objective by external factors that are not directly related to the eating experience.

When we chose to explore the effect of the sight of the social context, we wondered how a person's perception of food might be altered by the presence of other people.

We started by analyzing previous studies, and then we conducted our own experiments.

We came across an extensive bibliography.

During our research we found that there are numerous studies that have looked for correlations between food intake and the influence of emotions.

The approaches to the topic are varied, they range from maintaining specific diaries in which people annotated the quality of the food, the amount and the corresponding emotion, to others which analyzed food consumption following emotions caused by physical conditions such as obesity or bulimia.

Other studies addressed the gestural side, the unconscious imitative effect that other people's actions have on the observer.

In our bibliography, we included many references to the chameleon effect and to dietary behavior in social contexts.

We found that people tend to change their eating behavior in relation to others.

It is from this point of view that we have conducted our research over the last three years into the effect of "others" as a potential influence on our behavior in connection with food.

The difference from the past is that our exploration was based almost entirely on the effect of other people's unconscious emotions and actions on the observers.

In our research, we found that an environment that has a human emotional value may affect the food experience.

The evidence we found (Rizzato et al, 2016) allows us to presume that, in an environment where anger or aggressiveness are displayed, there is a significant chance that the food experience may be modified more substantially than at the sight of an absence of emotion (neutrality of the subjects) or at the sight of happiness on other people's faces.

We support the theory that the mere sight of these emotions can lead to a reduction in the subsequent consumption of food.

Our results lead us to think that, during the food experience, a behavior that consciously focuses only on food can prevent interference in its desirability, and probably in the subsequent approach to consumption, thus making the eating behavior closer to the norm.

In the first experiment, the effect of emotions such as anger on the desirability of the food is clearly evident.

We might even theorize that anger carries an effect similar to disgust, almost as if it had a repelling effect.

In the second experiment, we found that the sight of emotions generates a "distracting" effect towards food, making it somehow "less attractive" than food not associated to emotional stimuli.

This leads us to desume that the social context exerts effects which result in a decrease of the desirability of the food.

The discovery of mirror neurons has opened up a new world, in many ways still unexplored, in the field of interpersonal relations.

Moving beyond the controversies and criticism which inevitably arise after every discovery or human evolution, the irrefutable fact is that studies on mirror neurons have opened up numerous fields of research and reflection that involve human behavior and examine countless implications of such findings on cognitive, social and behavioral psychology.

This revolutionary discovery explains phenomena such as empathy, identification, child development and the understanding of other people's intentions.

According to neuroscientist Gallese (2005), empathy is based on a kind of "embodied simulation": "perceiving an action - and understanding its meaning - is equivalent to simulating it internally ".

Therefore, when one looks at other people's actions, the neurological process of simulation is automatically and unconsciously triggered.

Therefore embodied simulation is the functional mechanism at the basis of two structurally-linked phenomena: the understanding of actions (observation and imitation) and the attribution of intentions.

Gallese also speaks of a manifold system of inter-subjectivity sharing: the observer and the subject observed share the same bodily state, mental states, feelings and emotions; in other words, they enter into an intentional consonance.

From this we can deduce significant implications in the field of relations, considered as being a continuous and mutual exchange of embodied simulations.

Actions and emotions are conveyed between the observer and the subject observed, and as we found in our first experiment this effect actually produces an increase in the desirability of the food, by the mere sight of another person's face, not connected with an action oriented to the food, for a time of 250ms, which is just above the threshold of perception but not yet strong enough to be processed as a conscious stimulus worthy of assessment by the observer.

In an environment such as a restaurant, for example, according to these data the waiter plays a crucial role in the choice of food, and probably also in the diner's subsequent propensity to consume.

Just stopping at the influence on the mere desirability of the food is, in our opinion, an important starting-point for future investigation.

Our results have confirmed our insights on the effect of the mere sight of a person's face on the desirability of food, and this allows us to draw the first conclusions from our initial hypothesis about the influence of emotions and social interactions on the eating experience.

Our first experiment, in the way in which it was planned and executed, focused exactly on this type of "unaware" and possibly unexpected interferences, and confirmed our intentions, laying the foundation for further studies.

Secondly, our attention focused on the hypothesis that actions related to food, such as bringing it to the mouth with the intention of eating it, might be more relevant in terms of appeal and involvement than the sight of the mere emotions.

This might seem inconsistent with our first experiment, where emotions played a key role.

But it was for us a subsequent field of hypothesis, based on the idea that the motor acts directly related to food (without expressivity) might also influence choices compared to the combination of emotions.

This proved to be true: our second experiment confirmed the hypothesis of a significant influence of such gestures on the food experience.

The conclusion of this second aspect is that motor acts can be a powerful attraction factor in food marketing, and probably the recent studies on vitality forms (the modes of expression with which the actions are completed) can represent the starting-point for a new direction for food marketing especially in places in which food is consumed.

Initially, therefore, we analyzed emotions and their influence on our likely choices.

Then the actions related to food, devoid of emotions, captured our scientific interest and we found, as hypothesized, that their effect is even more important than that of emotions.

This confirms our idea that the effect of external human factors, in relation to the consumption of food, is even more rooted than we thought, and might even unconsciously influence consumers.

To us, this is not only a research field inviting development, but also the beginning of a possible new direction of scientific research involving behavioral psychology, food science and neuroscience.

Hybridization might give birth to new areas for scientific investigation, new studies and in-depth analysis, such as intelligent eating, or eating psychology, based on that intersection of disciplines that we strongly suggested and timidly began during the course of these three years of research.

5.2 Future Prospects

Future areas of research may proceed in different directions in investigating the behavioral repercussions which follow embodied simulation (the effect exerted on the food experience by the sight of others' actions and emotions): specifically, the search for connections between

choice criteria and behavioral mechanisms resulting from different motor stimuli observed in another person.

The data presented in this thesis, for example, were collected in the field of food, and suggest that the mere sight of other people's faces expressing emotion may affect the subsequent approach to food, even if these faces are not associated with behaviors which highlight motor intentions.

We can only imagine what might be the implications and applications of this observation. There might be repercussions in marketing, not only with regard to the sale and sponsorship of food, but, above all, in the marketing aimed at raising public awareness about possible eating disorders through "social advertising".

What emotions and actions, specifically included in social advertising, might really contribute to a subsequent eating behavior?

If it is true that there is intentional consonance with others as we share methods of action, feelings and emotions, then it may be true that there is an "emotional contagion" that operates at a totally unconscious level, possibly even changing the "emotional climate" in places where we share common experiences (the workplace, for example).

Even the use of different terms, as we communicate, can "generate" different feelings in the listener: is it possible that this is the result of internal views or representations of actions or emotions projected from the imagination of the listener?

If the answer were positive and subsequently demonstrated, what would be the repercussions in society?

These and many other questions should continue to stimulate science and research to conduct careful and accurate analyses that provide as many answers as possible leading towards a positive evolution of social coexistence.

Significant progress in support of an ever better relational approach can be achieved both in the workplace and in the family with the help of all scientific fields involved and through heterosis of scientific thought, which aims at creating a hybridity that provides basic guidelines for a homogeneous and harmonious development of positive social behavior.

5.3 References

Gallese, V. (2005). Embodied simulation: From neurons to phenomenal experience. *Phenomenology and the Cognitive Sciences*, 4: 23–48

Rizzato, M., Di Dio, C., Fasano, F., Gilli, G., Marchetti, A., & Sensidoni, A. (2016). Is food desirability affected by social interaction? *Food quality and preference*. Vol 50, 109-116.

Scientific Activity (2012-2013)

Seminars & Lessons

1 october 2012 8 october 2012 15 october 2012 22 october 2012 5 november 2012 19 november 2012	Prof. Alessandro Sensidoni	Lessons in "introduzione alle tecnologie alimentari" course.	Faculty of Food Science, University of Ud, Italy

Workshops

25-27 September	Workshop	XVIII Workshop on the developments in the italian PhD Research on Food Science Technology and Biotechnology. Poster presentation.	Conegliano, Tv, Italy

Teaching and other activity

5 november, 2012	Teaching	Seminar on course "introduzione alle tecnologie alimentari". Lesson title: "interference between subjectivity in food quality and objectivity"	Univ. Ud, Italy Faculty of Food Science
4 december, 2012	Teaching	Lesson title: "coaching for students in food science". On course "strategie per la ricerca e sviluppo".	Univ. Ud, Italy Faculty of Food Science
15 may, 2013	Teaching	Lesson title: "Scienza e comunicazione: nuove frontiere nel marketing alimentare e sociale"	Univ. Parma, Italy Faculty of Economy

Scientific Activity (2014)

Seminars

15 april 2014	Dr. Lenoci (Carter & Bennet)	"La comunicazione nel settore alimentare"	Ud, Dial, Italy
17 september 2014	Prof. F. Debeufort (Univ. Dijon, F)	"Hydrocolloids as edible barrier or active packaging materials. Enhacement of thermal, mechanical, barrier and structural properties of blend polysaccharide and protein edible film by electron beam irradiation. Technologies for application of edible barriers on food and flexible packaging for active surface."	Ud, Dial, Italy
29 october 2014	Prof. Caso (Univ. Trento, Italy)	"Quale copyright per l'informazione digitale? Diritto d'autore, copyright e plagio"	Palazzo di Toppo Wassermann, Udine, Italy

Workshops

9 may 2014	Prof. Stecchini (Univ. Ud, Italy)	"Applicazioni della microbiologia predittiva"	Ud, Viale Ungheria, Italy
24 september 2014	Phd. Students	"workshop in the italian Pdh esearch on Food Science Tecnology and Biotechnology". Poster presentation.	Bari, University, Italy

Teaching and other activity

4 march 2014	Teaching	Lesson title: “Scienza e comunicazione: nuove frontiere del marketing alimentare e sociale”	Univ. Parma, Italy Faculty of Economy
25 june 2014	Phd. Students	“Journal Club”. Presentation slides: “Gluten-free spaghetti made with chickpea, unripe plantain and maize flours: functional and chemical properties and starch digestibilty”.	Ud, Dial, Italy
3-5 october 2014	Teaching	On Universitary Master “la psicologia delle emozioni: viaggio fra teorie, tecniche e applicazioni”. Lesson Title: “emozioni e rapporto con il cibo”.	Univ. Trieste, Italy

Scientific Activity (2015)

Seminars

7 april, 2015	D.ssa Tanja Zontar	National Seminar in Food Safety and Quality.	University of Ljubljana, Slovenia.
14 may 2015 15 may 2015	Dr. Mattia Crosetto	Seminar: "introduzione al project design/redazione: dal background al progetto".	Sala convegni Gusmani, Palazzo Antonini, Udine, Italy

Teaching and other activity

19 june 2015	Teaching	Speech to seminar: "i neuroni specchio tra emozione e decisione: metodi e frontiere delle neuroscienze". Title speech: "il meccanismo dei neuroni specchio: applicazioni di comunicazione sociale". Presentation of PhD activity.	University of Camerino, School of "Scienze del Farmaco e dei Prodotti della Salute". Civitanova Marche, Sala Conferenze BCC.
26 september 2015	Teaching	Universitary Master. Title lesson: "emozioni e rapporto con il cibo".	Lib. Univ. Gorizia, Italy, Grand Hotel Entourage, Go