Making Sensory, Social and Motivational Decisions about the Body

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I, Elena Panagiotopoulou, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Abstract

Grounding the self in the body makes the bodily self the starting point for the science of the study of self. Our bodily experience encompasses different aspects, such as bodily self-awareness, body ownership and body image. Nevertheless, while much research has focused on such dimensions, our understanding of the relation between them has been poorly understood. This thesis combined experimental methods of embodied cognition with cognitive and emotional manipulations to investigate this relationship.

In a series of empirical studies, the thesis focused on: 1) how we combine sensory modalities to perceive our bodily self (self-face recognition), 2) how we combine sensory signals from our own versus other bodies to perceive the bodily affective state (self-other distinction) and 3) how we compare ideals about the body against other rewards and risks to make body-related decisions (value-guided decisions made under uncertainty). These questions were addressed in healthy individuals, people with subclinical tendencies for disordered eating, as well as patients with anorexia nervosa (AN).

The findings suggest that our physical body, as perceived and represented from the inside, as well as from the outside, influences sensory, social and motivational aspects of the self. Specifically, increased embodied affectivity, as well as increased attractiveness of other people, enhance the multisensory modulation of self-face recognition. In addition, perceived attractiveness of the self in active comparison to other people appears to influence self-other distinction of bodily affective states. Finally, for people with subclinical and clinical body image disturbances in the context of disordered eating, risk-taking in the face of uncertainty appears to be moderated by the value of the body outcome with which reward and risk are coupled.

Impact Statement

The work presented in this thesis provides important behavioral and neurophysiological insights into the relation between different dimensions of the bodily self and, ultimately, how we make sensory, social and motivational decisions about the body. The thesis employed an interdisciplinary approach, combining methods from normally independent domains, such as social psychology, social cognitive neuroscience and psychophysics of tactile perception. As such, the scientific gains of this work are expected to have an impact beyond the aforementioned disciplines, but also more broadly in the fields of neuroscience, psychiatry and the humanities. Moreover, apart from healthy subjects, also individuals with sub-clinical body image disturbances, as well as patients with clinical eating disorders and, more specifically, anorexia nervosa (restricting type) were tested, hence adding a clinical applicability to the novel findings. Specifically, the understanding of the relationship between risk-taking and reward processing in body image disturbances is of direct relevance to the aetiology of eating disorders and, particularly, to recent developments in psychiatry regarding transdiagnostic understanding of psychopathology. Moreover, the findings hold potential for leading to novel screening processes and regulations regarding cosmetic surgical procedures, which have been on the rise worldwide, and could, therefore, predict surgery satisfaction and quality of life.

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Peer-reviewed publication arising from this thesis to date

Panagiotopoulou, E., Filippetti, M.L., Tsakiris, M., & Fotopoulou, A. (2017) Affective Touch Enhances Self-Face Recognition During Multisensory Integration. *Scientific Reports, 7*: 12883

Chapter 1 |

Introduction

1.1 Overview of Chapter

The question of how the brain gives us a sense of self is a topic of great scientific interest. According to various influential views in science, psychoanalysis and philosophy, the self is primarily situated in a physical body, which serves as the basis of our psychological self. Freud (1923) famously wrote that the ego is "first and foremost a bodily ego" derived from sensorial experiences. Lacan (1949/1977) suggested that human infants pass through a stage in which an external image of the body (as reflected in the mirror) produces a psychic response that gives rise to the mental representation of an "I". More recent approaches in the so-called field of 'embodied cognition' also point to embodiment as a central anchor for the acquisition of a sense of self (Bermúdez et al. 1995). Over the last 30 years, a large body of research in this growing field has shown that cognitive processes are deeply rooted in the body's interactions with the world (see Wilson, 2002) and, therefore, grounding the self in the body makes the bodily self the starting point for the science of the self (Tsakiris, 2016). Importantly, our bodily experience encompasses different aspects, such as bodily self-awareness (Babo-Rebelo et al., 2016), body ownership (Tsakiris et al. 2011), as well as body image (e.g. Badoud & Tsakiris, 2017). Much research has focused on such dimensions of the bodily self but less is known about their relationship. How does our awareness of the body from inside (i.e. interoception) relate to our perception of the body from the outside (i.e. physical appearance)? How does our subjective awareness of the body relate to how we perceive other bodies, and how does the latter perception influence the various facets of the self? The current thesis aims to address these questions in healthy individuals, people with subclinical tendencies for disordered eating, as well as patients with anorexia nervosa. Thus, the thesis will focus on: 1) how we combine sensory modalities to perceive our bodily self (self-face recognition), 2) how we combine sensory signals from our own versus other bodies to perceive the bodily affective state (self-other distinction) and 3) how we compare ideals about the body against other rewards and risks to make body-related decisions (value-guided decisions made under uncertainty). To address these aims, the thesis used methods from experimental psychology and social cognitive neuroscience, and drew on a variety of research traditions to combine some of their insights in a novel way. The following sections of this first chapter will first briefly outline the current literature on the multifaceted concept of body image, the role of body image disturbances in clinical eating disorders and body modification, as well as facial attractiveness as a primary attribute of beauty (see section 1.2). Next, it will review the current literature on the multisensory basis of the bodily self, considering both the exteroceptive and interoceptive body (see section 1.3). Subsequently, it will describe the current literature on the social origins of the bodily self, highlighting the importance of self-other distinction for interpersonal understanding (see section 1.4). Finally, it will review recent evidence on value-guided decision-making biases among individuals with body image disturbances and, more specifically, risk discounting (see section 1.5). The chapter will conclude with a summary of the specific objectives of the thesis, illustrating the main aims, and an outline of the following chapters (section 1.6).

1.2 Body Image and Related Disturbances

1.2.1 The Multi-Faceted Concept of Body Image

The term ‘body image’ was first coined by the Austrian neurologist and psychoanalyst Paul Schilder as “the picture of our own body which we form in our mind, that is to say, the way it appears to ourselves” (Schilder, 1935). The concept has been used in different fields, such as psychology, medicine, psychoanalysis and cognitive neuroscience, yet currently there is no consensus definition for the term ‘body image’. Badoud and Tsakiris (2017) adopted a broad definition of body image as “the conscious predominantly visual, mental representation of one’s own body and of our perceptual, cognitive and affective attitudes towards it”, but as I will explain below, several findings suggest that body image is not predominately visual but rather a multisensory construct. Importantly, body image is not considered a single construct bur rather encompasses several sub-components (for a review see Badoud & Tsakiris, 2017). For instance, Longo et al. (2008a) distinguished the 'self-specific' body image, referring to the recognition that a particular visual object belongs to one's own body, from the 'generic' body image, which is a more general mental representation of the structure of the whole body.

In addition, to these cognitive perspectives, in the field of clinical and social psychology, body image has been described as a multifaceted psychological experience of embodiment, simultaneously including perceptual, cognitive and affective components (Cash, 2004; Cash and Deagle, 1997; Cash and Green, 1986). More specifically, perceptual components are related to people's judgments of their size, shape and weight relative to their actual proportions; cognitive components are related to people's beliefs about their body appearance; and affective components are related to people's feelings towards their body appearance (Cash and Green, 1986). Interestingly, a handful of functional neuroimaging studies have found that the different sub-components of body image engage different brain regions, with the lateral fusiform gyrus, inferior parietal cortex and the lateral prefrontal cortex being involved in perceptual components (Uher et al., 2005), while the insular and amygdala networks are involved in affective components (Friederich et al., 2010).

However, the majority of empirical data are focused on the visual component of body image, dealing with it as a unisensory, visual concept and paying less attention to the more representational and emotional aspects of the body (Badoud & Tsakiris, 2017). Other sensory signals, such as visual, tactile, proprioceptive and auditory, have only recently been considered (e.g. Sakamoto, 2017; Gaudio et al., 2014). Beyond exteroceptive signals, Badoud and Tsakiris (2017) suggested that interoception, i.e. the perception of the physiological state of the body involving both sensations from within the body, as well as sensations whose stimuli are typically located outside the body (see Ceunen, Vlaeyen & Van Diest, 2016), may play a crucial role in body image components. More specifically, previous research has demonstrated reduced levels of interoceptive awareness in people with body image disturbances (Pollatos & Georgiou, 2016; Pollatos et al., 2008; Khalsa et al., 2015; Yoshikatsu and Toshikiyo, 2001; Santel et al., 2006), indicating a link between interoceptive processing and body image concerns in non-clinical populations, as well as body image disturbances and eating disorders in clinical populations (Badoud & Tsakiris, 2017). However, interoception has only recently been included in empirical studies that do not merely examine disturbed but also positive body image (Eshkevari et al. 2014), hence, the eventual contribution of interoception to body image remains poorly understood (Badoud & Tsakiris, 2017).

Accordingly, clinical and social psychologists have developed different methods for assessing the different components of body image, including experimental and self-report measures. To assess perceptual components of body image various experimental methods have been used, such as paradigms that ask participants to choose the image that most closely fits to their body size and shape (e.g. Hodzic et al., 2009; Peelen and Downing, 2007), whereas the affective and cognitive dimensions are often tackled by self-report measures or experimental methods like the negative body-image word task (Miyake et al., 2010). More generally, the majority of measures for body image dissatisfaction, measured by the discrepancy between actual vs. ideal body image, typically rely on self-report questionnaires, such as the widely used Body Image States Scale (BISS; Cash et al., 2002) which are, however, susceptible to various biases, such as social desirability and self-deception (Glashouwerm Bennik, de Jong & Spruyt, 2018). A few implicit measures have been recently developed to circumvent the limitations of self-report questionnaires, such as the Implicit Relational Assessment Procedure (IRAP; Barnes-Holmes et al., 2006) and the Relational Responding Task (RRT; De Houwer et al., 2015). Recent evidence has shown that there is a consistency between self-reported body image dissatisfaction and implicit perception of actual body image, with people who score high in body image dissatisfaction, displaying higher levels of implicit I-am-fat beliefs (Heider et al., 2015; 2018; Glashouwer et al., 2018). However, Glashouwer et al. (2018) found no differences between people who score high vs. low in self-reported body image dissatisfaction in terms of implicit perception of ideal body image (i.e. I–want-to-be-thin beliefs). These findings suggest that there may not be a discrepancy between explicit and implicit body image beliefs, at least when it comes to perception of actual body image. Nevertheless, the clinical-social literature and methods have not been integrated with the multisensory methods of cognitive psychology. Hence, one of the aims of this thesis is to combine such perspectives and methods.

1.2.2 Risk Factors for Body Image Disturbances and Eating Disorders

While a positive body image has been found to predict various health-related outcomes, such as physical activity (Andrew et al. 2016), disturbances in one or several of the body image components discussed in the previous section have been associated with a range of physical, as well as mental health consequences. Body image disturbances refer to a maladaptive subjective perception and attitude towards one's body (Gardner 2011), arising from an incongruence between one's body image (the perceived view of one's own body) and the objective view from an external observer (Thompson & Stice, 2001). Body image disturbances can occur along several dimensions, primarily weight, shape and appearance (Thompson & Stice, 2001) and include cognitive factors (e.g. overvaluation of one's appearance in sense of self worth), evaluative components (e.g. dissatisfaction with appearance) and behavioural aspects (e.g. self-checking) (Cash & Smolack, 2011; Cash, Fleming, Alindogan, Steadman, & Whitehead, 2002). Body image disturbances can manifest through affective reactions of stress and unhappiness, or cognitive reactions of self-degradation and reduced self-esteem (Thompson et al., 1999). In turn, these reactions can lead to the desperate use of high-risk behaviours to modify the body while neglecting its associated risks (Grabe, Ward & Hyde, 2008). Such behaviours include strict dieting, binge eating and induced vomiting, meal skipping, the use of laxatives and excessive physical exercise and entail serious risk (e.g. malnutrition, dehydration and exhaustion). Ultimately, body image disturbances can lead to clinical mental health disorders, such as depression and eating disorders (e.g. Jackson et al., 2014; Cash & Deagle, 1997; Johnson & Wardle, 2005; Grabe, Hyde & Lindberg, 2007). Clinical and empirical research has shown that such disturbances constitute core features of the eating disorders psychopathology (e.g. Cash & Deagle, 1997; Fairburn & Harrison, 2003), most notably of anorexia nervosa (AN).

Given the rise of body image disturbances in the modern world (e.g. Grossbard, Lee, Neighbors & Larimer, 2008; Tiggemann, 2004; Thompson & Stice, 2001) the understanding of the risk factors of such disturbances and, subsequently, eating disorders, is considered an area of research priority. Research on the risk factors promoting body image disturbances has pointed to the contribution of socio-cultural, cognitive, as well biological processes (for a review see Urgesi, 2015). To begin with, one of the most prominent risk factors for such disturbances is thought to be the internalisation of societal values of an ideal body image (Thompson & Stice, 2001), which currently revolve around having a slender figure (Mills & Fuller-Tyszkiewicz, 2017). Attaining these ideal body standards often brings a clear advantage in interpersonal judgment and social exchanges, whereas failing to conform to them is often associated with negative judgment or even social rejection (Fouts & Burggraf, 1999). A large body of evidence has been supporting the objectification theory as a theoretical account of the high prevalence of body image disturbances and eating disorders among women nowadays (Fredrickson & Roberts, 1997). According to this theory individuals who self-objectify, internalise an external observer's perspective of their own physical self and begin to view their body as an object that must be constantly monitored and scrutinised in order to meet the internalised cultural standards of beauty and thinness (Noll & Frederickson, 1998; Jongenelis, Byrne & Pattigrew, 2014). Although the role of the media has not been yet thoroughly examined, some evidence suggests that the media may play a crucial role in promoting such body ideals, which are representative of only a small proportion of the female population (Thompson, Heinberg, Altabe & Tantleff-Dunn, 1999), ultimately leading to an increase in body image dissatisfaction (Benowitz-Fredericks, Garcia, Massey, Vasagar & Borzekowski, 2012).

More recently, social media, a non-traditional form of media, has become increasingly popular worldwide (Fuchs, 2017). Several correlational studies have shown that adolescents, who use social media platforms more frequently, tend to be more dissatisfied with their bodies (e.g. Tiggemann & Miller, 2010; Tiggemman & Slater, 2013), through various mechanisms, including physical appearance comparisons and self-objectification. However, little is known about the causal direction of this relationship. deVries, Peter, de Graaf & Nikken (2016) tested over 600 adolescents boys and girls to address this gap and through structural equation modeling found that social network platform use was, in fact, predictive of increased body image dissatisfaction. Moreover, a recent study with 2,733 men showed that associations of social media use with both muscularity dissatisfaction and eating disorder symptoms were stronger for image-centric social media sites, such as Instagram, as compared to non-image-centric sites, such as Wordpress, suggesting that social media platforms that more centrally involve imagery may be of greater concern (Griffiths, Murray, Krug & McLean, 2018). Despite the large body of evidence suggesting that (social) media may, in fact, contribute to the development of body image disturbances, it is important to note that all of these studies used self-report measures for social media use, which may be subject to various biases.

Importantly, sociocultural pressure beyond mass media, such as direct parental and peer influence through modelling or teasing about being overweight, have also been proposed to be causes of body dissatisfaction (Martjn, Alleva & Jansen, 2015). Family factors, such as parental obesity, parental overprotection, family conflict, parental neglect, parental loss or absence and parent psychopathology may moderate the impact of socio-cultural influences and increase the risk for developing eating disorders (see Shisslak & Crago, 2001). Swami (2015) suggested that the cultural binding of eating disorders related to either socio-economic status or geographical origin is also indicative of the important role that social influences play in the internalisation of body ideals. Yet, a major limitation of sociocultural accounts on the development of body image disturbances is that they do not account for individual differences that moderate the impact of sociocultural ideals. In other words, the pervasiveness of (social) media is sufficient to expose most people to idealized thin body images, yet not the entire population develops body image disturbances and eating disorders.

Cognitive processes, and in particular biases, such as focusing more on one's own negative features rather than the positive (Martjn et al., 2015) have also been proposed to contribute to body image disturbances. A large number of studies have shown that people with body image disturbances tend to overestimate the size of their body, as well as others' bodies, and display negative affect towards their body (e.g. Cornelissen, Gledhill, Cornelissen, & Tovée, 2016**;** Cornelissen, Johns, & Tovée, 2013; George, Cornelissen, Hancock, Kiviniemi; Tovée, 2011). For instance, Tovée, Benson, Emery, Mason, & Cohen‑Tovée (2003) investigated body size estimation among anorexic, bulimic and control participants with a specially designed software system that uses biometric data based on real body shapes, instead of simply stretching or compressing images of bodies. The results showed that control participant were very accurate at estimating their body size, whereas anorexic and bulimic participants were found to significantly overestimate their body size. A low BMI even in the absence of anorexic symptomatology has also been found to relate to body size overestimation. In a cross-sectional study by Cornelissen, Bester, Cairns, Tovée, & Cornelissen (2015) investigating the influence on one's own BMI on body size estimation, participants with a lower BMI were found to overestimate their size, whereas participants with a higher BMI did the opposite, a perceptual phenomenon known as contraction bias (Poulton, 1989). What is more, various cognitive bias training programs have been found to be effective for treating body image disturbances (Gledhiil, Cornelissen, Cornelissen, Penton-Voak, Munafo & Tovée, 2016), suggesting that impaired cognitive processes may, in fact, play a key role in the developmental and maintenance of body image disturbances. Taking things a step further, Riva, Gaudio & Dakanalis (2015) proposed a model for the cognitive mechanisms involved in the establishment and maintenance of clinical, body image disturbances, whereby they complemented the objectification theory described above (Fredrickson & Roberts, 1997) with the allocentric lock hypothesis (Riva, 2012). According to this hypothesis, people with body image disturbances are locked to an allocentric representation of their body deriving from other people's negative evaluations and they fail to update their body representation on the basis of perceptual input even after weight loss. In fact, a recent study found that after embodiment of a virtual skinny body via visuo-tactile stimulation, participants reported a decrease in the ratio between estimated and actual body measures (Serino et al., 2016). According to the allocentric lock hypothesis, these findings suggest that virtual body swapping can induce a change in the stored representation of the body. However, this has only been assessed in this body swap study and no other methodologies have been used allowing for more sophisticated and controlled ways of measuring changes in body representation.

Finally, biological psychiatry studies suggest a neural basis for body image disturbances. More specifically, research has shown structural and functional alterations of occipito-temporal and temporo-parietal areas cortices during body processing among individuals with body image disturbances and anorexia nervosa (Suchan et al., 2010;

2013; 2015; Uher et al., 2015; Urgesi et al., 2012; 2014). Such alterations are thought to be responsible for the perceptual, cognitive, emotional and behavioural components of body image disturbances in eating disorders (Suchan et al., 2015). In addition, there is evidence suggesting ventral and dorsal neural circuit dysfunctions in individuals with eating disorders perhaps due to alterations in serotonin and dopamine metabolism (Kaye, Fudge & Paulus, 2009). Altered serotonin neuronal pathway activity has been found to persist even after recovery from an eating disorder, hence indicating that such psychobiological alterations may influence traits, such as increased anxiety or extremes of impulse control, that, in turn, contribute to a vulnerability to eating disorders (Barbarich, Kaye & Jimerson, 2003). Moreover, genes have been proposed to play a significant role in the development of eating disorders, with research involving 31,406 twins suggesting that genetic heritability accounts for approximately 50–80% of the risk of developing an eating disorder (Bulik et al., 2006). Twin studies have also shown that genetic factors may exert a significant influence of thin internalization and, ultimately, body image disturbances (Suisman et al., 2012).

As shown above, a plethora of studies have provided evidence for the involvement of socio-cultural, cognitive and biological processes in the development and maintenance of body image disturbances. Yet very few studies combine methods and concepts across fields. Thus, for example, most of the above studies on perceptual and cognitive biases focus on visual aspects of the body, or emotional and cognitive attitudes towards the body. As I will explain below, very few studies examine multisensory perceptions on the body, and even less studies use experimental methods from embodied cognition in combination with cognitive and emotional manipulations. This will be one of the aims of the present study.

1.2.3 Body Image Disturbances and Body Modification

In parallel to the noted rise in body image dissatisfaction in the modern world and, in particular, Western societies (e.g. Tiggemann, 2004), there is also an increase in the availability and normalisation of body modification methods (digital and in the flesh), as a way to change one's shape and weight to conform to ideal body standards. In recent years, many people turn to non-invasive procedures, such as Botox, dermal fillers and chemical peels. In 2017 alone, over 23 million cosmetic procedures were performed globally and approximately 12 million were non-surgical (International Society of Aesthetic Plastic Surgery Report, 2017). However, in extreme cases of preoccupation with one's own body parts perceived as flawed, some individuals choose to pursue invasive surgical procedures, such as face lift, breast augmentation or rhinoplasty. In 2017, approximately 11 million surgical procedures were performed globally and the numbers keep rising every year (International Society of Aesthetic Plastic Surgery Report, 2017). All of these cosmetic surgical procedures were performed for aesthetic purposes only, and are different from reconstructive surgical procedures which are performed on abnormal structures of the body, caused by trauma, disease, congenital defects, developmental abnormalities, infection or tumours. Given that surgical procedures have associated risks and complications, such as infections and scars (NHS, 2015), the enormously growing cosmetic surgery market indicates an ironically great propensity towards conferring risks onto one's own body in pursuit of an ideal body. Therefore, it is important to understand the mechanisms underlying this counter-intuitive phenomenon.

In terms of factors increasing the likelihood of pursuing cosmetic surgery, body image dissatisfaction, which is a feature of body image disturbance, is found to strongly motivate cosmetic surgery (e.g. Sarwer, Grossbart & Didie, 2002; Bolton, Pruzinsky, Cash & Persing, 2003; Didie & Sarwer, 2003; Sarwer, Bartleet, Bucky et al., 1998; Sarwer, LaRossa, Bartleee, Low, Bucky & Whitacker, 2003). Apart from eating disorders, body image disturbance is also a central feature of body dysmorphic disorder (BDD; Rosen & Ramirez, 1998), a mental health disorder classified under "Obsessive-Compulsive and Related Disorders" according to DSM-IV. BDD is defined as a preoccupation with a slight or imagined defect in appearance that causes significant disruption in daily functioning (APA, 2000) and is found to be overrepresented among individuals who seek cosmetic surgery (e.g. Sarwer, Magee & Crerand, 2004; Dufresne, Phillips, Vittorio & Wilkel, 2001). For example, Sarwer, Wadden, Pertschuk & Whitaker (2002) asked a sample of 132 women to complete some body image measures prior to surgery, including the Body Dysmorphic Disorder Examination Self-Report. The results showed that while participants did not report greater dissatisfaction with overall appearance as compared to a normative sample, they did report greater dissatisfaction with a specific bodily feature and 7% of them matched diagnostic criteria for BDD. Yet, apart from body image disturbances, socio-cultural influences also appear to play a crucial role in the increasing rate of cosmetic operations. A study by Ashikali, Dittma & Ayers (2016) explored adolescent girls' views on cosmetic surgery, running seven focus groups with 27 girls aged 15-18 years, whereby participants had to read case studies of women who had cosmetic surgery and discuss their views. The results showed that increased exposure to cosmetic surgery advertisements led not only to higher body image dissatisfaction, but also a more positive attitude towards cosmetic surgery procedures. In addition, a large, multisite study with 559 women investigated their experiences with, and attitudes about cosmetic surgery and how these relate to multiple facets of body image, using various self-report measures (Sarwer et al., 2005). The findings revealed that a greater psychological investment in physical appearance and a greater internalisation of mass media images of beauty predicted more favourable attitudes toward cosmetic surgery. Overall, it appears that body image concerns, as well as socio-cultural influences play a crucial role in motivating cosmetic surgery. However, unlike the wealth of empirical research in eating disorders and despite the increasing numbers of individuals seeking cosmetic medical treatments throughout their lives, research on risk factors promoting acceptance and pursuit of cosmetic surgery is still very limited and relies exclusively on self-report measures. One of the aims of this thesis is to use a novel behavioural task to investigate body-related risk-taking behaviours among individuals with body image disturbances, who either have disordered eating and/or seek cosmetic surgery.

1.2.4 Beauty Beyond the Body: Facial attractiveness

The previous sections focused on how biological, cognitive and socio-cultural factors may lead to body image disturbances and, in turn, clinical eating disorders and the pursuit of invasive cosmetic surgery for aesthetic purposes alone. So far, the focus has been on body image, as the perception, representation and attitude towards one's own body. In this section, the focus will be shifted to how the body and particularly the face is perceived by other people, rather than the self. As mentioned before, the ideal body standards currently revolve around a thin, well-toned figure (Mills & Fuller-Tyszkiewicz, 2017). Yet, more than 20% of cosmetic procedures performed globally are being carried out only on the face (International Society of Aesthetic Plastic Surgery Report, 2016). When one refers to the body, the face is usually not considered, however, it is this body part that is the most representative instance of personal identity (Filippetti, 2015) and the nature and effects of facial attractiveness have been increasingly fascinating not only artists but also scientists.

According to the maxim "beauty is in the eye of the beholder", different people have different ideas about what makes someone beautiful (Spears, 1993). However, a large body of evidence suggests that there seems to be considerable agreement across individuals and cultures about what makes a face attractive (Langlois et al., 2000; Little, 2014). Social and evolutionary psychology has focused on two main attributes of facial attractiveness. The first is averageness, defined as the extent to which a face resembles the average facial configuration of the population. Computer-generated average faces have been consistently rated as more attractive than almost all of the individual faces that constituted them (Langlois & Roggman, 1990; Langlois, Roggman & Musselman, 1994; Fink & Penton-Voak, 2002). Another study investigating spatial relations between facial features has shown that the "golden" ratios for facial beauty match those of an average face (Pallett, Link & Lee, 2010). One possible explanation of this effect seems to be that faces that approximate a facial configuration that is close to the average of the population are being processed more fluently. This fluent processing is usually error-free and, hence, more "pleasing" (Trujilo, Jankowitsch & Langlois, 2014). The second attribute is facial symmetry, defined as the extent to which the two halves of a face are the same. A large body of evidence has shown that facial symmetry is related to judgments of attractiveness (Fink & Penton-Voak, 2002; Rhodes et al., 1999; Perrett et al., 1999; Grammer & Thornhill, 1998; but see Swaddle & Cuthill, 2015).

Interestingly, facial attractiveness appears to be an influential factor for social exchanges, affecting people's perceptions at high-order emotional and cognitive levels (Langlois et al., 2000). Research has also provided evidence for the "what is beautiful is good" stereotype (Dion et al., 1972), whereby physically attractive individuals are believed to possess a wide variety of positive personal qualities. For instance, individuals who were rated as more attractive were also rated as more competent and friendly (Mobius and Rosenblat, 2006; Berscheid & Walster, 1972), more intelligent (Zebrowitz et al., 2002), and as having more positive personality traits as compared to unattractive individuals (Snyder et al., 1977). In a study investigating the influence of physical attractiveness on student evaluations of college professors, students from four separate colleges were asked to anonymously evaluate their professors in terms of overall quality and then answer if they thought they were attractive or not (Riniolo, Johnson, Sherman & Misso, 2006). The results showed that professors who were perceived as attractive, received higher student evaluations than professors who rated as less attractive. The attribution of more positive qualities to attractive people is the case for adults as much as for children (for a review see Langlois et al., 2000). Crucially, this effect extends beyond interpersonal judgment to social behaviour. Attractive children and adults are treated in a more positive way, as compared to unattractive people (see Langlois et al., 2000). For example, in a study by Smith (1985), 38 pre-school children were observed for 5 consecutive days while they were interacting with their peers. The results showed that attractive girls received more prosocial and less aggressive behaviours than unattractive girls, whereas no differences were found between boys. Moreover, attractive individuals have been found to receive higher salaries (Hamermesh & Biddle, 1993) and more money in the ultimatum game (UG) even if they had not demanded it (Solnick & Schweitzer, 1999).

Overall, findings indicate an advantage for attractive people in terms of how other people perceive and judge them in social interactions and beyond. However, it should be noted that the research described above cannot establish any causal link between attractiveness and advantages in social judgments and interactions. When it comes to studies that are correlational in nature, it is possible that perceiving someone as more friendly or competent leads to higher levels of perceived attractiveness and not vice versa. Moreover, in most of these studies attractiveness was not experimentally manipulated, but was rather subjectively perceived. Yet, while there seems to be a general agreement about what makes a face attractive on not (e.g. Langlois et al. 2000; Woo, 2007), there is evidence pointing to inter-individual differences in attractiveness judgments that may arise from differences in learning and prior life experience (Little & Perrett, 2014; Hönekopp, 2007).

1.2.5 Summary

To sum up, this section discussed the multi-faceted concept of body image and how it is measured, as well as the role of exteroceptive and interoceptive signals. Subsequently, multi-dimensional risk factors for body image disturbances were described and how these may lead to clinical eating disorders and the pursuit of cosmetic surgery. In the final section, the focus was shifted from body image as a representation of the body to the body itself, particularly the face, and how it is externally perceived by other people, exerting an influence on social judgments and interactions. The sections that follow will focus on how the physical body, as perceived and represented from the inside and from the outside, as well as subclinical and clinical body image disturbances, affect how we make sensory, social and motivational decisions about the body.

1.3 Making sensory decisions about the body

1.3.1 The Multisensory Basis of the Bodily Self

As mentioned above, it is increasingly understood that the way we experience our body and form a representation of it, relies on input from multiple sensory modalities, rather than just the visual modality (e.g. Longo, 2015). This understanding is linked to earlier developments in the study of another fundamental aspect of our bodily self, namely body ownership. Body ownership refers to the sense that "my body" belongs to me (Gallagher, 2000). Over the past 20 years, body ownership has been understood as distinct from the older tradition of studying in visual, self-recognition paradigms and it has instead been addressed in the context of multisensory integration, i.e. integration of information from different sensory modalities (Tsakiris & Haggard, 2005). Interestingly, various experimental bodily illusions that induce changes in body ownership have been found to provide information about how people represent their bodies as their own by combining visual information with other modalities, such as touch and proprioception (Badoud & Tsakiris, 2017).

The most well-known bodily illusion that induces changes in body ownership is the rubber hand illusion (RHI; Botvinick & Cohen, 1998), in which watching a rubber hand being stroked synchronously with one's own hand (which is out of view) gives rise to the feeling that the rubber hand belongs to one's own body. However, the illusion disappears when the interpersonal multisensory stimulation is asynchronous, i.e. when there is a delay between what we see and what we feel. Moreover, participants report that their own hand seems to have disappeared (Longo et al., 2008), suggesting that the changes caused by RHI are not due to an extension of their body but rather the replacement of their own hand with the new, rubber hand. Interestingly, the RHI is not influenced by various characteristics of the rubber hand, such as size (e.g. Heed et al., 2011; Bruno & Bertamini, 2010; Pavani & Zampini, 2007; Haggard & Jundi, 2009; Haans, Ijsselsteijn and Kort, 2008) or colour (e.g. Farmer, Tajadura-Jimenez & Tsakiris, 2012; Haans, Ijsselsteijn and Kort, 2008), unless one has an eating disturbance or implicit racial bias, respectively. A similar effect as the one of the RHI has also been observed with other body parts (Guterstam, Petkova & Ehrsoon, 2011), as well as the whole body (Lenggenhager, Tadi, Metzinger & Blanke, 2007; Petkova & Ehrsson, 2008). Synchronous but not asynchronous visuo-tactile stimulation induces a shift in the first-person perspective such that participants perceive their actual body being located behind its visual image as if they are looking at it from another person's perspective. Lenggenhager et al. (2007) induced a full-body illusion, whereby after synchronous stimulation, participants experienced a virtual body as being their actual body. Similar multisensory-induced effects are also found for the face, which is probably the most representative instance of personal identity (Filippetti, 2015) and the ability to recognise it is considered an index of self-awareness and a fundamental aspect of the sense of selfhood (Gallup, 1970; Rochat, 2009). The so-called 'enfacement illusion' will be discussed in more detail in Chapters 2 and 3.

Overall, multisensory integration appears to be the main mechanism driving these effects. It can be used to create and update the mental representation of one's body/face and, as a consequence, the sense of body or face ownership. Yet, apart from the temporal properties of multisensory integration, i.e. synchrony, spatial properties, are also crucial in maintaining and updating mental representations of one's body (Longo & Haggard, 2012). Those bodily illusions discussed above arise due to the temporal and spatial congruency between felt and seen sensory events and the aim of multisensory processing is to resolve potential conflicts in order to generate a coherent sense of the self on the basis of the sensory evidence that is available (Tsakiris, 2016). By altering a purely bodily aspect of the self, that of body ownership, social and affective processes influencing the way we relate to others are ultimately affected as well.

Crucially, changes in body ownership, as a result of such bodily illusions, may also lead to changes in body image. In particular, participants who have experienced the RHI have been found to perceive their actual hand and the rubber hand much more physically similar as compared to participants who have not experienced the illusion (Longo, Schüür, Kammers, Tsakiris & Haggard, 2009). Research has also shown that changes in body ownership may lead to an improved body image in patients with anorexia nervosa (AN). In fact, Keizer, Smeets, Postma, van Elburg & Dijkerman (2014) found that after inducing the RHI in AN patients, they estimated their hand size more accurately than before the induction of the illusion. Moreover, another recent study with AN patients by Keizer, van Elburg, Helms & Dijkerman (2016) found that the overestimation of the size of shoulders, abdomen and hips was reduced after the induction of the full body illusion. A change in explicit reports of body satisfaction in response to such bodily illusions has also been found in healthy individuals though it was linked to non-clinical eating disorder thoughts and behaviours (Preston & Ehrsson, 2014). More recently, Preston & Ehrsson (2016) found that the results obtained in the explicit measure of body satisfaction did not mirror the results with the implicit measure. However, while in the implicit measure there was a positive effect of synchrony of touch but not size of the body (slim vs. obese) being owned in the illusion, both implicit and explicit changes in affective experience of the body were associated with behaviours and thoughts associated with non-clinical disordered eating. Therefore, it appears that multisensory-induced changes in estimation of body size may modulate body satisfaction. Moreover, women with (non-clinical) disordered eating have more malleable affective representations of the body, which could be a starting point for new interventions to be developed. However, the exact mechanisms underlying such changes in body size estimation still remain unknown.

1.3.2 From the Exteroceptively Driven Sense of Body Ownership to the Interoceptive Body

The evidence discussed above demonstrates how plastic our body awareness is based on feedback that we get from how we perceive the world from the outside (i.e. exteroception). Yet, we can also become aware of ourselves though bodily signals coming from the inside (i.e. interoception) (Tsakiris, 2016). As mentioned in section 1.2.1, interoception has been recently defined as the perception of the physiological state of the body involving both sensations from within the body, e.g. cardiac and respiratory functions, thirst, digestion, as well as sensations whose stimuli are typically located outside the body, e.g. taste, pain, affective touch (Craig, 2002; Ceunen et al., 2016). As is the case with the awareness of other sensory modalities (e.g. visual or tactile), the awareness of interoceptive states is also very important for the organism (Tsakiris, 2016). Interoception plays a unique role in managing the efficient physiological function of the organism (i.e., homeostasis) and is, therefore, critical for ensuring its stability in a constantly changing environment.

Nevertheless, as opposed to the plethora of evidence on visual and somatosensory awareness, there is a significant lack of evidence on interoceptive awareness due to the difficulty in causally manipulating interoceptive states. The main measurement methods so far are focused on heartbeat detection procedures requiring participants to either count their heartbeats or perceive synchrony/asynchrony between own heartbeats and external stimuli. Both of these methods provide measures of interoceptive accuracy (IAcc), which is thought to reflect trait-like sensitivity to one’s visceral signals and has important consequences for physical health, emotions and cognition (Tsakiris, 2016). For instance, IAcc has been linked to anxiety, depersonalisation disorder, as well as eating disorders (for a review see Herbert & Pollatos, 2012).

Crucially, beyond the mental health domain, awareness of interoceptive states has also been found to play a critical role in self-awareness. The insula, which has been recently identified as the cortical hub for the primary interoceptive information about the physiological condition of the body, has also been shown to play a crucial role in representing the experience of the body as mine (Craig, 2009; Critchley, Wiens, Rotshtein, Öhman & Dolan, 2004; Critchleym Wiens, Rotshtein & Craig, 2009). Evidence also points to the insula in integrating the interoceptive sides of the bodily self with other exteroceptive (Simmons et al., 2013), cognitive and social information, providing the basis for all subjective feelings from the body and even emotional awareness (Critchley et al., 2004; Cameron, 2001; Bernhardt & Singer, 2012).

While most studies to date have been focusing on how exteroceptive signals such as vision and touch are integrated in the brain to create the sense of body ownership, only recently scholars have begun to investigate the effects of interoceptive signals on such bodily illusions. Tsakiris, Tajadura-Jiménez, and Costantini (2011) showed that individual differences in cardiac interoceptive sensitivity can influence the RHI. In particular, they found a negative correlation between IAcc and RHI, such that people with lower IAcc showed a stronger RHI measured behaviourally and physiologically (i.e., drop in skin temperature). The relationship between interoception and body representation has also been investigated in the context of the virtual bodily illusions. For instance, in two virtual reality studies (Aspell, et al., 2013; Suzuki, Garfinkel, Critchley & Seth, 2013) visual feedback of participants' own heartbeat was provided 'on-line' (i.e. during the virtual reality tasks) by means of a flashing virtual body or hand in synchrony or out-of-synchrony with the participants' own heartbeats, with the synchronous condition increasing self-identification with the virtual body (Aspell, et al., 2013) and embodiment of the rubber hand (Suzuki et al., 2013), respectively. Thus, when interoceptive signals are artificially provided also in the visual domain, vision seems capable of 'capturing' interoception, leading to enhanced down regulation of proprioception as in the classic RHI paradigm. So far, the studies mentioned above have focused exclusively on cardiac awareness as a form of interoception, however, the ecological validity is somewhat low when providing 'online' visual or auditory feedback of interoceptive modalities that are not habitually experienced via such exteroceptive modalities (e.g. heartbeat related flashing of virtual bodies or hands) (Crucianelli, Krahé, Jenkinson & Fotopoulou, 2018). On the other hand, interoceptive modalities such as affective touch or cutaneous pain, whose stimuli are typically located outside the body, can be manipulated 'on-line' with higher ecological validity.

Recently, affective touch, a specialised interoceptive modality coming from the outside of the body, has been found to modulate the sense of body ownership in the context of multisensory integration. Affective touch, is thought to be coded by specialised, slow-conducting, unmyelinated peripheral nerve fibers, known as C tactile afferents (Olausson et al., 2002; McGlone, Vallbo, Olausson, Löken & Weeberg, 2007), which are found in hairy skin (Vallbo, Olausson & Wessberg, 1999; Liu et al. 2009). The optimal stroking velocities at which they fire vigorously are 1-10 cm/sec (Löken, Wessberg, Morrison, McGlone & Olausson, 2009) and the activation of CT-afferent fibers correlates with subjective ratings of pleasantness, indicating that CT-afferents may constitute a peripheral ascending pathway for pleasant tactile stimulation (Löken et al. 2009). Affective touch has been shown to enhance RHI both in subjective reports (Crucianelli et al. 2013; 2018; Lloyd et al. 2013) and in more implicit, behavioural measures (vanStralen et al. 2014), suggesting a strong link between affective touch and body awareness (Gentsch, Crucianelli, Jenksinson & Fotopoulou, 2016; Ciaunica & Fotopoulou, 2017; Fotopoulou & Tsakiris, 2017). More generally, it has been proposed that the core affective aspects of selfhood are shaped by embodied interactions with other people, including affective tactile experiences in early infancy and beyond (Fotopoulou & Tsakiris, 2017).

Overall, the evidence discussed above indicates that not only exteroceptive but also interoceptive information contribute to our sense of body ownership, with the latter being studied predominantly in the context of cardiac awareness and, more recently, affective touch. Nevertheless, no study to date has tested whether increasing affectivity during the process of multisensory integration would also enhance effects of ownership and recognition of our own face, which is an important aspect of personal and social identity. Moreover, given that affective touch is a specialised interoceptive modality coming from outside the body but simultaneously generating pleasant sensations within the body, it still remains unknown whether increasing affectivity exclusively outside the body would similarly enhance effects of recognition of our own face. Accordingly one of the aims of this thesis is to investigate the role of affective touch and facial attractiveness in the multisensory modulation of self-face recognition.

1.4 Making social decisions about the body

Section 1.3 focused on how people make sensory decisions about their bodies, i.e. how different factors influence the sense of body ownership/self-face recognition during the process of multisensory integration. Yet, we live in a social world and social interactions are crucial at every stage of life. In fact, human cognition is necessarily embedded in a social context (Schilbach, Eickhoff, Rotarsak-Jagiela, Fink & Vogeley, 2008), hence, social information may play a crucial role in how we experience our bodies.

1.4.1 The Social Origins of the (Bodily) Self

Over the past decades, there have been several debates in psychology, psychoanalysis, philosophy and neuroscience surrounding the question of whether bodily or social experiences form the basis of the constitution of the self and a large body of theoretical accounts and empirical evidence have been put forward, further contributing to the idea of a socially constructed self.

To begin with, building a mind is thought to be closely interwoven with the process of understanding other minds (Fotopoulou & Tsakiris, 2017). Nevertheless, scholars disagree on how exactly we get to know our bodily self, as well as understand other minds. One way is thought to be the first-person perspective (1PP) according to which we integrate multimodal signals into an egocentric reference frame (Vogeley et al., 2001; Blanke et al., 2015) and also “simulate” with our own, first-person, embodied perspective through mirror neurons (e.g. Gallese, 2005). Another way is by adopting a third-person perspective (3PP) and understanding other minds through cognitive inference (e.g. Morton & Frith, 1995). More specifically, this ability is referred to as ‘theory of mind’ (ToM) or ‘mentalising’ (Frith & Frith, 2007), which is the capacity to attribute mental states, such as beliefs, desires, feelings and intentions to oneself but also to others. More recently, a number of intermediate positions have been put forward, namely second-person approaches (Reddy, 2008; Schilbach et al. 2013 and interaction theory (Fuchs & De Jaegher, 2009; Gallagher, 2001; 2004), suggesting that people adopt neither a first-person nor a third-person perspective in understanding other minds. Instead, early, social interactions with other people starting in infancy and beyond are fundamental to build shared "we-experiences" that progressively form the basis for social understanding but also self-awareness (Fotopoulou & Tsakiris, 2017). In line with second-person approaches and interaction theories, there is a view highlighting the role of social bodily interactions as the primary organizers of the self (Ciaunica & Fotopoulou, 2017; Fotopoulou & Tsakiris, 2017). In fact, Fotopoulou and Tsakiris (2017) suggest that "mentalization" of the body throughout development does not only include one's own body but also other bodies in proximity with which one interacts.

Supporting evidence for this view comes from infant studies showing that mutual engagement during social interactions allows the infant to develop awareness of the self as the object of attention, and of others as "attending" beings, hence representing the self and other as separate psychological entities (Reddy, 2003; Akhtar & Gernsbacher, 2008). Moreover, a clinical study with 51 patients who had moderate to severe traumatic brain injury (TBI) showed that self-awareness difficulties are closely related to impairments in social signal processing, with a positive correlation found between performance in emotion recognition task and levels of self-awareness, both of which were significantly lower for TBI patients as compared to healthy controls (Spikman et al., 2013). Crucially, as discussed above, bodily self-awareness is a core element of self-awareness and it also appears to be influenced by social contact. While it has been recently shown that the perception of eye contact enhances bodily self-awareness (Baltazar et al., 2014; Conty, George & Hietanen, 2016), a recent study investigated the role of social contact in other sensory modalities, specifically auditory and tactile (Hazem, Beaurenaut, George & Conty, 2018). The findings showed that participants demonstrated more accurate rating of their bodily reactions following social contact, suggesting that social contact enhances bodily self-awareness irrespective of sensory modality. Overall, the evidence discussed above supports the view of a socially constructed self and the notion that interpersonal contact is crucial for developing an awareness of our bodies, indicating that bodily self-awareness should not be studied in passive isolation from its social context (Ciaunica & Fotopoulou, 2016).

1.4.2 Understanding Minds: From 'We' Experiences to Self-Other Distinction

The above section illustrated the importance of 'we' experiences and attuned, social interactions for developing social understanding, as well as (bodily) self-awareness. Yet**,** one capacity that is paradoxically crucial for understanding own and other minds, especially, when the two experiences are not aligned, is the capacity to distinguish between self- and other-representations (Singer & Lamm, 2009), often referred to as self-other distinction (Spengler, von Cramon & Brass, 2009). Self-other distinction is regarded as the perquisite for feeling empathy and engaging in prosocial behaviours. This is illustrated in the definition of empathy by Zahavi and Rochat (2015) according to which it is "the experience of the embodied mind of the other, an experience which rather than eliminating the difference between self-experience and other-experience takes the asymmetry to be a necessary and persistent existential fact". The self-other distinction has been studied in different domains such as perception-action in the form of inhibiting automatic imitation tendencies (Wang & Hamilton, 2012) and representation of mental states of others contradicting own mental states (Spengler, von Cramon & Brass, 2009).

Given that we often rely on our own experiences to infer those of others (Gallese and Goldman, 1998; Singer et al., 2004; Keysers and Gazzola, 2007), when these two experiences do not align, it is crucial for one to be able to mentally disengage from their embodied 1PP. In the affective domain, self-other distinction has been studied in the form of understanding the emotions of other people that may be congruent or incongruent to one's own. More specifically, Silani, Lamm, Ruff & Singer (2013) virtually paired up participants and delivered simultaneous tactile stimulation with materials of positive or negative valence while, at the same time, showing them separately a picture depicting what they were stimulated with, as well as what the other participant was stimulated with. The stimulation was either affectively congruent (both positive or both negative) or incongruent (one positive, other negative). Subsequently, participants were asked to judge how they felt and how they thought the other participant felt. The results showed that people tend to use the self as a reference point to judge the affective experience of other people, a bias referred to as emotional egocentricity (see more details in Introduction of Chapter 4). Therefore, people appear to have a tendency to project their own psychological states to other minds, failing to fully mentally disengage from their embodied 1PP (Samson et al., 2010; Silani et al., 2013).

Nevertheless, despite the fact that the aforementioned study set out to investigate people's ability to separate their own bodily experience from that of other people during social interactions, what the paradigm seems to be missing is an embodied social context. More specifically, participants were virtually paired (they saw pictures of the items that the other person was seeing in a computer screen) and, thus, were not able to actually see what the other participant was experiencing. Moreover, no research to date has explored how one's perception of their physical appearance in active comparison with others, may influence their understanding of own bodily experience and the ability to disengage it from others' bodily experience. Accordingly, another aim of this thesis is to investigate how we combine sensory signals from our own versus other bodies to perceive the bodily affective state (self-other distinction).

1.5 Making motivational decisions about the body

The previous sections focused on how we make sensory (i.e. self-face recognition) and social decisions (i.e. self/other distinction) about our bodies. This section will focus on how we make motivational, or value-guided decisions about our bodies, e.g. decisions that are guided by the expected value of a choice. In every-day life, most people have to make decisions with varying degree of importance in terms of their outcome and consequences, many of which are made in the face of uncertainty. For these decisions, people need to continually balance the benefits and costs of their decisions, with the cost taking different forms, such as time, effort or risk.

1.5.1 Value-guided Decision-Making in Anorexia Nervosa

Research has shown that clinical populations may have a bias in value-guided decision-making (e.g. Bickel et al., 2012). One type is delay discounting, defined as the degree to which a reward is devalued as a function of the delay of its receipt (Bickel & Marsch, 2001). In other words, the value of a reward declines with delay and most people appear to prefer immediate delivery of a smaller reward rather than delayed delivery of a bigger reward (e.g. Cardinal, 2006; Hardisty & Weber, 2009; Mazur, 1987). Delay discounting is typically assessed by tasks that provide a measure of choice impulsivity (preference for smaller-sooner rewards) and temporal foresight (preference for larger-later rewards) (Kekic et al., 2014). Delay discounting has been linked to a number of disorders. For instance, populations with substance abuse disorders (Bickel, et al., 2007; Kirby & Petry, 2004; Mackillop, et al., 2011), and other "impulsive" disorders (Madden, Francisco, Brewer, & Stein, 2011) have been found to show greater discounting. On the contrary, individuals with anorexia nervosa (AN), a disorder characterised among other clinical features by neglect of immediate reward (food) and fear of gaining weight, show the opposite behaviour. In other words, they tend to discount delays significantly less than healthy peers. In a recent study exploring delay discounting among AN individuals, AN patients were found to reduce the value of a monetary reward over time significantly less than their healthy peers (Steinglass et al., 2016). Similarly, Decker, Figner & Steinglass (2015) found that before treatment, the AN group showed a preference for delayed over earlier rewards as compared to healthy controls, yet after weight restoration, there were no significant differences between the two groups. The results suggest that the undernourished state of AN may, in fact, amplify this tendency to discount delay significantly less. This tendency to discount the reward of food now in order to achieve an ideal body later, has been attributed to dysregulated ventral striatal pathways and hyperactive dorsal cognitive circuits (Kaye et al., 2013).

Apart from delay of receipt, risk is another form of cost of a decision. As mentioned in sections 1.2.2 and 1.2.3, increasingly more people engage in behaviours, such as starvation or seeking cosmetic surgery, conferring risks onto their bodies in pursuit of an ideal body. Hence, this thesis will focus on risk discounting, which is another type of value-guided decision, whereby a smaller reward is accepted in exchange for a smaller risk. Surprisingly, there seems to a significant lack of research on risk discounting in such populations, especially with reference to body appearance. The section that follows will discuss the literature of risk discounting among patients with eating disorders (ED), highlighting an important gap in the literature.

1.5.2 Risk Discounting in Eating Disorders

Risk-taking is a topic that has received extensive scientific interest given that it is directly linked to the choices we make and, ultimately, the quality of our lives. Risk-taking behaviours are defined as those potentially involving a varying degree of harm, whilst also having the potential to elicit beneficial or rewarding consequences (Leigh, 1999). In terms of risk-taking in eating disorders, a meta-analysis on self-report data has shown that patients with restrictive types of AN tend to take fewer risks (Harrison et al., 2010), whereas research with binging patients has led to inconsistent results. On the one hand, there is some evidence suggesting that binging patients engage in more risk-taking behaviours as compared to healthy controls (Svaldi, Brand & Tuschen-Caffier, 2010) and choose more often risky options with small outcome expectancies (Brand et al., 2007; Tchanturia et al., 2007; Brogan et al., 2010). On the other hand, other studies with larger sample sizes have not found any differences between binging patients and healthy controls (Cavedini et al., 2004; Van den Eynde et al., 2012; Wu et al., 2013). However, in these studies participants were not primed with food, hence limiting conclusions regarding the decision-making processes involved in binge. Recently, a cross-sectional study was conducted with binging patients: 20 with bulimia nervosa (BN) and 23 with anorexia nervosa binging type (ANB) and two control groups: 22 non-binging restrictive anorexia nervosa (ANR) patients and 20 healthy controls, without any concomitant impulsive disorder (Neveau, 2016). Participants were asked to complete a behavioural risk-taking task and before each trial an image was displayed, representing a food, stressful or neutral stimulus. The results showed that food stimuli triggered more conservative choices with a higher aversion to losses and, hence, lower sensitivity to reward, in both binging and non-binging patients with BN and ANR after being primed by binge food cues as compared to neutral cues. Their choices were similar to the choices made by healthy participants when they were primed with stressful cues. ANB patients exhibited a higher variability in their choices in the food as compared to neutral condition and this higher variability was associated with higher difficulties to discard irrelevant information. Overall, it appears that binging and non-binging patients' decision-making under uncertainty was modulated toward safe options when patients were primed by binge foods cues as was the case when healthy participants had to make decisions under uncertainty and were primed with non-food stressful cues. Fear and avoidance of food appear to be core affective and behavioural aspects of body image disturbances, yet the motivation behind them is that they interact and lead to weight gain and loss (e.g. Steinglass et al., 2010), hence influencing the appearance of the body. It is, therefore, crucial to explore risk discounting among patients with body image disturbances with specific reference to body appearance, something that, to the best of my knowledge, no study to date has ever investigated. Last but not least, the majority of research so far has focused on individuals with clinical eating disorders. However, the growing prevalence of body image concerns among healthy individuals, suggests that emphasis should also be put on people with body image disturbances at sub-threshold levels. Accordingly, one of the aims of this thesis is to use a novel behavioural task to investigate risk discounting with specific reference to body appearance among individuals with clinical, as well as sub-clinical body image disturbances.

1.6 Overview of Thesis

Based on the above review, in a series of empirical studies, this thesis will focus on: 1) how we combine sensory modalities to perceive our bodily self (self-face recognition), 2) how we combine sensory signals from our own versus other bodies to perceive the bodily affective state (self-other distinction) and 3) how we compare ideals about the body against other rewards and risks to make body-related decisions (value-guided decisions made under uncertainty). These questions will be addressed in healthy individuals, people with non-clinical disordered eating, as well as patients with anorexia nervosa (restricting type). These empirical studies are outlined below:

<u>*Making sensory decisions about the body*</u>

Study 1: The Role of Affective Touch in the Multisensory Modulation of Self-Face Recognition *(Chapter 2).*

As reviewed in section 1.3, a growing body of evidence points to a strong link between affective touch and bodily awareness. However, while there is evidence suggesting that affective touch modulates the experience of body ownership, no study to date has tested whether increasing affectivity during the process of multisensory integration would enhance effects of recognition of our own face, an important aspect of personal and social identity. This study used the enfacement illusion paradigm to investigate for the first time the role of affective touch vs. neutral touch in the multisensory modulation of self-face recognition over two experiments. In line with previous evidence, higher levels of enfacement for affective (slow) vs. neutral (fast) touch were predicted for temporally and spatially congruent interpersonal stimulation.

Study 2: The Role of Attractiveness in the Multisensory Modulation of Face Ownership *(Chapter 3).*

As reviewed in section 1.3, affective touch is a specialised interoceptive modality coming from outside the body but simultaneously generating pleasant sensations within the body. However, it still remains unknown whether increasing affectivity exclusively from outside would similarly enhance effects of ownership of our face. While the previous study focused on the physical body perceived from inside (i.e. affective touch), this study focused on external perception of a body, i.e. perception of its physical appearance. The study used the enfacement illusion to investigate for the first time, over two experiments, how another person's facial attractiveness may modulate the multisensory modulation of one's face ownership. In line with previous evidence, higher levels of enfacement for attractive vs. non-attractive face were predicted for temporally and spatially congruent interpersonal stimulation.

Making social decisions about the body

Study 3: Separating the Self from Beauty: The Role of Perceived Attractiveness in Self-Other Distinction in an Embodied Context *(Chapter 4).*

As reviewed in section 1.4 sharing 'we' embodied experiences is crucial for interpersonal understanding, as well as for developing self-awareness. Moreover, the ability to distinguish between own and other mental states appears to be a prerequisite for interpersonal understanding and it has, therefore, been studied extensively in the cognitive and affective domain. Nevertheless, there seems to be a lack of research on self-other distinction in an embodied context, involving bodies in proximal distance from one another. Moreover, the question remains as to how the perception of one's own physical appearance in active comparison with another person, may influence the ability to separate own bodily experience from that of others during social interactions. Over two experiments, this study explored for the first time the role of perceived attractiveness in self-other distinction in an embodied context, using a novel visuo-tactile paradigm assessing egocentricity. In line with previous evidence, it was hypothesised that people who perceived themselves as more physically attractive than others would project their own emotional, embodied experience into others, whereas people who perceived themselves as less physically attractive would introject the emotional, embodied experience of others.

Making motivational decisions about the body

Study 4: Body Size Risk Taking in Individuals with Sub-clinical Body Image Disturbances *(Chapter 5).*

As reviewed in section 1.5, patients with eating disorders demonstrate various biases when they make value-guided decisions, such as delay discounting and risk discounting. Yet, there has been a significant lack of research on risk discounting with specific reference to body appearance. Given the growing prevalence of body image concerns among healthy individuals, this study investigated for the first time the relationship between risk-taking and reward processing among women with body image disturbances at sub-threshold levels, using a novel body task for risk-taking. It was hypothesised that, for people with high body image concerns, the extent of risk-taking would be moderated by the value of the reward. More specifically, those people would be more risk averse when both reward and risk were coupled with a 'feared' body outcome (i.e. a body increasing in size) and risk aversion would be lower when both reward and risk were coupled with an 'idealised' body outcome (i.e. body decreasing in size).

Study 5: Body-Related Risk taking in Anorexia Nervosa *(Chapter 6).*

This study is a replication of Study 4 on a clinical population. More specifically, the study investigated the relationship between risk-taking and reward processing among patients with Anorexia Nervosa (AN), recovered patients and healthy controls. It was hypothesised, that for individuals with AN, the extent of risk-taking would be moderated by the value of the reward. More specifically, they would be more risk averse when both reward and risk were coupled with a 'feared' body outcome (i.e. a body increasing in size) and risk aversion would be lower when both reward and risk were coupled with an 'idealised' body outcome (i.e. body decreasing in size), as compared to recovered patients and, to a greater extent, healthy controls.

Chapter 2 |

The Role of Affective Touch in the Multisensory Modulation of Self-Face Recognition

2.1 Introduction

While classic views on interoception define it as the "perception of the body from within", according to a more recent notion of interoception the perception of the physiological state of the body involves both sensations from within the body, e.g. cardiac and respiratory functions, thirst, digestion, as well as sensations whose stimuli are typically located outside the body, e.g. taste, pain, affective touch (Craig, 2002; Ceunen, Vlaeyen & Van Diest, 2016). As mentioned in Chapter 1, sensory pleasure on the skin, i.e. affective touch, is thought to be coded by specialised, slow-conducting, unmyelinated peripheral nerve fibers, known as C tactile afferents (Olausson et al., 2002; McGlone, Vallbo, Olausson, Löken & Weeberg, 2007) which are found in hairy skin (Vallbo, Olausson & Wessberg, 1999; Liu et al. 2009). The optimal stroking velocities at which they fire vigorously are 1-10 cm/sec (Löken, Wessberg, Morrison, McGlone & Olausson, 2009) and the activation of CT-afferent fibers correlates with subjective ratings of pleasantness, indicating that CT-afferents may constitute a peripheral ascending pathway for pleasant tactile stimulation (Löken et al. 2009). Research has shown that CT-afferents may project via thalamic pathways to the posterior insular cortex (Olausson et al., 2002; Morrison, Bjornsdotter & Olausson, 2011; but see Gazzola et al., 2012), conferring thus the affective value of this type of touch.

Recent evidence suggests that affective touch may be involved in the construction and maintenance of body ownership (Crucianelli, Metcalf, Fotopoulou & Jenkinson, 2013; van Stralen et al., 2014; Lloyd, Gillis, Lewis, Farrell & Morrison, 2013; Crucianelli, Krahé, Jenkinson & Fotopoulou, 2017) which is defined as the psychological sense that the physical body "belongs to me" (Gallagher, 2000). Over the last 20 years, psychophysical and computational research has shown that the sense of body ownership relies on the integration of information from different sensory modalities, the so-called, multisensory integration (Tsakiris & Haggard, 2005). Well-known paradigms such as the "rubber hand illusion" (RHI; Botvinick & Cohen, 1998; Tsakiris & Haggard, 2005) and the "full body illusion" (Ehrsson, 2007; Lenggenhager, Tadi, Metzinger & Blanke, 2007) have demonstrated that temporal and spatial congruence between felt and seen sensory events gives rise to feelings of body ownership, even for plastic or virtual body parts. Importantly, other aspects of the bodily self, such as the ability to recognise our own face, appear susceptible to change through synchronous, multisensory stimulation (Tsakiris, 2008; Sforza, Bufalari, Haggard, & Aglioti, 2010; Paladino, Mazzurega, Pavani & Schubert, 2010). Self-face recognition is considered as an index for self-awareness (Povinelli & Simon, 1998; Gallup, 1970; Rochat, 2009) thought to be supported by both off-line stored information on one's face appearance (Tong & Nakayama, 1999; Sugiura et al., 2014) and on on-line multisensory integration mechanisms (Apps & Tsakiris, 2014; Sugiura et al., 2014). It was only recently that the role of multisensory integration in self-face recognition was tested for the first time (Tsakiris, 2008). Participants were stroked on the face while they were watching a video with another face being stroked in synchrony or asynchrony (1s delay) and they performed a self-recognition task before and after this interpersonal visuo-tactile stimulation. The results showed that after synchronous, but not asynchronous stimulation, participants accepted as self-stimuli faces that were significantly more morphed towards the other face. Similar effects were reported in the description of this "enfacement illusion" (Sforza et al., 2010), while there is also evidence that this blurring of self-other boundaries extends beyond body perception to a more conceptual merging between self and other, by affecting social cognition processes (Paladino et al., 2010). Moreover, research has shown that synchronous interpersonal multisensory stimulation influences affective judgements of the other face, including ratings of greater attractiveness and trustworthiness (Tajadura-Jiménez, Longo, Coleman & Tsakiris, 2012).

However, to the best of my knowledge, the opposite relation, namely how affective experiences may influence self-face recognition has not been investigated. Even in the case of body ownership, the majority of studies to date have focused on how exteroceptive signals such as vision and discriminatory touch are integrated, while the role of interoceptive signals in body ownership has been investigated only recently. For instance, as mentioned in section Chapter 1, in two virtual reality studies (Aspell, et al., 2013; Suzuki, Garfinkel, Critchley & Seth, 2013) visual feedback of participants' own heartbeat was provided 'on-line' (i.e. during the virtual reality tasks) by means of a flashing virtual body or hand in synchrony or out-of-synchrony with the participants' own heartbeats, with the synchronous condition increasing self-identification with the virtual body (Aspell, et al., 2013) and embodiment of the rubber hand (Suzuki et al., 2013), respectively. Thus, when interoceptive signals are artificially provided also in the visual domain, vision seems capable of 'capturing' interoception, leading to enhanced down regulation of proprioception as in the classic RHI paradigm. Most importantly for the present study, affective (CT-optimal) touch has been found to enhance the experience of owning a rubber hand more than neutral (CT-suboptimal) touch, in both subjective report (Crucianelli et al., 2013; 2017; Lloyd et al., 2013) and in implicit, behavioural measures (van Stralen et al., 2014), for mixed results see de Jong, Keizer, Engel & Dijkerman, 2017. Such findings suggest a strong link between affective touch and body awareness (Gentsch, Crucianelli, Jenksinson & Fotopoulou, 2016; Ciaunica & Fotopoulou, 2017; Fotopoulou & Tsakiris, 2017). More generally, it has been suggested that the core affective aspects of selfhood are shaped by embodied interactions with other people throughout the lifespan and starting with affective touch experiences in early infancy (Fotopoulou & Tsakiris, 2017). Nevertheless, the potential (developmental) role of affective touch in self-formation and self-other boundaries remains an understudied scientific question. While there is the above evidence that affective touch modulates the experience of body ownership, no study has tested whether increasing affectivity during the process of multisensory integration would enhance effects of recognition of our own face, an important aspect of personal and social identity.

To this end, the present study used the enfacement illusion paradigm to investigate for the first time the role of affective touch in the multisensory modulation of self-face recognition in two experiments. In the first experiment, participants were stroked on the cheek while they were looking at another unfamiliar face being stroked on the cheek in synchrony or asynchrony with affective (slow; CT-optimal) vs. neutral (fast; CT-suboptimal) touch. The second experiment was identical to the first but instead of using asynchrony, spatial incongruence of touch (cheek vs. forehead) was introduced as an alternative control condition. In both experiments, participants were asked to perform a self-recognition task before and after the interpersonal visuo-tactile stimulation in which they were presented with a movie showing their face morphing in 1% incremental steps into the other face, or vice versa, and they were instructed to stop the movie at the point where they felt that the face began to look more like the face it was morphing into. They also completed a questionnaire (see details in Methods) capturing their subjective experience. In line with previous evidence, higher levels of enfacement for affective (slow) vs. neutral (fast) touch were predicted when the stroking was synchronous (Experiment 1) and spatially congruent (Experiment 2).

2.2 Experiment 1

2.2.1 Method

2.2.1.1 Participants

Thirty right-handed healthy females (age 25.16 ± 3.13SD years) were recruited from UCL Psychology Subject Pool and took part in a single 1-hour session for course credit or £10. The sample size was determined based on prior power calculations (Cohen's d set at 0.25; G*Power 3.1) in accordance with the average effect sizes reported in experimental social psychology (Richard, Bond & Stokes-Zoota, 2003). Participants had no known physical and mental illness and no skin diseases. Signed informed consent was obtained from all participants prior to their participation. The study was approved by the Ethics Committee of the Research Department of Clinical, Educational and Health Psychology, University College London. The experiment was performed in accordance with relevant guidelines and regulations.

2.2.1.2 Design

The experiment employed a 2x2 within-subjects design with two factors: 1) Synchrony (synchronous vs. asynchronous) and 2) Stroking Velocity (slow, affective vs. fast, neutral). The dependent measures were: a) a self-recognition task as a behavioural measure of the illusion and b) an enfacement questionnaire capturing the subjective experience of the illusion (see Materials section for details). As a manipulation check, participants were asked to rate how pleasant the touch was.

2.2.1.3 Materials

Construction of the Visuo-tactile Stimulation Videos:

For the induction of the illusion, enfacement movies were created displaying an unfamiliar face (same sex, same age+/- 5 years; see Tajadura-Jiménez et al., 2012) being stroked on the cheek with a cosmetic-like soft brush. Each stroke covered a distance of 6cm on the cheek and there were two stroking velocities; slow (3cm/s) and fast (18cm/s). The stimulation time across slow and fast stroking was kept constant (Crucianelli et al., 2013; 2017). A resting period interleaved each stroke. For slow touch, there were 2 sec of stimulation followed by 2 sec of rest, while for fast touch there was 1 sec of stimulation followed by 1 sec of rest. Each movie lasted 120 sec with 60 sec of tactile stimulation and 60 sec of rest. The mismatch between visual and tactile stimulation in the asynchronous conditions was 1 second, hence the amount of stimulation across synchronous and asynchronous was kept constant. Two different unfamiliar faces were used in the experiment, so that half of the participants saw Face 1 for slow and Face 2 for fast touch and vice versa.

Construction of Morphing Movies for the Behavioural, Self-recognition Task

A digital photograph of the participant was taken at the beginning of the experimental session. The participant's face in the photograph was mirror-transposed, converted to greyscale, and all non-facial attributes were removed (e.g. background, hear, ears) with GNU Image Manipulation Program (GIMP). A computerized morphing procedure implementing a mesh warping algorithm (Abrasoft Fantamorph) was used to merge each participant's face with the unfamiliar face (Face 1 and 2) in 1% steps resulting in 100 frames with graded blending of the facial features of the two faces. For each participant, four morphing movies were created since there were two unfamiliar faces (Face 1 and 2) and two directions: from 100% self to 0% self (*"self to other"* direction) and from 0% self to 100% self (*"other to self"* direction). Each movie lasted 33 seconds and contained 100 frames.

Enfacement questionnaire (Subjective Measure):

After each stimulation session, participants were also asked to complete an enfacement questionnaire to capture the subjective experience of the illusion. The questionnaire contained 8 items presented in a random order (7-point Likert-type scale; -3, strongly disagree; +3, strongly agree) (Figure 2.1). The statements were selected from previous studies of multisensory-induced body illusions (see Tajadura-Jiménez et al., 2012). Based on a principal component analysis (Tajadura-Jiménez et al., 2012), the questionnaire used consisted of three sub-components: *self-identification,* that is the extent to which participants feel that the other's face is theirs (items 1-3, 6); *similarity,* that is the extent to which participants perceive the other's face as similar to theirs (items 4,5); and *affect,* that is the extent to which participants judge the other's face as attractive and trustworthy (items, 7,8). The overall subjective enfacement score was obtained by averaging these three subcomponent scores (Figure 2.1).

1. I felt like the other's face was my face
2. It seemed like the other's face belonged to me
3. It seemed like I was looking at my own mirror reflection
4. It seemed like the other's face began to resemble my own face
5. It seemed like my own face began to resemble the other person's face
6. I felt that I was imitating the other person
7. I found the other face attractive
8. I found the other face trustworthy

Figure 2. 1 Enfacement Questionnaire

2.2.1.4 Procedure

Computer-generated stimulation was controlled by a customized software program (Presentation software, Neurobehavioral Systems Inc.) and presented on the screen, which was placed at a viewing distance of approximately 50 cm. At the beginning of the session, participants were asked to complete the baseline *self-recognition task* watching the morphing movie (Figure 2.2a). For the “other to self” direction of morphing, participants were asked to press the space key, with their right index finger, as soon as they perceived the face to look more like “self” than “other”. For the “self to other” direction movies, participants were asked to press the same key when they perceived the face to look more like “other” than “self”. As soon as the participants pressed the key, the movie stopped and the number of seconds at which the movie was stopped was recorded each time. Participants received prior training on this task, by watching movies where Face 1 was morphing to Face 2 or vice versa. Following the baseline *self-recognition task*, participants were instructed to look at the screen placed in front of them, relax and simply observe the visuo-tactile stimulation video, which lasted 120 sec. The models in the movie looked straight at the camera with a neutral expression. As soon as the video began, tactile stimulation was delivered on the participant's right cheek using the same cosmetic-like soft brush. The experimenter (i.e. author of this thesis) manually delivered tactile stimulation on the participant's cheek on a specular congruent location between both faces (Figure 2.2b). She was previously trained to deliver synchronous and asynchronous stimulation (1-sec delay), by listening through earphones the audio file of the visuo-tactile stimulation video and learning to pace her tactile stimulation with a tone and, later, by counting seconds. During the testing, a research assistant was present in the room, yet out of the view of the participant, in order to ensure that the interpersonal visuo-tactile stimulation was synchronous and asynchronous (with exactly 1-sec delay), respectively. Therefore, participants were touched on the same location in four different ways: synchronously with slow velocity (*slow synchronous*), synchronously with fast velocity (*fast synchronous*), with 1-sec-delay and slow velocity (*slow asynchronous*) and with 1-sec-delay and fast velocity (*fast asynchronous*) (Figure 2.3a). After the tactile stimulation period, participants performed exactly the same *self-recognition task* as in baseline. At the end of the task, participants completed the *enfacement questionnaire,* followed by the *subjective pleasantness rating* for the tactile stimulation (Figure 2.3b). In total, each participant performed 4 blocks (one for each condition). The order of blocks was randomised and there was a two-minute break between blocks, during which participants were asked to look at their face in order to break the illusion (Photobooth application for Mac computers).

a.

b.

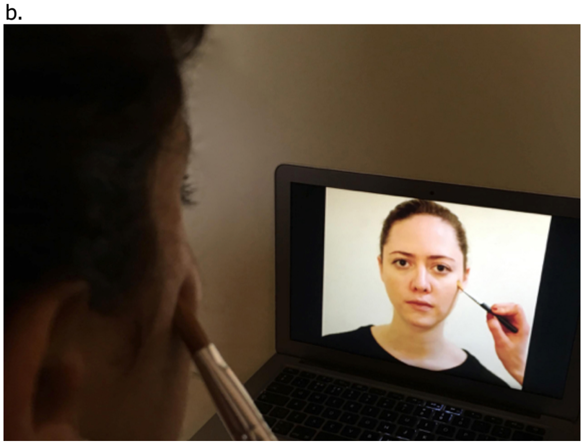

Figure 2. 2 Illustrative example of the morphing procedure with direction of morphing (from "other to self" and from "self to other") displayed in the two types of movies (Fig 2a) and experimental set-up during interpersonal visuo-tactile stimulation (Fig 2b).

a.

	Slow touch (affective)	**Fast touch (neutral)**
Synchronous	Slow synchronous	Fast synchronous
Asynchronous	Slow asynchronous	Fast asynchronous

b.

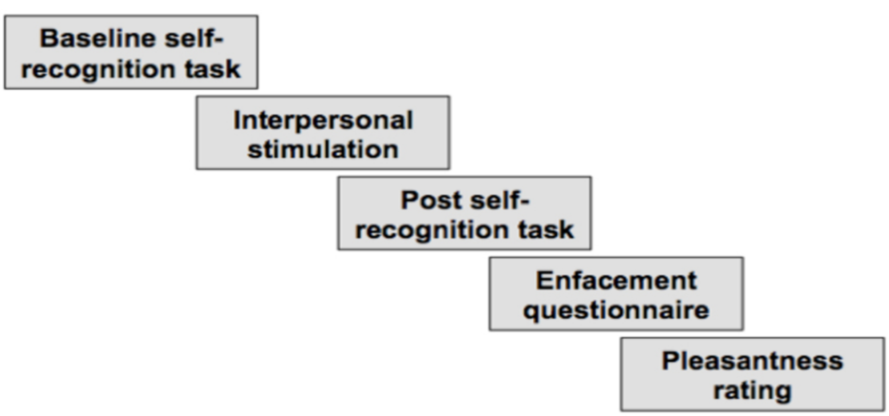

Figure 2. 3 Four different conditions (blocks) (Fig 3a) and experimental procedure per block (Fig 3b).

2.2.1.5 Data analysis

Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) version 23 (IBM, Chicago, IL, USA). For our manipulation check, given that pleasantness ratings were not normal, Wilcoxon signed-rank tests were performed. For the overall subjective enfacement (i.e. average score of enfacement questionnaire), repeated-measures analysis of variance (ANOVA) were performed, with Synchrony (synchronous vs. asynchronous) and Stroking Velocity (slow vs. fast) as within-subject factors. The same analysis was performed for the individual sub-components of the questionnaire: self-identification, similarity and affect. For the analysis of the self-recognition task, the means of seconds at which participants stopped the videos were converted into % of frames containing the "self". There is evidence from previous research using brain stimulation that the ability for self-other discrimination is influenced independently of the direction of morphing videos (Heinisch, Dinse, Tegenthoff, Juckel & Brüne, 2010; Heinisch, Krüger & Brüne, 2012; Payne & Tsakiris, 2016). Given that there was no interest in the directions themselves, the two directions of morphing ("self to other" and "other to self") were averaged and the mean values were submitted to a 2x2x2 ANOVA, with the factors of Synchrony (synchronous vs. asynchronous), Stroking velocity (slow vs. fast) and Judgment (pre vs. post). All post hoc analyses were performed using Bonferroni correction. Level of significance was set to 0.05.

2.2.2 Results

2.2.2.1 Subjective Enfacement

Overall Enfacement: *Composite score of Self-identification, Similarity and Affect*

A 2x2 ANOVA revealed a significant main effect of "synchrony" (F (1,29) = 40.53, $p < .001$, $\eta^2 = .583$) with synchronous stroking (mean = .456, SE = .125) producing higher levels of subjective enfacement as compared to asynchronous stroking (mean = -.400, SE = .142), which confirmed the presence of the illusion. A significant main effect was also found for "stroking velocity" (F (1,29) = 5.87, $p = .022$, $\eta^2 = .168$) with slow stroking (mean = .247, SE = .146) producing higher levels of subjective enfacement as compared to fast stroking (mean = -.192, SE = .148). The interaction between "synchrony" and "stroking velocity" was not significant (F (1,29) = .811, $p = .375$, $\eta^2 = .027$), (Figure 2.4).

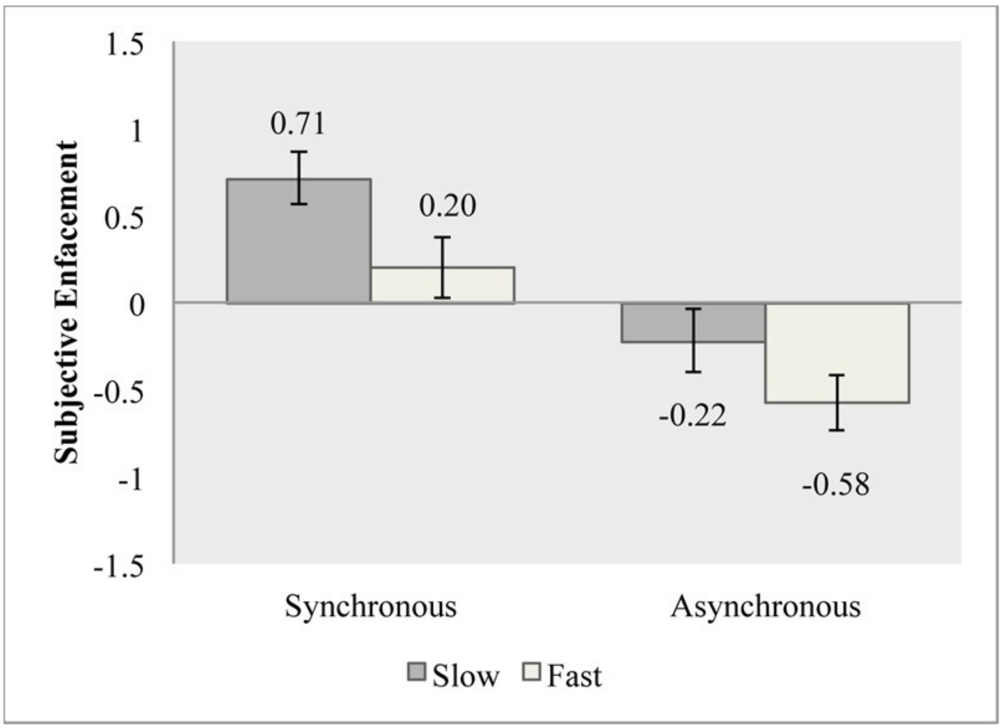

Figure 2. 4 Means for overall subjective enfacement in Exp. 1. Higher scores indicate greater enfacement. Error bars denote standard errors.

Sub-component analysis

The same pattern of results was found for the individual subcomponents of the questionnaire, with synchronous stroking, as compared to asynchronous, producing higher levels of both self-identification [F (1,29) = 36.03, $p < .001$, $\eta^2 = .554$] and similarity [F (1,29) = 24.07, $p < .001$, $\eta^2 = .454$] and slow stroking, as compared to fast, also producing higher levels of self-identification [F (1,29) = 4.86, $p = .036$, $\eta^2 = .144$] and similarity [F (1,29) = 6.98, $p = .013$, $\eta^2 = .194$]. With regards to the affect component, synchronous stroking led to higher levels of affect towards the other face [F (1,29) = 6.32, $p = .018$, $\eta^2 = .179$]. The effect of stroking velocity was not significant but a trend of more affect following slow stroking as compared to fast stroking was noted [F (1,29) = 3.42, $p = .075$, $\eta^2 = .106$]. All interactions between synchrony and stroking velocity were non-significant (see Appendix 1 for illusion sub-component scores).

2.2.2.2 Self-recognition task

The analysis revealed a significant main effect of "judgment" (F(1,29) = 4.81, $p = .036$, $\eta^2 = .142$). The two-way interaction between "synchrony" and "judgment" was significant (F(1,29) = 4.41, $p = .045$, $\eta^2 = .132$), as well as the two-way interaction between "synchrony" and "stroking velocity" (F(1,29) = 7.52, $p = .010$, $\eta^2 = .206$). Bonferroni-corrected post hoc tests revealed that the percentage of "self" in the average frame significantly increased in post-tests when the stimulation was synchronous (t(20) = -2.72, $p = .011$, $d = 0.41$) but not asynchronous (t(29) = .719, $p = .478$, $d = 0.11$). Moreover, slow stimulation led to a significantly higher percentage of "self" in the average frame as compared to fast stimulation, only when the touch was synchronous (t(29) = 2.59, $p = .015$, $d = 0.41$) but not asynchronous (t(29) = -.349, $p = .729$, $d = 0.06$) (Figure 2.5).

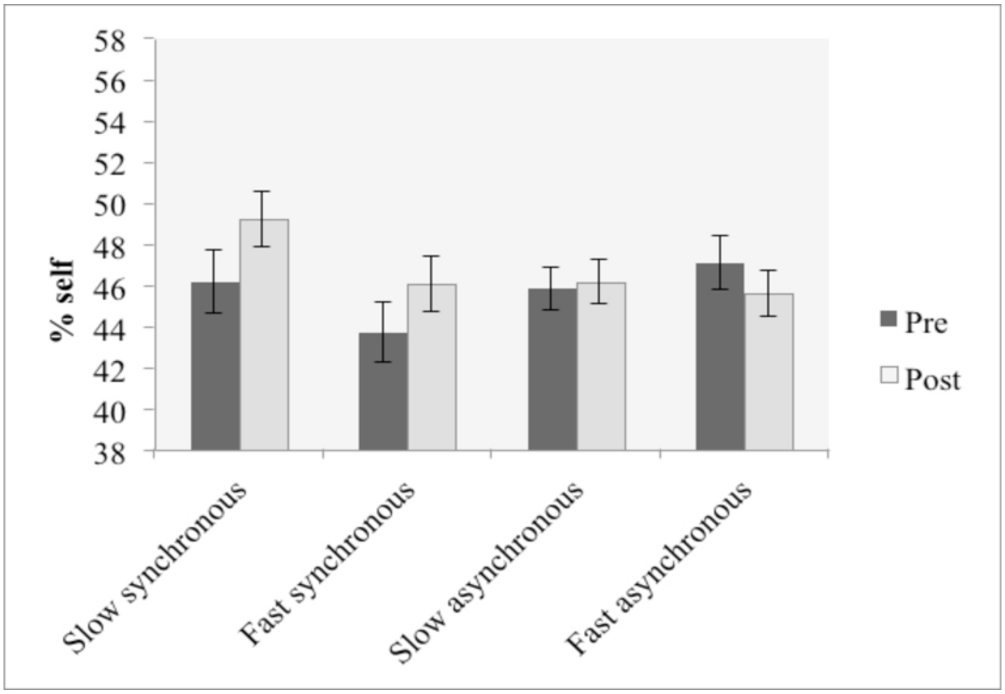

Figure 2. 5 Means for percentage of frames containing 'self' in the different conditions. Error bars denote standard errors.

2.2.2.3 Pleasantness Ratings

To establish whether slow touch was perceived as significantly more pleasant that fast touch (a manipulation check), the main effect of "stroking velocity" on pleasantness ratings was examined. A Wilcoxon signed ranked test confirmed that participants perceived slow stroking (median = 1.25, IQR = 1.63) as significantly more pleasant than fast stroking (median = -.25, IQR = 2.00, Z = -4.45, $p < .001$, r = -.812).

2.2.3 Discussion

The first experiment set out to investigate the modulation of self-face recognition by affective touch using asynchrony as a control condition. Participants were stroked on their cheek while they were watching an unfamiliar face being stroked on the cheek in synchrony or asynchrony with slow (3cm/s) vs. fast (18 cm/s) velocity. Higher levels of enfacement were predicted for slow vs. fast velocity when the stimulation was synchronous.

As expected, it was found that slow touch (3 cm/s) was perceived as more pleasant than fast touch (18 cm/s). This suggests that our touch manipulation was successful. With regards to subjective enfacement (as captured by the enfacement questionnaire), it was found that synchronous stimulation led to higher levels of enfacement as compared to asynchronous stimulation, confirming the important role of multisensory integration in self-face recognition (Tsakiris, 2008; Sforza et al., 2010; Paladino et al., 2010, Tajadura-Jiménez et al., 2012). Yet, the first direct evidence that the velocity of touch is crucial was also provided, given that affective (slow) touch led to significantly higher levels of overall subjective enfacement as compared to neutral (fast) touch. Interestingly, and contrary to our predictions, no interaction between synchrony and stroking velocity were found. Thus, subjective enfacement was present when the stimulation was synchronous, i.e. positive ratings, and these appeared to increase further when slow, affective touch was applied. By contrast, asynchronous stimulation led to negative ratings, yet these were less negative in slow than in fast touch. Thus, affective touch increased feelings of enfacement and decreased feelings of non-enfacement. The former effect of affective touch on synchronous stimulation had been predicted but not the effect of affective touch on asynchronous stimulation. Taken together, these results suggest that synchrony and affective touch may have orthogonal effects on self-face recognition during the enfacement illusion (see below for potential mechanisms behind these effects and the rationale behind our second experiment).

The same pattern of results described for the overall subjective enfacement was also seen for the individual sub-components, self-identification and similarity. While previous research has shown that even when we feel dissimilar to others, shared multisensory experiences can change the self-other boundaries leading to increased similarity (Tsakiris, 2008; Paladino et al., 2010), in this study it was demonstrated that when those synchronised sensory experiences are affective in nature, perceived similarity and identification with others increased even more when the stimulation was synchronous and decreased less when the stimulation was asynchronous. It therefore appears that affective touch in the context of multisensory integration can alter aspects of the selfhood, i.e. self-other boundaries (Fotopoulou & Tsakiris, 2017), giving rise to a "like-me" nature of others. According to developmental models, this "like-me" nature is the starting point for social cognition and intersubjectivity (Meltzoff, 2007a; 2007b).

With regards to the self-recognition task, the presence of the illusion was confirmed, by finding a two-way interaction between synchrony and judgment. That is, synchronous stimulation, but not asynchronous, led to a significant change in self-recognition. A significant two-way interaction between synchrony and velocity was also found, but this was not significant when baseline scores were taken into account in the three-way interaction. Therefore, the results show that affective touch had no significant effect on behavioural self-face recognition.

More generally, recent studies have shown that both synchrony and asynchrony can have effects on multisensory integration and on body ownership and these may be caused by partly independent mechanisms (Rohde, Di Luca & Ernst, 2011; Abdulkarim & Ehrsson, 2015). Specifically, while synchrony may be a necessary condition for multisensory integration, asynchrony may cause more than just 'non-integration' of sensory modalities[38]. Indeed, the intersensory conflict arising from asynchronous stimulation has been found to underlie unpleasant feelings of "deaffererence", a sensation that one's own limb is felt as numb and less vivid (Longo, Schüür, Kammers & Tsakiris, 2008). Thus, asynchrony, the most commonly used control condition in multisensory integration paradigms, may not actually be perceived as a neutral, baseline condition.

In this experiment, it was demonstrated that affective touch, as a specialised interoceptive modality with positive valence, leads to increased subjective enfacement (as compared to neural touch) after synchronous tactile stimulations, in line with previous research (Crucianelli et al., 2013; 2017), which has shown that the experience of owning a rubber hand is enhanced when the touch is slow and synchronous. Yet, what was also demonstrated for the first time is that slow, affective touch also leads to less subjective "resistance" to the illusion in asynchronous conditions. It is suggested that this reduction may be explained as a reduction of subjective "deafference" by affective touch during asynchronous stroking.

To validate our conclusions regarding our main aim, namely the role of affective touch in self-face recognition, a second experiment was conducted using spatial incongruence as a control condition in order to understand whether our results were due to general affectivity or potentially orthogonal mechanisms of affective touch and temporal synchrony effects on self-face recognition. Spatial incongruence was chosen as a control condition given that there is no evidence that it causes the same degree of "deafference" as asynchrony, and also because it controls for the general effect of increased attention during synchronous interpersonal visuo-tactile stimulation[41]. In other words, synchronous stimulation ensured comparable levels of attention, whereas the congruence of the location was used to selectively induce the illusion or not. In the second experiment, participants were touched on a congruent or incongruent location (cheek vs. forehead) with affective (slow; CT-optimal) vs. neutral (fast; CT-suboptimal) touch. Slow, affective touch was expected to enhance enfacement as compared to fast, neutral touch for spatially congruent stimulation, but not to reduce "resistance" to the enfacement for spatially incongruent stimulation.

2.3 Experiment 2

2.3.1 Method

2.3.1.1 Participants

Thirty-eight right-handed healthy females (age 22.30 ± 3.31SD years) were recruited from UCL Psychology Subject Pool and took part in a single 1-hour session for course credit or £10. The sample size (N=35) was determined based on prior power calculations (Cohen's d set at 0.25; G*Power 3.1) in accordance with the average effect sizes reported in experimental social psychology (Richard, Bond & Stokes-Zoota, 2003). Three additional participants were tested given that due to multiple cancellations extra slots were booked to ensure that the total sample size will be reached. Due to a technical problem it was not possbile to play the morphing videos for one of the participants so there are only subjective ratings for this subject. Participants had no known physical and mental illness and no skin diseases. Signed informed consent was obtained from all participants prior to their participation. The study was approved by the Ethics Committee of the Research Department of Clinical, Educational and Health Psychology, University College London. The experiment was performed in accordance with relevant guidelines and regulations.

2.3.1.2 Design, Materials, Procedure

Design, materials and procedures were identical to Experiment 1, but in this experiment in half of the blocks participants were touched on a congruent location (i.e. cheek) with slow vs. fast velocity, and in the other half they were touched on an incongruent location (i.e. forehead) with slow vs. fast velocity.

2.3.1.3 Data analysis

Data analysis was identical to Experiment 1 but with Congruence used instead of Synchrony as a within-subjects factor.

2.3.2 Results

2.3.2.1 Subjective Enfacement

Overall Enfacement: *Composite score of Self-identification, Similarity and Affect*

A 2x2 repeated ANOVA revealed a significant main effect of "spatial congruence" (F (1,37) = 31.24, $p < .001$, η^2=. 458) with stroking on a congruent location (mean = .304, SE = .155) producing higher levels of subjective enfacement as compared to stroking on an incongruent location (mean = -.336, SE = .146), confirming the presence of the illusion. A significant main effect of "stroking velocity" was also found (F (1,37) = 4.83, p = .034, η^2=.116), with slow stroking (mean = .120, SE = .159) producing higher levels of enfacement as compared to fast stroking (mean = -.151, SE = .146). Furthermore, a significant interaction between "spatial congruence" and "stroking velocity" was found (F (1,37) = 4.21, p = .047, η^2 = .102). Bonferroni-corrected post hoc analyses revealed that slow congruent stroking led to significantly higher levels of enfacement as compared to fast congruent stroking ($t(37)$ = 3.12, p =.004, d = 0.51), while the difference between slow incongruent and fast incongruent stroking was not significant ($t(37)$ = .780, p = .441) (Figure 2.6).

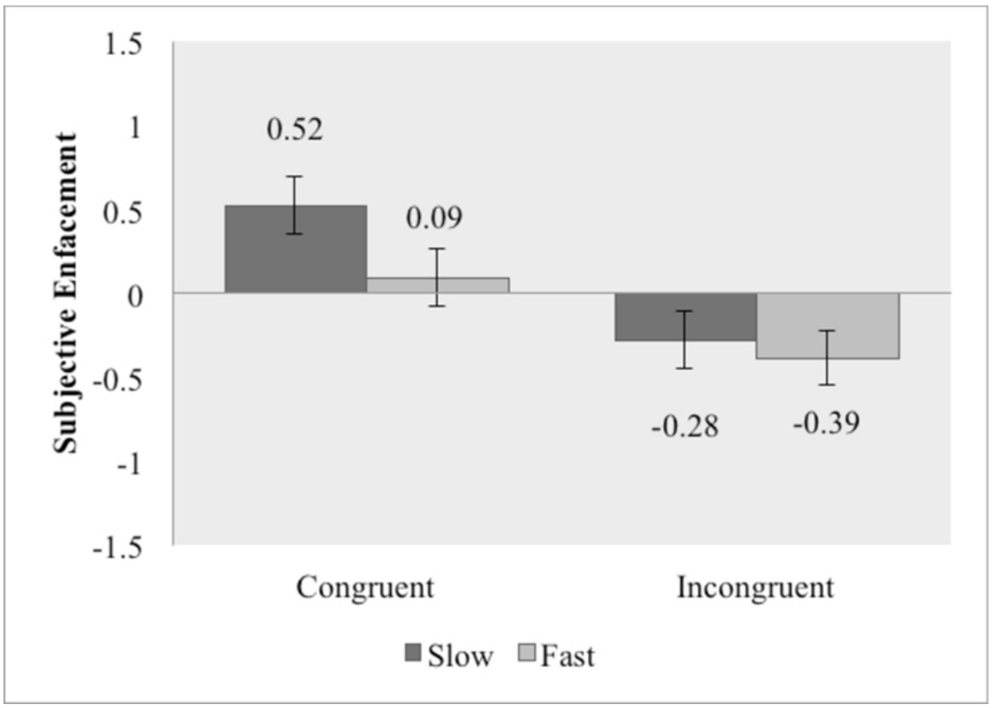

Figure 2. 6 Means for overall subjective enfacement in Exp. 2. Higher scores indicate greater enfacement. Error bars denote standard errors.

Sub-component analysis

For the individual sub-components, self-identification was found to be higher for spatial congruence (F (1,37) = 29.50, $p < .001$, η^2 = .444) and a trend was also noted for slow velocity ($F(1,37)$ = 3.02, p = .090, η^2 = .076). The interaction between spatial congruence and velocity was significant ($F(1,37)$ = 4.25, p = 0.46, η^2 = .103). Bonferroni-corrected post hoc analyses revealed that slow congruent stroking led to significantly higher levels of self-identification as compared to fast congruent stroking ($t(37)$ = 2.70, p =.010, d =

0.44), while the difference between slow incongruent and fast incongruent stroking was not significant (t(37) = .069, p = .945, *d* = 0.11). With regard to similarity, spatial congruence produced higher levels of similarity as compared to spatial incongruence ($F(1,37) = 29.34$, $p < .001$, $\eta^2 = .442$) and a trend was also noted for slow velocity ($F(1,37) = 3.51$, $p = .069$, $\eta^2 = .087$). The interaction was non-significant. For the affect component a trend was found for spatial congruence ($F(1,37) = 3.12$, $p = .086$, $\eta^2 = .078$) and slow velocity ($F(1,37) = 3.48$, $p = .070$, $\eta^2 = .086$) both leading to higher levels of affect as compared to spatial incongruence and fast velocity respectively. The interaction was non-significant (see Appendix 2 for illusion sub-component scores).

2.3.2.2 Self-recognition task

The analysis revealed a significant main effect of "judgment" ($F = (1,37) = 11.80$, $p < .001$, $^2 = .242$), suggesting that, regardless of stroking velocity or spatial congruence, after visuo-tactile stimulation self-other blurring increased. However, the other main effects or interactions were not significant.

2.3.2.3 Pleasantness Ratings

To establish whether slow touch was perceived as significantly more pleasant than fast touch, the main effect of "stroking velocity" on pleasantness ratings was examined (manipulation check). A Wilcoxon signed ranked test confirmed that participants perceived slow stroking (median = 2.00, IQR = 1.63) as significantly more pleasant than fast stroking (median = 1.50, IQR = 1.50, Z= -3.49, $p < .001$, r = -.567).

2.4 General Discussion

Over two experiments, the enfacement illusion paradigm was used to investigate for the first time the role of affective touch in the modulation of self-face recognition. The results demonstrate that affective touch, delivered interpersonally according to the properties of the specialised C tactile (CT) afferents and giving rise to subjective feelings of sensory pleasure, played a crucial role in the modulation of self-face recognition during multisensory integration. Specifically, in line with previous studies on CT-optimal touch, our findings confirmed that affective (CT-optimal, slow) touch on the face was perceived as more pleasant than neutral (CT-non optimal, fast) touch. Importantly, in both experiments, when the multisensory stimulation between the two faces was synchronous and spatially congruent, affective touch appeared to lead to higher levels of subjective enfacement of the "other" face as compared to emotionally neutral touch. In Experiment 1, this difference between affective vs. neutral touch was also observed when the stimulation was asynchronous, with affective touch leading to less resistance to subjective enfacement as compared to neutral touch, i.e. less disagreement with the statements of the enfacement questionnaire. It is speculated that the positive valence of affective touch has the potential to reduce the "deafference", e.g. unpleasant, numb feelings about the body (Longo et al., 2008) caused by the temporal mismatch between felt and seen tactile stimulation. Of course, in order to test this hypothesis regarding the relation between CT optimal touch and deafference, further dedicated study would be needed, for example an experiment in which both factors will be manipulated parametrically and their relation would be thus explored in greater specificity.

As regards the hypothesis and aims of the present study however, in the second experiment, in which participants were only touched synchronously either on congruent or incongruent locations on the face (cheek vs. forehead), it was found that affective touch enhanced self-face recognition only in the congruent and not in the incongruent condition, confirming the unique role of affective touch in the processes of multisensory integration that underlie feelings of self-identification. Indeed, affective touch had a different effect on subjective self-face recognition under temporal mismatch (orthogonal effects of tactile affectivity and synchrony on multisensory integration) as compared to spatial mismatch (effect of affectivity was dependent on spatial congruence). As mentioned above, it has been shown that synchrony and spatial congruence during multisensory stimulation lead to a perceptual binding between seen and felt events, while the effects of multimodal asynchronous stimulation may be subject to several other mechanisms (Rhode et al. 2011; Abdulkarim & Ehrsson, 2015) including attentional confounds (Tajadura-Jiménez & Tsakiris, 2014) and "deafference" (Longo et al., 2008). Such factors do not seem to apply during multimodal experiences of spatial incongruence, presumably because it is less common and, thus, less probable and plausible (Zeller, Litvak, Friston & Classen, 2015) for an individual to be touched in synchrony with another's body part in a proximal and congruent position, than it is to be touched in synchrony with another's body part in an incongruent position. This interpretation fits with recent Bayesian predictive coding accounts of self-identification feelings during multisensory integration (Zeller et al., 2015); in relation to interoception see Crucianelli et al., 2017. Therefore, the second experiment, which used a control condition without some of the known complexities of "asynchrony", confirmed that affective touch has a unique effect on self-face recognition during multisensory integration, over and above any general effects of pleasantness or social desirability on subjective judgements.

Yet, our study showed a dissociation between self-report measures (enfacement questionnaire) and behavioural measures (self-face recognition task), given that there was no effect of affective touch on behavioural self-face recognition. This result is in line with recent data from the rubber hand illusion and affective touch, where similar dissociations in the effects of affective touch on the illusion were observed (Crucianelli et al., 2013; Lloyd et al., 2013; van Stralen et al., 2014). The presence of contradictory findings suggests that future studies should specifically investigate this interesting modulation further.

One limitation of this study is that the effects of temporal synchrony and spatial incongruence on the illusion were not compared directly and, hence, any comparison is purely qualitative. Moreover, another question raised by this study is whether the modulatory effects of affective touch on enfacement are due to bottom-up CT-afferent signalling or top-down learned expectations conveyed by the "seen" slow touch on the other face (Gentsch, Panagiotopoulou & Fotopoulou, 2015; Morrison et al., 2011). Knowing that the CT-afferents are found in hairy skin only (i.e. cheek, forehead) and not on the glabrous skin (Vallbo et al., 1999; Liu et al., 2011), it would be interesting to compare the effects of slow vs. fast tactile stimulation on both hairy (e.g. cheek) and glabrous sites (e.g. lips) in order to gain insight into the separate involvement of bottom-up mechanisms and top-down expectations of sensory pleasure. Moreover, it is important to note that while affective touch is included within the broader definition of interoception (see Tsakiris & Critchley, 2016), evidence has pointed to dissociations between interoceptive signals. For instance, Garfinkel et al. (2016) demonstrated a dissociation between cardiac and respiratory measures of interoceptive accuracy (Garfinkel et al., 2016), suggesting that detection accuracies across different interoceptive modalities are dissociable. Moreover, while both cardiac and respiratory signals are not emotionally valenced, other bodily signals are negatively (e.g. pain) or, in this case, positively (affective touch) valenced, with the latter also having a social, affective-motivational component. Therefore, it is still unknown to what extent the results of the current research are generalizable to other interoceptive signals and further research is required to establish whether interoception more generally enhances self-face recognition or this is specific to affective touch.

To conclude, this study provides the first direct evidence that embodied affective interactions and particularly affective touch during multisensory integration enhances subjective self-face recognition. These effects were found to be selective to other conditions of multisensory integration and particularly spatial congruence. Thus, the effects of affective touch on self-face recognition do not seem to be explained by general mood or pleasantness effects. Overall, research has shown that affective touch may have a great impact on our physical and emotional well-being. Social, affective touch may serve as a homeostatic regulator (Fotopoulou & Tsakiris, 2017), a “stress buffer”, regulating the body’s responses to acute stressors (Morrison, 2016), as well as a regulator of fundamental bodily emotions, such as pain (Krahé, Springer, Weinman & Fotopoulou, 2013; Krahé, Drabek, Paloyelis & Fotopoulou, 2016). The present study provides evidence that CT-optimal affective touch may also affect our bodily self and ultimately determine how one perceives the boundaries of his/her own body. Increasing embodied affectivity appears to have a potent role in the formation of the bodily boundaries of the self, by allowing identification of the psychological self with a physical body and, more specifically, a face, which is considered a hallmark of our identity.

Chapter 3 |

The Role of Attractiveness in the Multisensory Modulation of Face Ownership

3.1 Introduction

The previous chapter investigated how affective touch influences self-face recognition during multisensory integration. Despite the fact that the tactile stimulus in affective touch comes from outside the body, affective touch is considered an interoceptive modality that elicits pleasant sensations relevant to the body's homeostasis (Craig, 2003; Morrison, Bjornsdotter & Olausson, 2011). This chapter will focus on how an affective stimulus that is merely visually presented, hence it comes exclusively from outside the body, can influence self-face recognition during multisensory integration. Given that the research described in Chapter 2 showed a dissociation between self-report measures (enfacement questionnaire) and behavioural measures (self-recognition task), in this chapter the term 'face ownership' will be used instead to describe both subjective and behavioural aspects of enfacement, with identification and similarity referring to the subjective component and self-face recognition referring to the behavioural component. Therefore, the study described in this chapter will investigate the role of facial attractiveness in the multisensory modulation of face ownership. As mentioned in Chapters 1 and 2, multisensory integration, defined as the ability of the brain to synthesize information across modalities, is fundamental for the bodily self. Numerous bodily illusions, such as the "rubber hand illusion" (RHI; Botvinick & Cohen, 1998) and the "full body illusion" (Lenggenhager et al. 2007; Ehrsson, 2007), have illustrated that the temporal and spatial congruency between seen and felt sensory events gives rise to the sense of body ownership, i.e. the feeling that a body (part) belongs to me (see Chapter 1). In Chapter 2, it was discussed in more detail that the same is also true for the face, which is probably the most representative instance of personal identity (Filippetti, 2015) and the ability to recognise it is considered an index of self-awareness and a fundamental aspect of the sense of selfhood (Gallup, 1970; Rochat, 2009). Synchronous multisensory stimulation between two faces gives rise to the "enfacement illusion" and participants assimilate more of the other person's features in their own self-face representation (Tsakiris, 2008; Paladino et al., 2010; Sforza et al., 2010). The "enfacement illusion" extends beyond body perception to a more conceptual merging between self and other, by affecting social cognition processes (Paladino et al., 2010). Importantly, synchronous multisensory stimulation also leads to an increase in affective ratings for the other face, including ratings of greater attractiveness and trustworthiness after the induction of the enfacement illusion (Tajadura et al., 2012b). Conversely, the levels of enfacement also appear to be influenced by affectivity. The study described in Chapter 2 demonstrated that increasing embodied affectivity, i.e. affective touch, leads to higher levels of enfacement and, hence, appears to play a potent role in the formation of the bodily boundaries of the self (Panagiotopoulou, Filippetti, Tsakiris & Fotopoulou, 2017). Moreover, in a study employing the "enfacement illusion" paradigm among individuals who were familiar to each other, the strength of the illusion was found to positively correlate with physical attractiveness attributed to the partner's face on a five-point Likert scale, where 1 was "very low" and 5 was "very high" (Sforza et al., 2010). In other words, the higher the perceived attractiveness of a familiar face prior to the illusion, the higher the levels of enfacement with that face. However, this study could only establish a correlation between facial attractiveness and enfacement given that facial attractiveness was not experimentally manipulated using both attractive and unattractive faces but rather merely measured on the basis of subjective ratings and then correlated with enfacement scores. Moreover, the partners of that study were familiar to each other, hence it cannot be ruled out that perceived attractiveness may have been influenced by other factors such as familiarity and social desirability. Therefore, the central aim of the present investigations was to explore the causal relation between facial attractiveness and face ownership during multisensory integration with unfamiliar faces.

Before going on to present how this aim will be addressed, it is important to note that the perception of facial attractiveness and more general physical attractiveness has been the focus of a large body of literature. As described in Chapter 1, the perception of facial attractiveness shows a high level of agreement across individuals, cultures and age groups, yet there is still a debate about whether this reflects an innate preference (e.g. Langlois, Roggman, Casey, Ritter, Riesser-Danner & Jenkins, 1987), or common learning as a result of adaptation (e.g. Hahn & Perrett, 2014). Crucially, facial attractiveness appears to be an influential factor for social exchanges, affecting people's perceptions at high-order emotional and cognitive levels (Langlois et al., 2000). More specifically, according to the "what is beautiful is good" stereotype (Dion et al., 1972), which is supported by a large body of evidence, physically attractive individuals are thought to possess a wide variety of positive personal qualities (see Chapter 1). This effect extends beyond interpersonal judgment to social behaviour, with attractive children and adults being treated in a more positive way, as compared to unattractive people (Langlois et al., 2000), Overall, it appears that there is an advantage for attractive people in terms of how other people perceive and judge them in social interactions and beyond.

Importantly, some findings in this field of research have potentially important implications for multisensory integration. Specifically, visual remapping of touch (VRT), that is the enhancement of tactile perception on the face when observing someone also receiving touch on the face, has been found to be present when touch is applied to an attractive, but not an unattractive avatar (Noel, Giovagnoli, Costa & Serino, 2014). The authors argue that there are various possible explanations for the modulation of multisensory effects by the perception of facial attractiveness. One such is that ascribing physical beauty is closely associated with ascribing positive social values that are ranked high in the evolutionary list, as discussed above and in Chapter 1, and the results may, therefore, reflect a more abstract interaction between attractiveness and imitation reported by numerous social psychology studies (e.g. Müller et al., 2013; Van Leeuwen et al., 2009; Babel, 2012). Another possible explanation is that perception of attractiveness may lead to higher levels of arousal or attention, which can, in turn, result in the modulation of low-level perceptual processes, such as the VRT. Although this study suggests that top-down perceptual factors, such as the attribution of physical attractiveness, become somehow coded in one's multisensory system (Noel et al., 2014), the question remains as to whether facial attractiveness can also influence face ownership during multisensory integration. In other words, it remains unknown whether another person's facial attractiveness can influence the extent to which his/her facial features are assimilated in one's own self-face representation as a result of interpersonal multisensory stimulation. This is important as such assimilations are considered the developmental building blocks of the mental representation of our face, and by extension our own identity (Fotopoulou & Tsakiris, 2017; Rochat, 2008). In other terms, are we more inclined to build the mental representation of our face in identification with more rather than less attractive faces?

In order to address this question the current study used the enfacement illusion paradigm to examine for the first time the role of attractiveness in the multisensory modulation of face ownership over two experiments. In a first experiment (N=35), participants were stroked on the cheek while they were seeing an attractive or a non-attractive face being stroked on the cheek in synchrony or asynchrony. Participants were asked to complete a behavioural self-face recognition task before and after the induction of the illusion, as well as an enfacement questionnaire capturing the subjective experience of the illusion. In the second experiment (N=35), two new faces were used and spatial incongruency (cheek vs. forehead) was introduced as a control condition instead of temporal asynchrony. This choice of an alternative control condition has been made as both amodal properties (temporal and spatial congruency) have been found critical in promoting multisensory integration in previous studies, but the findings of the previous study reported in Chapter 2, showed that temporal synchrony and tactile affectivity may have orthogonal effects on face ownership, whereas the effect of tactile affectivity was dependent on spatial congruence. Thus, I hypothesised that perceived attractiveness, which is also an affective dimension, may depend on spatial congruency. Based on the studies reviewed above, showing the enhancing effects of facial attractiveness on multisensory integration, higher levels of enfacement were expected for an attractive vs. a non-attractive face, particularly in the synchronous (Experiment 1) and the spatially congruent (Experiment 2) condition. Such a finding would suggest that attractiveness has an effect on the multisensory integration process itself, rather than being a more general, top-down effect, e.g. people are willing to see themselves more similar to an attractive rather than a non-attractive face, irrespective of multisensory integration. If the latter was true, then one would expect to see an effect of attractiveness irrespective of synchrony (Experiment 1) or of spatial congruency (Experiment 2) of touch.

3.2 Experiment 1

3.2.1 Method

3.2.1.1 Participants

Thirty-five Caucasian female participants (Mean age 24.30 ± 3.13SD years) with no psychiatric or neurological history were recruited online via a University Subject Pool system and took part in a single one-hour experimental session in a laboratory setting. The sample size was determined based on prior calculations for 99% power (effect size f set at 0.34, G*Power 3.1) in accordance with the effect size obtained in the significant interaction of Experiment 2 in Chapter 2 ($\eta^2 = .102$). The reason why females were only tested is that the experimenter delivering the touch was female and there is evidence suggesting that the hedonic value of touch varies according to the gender of both giver and receiver (Gazzola et al., 2012). Participants were reimbursed for their time with either payment (£10) or course credits. Written, informed consent was obtained from all participants prior to their participation. The study was approved by the Ethics Committee of the Research Department of Clinical, Educational and Health Psychology, University College London and was conducted according to the Declaration of Helsinki.

3.2.1.2 Design

The study employed a 2 x 2 within-subject design with two factors; 1) Synchrony (synchronous tactile stimulation vs. asynchronous tactile stimulation) and 2) Attractiveness (other attractive face vs. other non-attractive face). The dependent measures were: a) a self-recognition task as a behavioural measure of the illusion that was delivered before and after the interpersonal stimulation and b) an enfacement questionnaire capturing the subjective experience of the illusion that was delivered only after the stimulation (see Materials section for details on selection of faces etc.).

3.2.1.3 Materials

Facial Attractiveness Survey

In order to select the attractive and non-attractive faces for the visuo-tactile stimulation videos (described below), a survey was conducted with a separate sample of 65 Caucasian women (mean age = 28.68, SD = 11.64). Participants of this survey were presented with 25 Caucasian female faces and were asked to rate on a scale from 0 (not at all) to 100 (extremely) how “attractive”, “trustworthy”, “dominant” and “distinctive” each face was. Those 25 faces were from an unselected, consecutive sample of women who had previously taken part in Experiment 2 of Chapter 2, were unknown to current participants and had given their written permission for their faces to be used in this new experiment. These attributes were chosen as they have been found to be distinct properties that influence attractiveness ratings. Specifically, trustworthiness and dominance were selected given that they are thought to be primary dimensions of face evaluation influencing social judgments (Oosterhof & Todorov, 2008). Distinctiveness, defined as deviation from an average face, was also controlled for, given previous research showing that there is a complex relationship with attractiveness, with unattractive faces being distinctive, and attractive faces being rated at all levels of distinctiveness (Wickham & Morris, 2003). For the current sample of 25 faces, the mean rating for attractiveness was 37.66 (SD = 11.46), trustworthiness 42.44 (SD = 7.93), dominance 38.36 (SD = 5.70) and distinctiveness 41.76 (SD = 4.61). The two faces selected to represent attractive and non-attractive faces were the ones that were best matched for trustworthiness, dominance and distinctiveness, however they differed in perceived attractiveness (see Table 3.1 for details).

	Attractiveness	*Trustworthiness*	*Dominance*	*Distinctiveness*
Attractive	63.29 (22.29)	46.26 (22.87)	40.22 (21.84)	43.22 (21.10)
Non-attractive	24.91 (19.98)	38.61 (22.97)	36.21 (19.83)	39.14 (22.64)

Table 3. 1 Means (and standard deviations) for attribute scores for selected faces in Exp. 1

Construction of the Visuo-tactile Stimulation Videos

For the induction of the illusion, two visuo-tactile stimulation video clips were created (see section 2.2.3 for more details). The two females, the faces of whom were selected to represent the attractive and non-attractive face respectively, were invited to the lab at UCL to create the two videos. Each of these videos displayed the (attractive or non-attractive) face being stroked on the cheek with a soft cosmetic brush. Each stroke covered a distance of 8 cm in 1 sec. Each video lasted 120 seconds; 1 second of tactile stimulation followed by 1 second of rest (60 strokes in total).

Construction of Morphing Movies for the Behavioural, Self-recognition Task

For the self-recognition task, morphing movies were created for each participant (see section 2.2.3 for details). A digital photograph of the participant was taken at the beginning of the experimental session. The participant's face in the photograph was mirror-transposed, converted to greyscale, and all non-facial attributes were removed (e.g. background, hair, ears) with GNU Image Manipulation Program (GIMP). A computerized morphing procedure implementing a mesh warping algorithm (Abrasoft Fantamorph) was used to merge each participant's face with the unfamiliar face (attractive and less attractive) in 1% steps resulting in 100 frames with graded blending of the facial features of the two faces. For each participant, four morphing movies were created since there were two unfamiliar faces (attractive vs. non-attractive) and two directions: from 100% self to 0% self ("*self to other"* direction) and from 0% self to

100% self (*"other to self"* direction). Each movie lasted 33 seconds and contained 100 frames (see Figure 3.1).

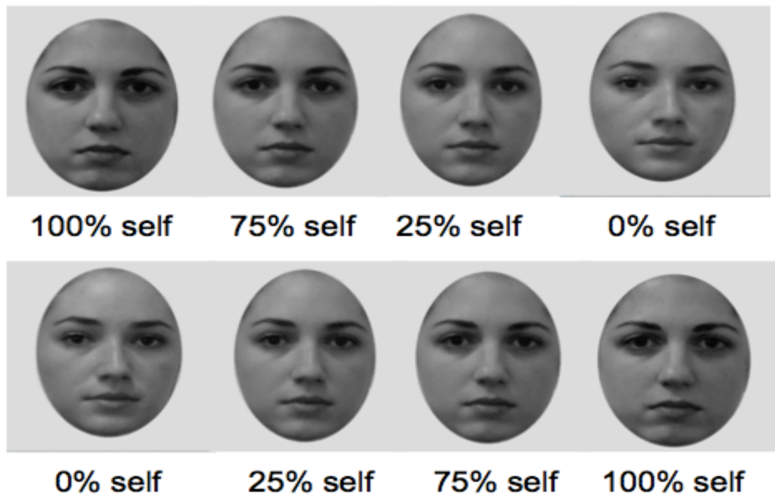

Figure 3. 1 Illustrative example of self-recognition task with the selected attractive face (top right and bottom left).

<u>Enfacement Questionnaire (Subjective Measure):</u>

After the interpersonal stimulation, participants were asked to complete a previously used enfacement questionnaire (see Figure 2.1), consisting of 8 questions presented in a random order (7-point Likert-type scale; −3, strongly disagree; +3, strongly agree), which reflected participants' subjective experience of the illusion. The questionnaire used consisted of three sub-components: *identification*, that is the extent to which participants feel that the other's face is theirs (items 1–3, 6); *similarity*, that is the extent to which participants perceive the other's face as similar to theirs (items 4, 5); and *affect*, that is the extent to which participants judge the other's face as attractive and trustworthy (items 7, 8).

3.2.1.4 Procedure

The procedure was identical to that of the first experiment of Chapter 2. The experimental session began with a baseline self-recognition task, on which participants have received prior training (see section 2.24 for details). In the actual task, participants were presented with two morphing movies showing: a) their own face morphing into one of the attractive or non-attractive faces ("self to other" direction) and b) the attractive or non-attractive face morphing into their own face ("other to self" direction). Participants were asked to press the space key, with their right index finger, as soon as they thought that the face shown began to look more like the face that it was morphing into (self or other depending on direction of movie). The number of seconds at which the movie was stopped was recorded. Following this baseline *self-recognition task*, participants were instructed to look at the screen placed in front of them, relax and watch the visuo-tactile stimulation video (see section 2.2.4 for details). As soon as the video began, tactile stimulation was delivered by the experimenter with a cosmetic-like soft brush on a specular congruent location between both faces either synchronously or asynchronously (with 1 sec delay) (for details on how synchrony was controlled, please see Chapter 2). Right after the task, participants completed the same self-recognition task as in baseline, as well as the enfacement questionnaire. In total, there were four conditions: 1) *attractive* face with *synchronous* stimulation; 2) *unattractive* face with *synchronous* stimulation; 3) *attractive* face with *asynchronous* stimulation; 4) *unattractive* face with *asynchronous* stimulation. The order of these conditions was randomized. Between conditions, participants were instructed to look at their own face for 90 seconds using Photobooth application for Mac computers) in order to "break" the enfacement illusion and in preparation for the next block (see Figure 3.2).

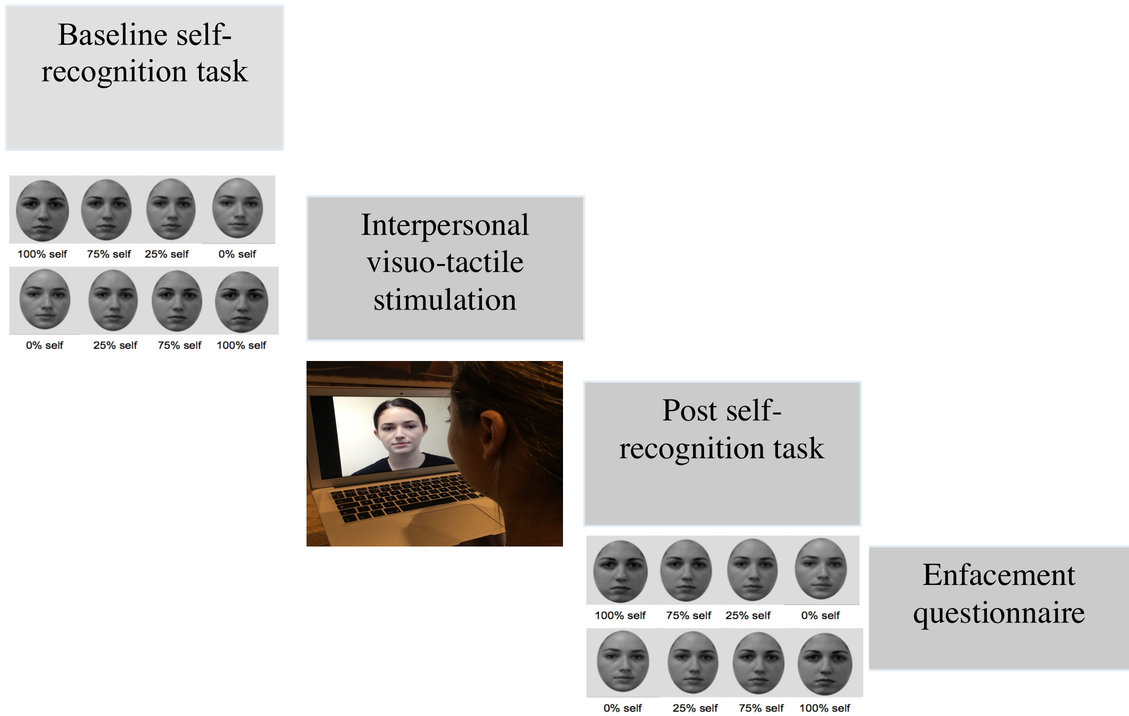

Figure 3. 2 Experimental procedure per block in Exp. 1

3.2.1.5 Data analysis

All of the statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) version 23 (IBM, Chicago, IL, USA). In the previous study described in Chapter 2, an overall enfacement score was obtained, yet in the current study, the faces' attractiveness and trustworthiness were manipulated (i.e. affect component of enfacement questionnaire), hence the overall score was calculated only based on the two first subcomponents (identification and similarity), and the four individual sub-components were analysed separately, with the last two items comprising the 'affect' subcomponent (i.e. attractiveness and trustworthiness) acting as manipulation checks. Separate, repeated-measures analysis of variance (ANOVA) were performed on the overall and the subcomponent scores with Synchrony (synchronous vs. asynchronous) and Attractiveness (attractive vs. non-attractive) as within-subject factors.

For the analysis of the self-recognition task, the means of seconds at which participants stopped the videos were converted into % of frames containing the "self". As discussed in section 2.2.5, there is evidence that the ability for self-other discrimination is influenced independently of the direction of morphing videos (Heinisch et al., 2010; Heinisch et al. 2012; Payne & Tsakiris, 2016) so the two directions of morphing ("self to other" and "other to self") were averaged. As variable baseline enfacement scores have been noted in the previous study using the task (see Chapter 2), and also repeated measures (Level 1) were nested within individuals (Level 2), multilevel modelling was implemented. First, a linear mixed model (LMM) was performed to explore the effects of attractiveness on 'pre' scores, with 'pre' score as the outcome variable, 'attractiveness' as a dummy-coded categorical predictor and subjects specified as random effects. Subsequently, based on the results of the above model that, as predicted, showed that baselines scores differed not only within and between individuals, but also on the basis of the attractiveness manipulation, a second LMM was performed with 'post' score as the outcome variable and 'pre' score as the continuous predictor, mean-centred in order to avoid multicollinearity (Tabachnick & Fidell, 2007). 'Synchrony' and 'attractiveness' conditions were inserted in the models as dummy-coded categorical predictors. In all of the analyses, fixed main effects for each of the categorical and continuous explanatory variables were specified, as well as the interaction term between synchrony and attractiveness. Random intercepts for subjects were also specified (i.e. random effects).

3.2.2 Results

3.2.2.1 Subjective Enfacement

Overall Enfacement

A 2x2 ANOVA revealed a significant main effect of "synchrony" [F (1,34) = 47.27, $p < .001$, $\eta^2 = .582$] with synchronous stroking producing higher levels of identification as compared to asynchronous stroking. A significant main effect was also found for "attractiveness" [F (1,34) = 6.48, $p = .016$, $\eta^2 = .160$] with attractive face producing higher levels of identification as compared to non-attractive face. The interaction between "synchrony" and "attractiveness" was not significant [F (1,34) = 3.01, p = .092, η^2 = .081)] (Figure 3.3).

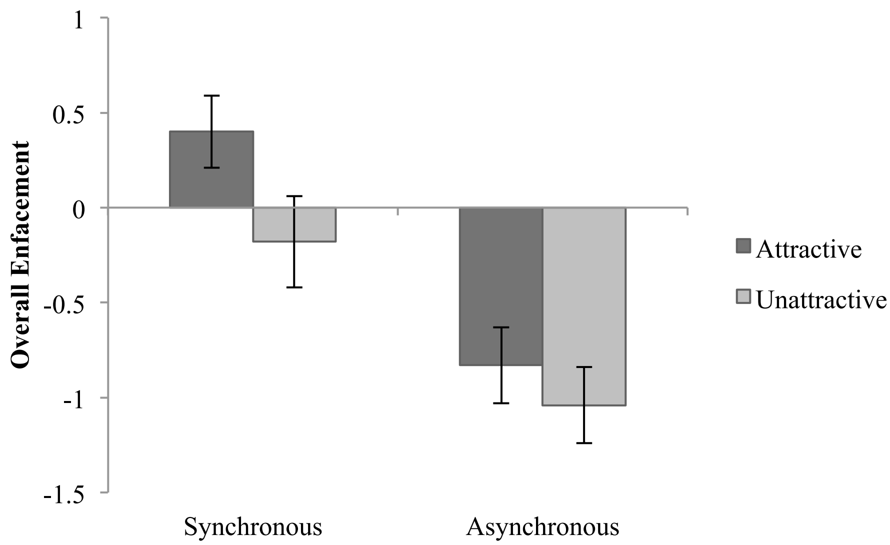

Figure 3. 3 Means for overall subjective enfacement in Exp. 1. Higher scores indicate higher levels of enfacement. Error bars denote standard errors.

Sub-component analysis: Identification

A 2x2 ANOVA revealed a significant main effect of "synchrony" [F (1,34) = 49.07, p < .001, η^2 = .591] with synchronous stroking producing higher levels of identification as compared to asynchronous stroking. A significant main effect was also found for "attractiveness" [F (1,34) = 4.52, p = .041, η^2 = .117] with attractive face producing higher levels of identification as compared to non-attractive face. The interaction between "synchrony" and "attractiveness" was not significant [F (1,34) = 1.01, p = .322, η^2 = .029)] (Figure 3.4).

Sub-component analysis: Similarity

A 2x2 ANOVA revealed a significant main effect of “synchrony” [F (1,34) = 19.36, $p <$ .001, η^2 = .363] with synchronous stroking producing higher levels of similarity as compared to asynchronous stroking. A significant main effect was also found for “attractiveness” [F (1,34) = 6.07, p = .019, η^2 = .151] with attractive face producing higher levels of similarity as compared to non-attractive face. The interaction between “synchrony” and “attractiveness” was also significant [F (1,34) = 4.73, p = .037, η^2 = .122)]. Bonferroni-corrected post hoc tests revealed that perceived similarity was higher for attractive vs. unattractive face when the stimulation was synchronous [t (34) = 2.88, p = .007] but not asynchronous [t (34) = .991, p = .329] (Figure 3.4).

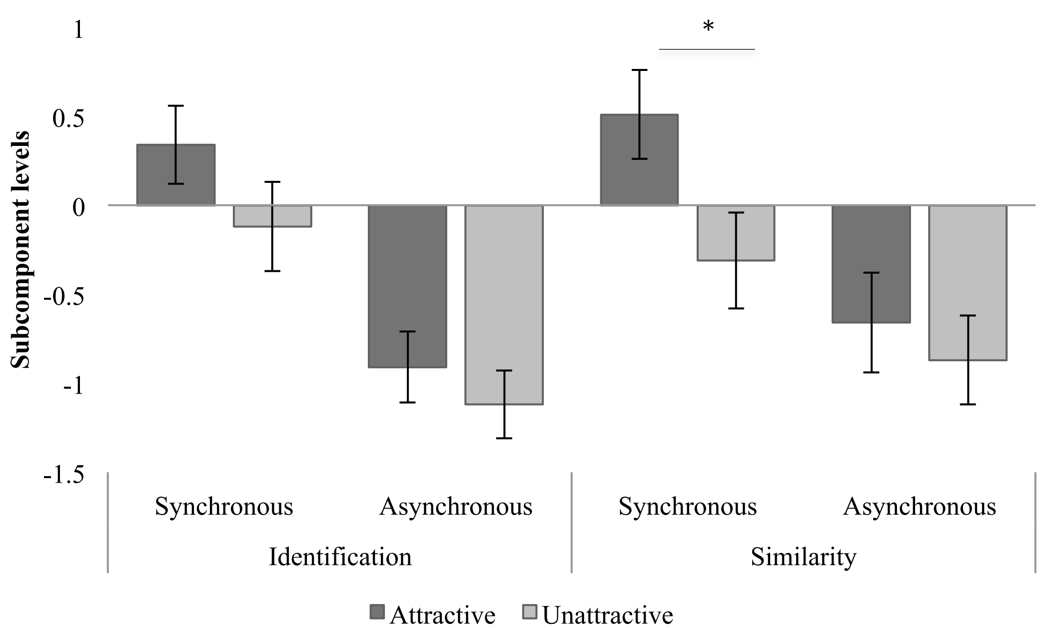

Figure 3. 4 Means for identification and similarity in Exp. 1. Higher scores indicate higher levels of each sub-component. Error bars denote standard errors

Manipulation check: Trustworthiness

A 2x2 ANOVA revealed a significant main effect of “attractiveness” [$F\ (1,34) = 18.23$, $p < .001$, $\eta^2 = .349$] with attractive face producing higher levels of trustworthiness as compared to non-attractive face. A trend was found for “synchrony” [$F\ (1,34) = 4.01$, $p = .053$, $\eta^2 = .105$] with synchronous stroking producing higher levels of trustworthiness as compared to asynchronous stroking. The interaction between “synchrony” and “attractiveness” was not significant [$F\ (1,34) = 1.200$, $p = .324$, $\eta^2 = .029$] (Figure 3.5).

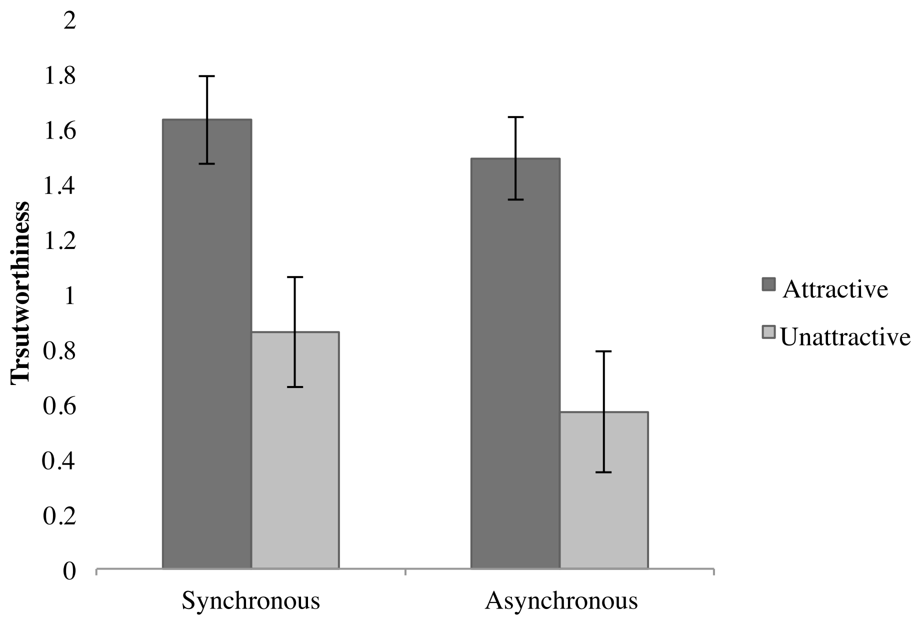

Figure 3. 5 Means for trustworthiness in Exp. 1. Higher scores indicate greater trustworthiness. Error bars denote standard errors

Manipulation check: Attractiveness

A 2x2 ANOVA revealed a significant main effect of “attractiveness” [$F\ (1,34) = 26.34$, $p < .001$, $\eta^2 = .459$] with attractive face being rated as more attractive than the non-attractive face. A trend was found for “synchrony” [$F\ (1,34) = 3.21$, $p = .083$, $\eta^2 = .094$] with synchronous stroking producing higher levels of attractiveness as compared to asynchronous stroking. The interaction between “synchrony” and “attractiveness” was not significant [$F\ (1,34) = .897$, $p = .351$, $\eta^2 = .028$)] (Figure 3.6).

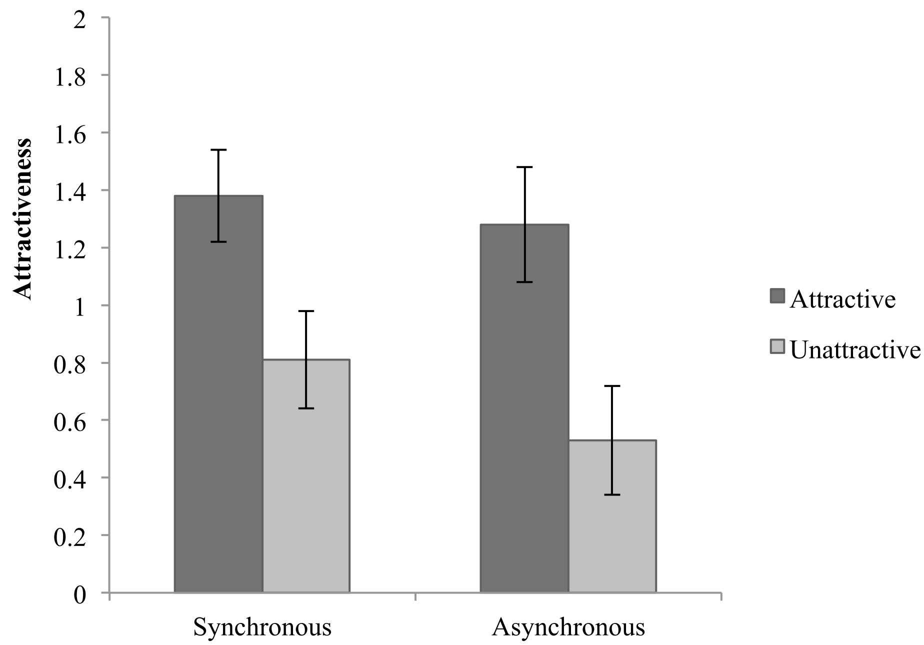

Figure 3. 6 Means for attractiveness in Exp. 1. Higher scores indicate greater attractiveness. Error bars denote standard errors.

3.3.2.2 Self-recognition task

The figure below illustrates the levels of behavioural enfacement per condition:

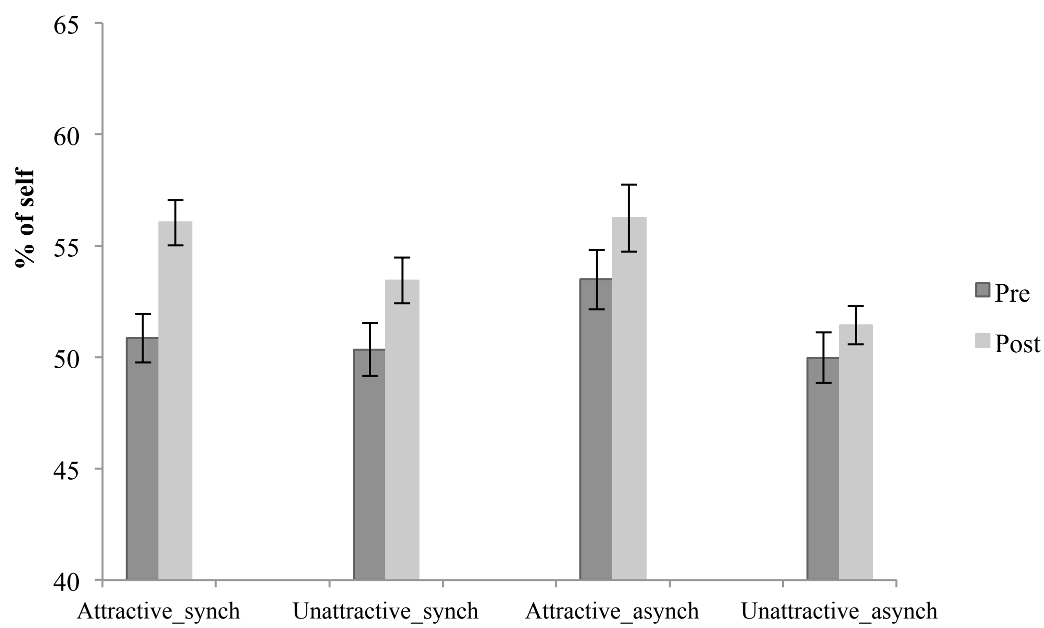

Figure 3. 7 Means for percentage of frames containing 'self' in the different conditions. Error bars denote standard errors.

The first LMM revealed a significant effect of attractiveness on 'pre' score (b = -4.71, SE = .808, p < .001), with attractive face (M = 52.17, SD = 6.15) leading to higher levels of behavioural enfacement, as compared to unattractive face (M = 50.16, SD = 6.81).

The results for the second LMM with 'post' score as the outcome variable are presented in the table below:

				95% Confidence Interval	
Effect	b	SE	p-value	Lower Bound	Upper Bound
Synchrony	**3.459247**	**1.247233**	**.009**	**.930959**	**5.987536**
Attractiveness	.132677	1.006735	.896	-1.913567	2.178921
Synchrony x Attractiveness	-.206752	1.693915	.904	-3.651071	3.237566
Pre	**.516553**	**.074970**	**.000**	**.367739**	**.665367**

Table 3. 2 Multilevel modelling results for outcome variable 'post' scores in self-face recognition (Exp. 1). Significant main effects and interactions are highlighted in bold.

As one can see from the table above, there was a significant main effect of synchrony with synchronous stimulation (M = 54.046, SD = .845) leading to higher levels of behavioural enfacement as compared to asynchronous stimulation (M = 51.11, SD = .716). The main effect of attractiveness and the interaction between attractiveness and synchrony were non-significant.

3.2.3 Discussion

In this first experiment, the enfacement illusion paradigm was used to explore for the first time the role of facial attractiveness in the modulation of face owneship during multisensory integration. Participants were stroked on their face while they were watching an attractive and non-attractive unfamiliar face being stroked in synchrony vs. asynchrony with their own face. Based on the hypothesis that facial attractiveness may have a direct effect on multisensory integration, higher levels of enfacement for attractive vs. non-attractive face were expected, particularly when the stroking was synchronous, rather than asynchronous. The findings showed that synchronous stimulation led to higher levels of enfacement, measured both at a behavioural (self-recognition task) and a subjective level (questionnaire), thus replicating the “enfacement illusion” and confirming the important role of multisensory integration in face ownership (Tsakiris, 2008; Sforza et al., 2010, Paladino et al. 2010). The main hypothesis regarding the role of facial attractiveness in the illusion was, however, only partly confirmed.

In terms of behavioural face ownership as captured by the self-face recognition task, no main effect of attractiveness or interaction between synchrony and attractiveness was found. Yet, attractiveness was found to enhance behavioural enfacement at baseline, prior to any interpersonal visuo-tactile stimulation. In other words, participants enfaced more the attractive, as compared to the non-attractive face, just by looking at it, independently of any multisensory visuo-tactile process. Previous research on other bodily illusions has shown that congruent visuo-proprioceptive cues may be sufficient to induce subjective embodiment of a fake body (part), in the absence of visuo-tactile integration, a phenomenon known as visual capture (e.g. Carey, Crucianelli, Preston & Fotopoulou, 2018; Ponzo, Kirsch, Fotopoulou & Jenkinson, 2018; Martinaud, Besharati, Jenkison & Fotopoulou, 2017; Crucianelli, Krahé, Jenkinson & Fotopoulou, 2017). The finding of the current experiment suggests that attractiveness may have a first effect on enfacement purely based on vision and irrespective of multisensory integration.

With regards to subjective enfacement, a main effect of attractiveness was found for overall subjective enfacement, as well as the individual sub-components of identification and similarity. After interpersonal multisensory stimulation, the levels of overall enfacement, as well as identification (i.e. first sub-component) were significantly higher for an attractive face as compared to a non-attractive face, but no interaction between synchrony and attractiveness was found, in line with the behavioural findings. In fact, during synchronous stimulation, watching an attractive face led to an increase in the ratings for overall enfacement and identification. On the other hand, the ratings for overall enfacement and identification were negative when the stimulation was asynchronous, indicating the absence of enfacement, yet watching an attractive face, reduced the degree of non-enfacement. This pattern of results is similar to the previous findings described in Chapter 2, where pleasant, affective touch was found to increase feelings of enfacement during synchronous stimulation and decrease feelings of non-enfacement during asynchronous stimulation. One possible explanation is that an affective stimulus – previously affective touch and, in this case, an attractive face - may not only increase identification during optimal conditions of synchronous sensory stimulation but may also have the potential to reduce "deafference", which is described as a phenomenon of unpleasant and numb feelings about the body caused by the temporal mismatch between seen and felt tactile stimulation (Longo et al. 2008).

On the other hand, the present study found an interaction between synchrony and attractiveness for subjective similarity ratings (i.e. second sub-component), indicating that attractiveness led to higher levels of similarity in the synchronous condition rather than the asynchronous. This finding was also reported in the first experiment of Chapter 2 and it demonstrates that the processes of identification and similarity are possibly mediated by different mechanisms (discussed in Conclusion in more detail). With regards to the manipulation checks, it was confirmed that the attractive face was rated as more attractive as compared to the non-attractive face, yet it was also rated as more trustworthy despite the fact that the two faces were more balanced in trustworthiness (based on the results of the survey described in section 3.2.3). However, this could be explained by the fact that the current ratings were only obtained post-stimulation, i.e. they may relate to either baseline trustworthiness differences, multisensory integration, or longer exposure. Future studies should disambiguate between these possibilities.

More generally, in the previous study in Chapter 2, a different effect of affective touch on face ownership was found under temporal mismatch as compared to spatial mismatch. More specifically, the effect of affective touch during spatial mismatch (i.e. spatially incongruent stroking) was found to be dependent on spatial congruency. As described in Chapter 2, synchrony and spatial congruency during multisensory stimulation lead to a perceptual binding between seen and felt events, while the effects of multimodal asynchronous stimulation may be dependent on various other mechanisms (Rhode et al., 2011; Abdulkarim & Ehrsson, 2015), once such being “deafference” (Longo et al., 2008). These factors seem to apply to lesser degrees during multimodal experiences of spatial incongruency, presumably because it is less common, hence less probable and plausible (Zeller et al., 2015) for an individual to be touched in synchrony with another’s body part in a proximal and congruent position, than it is to be touched in synchrony with another’s body part in an incongruent position.

To this end, it was decided to conduct a second experiment to explore whether the effect of facial attractiveness on face ownership is also dependent on spatial congruency. Moreover, given the lack of baseline ratings for the subjective measure of this first experiment, another aim of the second experiment was to investigate whether the effect of attractiveness at baseline is true for subjective enfacement too. To achieve these aims, spatial incongruency (cheek vs. forehead) was introduced as an alternative to temporal asynchrony in order to control for the phenomenon of “deafference” found predominantly during asynchronous stimulation. Thus, based on the results of my previous research, it was expected that facial attractiveness would lead to higher levels of enfacement during spatially congruent but not incongruent stimulation. Moreover, the enfacement questionnaire was administered both at baseline and post-stimulation and, in line with the hypothesis that the effect of attractiveness is purely based on vision, it was hypothesised that attractiveness would enhance subjective enfacement even at baseline, prior to any interpersonal visuo-tactile stimulation.

3.3 Experiment 2

3.3.1 Method

3.3.1.1 Participants

Thirty-five Caucasian female participants (Mean age 20.89 $\pm$ 2.74SD years) with no psychiatric or neurological history were recruited online via the UCL SONA Psychology Subject Pool system and took part in a single 30-minute experimental session in a laboratory setting. The sample size was determined based on prior calculations for 99% power (effect size f set at 0.37, G*Power 3.1) in accordance with the effect size obtained in the significant interaction between synchrony and attractiveness in Experiment 1 (η^2 = .102). Participants were reimbursed for their time with either payment (£5) or course credits. Written informed consent was obtained from all participants prior to their participation. The study was approved by the Ethics Committee of the Research Department of Clinical, Educational and Health Psychology, University College London and was conducted according to the Declaration of Helsinki.

3.3.1.2 Design, Materials and Procedure

Design, materials and procedures were identical to Study 1, except for the following four differences:

1) In order to ensure that the results of the first experiment were not down to some characteristic of the selected faces, two new faces were used in the visuo-tactile stimulation videos, once again selected on the basis of the results of an independent survey with a separate sample of 25 Caucasian women (mean age = 25.42, SD = 9.43). Participants of this survey were presented with 11 Caucasian female faces and were asked to rate on a scale from 0 (not at all) to 100 (extremely) how “attractive”, “trustworthy”, “dominant” and “distinctive” each face was. Those 11 faces were from an

unselected, consecutive sample of women who had previously taken part in Experiment 1 of this chapter, were unknown to current participants and had given their written permission for their faces to be used in this new experiment. For the current sample of 11 faces, the mean rating for attractiveness was 43.99 (SD = 13.81), trustworthiness 49.74 (SD = 5.66), dominance 50.38 (SD = 8.25) and distinctiveness 56.67 (SD = 9.60). The two faces selected to represent attractive and non-attractive faces were the ones that were best matched for trustworthiness, dominance and distinctiveness, however they differed in perceived attractiveness (see Table 3.3 for details). Moreover, they were matched for eye and hair colour (blond hair, blue eyes).

	Attractiveness	*Trustworthiness*	*Dominance*	*Distinctiveness*
Attractive	60.00 (15.63)	50.00 (15.49)	49.17 (13.57)	46.67 (12.11)
Non-attractive	30.00 (6.32)	45.00 (10.00)	47.50 (15.41)	60.00 (16.73)

Table 3. 3 Means (and standard deviations) for attribute scores for selected faces for Exp. 2

2) Spatial incongruence was used as a control instead of asynchrony. In half of the trials participants were touched on a congruent location (i.e. cheek) with attractive vs. less attractive face, and in the other half they were touched on an incongruent location (i.e. forehead) with attractive vs. non-attractive face.

3) Due to time and practical constraints, there was no behavioural measure of enfacement (i.e. self-face recognition test). Instead, the enfacement questionnaire was administered both before (baseline) and after the interpersonal stimulation (post), unlike Experiment 1 where it was only administered post-stimulation. Specifically, participants were presented for 5 seconds with still images of the attractive and the non-attractive face in order to obtain a measure of enfacement prior to any interpersonal stimulation. This was repeated twice for each face to match the number of post-stimulation enfacement scores.

4) Given that Experiment 1 did not involve any measure of participants' self-attractiveness, yet this may have influenced the degree of perceived similarity between

themselves and the attractive versus the unattractive face, at the end of the experimental task, participants were asked to complete a short demographic questionnaire, as well as the physical attractiveness item (item number 4) from the Body Image States Scale (BISS; Cash, Fleming, Alindogan, Steadman, & Whitehead, 2002). Specifically, participants had to select one of the following statements regarding how they felt about their physical attractiveness in that particular moment:: *extremely physically unattractive* (1), *very physically unattractive* (2), *moderately physically unattractive* (3), *slightly physically unattractive* (4), *neither attractive nor unattractive* (5), *slightly physically attractive* (6), *moderately physically attractive* (7), *very physically attractive* (8) and *extremely physically attractive* (9).[1]

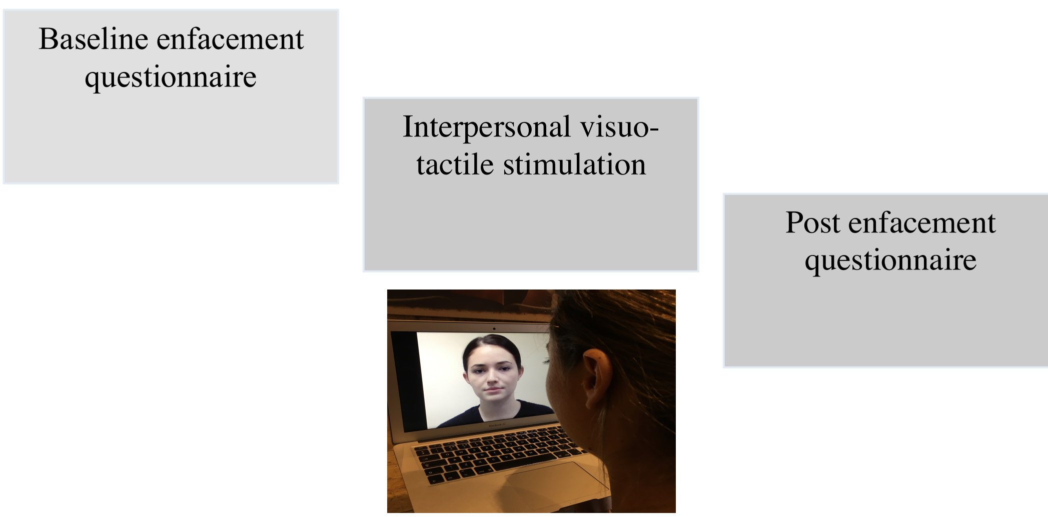

Figure 3. 8 Experimental procedure per block in Exp. 2

3.3.1.3 Data analysis

All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) version 23 (IBM, Chicago, IL, USA). Given that repeated measures (Level 1) were nested within individuals (Level 2), multilevel modelling was

[1] Data for Experiment 2 in this chapter were collected by an undergraduate psychology student (EK), who was previously trained by the author of the thesis.

implemented**.** First, a linear mixed model (LMM) was performed to explore the effects of attractiveness on ‘pre’ scores, with ‘pre’ score as the outcome variable, ‘attractiveness’ as a dummy-coded categorical predictor and subjects specified as random effects. Subsequently, based on the results of the above model that as predicted showed that baselines scores differed not only within and between individuals, but also based on the attractiveness manipulation, a second LMM was performed with ‘post’ score as the outcome variable and ‘pre’ score as the continuous predictor, mean-centred in order to avoid multicollinearity (Tabachnick & Fidell, 2007). ‘Synchrony’ and ‘attractiveness’ conditions were inserted in the models as dummy-coded categorical predictors. In all of the analyses, fixed main effects for each of the categorical and continuous explanatory variables were specified, as well as the interaction term between synchrony and attractiveness. Random intercepts for subjects were also specified (i.e. random effects). As in Experiment 1, the overall score was calculated by averaging the two first subcomponents (identification and similarity), and then the three individual sub-components were analysed separately, with the items of attractiveness and trustworthiness (i.e. ‘affect’ subcomponent) acting as manipulation checks.

3.3.2 Results

Overall Enfacement

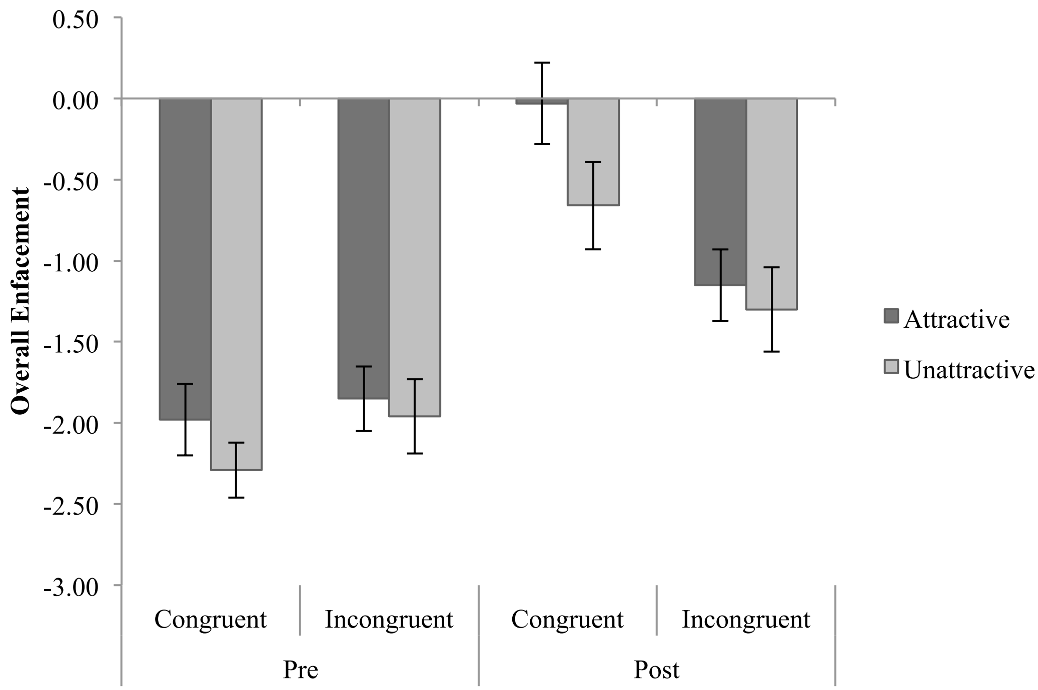

Figure 3. 9 Means for overall enfacement in Exp. 2. Higher scores indicate greater enfacement. Error bars denote standard errors.

The first LMM showed a significant effect of attractiveness on 'pre' scores (b = .311 SE = .129, p = .021), with attractive face (M = -1.92, SD = 1.26) leading to higher levels of enfacement, as compared to unattractive face (M = -2.13, SD = 1.16).

The results of the second LMM with 'post' score as the outcome variable are presented in the table below:

				95% Confidence Interval	
Effect	b	SE	p-value	Lower Bound	Upper Bound
Attractiveness	.153089	.185730	.416	-.224444	.530622
Congruency	**.640733**	**.205812**	**.004**	**.222641**	**1.058825**

Congruency x Attractiveness	.482143	.295539	.112	-.119504	1.083789
Pre	**.675441**	**.083201**	**.000**	**.510442**	**.840440**
Self_attractiveness	-.023515	.066805	.727	-.159620	.112591

Table 3. 4 Multilevel modelling results for outcome variable 'post' scores in subjective enfacement (Exp. 2). Significant main effects and interactions are highlighted in bold.

As one can see from the table above, there was a significant main effect of congruency with congruent stimulation (M = -..346, SD = 1.55) leading to higher levels of overall enfacement as compared to incongruent stimulation (M = -1.22, SD = 1.42). The main effect of attractiveness and the interaction between attractiveness and congruency were non-significant.

<u>*Sub-component analysis*</u>*: Identification*

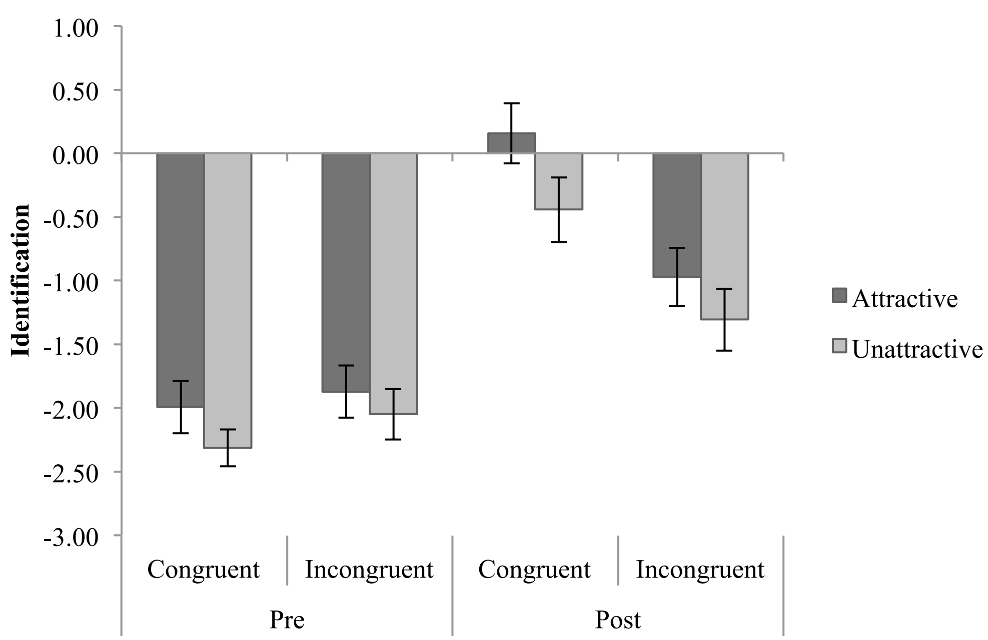

Figure 3.10 Means for identification in Exp. 2. Higher scores indicate greater identification. Error bars denote standard errors.

The first LMM showed a significant effect of attractiveness on 'pre' scores (*b* = .250 *SE* = .119, *p* = .038), with attractive face (M = -1.93, SD = 1.21) leading to higher levels of identification, as compared to unattractive face (M = -2.18, SD = 1.02).

The results of the second LMM with 'post' score as the outcome variable are presented in the table below:

				95% Confidence Interval	
Effect	b	SE	p-value	Lower Bound	Upper Bound
Congruency	**.861212**	**.223246**	**.000**	**.407413**	**1.315011**
Attractiveness	.332641	.195536	.098	-.065073	.730354
Congruency x Attractiveness	.285863	.310368	.364	-.345910	.917637
Pre	**.602448**	**.094414**	**.000**	**.415088**	**.789809**
Self-Attractiveness	-.034759	.070257	.624	-.177863	.108346

Table 3. 5 Multilevel modelling results for outcome variable 'post' scores in Identification (Exp. 2). Significant main effects and interactions are highlighted in bold.

As one can see from the table above, there was a significant main effect of congruency with congruent stimulation (M = -.143, SD = 1.49.) leading to higher levels of identification as compared to incongruent stimulation (M = -1.14, SD = 1.41.). The main effect of attractiveness and the interaction between attractiveness and congruency were non-significant.

<u>*Sub-component analysis:*</u> *Similarity*

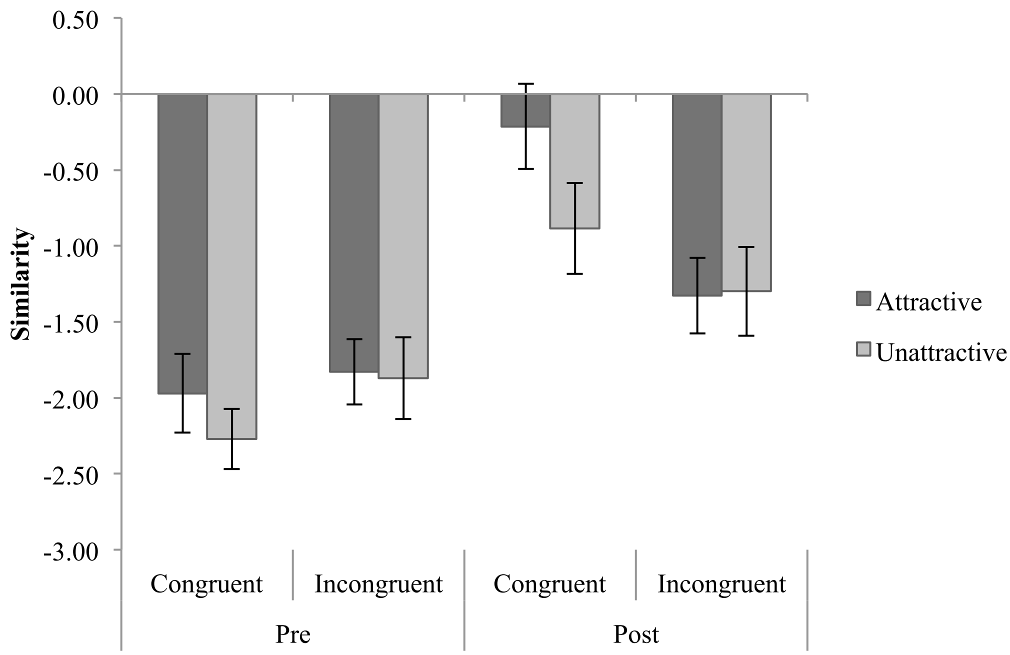

Figure 3. 11 Means for similarity in Exp. 2. Higher scores indicate greater similarity. Error bars denote standard errors.

The first LMM found no main effect of attractiveness on 'pre' scores (*b* = .171 *SE* = .162, *p* = .293).

The results of the second LMM with 'post' score as the outcome variable are presented in the table below:

Effect	b	SE	p-value	95% Confidence Interval Lower Bound	Upper Bound
Congruency	.414286	.213760	.061	-.019772	.848343
Attractiveness	-.028842	.245289	.907	-.527052	.469367
Congruency x Attractiveness	**.700271**	**.334618**	**.044**	**.019141**	**1.381401**
Pre	**.632506**	**.082976**	**.000**	**.467971**	**.797042**
Self-Attractiveness	-.018887	.073598	.799	-.169009	.131235

Table 3. 6 Multilevel modelling results for outcome variable ‘post’ scores in Similarity (Exp. 2). Significant main effects and interactions are highlighted in bold.

As one can see from the table above there was a significant interaction between congruency and attractiveness. Post hoc tests revealed that perceived similarity was higher for attractive vs. unattractive face when the stimulation was congruent [t (34) = 2.21, p = .034] but not incongruent [t (34) = -.101, p = .920].

Manipulation check: Trustworthiness

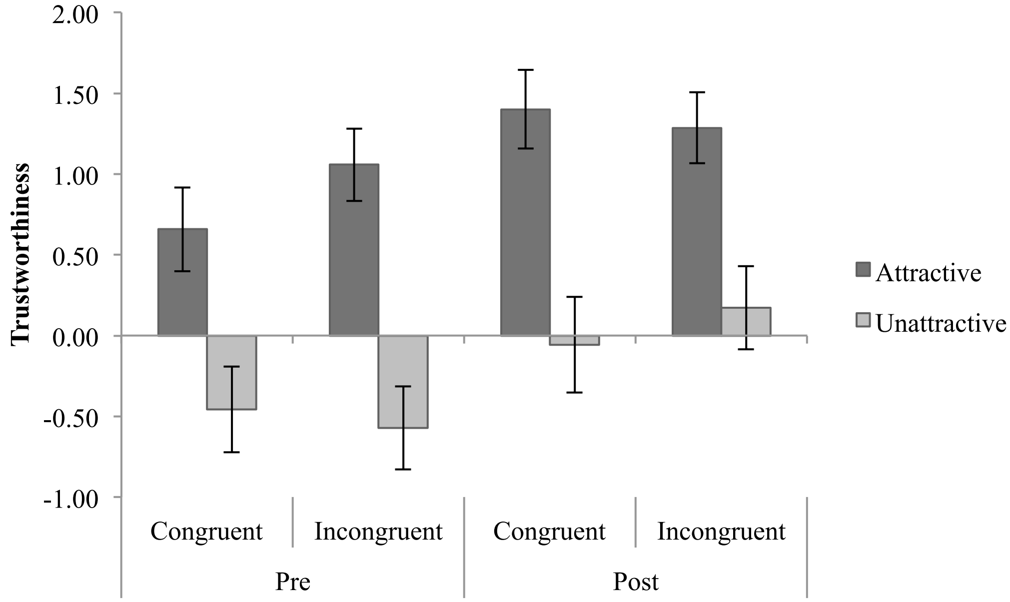

Figure 3. 12 Means for trustworthiness in Exp. 2. Higher scores indicate greater trustworthiness. Error bars denote standard errors**.**

The first LMM found a significant main effect of attractiveness on 'pre' score (b = 1.37 SE = .205, p < .001), with attractive face (M = .857, SD = 1.44) leading to higher levels of trustworthiness, as compared to unattractive face (M = -.514, SD = 1.54).

The results of the second LMM with 'post' score as the outcome variable are presented in the table below:

				95% Confidence Interval	
Effect	b	SE	p-value	Lower Bound	Upper Bound
Congruency	-.228571	.315744	.474	-.870570	.413428
Attractiveness	**1.114286**	**.257329**	**.000**	**.591545**	**1.637027**

Congruency x Attractiveness	.342857	.289842	.246	-.249029	.934743
Pre	**.530370**	**.062000**	**.000**	**.407283**	**.653457**
Self-Attractiveness	-.038794	.058993	.515	-.158777	.081190

Table 3. 7 Multilevel modelling results for outcome variable 'post' scores in Trustworthiness (Exp. 2). Significant main effects and interactions are highlighted in bold.

As one can see from the table above, there was a significant main effect of attractiveness with attractive face (M = .1.34, SD = 1.36.) leading to higher levels of trustworthiness as compared to non-attractive face (M = .057, SD = 1.63.). The main effect of congruency and the interaction between attractiveness and congruency were non-significant.

Manipulation check: Attractiveness

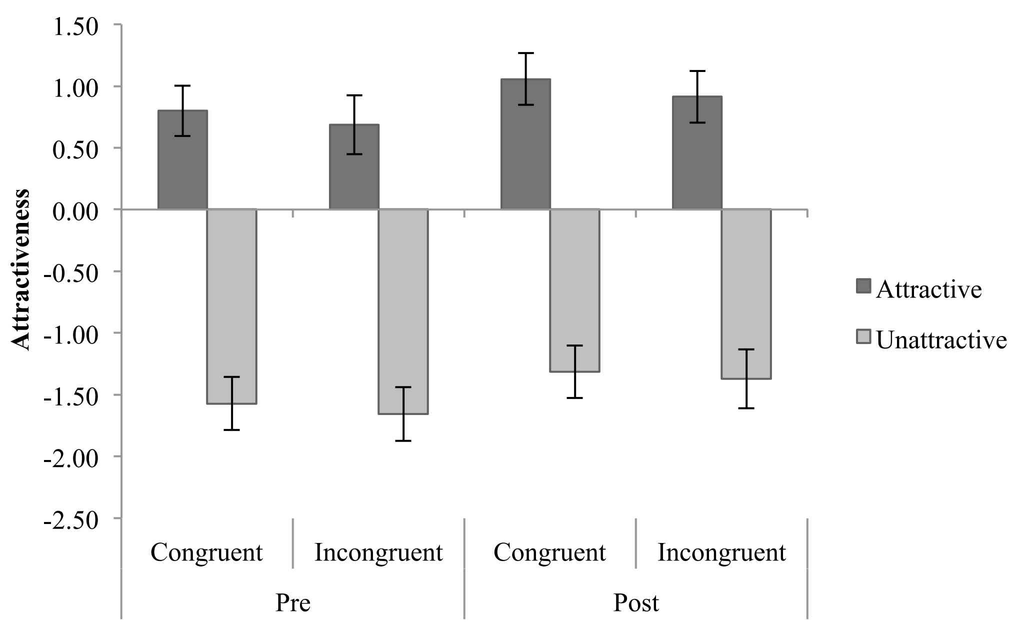

Figure 3. 13 Means for attractiveness in Exp. 2. Higher scores indicate greater attractiveness. Error bars denote standard errors.

The first LMM found a significant main effect of attractiveness on 'pre' score (b = 2.36 SE = .168, p < .001), with attractive face (M = .743, SD = 1.30) leading to higher levels of attractiveness, as compared to unattractive face (M = -1.61, SD = 1.27).

The results of the second LMM with 'post' scores as the outcome variable are presented in the table below

				95% Confidence Interval	
Effect	b	SE	p-value	Lower Bound	Upper Bound
Congruency	.057143	.168203	.736	-.282873	.397159
Attractiveness	**2.285714**	**.178182**	**.000**	**1.926651**	**2.644778**
Congruency x Attractiveness	.085714	.208995	.685	-.340415	.511843
Pre	**.661801**	**.055862**	**.000**	**.551026**	**.772575**
Self-Attractiveness	-.026214	.043821	.556	-.117219	.064792

Table 3. 8 Multilevel modelling results for outcome variable 'post' scores in Attractiveness (Exp. 2). Significant main effects and interactions are highlighted in bold.

As one can see from the table above, there was a significant main effect of attractiveness with attractive face (M = .986, SD = 1.23.) leading to higher levels of attractiveness as compared to non-attractive face (M = -1.343, SD = 1.33.). The main effect of congruency and the interaction between attractiveness and congruency were non-significant.

3.4 General Discussion

Over two experiments, this study investigated for the first time the role of attractiveness in the multisensory modulation of face ownership using the enfacement illusion paradigm. First, the important role of multisensory integration in face ownership recognition was confirmed (Tsakiris, 2008; Sforza et al., 2010, Paladino et al., 2010), showing that temporally and spatially congruent visuo-tactile stimulation leads to higher levels of enfacement, measured both at a subjective and a behavioural level (the latter measured only in Experiment 1). Most importantly, this study provided the first direct evidence that facial attractiveness has an effect on face ownership independently of multisensory integration processes.

To begin with, the results of both experiments suggest that subjective, as well as behavioural face ownership appear to be higher for an attractive vs. a non-attractive face, even when participants were visually exposed to the face for only five seconds, in the absence of any visuo-tactile stimulation. This finding suggests that the effect of attractiveness on face ownership seems to be present after mere visual exposure, without any multisensory integration processes. Moreover, attractiveness was also found to lead to increased levels of overall subjective enfacement and perceived identification (first sub-component) during synchronous stimulation and decreased levels of non-enfacement/identification during asynchronous stimulation, also indicating that attractiveness enhances subjective enfacement and identification independently of multisensory effects. Nevertheless, the same was not true for perceived similarity (second sub-component). For similarity ratings, and in line with the hypotheses, an interaction was found between attractiveness and synchrony, as well as between attractiveness and spatial congruency, indicating that attractiveness enhanced perceived similarity when the stimulation was temporally and spatially congruent but not when it was incongruent. The discrepancy in the effect of attractiveness on perceived identification and similarity was also demonstrated by the effect of attractiveness on identification at baseline, purely based on vision, which was not found for similarity. This discrepancy between the two sub-components is in line with the findings reported in the previous research (Chapter 2), indicating that identification and similarity are possibly mediated by independent mechanisms. In fact, self-identification is considered to be one of the key processes involved in the formation of a mental representation of our physical appearance (Tajadura et al., 2012b). This process matches to the identification component of the enfacement questionnaire, referring to a more general matching between felt and seen sensorimotor signals (Tajadura et al., 2012), which, in turn, leads to the formation of a mental representation of one's physical appearance. However, the sub-component of similarity refers to a more specific experience of physical resemblance with the other person and, hence, it may be considered a distinct process, whereby the effect of attractiveness is dependent on multisensory integration. It, therefore, appears to be important to explore these two processes separately rather than merely obtaining an overall score of enfacement.

The possible interpretations regarding the underpinning reasons for the effect of attractiveness are multiple. One plausible interpretation of why people are inclined to identify more with an attractive face as compared to a non-attractive face after brief visual exposure could be provided by salience-driven attention. Previous research has shown that attractive faces capture greater spatial attention as compared to non-attractive faces, even if the task is unrelated to the judgment of attractiveness (e.g. Sui & Liu, 2009; Chen et al., 2012; Liu & Chen, 2012). More recently, attractiveness has also been found to temporally modulate visual attention (Nakamura & Kawabata, 2014) and the attention to the attractiveness of a face has been shown to be rapid and automatic (Palermo & Rhodes, 2007; Sui & Liu, 2009). Therefore, the fact that attractive faces capture greater attentional resources, which could be due to processing fluency, or could even be innate, deeply rooted in evolution (Thornshill and Gangestad, 1999), may be the reason why people identify more with the attractive faces as compared to the non-attractive. Moreover, from a social psychology perspective, research has shown that attractiveness leads to imitation, which is a fundamental aspect of the process of identification

(Tajadura et al., 2012). For instance, Muller et al. (2013) found that empathy predicts imitation but only for attractive others and not for unattractive. Similarly, Babel (2012) found social selectivity in spontaneous phonetic imitation, with the degree to which vowels were imitated being affected by attractiveness ratings. This imitation is thought to stem from the idea that "what is beautiful is good" and the need to affiliate with and take on characteristics and behaviours of people who are beautiful, hence nice (van Leeuwen, Veling, van Baaren & Dijksterhuis, 2009; Lakin & Chartand, 2003).

More generally, the findings of the current study suggest that an affective stimulus, such as a beautiful face, can enhance face ownership and this finding is in line with that of the previous study of this thesis (see Chapter 2), demonstrating that affective touch can also increase face ownership. Interestingly, the current research suggests that different aspects of affect, such as sensory pleasure and affectivity associated with attractive faces, enhance self-face recognition. However, previous research has shown that affectivity conveyed by facial expressions does not affect the enfacement illusion, with the strength of enfacement being the same regardless of the emotion expressed by the other person (Beck et al., 2015). Therefore, it is still unknown whether the results can generalise more broadly to different aspects of affect. Moreover, an important difference between this and the study described in the previous chapter is that, in the current study, the affective stimulus was merely visually presented, whereas in the previous study it was seen but also felt on one's own skin. A recent study by Filippetti, Kirsch, Crucianelli & Fotopoulou (2018) investigated the role of affective, top-down aspects of sensory congruency between visual and tactile modalities in the sense of body ownership using the rubber-hand illusion (RHI). They found that incongruency between felt and vicariously perceived sensory events led to lower levels of subjective embodiment, irrespective of any valence effect. To test the effect of such an incongruency, in the second experiment of the current research a measure of participants' perceived attractiveness was obtained, in order to explore the role of perceived attractiveness congruency in enfacement with an attractive vs. non-attractive face. Ratings of self-attractiveness were found to have no effect, suggesting that the top-down aspect of attractiveness congruency does not influence subjective enfacement of an attractive vs.

non-attractive face. Instead, actual physical resemblance could mediate this effect, however one limitation of this study is that the actual physical similarity between participants and the attractive and non-attractive faces was not controlled for. Nevertheless, this factor is unlikely to have an influence as the findings for the similarity sub-component suggest multisensory effects over and above initial baseline effects. Furthermore, although every effort was made to ensure that the models in the visuo-tactile stimulation videos were maintaining a neutral expression, it was not possible to systematically control for micro-expressions. Finally, for reasons explained in section 3.2.1 only females were tested in this study, hence, future studies could investigate whether the present results extend to females touched by a male experimenter, as well as to males, for whom dominance could potentially have a more pronounced effect as compared to attractiveness, given previous research suggesting that testosterone increases perceived dominance but not attractiveness of male faces (Swaddle & Reierson, 2002)

To conclude, while previous research has shown that synchronous visuo-tactile stimulation blurs the categorical boundaries between self and other and also increases ratings of attractiveness towards the other face (Tajadura-Jimenez et al., 2012), this study showed for the first time that the opposite is also true. Increased ratings of attractiveness of a new, unfamiliar face lead to blurring of self-other boundaries, allowing the identification of our psychological self with another's physical self, and more specifically their face, the most representative instance of personal and social identity. Crucially, the effect of attractiveness on face ownership showed dissociable mechanisms. The effect of attractiveness on perceived similarity appeared to be dependent on multisensory integration, while its effect on identification appeared to be independent of the multisensory integration processes (i.e. orthogonal effects). In fact, people are more inclined to identify with attractive faces even after being visually exposed to them for a brief period of time, in the absence of visuo-tactile processes, suggesting that this effect may be purely based on vision. This is true when identification is measured both at behavioural and a subjective level. On the other hand, attractiveness has a unique effect on similarity during multisensory integration, over and above any general effects of attractiveness. The exact mechanism behind this remains unknown, yet future research could try to disentangle whether people are more inclined to acquire ownership of more attractive faces due to bottom-up salience-driven attention or top-down processes, guided by higher level knowledge and expectations.

Chapter 4 |

Separating the Self from Beauty: The Role of Perceived Attractiveness in Self-Other Distinction in an Embodied Context

4.1 Introduction

The previous chapters investigated how we make sensory decisions about the body and, more specifically, how affective touch (Chapter 2) and facial attractiveness (Chapter 3) influence self-face recognition during multisensory integration. This chapter will investigate how we make social decisions about the body. More specifically, it will examine the role of perceived attractiveness in self vs. other distinction of affective states.

As mentioned in section 1.4, we live in a social world and social interactions are crucial at every stage of life. Notably, interpersonal understanding of mental states and actions, which is crucial for prosocial behaviours, relies greatly on one's capacity to distinguish between self and other-related representations, especially when the two experiences are not aligned (Singer & Lamm, 2009). This ability is referred to as self-other distinction (Spengler, von Cramon & Brass, 2009). A large body of literature has shown that shared neural activations between self and other underlie our ability to represent the internal states of others (Singer & Lamm, 2009; Bastiaansen et al., 2009; Mitchell, 2009; Preston & de Waal, 2002). Interestingly, humans tend to use the self as a reference point to understand others' mental states. This tendency to use the self as a reference point has been broadly referred to as 'egocentricity bias'. The opposite, namely 'altercentricity bias' refers to one's tendency to resonate and be very much influenced by another person's mental state (Singer & Lamm, 2009). However, conflict and misunderstandings may arise if these biases are inappropriately applied in different situations (Silani, Lamm, Ruff & Singer, 2013). For instance, using as a reference one's own pleasant experience to judge another person's unpleasant experience (or vice versa) can be problematic. It is, therefore, crucial for people to have a good balance between those two complementary biases, i.e. between projecting and introjecting own and others' mental states.

From a cognitive perspective, research has shown that egocentricity is a general feature of human cognition and people tend to be immersed in their own sensations and cognitions, judging others' experience based on what they can perceive externally (Pronin, 2008; Royzman et al., 2003). For example, Keysar et al. (2000) found that when people are asked to displace objects following instructions from people who have a different visual perspective they are more prone to make self-perspective related errors. Similarly, Birch and Bloom (2007) showed that when people are asked to reason about other people's beliefs related to an event, they are very much influenced by their own knowledge and experience of that specific event. More recently, as discussed in Chapter 1, research in the affective domain has confirmed the existence of an emotional egocentricity bias (EEB; Silani, Lamm, Ruff & Singer, 2013). Using a visuo-tactile paradigm assessing the degree to which empathic judgments are influenced by one's own emotions, a significant EEB with medium effect size was found. This bias could, however, be drastically increased by disrupting the right supramarginal gyrus (rSMG) with repetitive transcranial magnetic stimulation (TMS), indicating that this region is crucial for overcoming emotional egocentricity. In line with this result, Riva et al. (2016) found that emotional egocentricity is enhanced in adolescents, as well as in older adults, as compared to young and middle-aged adults. These results suggest that age-related changes of the EBB may be, in fact, due to the lifespan development of rSMG, which reaches full maturation at the end of adolescence and goes though an early decay. Moreover, empathy deficits are also thought to be a feature of psychopathology. In fact, in a study that used the same EEB paradigm (Silani et al., 2013), major depressive disorder (MDD) has been associated with self/other distinction deficits, with MDD patients being more egocentric during empathic judgments and more altercentric during self-emotion judgments (Hoffman et al., 2016). Nevertheless, what the aforementioned paradigms seem to be missing is an embodied context. More specifically, participants were virtually paired and, thus, were not able to actually see what the other participant was experiencing.

An interesting but understudied question concerns social factors that may influence our ability to separate our experience from that of other people during social interactions. A large body of research, discussed in Chapter 1, has shown that beauty is a very influential factor for social exchanges (Langlois et al., 2000), yet not much is known about how perceived attractiveness of self in comparison to others may influence one's capacity to distinguish self vs. other affective states. As mentioned in Chapter 1, according to the "what is beautiful is good" stereotype, physically attractive individuals are believed to possess a wide variety of positive personal qualities, such as kindness, trustworthiness and honesty. Apart from socially desirable qualities, higher moral standards are also often attributed to attractive people, with defendants who are less attractive being more likely to be judged as guilty (e.g. Burke et al. 1990). In a functional neuroimaging study (Tsukiura & Cabeza, 2011), participants were scanned while making attractiveness judgments about faces and goodness judgments about hypothetical actions. Results showed shared brain activity for aesthetic and moral judgments, providing further evidence for the "what is beautiful is good" stereotype. However, there is a scarcity of research exploring the effect of attractiveness and, in turn, all the positive qualities associated with it, on the extent to which one projects own mental states into other minds.

Interestingly, as demonstrated below, beauty has also been found to relate to a lack of concern for other people. During prisoner's dilemma or other similar economic games that focus on strategies employed when individuals are asked to make decisions involving other people, physically attractive men have been consistently found to be less likely to cooperate with others (Takahasi et al., 2006; Zaatari & Trivers, 2007; Shinada & Yamagishi, 2014), indicating that attractive people tend to skew to the selfish side, not being willing to share much with other individuals. This lack of concern for other people extends beyond actual attractiveness to perceived attractiveness. The "what is beautiful is good" stereotype was recently revisited in a study that investigated how perceived attractiveness relates to perceived personality, as well as actual personality (Segal-Caspi, Roccas & Sagiv, 2012). A sample of 118 women self-reported their traits and values and were subsequently videotaped while completing a task. A separate sample of 118 judges rated the attractiveness of those women, as well as their traits and values. The results showed that attractiveness significantly correlated with self-centered values that focused on self-promotion rather than concern for other people. In addition, in another study, women consensually identified as representative of one of three levels of attractiveness were asked to make attributions of personality traits for female targets consensually identified as representative of five levels of attractiveness. The results showed that the attribution of egocentric qualities increased with targets' increasing attractiveness (Galluci & Meyer, 1984). So far, the evidence suggests that people who are judged by others as attractive are also perceived as more egocentric, with a lack of concern for other people. Yet, the question remains as to whether people who perceive themselves are more attractive than others are actually more egocentric, i.e. more inclined to project their own mental states into others' minds.

To this end, the current study investigated for the first time the role of perceived attractiveness in self-other distinction of affective states. More specifically, the aim was to explore how one's own perceived attractiveness in active comparison with another person influences the two complementary biases: egocentricity (i.e. projection of own mental states into other minds) and altercentricity (i.e. introjection of others' mental states into our own). Given the interest in the perception of the body's physical appearance, the widely used emotional egocentricity task (Silani et al., 2013) was adapted to include an embodied aspect. In the new paradigm, participants were paired up and were allowed to see touch applied to each other's face, unlike the classic paradigm that virtually pairs up participants and uses merely pictorial representation of the stimulus that is allegedly touching each participant independently (e.g. a spider). In a series of two experiments, participants were touched with pleasant and unpleasant fabrics on the cheek in a congruent (same valence) or incongruent manner (opposite valence) and were asked to rate the pleasantness of the touch for the self or the other. In line with previous research suggesting that more attractive people are perceived as more self-promoting and egocentric, we predicted that people who perceive themselves as more attractive will be more likely to project their own emotional, embodied experience into others (i.e. higher levels of ‘egocentricity bias’), whereas people who perceive themselves as less attractive will be more likely to introject the emotional, embodied experience of others (i.e. higher levels of ‘altercentricity bias’).

4.2 Experiment 1

4.2.1 Method

4.2.1.1 Participants

Thirty-eight participants (age 28.97 $\pm$ 11.65 SD years, 20 females) with no known physical or mental disabilities were tested at a public event on haptics at the Royal Institution in London. The sample size was determined based on prior calculations for 95% power (effect size f set at 0.28, G*Power 3.1) in accordance with the effect size obtained in the significant interaction in Silani et al. (2013) (η^2 = .074). Participants were unknown to each other and assigned pairwise to the experimental session, forming 14 dyads. Written, informed consent was obtained from all participants prior to their participation. The study was approved by the Ethics Committee of the Research Department of Clinical, Educational and Health Psychology, University College London.

4.2.1.2 Design

The study employed a mixed design with the within-subjects factors; 1) target (self vs. other), 2) valence (pleasant vs. unpleasant) and 3) congruence (congruent vs. incongruent), resulting in eight different conditions. There was also a between-subjects factor: attractiveness (self more attractive vs. other more attractive). The dependent measures were participants’ pleasantness ratings for the touch that they felt (self) and the touch that they saw (other).

4.2.1.3 Materials

This novel embodied egocentricity task, based on a larger project that validated a forearm-version of this embodiment paradigm in four different experiments (Kirsch et al., in prep) allowed participants to see pleasant and unpleasant touch applied to each other's face. The choice of the two fabrics with which participants were touched was made on the basis of a pilot experiment involving a separate set of 12 participants, whereby 12 materials of different degrees of pleasantness (cotton wool ball, soft sponge, Velcro hook, Velcro hairy loops, hair doughnut, faux fur, sandpaper, linen fabric, wool yarn, latex, cotton fabric, synthetic wool yarn) were contrasted in a visual only, tactile only, and visuo-tactile conditions. The size and colour of the fabrics were matched to avoid perceptual confounds. Based on these data, the most pleasant and least pleasant (hereafter referred to as unpleasant) fabrics with similar visual appearance (i.e. size and colour) were selected. The two fabrics used for the current experiment were: cotton (pleasant) and scourer (unpleasant).

4.2.1.4 Procedure

Same-sex participants were paired up and seated on a chair opposite to each other (Figure 1). A curtain was installed between participants to prevent visual contact between them during ratings. Participants were asked to record all of their ratings on a booklet that they were given. First, the curtain was removed and participants were instructed to look at each other's face for 10 seconds. The curtain was re-installed and participants were asked to rate attractiveness, trustworthiness, dominance and distinctiveness of 'self' and 'other' on a scale from 0 (not at all) to 10 (extremely), as well as make a forced-choice about who is more attractive, trustworthy, dominant and distinctive ('self' or 'other'). The manipulation of interest was attractiveness, yet the other three ratings were used as a control. Trustworthiness and dominance were selected given that they are thought to be primary dimensions influencing social judgments (Oosterhof & Todorov, 2008). Participants were then asked to close their eyes while an experimenter delivered manual tactile stimulation on their cheek covering a distance of 6cm with the two different fabrics. Each stimulation block consisted of 2 strokes and participants were then asked to rate the pleasantness of the touch on a scale from 0 (not all) to 10 (extremely) in order to obtain baseline ratings for the tactile experience (feel). This was repeated twice for each fabric. Subsequently, the main experimental task began, during which two experimenters, seated behind each participant, delivered synchronous mirror-like tactile stimulation on a specular congruent location between the two faces. Participants were only able to see the stroke applied to the other person's face. Each stroke covered a distance of 6cm on the cheek and each stimulation block consisted of 2 stokes. In congruent trials, the two participants were touched by fabrics of the same valence, whereas in incongruent trials they were touched by fabrics of opposite valence. Participants were asked to focus both on the sensation of the touch that they felt (self) and the touch that they saw (other) given that immediately after each stimulation block, they had to judge either the pleasantness of the touch that they felt (self) or the touch that they saw (other) on the same scale from 0 (not all) to 10 (extremely) but they did not know in advance which question they would have to answer. In total, there were eight different conditions and each was repeated twice, resulting in 16 trials; eight pleasant (four congruent/four incongruent) and eight unpleasant (four congruent/four incongruent) (Figure 2). The order of the trials was randomised and there was a two-minute break halfway through the trials. After the main task, participants were asked to look at the different fabrics for 3 seconds and then rate how pleasant it would feel if they were touched by those on the same scale from 0 (not at all) to10 (extremely) in order to obtain baseline ratings for the visual experience (see). This was repeated twice for each fabric.

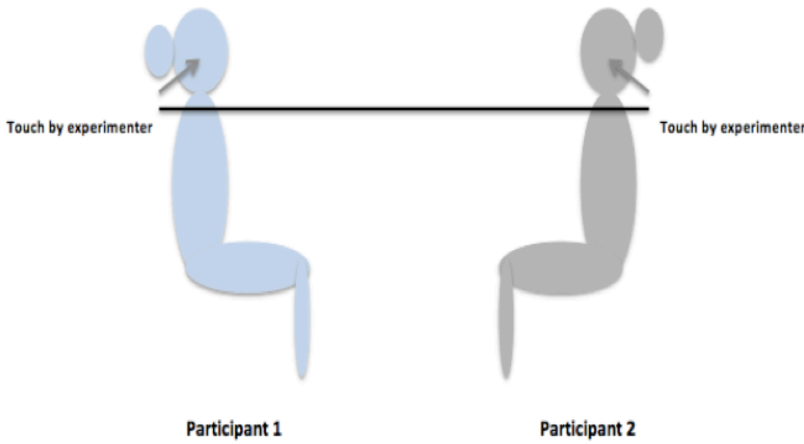

Figure 4. 1 Experimental set-up

Figure 4. 2 Experimental design. In congruent trials, the two participants were touched by fabrics of the same valence, either pleasant (cotton) or unpleasant (scourer), whereas in incongruent trials they were touched by fabrics of opposite valence**.**

4.2.1.5 Data analysis

Data were analysed using SPSS v. 23 (IBM, Chicago, IL, USA). The egocentricity bias (EB) was measured as the pure effect of the self on judging the other's pleasantness, therefore by seeing the other being touched during incongruent shared touch minus seeing the other being touched while there was no touch on the self. Hence, a score for EB was obtained by subtracting baseline ratings for visual experience (see) from other-related pleasantness ratings during incongruent trials. This was done separately for the pleasant and unpleasant fabric in order to control for valence effects. The altercentricity bias (AB) was measured as the pure effect of the other's experience on the self's pleasantness, therefore by feeling touch on the self during incongruent shared touch minus feeling touch when there was no touch on the other. Hence, a score for AB was obtained by subtracting the baseline ratings for tactile experience (feel) from self-related pleasantness ratings during incongruent trials. This was done again separately for the pleasant and unpleasant fabric. Total EB and AB scores were also obtained by calculating the average of pleasant and unpleasant biases, equalising for valence direction (Table 4.1).

To explore whether there were differences in baseline scores, a mixed ANOVA on baseline pleasantness scores was performed as a manipulation check with "target" (self vs. other) and "valence" (pleasant vs. unpleasant) as within-subjects factors and "attractiveness" (self vs. other) as a between-subjects factor. For the main task pleasantness scores, a mixed ANCOVA was performed with "target" (self vs. other), "valence" (pleasant vs. unpleasant) and "congruence" (congruent vs. incongruent) as within-subject factors, "attractiveness" (self vs. other) as between-subjects factor and the baseline difference scores between self (feel) vs. other (see) for each valence as covariates, given the asymmetry found in the baseline scores for unpleasant materials. Subsequently, to compare the levels of total egocentricity and altercentricity biases, independent samples t-tests were performed. Last but not least, to explore the effect of attractiveness on egocentricity and altercentricity biases, a dyadic multilevel modelling analysis was also carried out given that participants were nested within dyads and this analysis controls for non-independence of data. The analysis was done separately for the different biases entered as outcome variables (i.e. total egocentricity, total altercentricity and separately for pleasant and unpleasant materials). Attractiveness (i.e. self vs. other more attractive) was included as a dummy-coded categorical predictor factor. Baseline difference scores between feel and see for each valence were included as covariates, mean-centred in order to avoid multicollinearity (Tabachnick & Fidell, 2007), given the asymmetry found in the baseline scores. In all of the analyses, fixed main effects for the categorical explanatory variable were specified, as well as the random intercepts for dyads (i.e. random effects).

EB Pleasant	Rating other incongruent (self unpleasant - other pleasant) - baseline see unpleasant
EB Unpleasant	Rating other incongruent (self pleasant - other unpleasant) - baseline see pleasant
AB Pleasant	Rating self incongruent (self pleasant / other unpleasant) - baseline feel pleasant
AB Unpleasant	Rating self incongruent (self unpleasant / other pleasant) - baseline feel unpleasant
EB Total	(EB unpleasant - EB pleasant)/2
AB Total	(AB pleasant - AB unpleasant)/2

Table 4. 1 Formulas for bias calculations

4.2.2 Results

Out of the 38 participants, 19 of them rated the 'self' as more attractive, 18 rated the 'other' as more attractive and there was also one missing value. In total, there were thirteen pairs in which there was a mutual agreement on who is more attractive, three pairs in which both participants rated the 'self' as more attractive and three pairs in which both participants rated the 'other' as more attractive.

First, a mixed ANOVA on baseline scores was conducted with "target" (self vs. other) and "valence" (pleasant vs. unpleasant) as within-subjects factors and "attractiveness" (self vs. other) as a between-subjects factor.

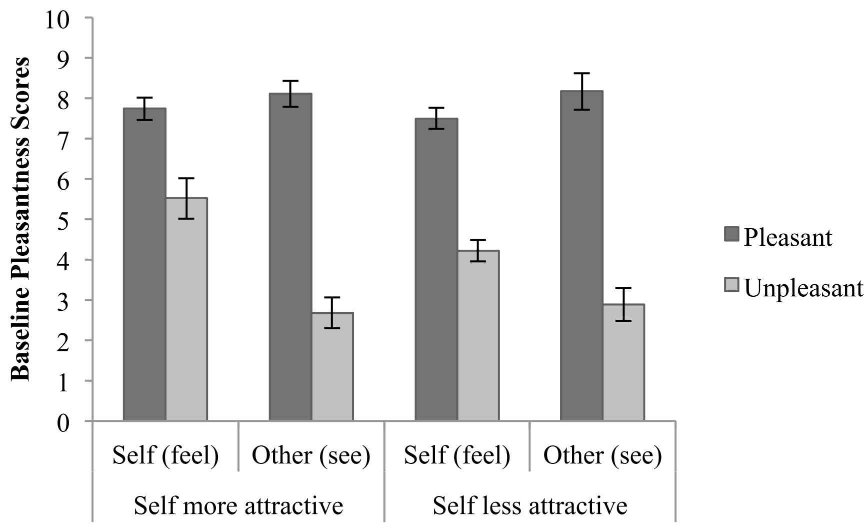

Figure 4. 3 Baseline pleasantness scores for participants who perceived self as more attractive vs. self as less attractive in Exp. 1. Error bars denote standard errors**.**

The results of this analysis revealed the expected main effect of valence [F (1,37) = 185.02, $p < .001$, $\eta^2 = .841$] with cotton (mean = 7.87, SE = .164) resulting in higher pleasantness ratings as compared to scourer (mean = 3.80, SE = .281). A significant main effect was also found for target [F (1,37) = 11.81, p = .002, $\eta^2 = .252$] with feel ratings (mean = 6.22, SE = .214) resulting in higher pleasantness as compared to see ratings (mean = 5.46, SE = .199). A significant interaction *target X valence* was also found [F (1,37) =51.48, $p < .001$, $\eta^2 = .595$]. Bonferroni-corrected post hoc analyses (alpha=0.0127) revealed that the difference between pleasant and unpleasant materials was significant both for self judgments [t (37) = 7.46, $p < .001$] and other judgments [t(37) = 16.98, $p < .001$], yet for unpleasant materials the difference between self and other judgments was significant [t(37) = 5.86, $p < .001$], whereas for pleasant materials it was not [t(37) = -2.47, p = .018]. The main effect of attractiveness, as well as all other interactions were non-significant (Figure 4.3). It therefore appears that people perceived the unpleasant fabric as more unpleasant when touching another person's face rather than when touching own face, i.e. asymmetrical effect of unpleasant touch on self (feel) vs. unpleasant touch on other (see). Importantly, the results also confirm that there was no effect of attractiveness on baseline scores.

Subsequently, a mixed ANCOVA on main task pleasantness scores revealed a main effect of valence [$F(1,37) = 51.15$, $p < .001$, $\eta^2 = .615$] with cotton (mean = 7.35, SE = .168) resulting in higher pleasantness ratings as compared to scourer (mean = 4.51, SE = .237). A significant main effect was also found for target [$F(1,37) = 5.74$, $p = .023$, $\eta^2 = .152$] with self (mean = 5.96, SE = .166) resulting in higher pleasantness ratings as compared to other (mean = 5.90, SE = .178). A significant interaction *target X baseline differential for unpleasant* was found [$F(1,37) = 4.96$, $p = .033$, $\eta^2 = .134$]. A significant interaction *target X valence* was also found [$F(1,37) = 22.53$, $p < .001$, $\eta^2 = .413$]. Bonferroni-corrected post hoc analyses (alpha=0.0127) revealed that the difference between pleasant and unpleasant materials was significant both for self judgments [$t(37) = 10.17$, $p < .001$] and other judgments [$t(37) = 5.86$, $p < .001$], yet the different between self vs. other was also significant both for pleasant materials [$t(37) = 3.62$, $p = .001$] as well as unpleasant materials [$t(37) = -3.09$, $p = .004$]. The three-way interaction was also significant *target X valence X congruence* [$F(1,37) = 6.80$, $p = .014$, $\eta^2 = .175$], as well as the three-way interaction between *target X valence X baseline differential for unpleasant congruence* [$F(1,37) = 10.60$, $p = .003$, $\eta^2 = .249$]. There was also a main effect of attractiveness [$F(1,37) = 9.17$, $p = .005$, $\eta^2 = .223$], with people who rated the self as more attractive (mean = 6.41, SE = .221) showing higher pleasantness ratings as compared to people who rated the other as more attractive (mean = 5.45, SE = .221), suggesting that people who perceive themselves as more attractive, also tend to perceive the different materials are more pleasant, regardless of their true valence.

Figure 4.4 below illustrates the levels of biases for people who found self more attractive vs. people who found the other more attractive.

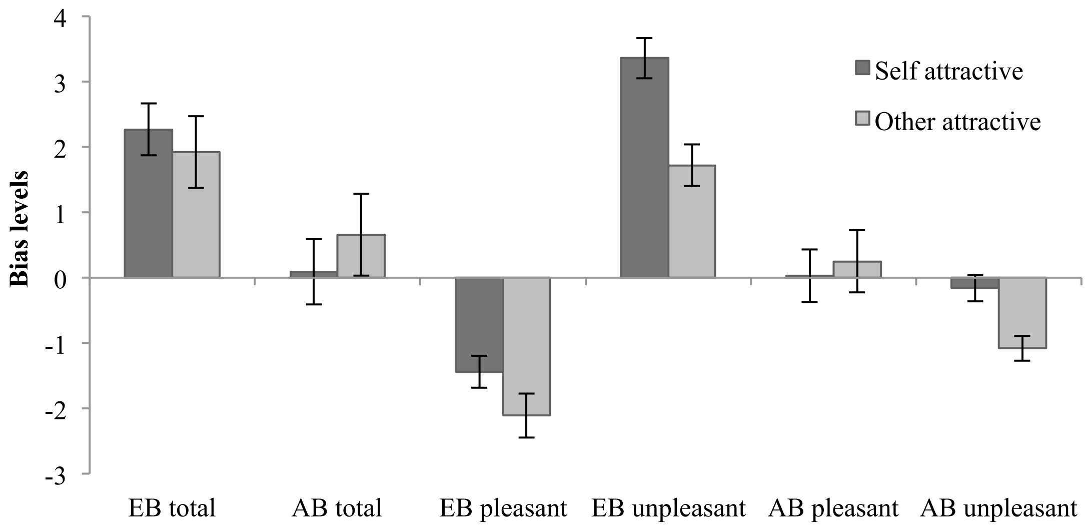

Figure 4. 4 Total levels of egocentricity and altercentricity biases in Exp. 1. In total biases and biases for unpleasant materials, higher scores indicate higher levels. In biases for pleasant materials, lower scores indicate higher levels. Error bars denote standard errors.

Independent-samples t-tests revealed that total levels of egocentricity bias (EB) are significantly higher than the total levels of altercentricity bias (AB) [$t(37) = 5.52$, $p < .001$]. Moreover, as one can see from Figure 4.4, people who rated the self as more attractive appear to be more egocentric overall, whereas people who rated the other as more attractive appear to be more altercentric overall. To explore whether these differences were significant**,** dyadic multilevel modelling analyses were conducted. Perceived attractiveness was found to have a significant effect on total altercentricity bias (b = -572, SE = .235, p = .023), with people who rate the other as more attractive having a higher total altercentricity bias (M = .659, SE = .186) as compared to people who rated the self as more attractive (M = .234, SE = .355) (see Figure 4.4). Perceived attractiveness was also found to have a significant effect on altercentricity bias for unpleasant material (b = 1.0988, SE = .371, p = .007), with people who rate the self as more attractive having a higher total altercentric bias when others were touched by pleasant and self was touched by unpleasant materials (M = -.011, SE = .301) as compared to people who rated the self as less attractive (M = -1.11, SE = .307). Moreover, attractiveness was found to have an effect on egocentricity bias for unpleasant material (b = 1.58, SE = .724, p = .038), with people who rate the self as more attractive having a higher egocentricity bias when others were touched by unpleasant and self was touched by pleasant materials (M = 3.24, SE = .528) as compared to people who rate the other as more attractive (M = 1.65, SE = .516) (see Figure 4.4).

4.2.3 Discussion

Overall, this experiment confirmed the existence of a significant emotional egocentricity bias in an embodied context, with people having a tendency to use the self as a reference point to judge others' affective experience, irrespective of attractiveness. Crucially, the results showed that people who rated the other as more attractive had a higher total altercentricity bias, i.e. they introjected the more attractive person's affective state into their own. However, the levels of altercentricity bias were higher for people who rated the self as more attractive, when the self was experiencing unpleasant and the other pleasant stimulation, i.e. they introjected more the pleasant state of the less attractive other. With regards to egocentricity, those who rated the self as more attractive had a higher egocentricity bias when others were touched by unpleasant and self was touched by pleasant material, i.e. they projected their own pleasant affective state into the less attractive other's unpleasant state. Overall, the findings of this experiment partly confirm the original hypotheses according to which people who perceive themselves as more attractive would be more egocentric whereas those who perceive themselves as less attractive would be more altercentric, yet they also suggest that the effect of attractiveness on centricity biases depends on valence with people who rate themselves as more attractive projecting more their own pleasant state but also introjecting more the less attractive person's pleasant state. Therefore, people who perceive themselves as more attractive seem to be particularly responsive to stimuli of positive valence during incongruent conditions and, importantly, this is not influenced by baseline ratings given that there were no baseline differences between self (feel) vs. other (see) ratings for pleasant materials.

However, the current experiment possessed three important limitations. First, only two fabrics were used (i.e. cotton, scourer), hence there was only one fabric to represent pleasant and unpleasant materials, respectively. Second, the experiment took place at a public event at the Royal Institution in London and not in the laboratory, hence extraneous variables, such as noise, could not be controlled for. Last but not least, although participants were instructed to stay still and have a neutral expression during the tactile stimulation, it was not possible to control for micro-expressions revealing emotions. Therefore, a second experiment was conducted as a replication of this first experiment in order to test participants in a more controlled setting (i.e. laboratory), as well as introduce two additional fabrics and control for facial micro-expressions of emotion. The hypotheses were identical to these of Experiment 1: higher levels of egocentricity bias was expected when one perceives the self as more attractive and/or higher levels of 'altercentricity bias' were expected when one perceives the other as more attractive and vice versa.

4.3 Experiment 2

4.3.1 Method

4.3.1.1 Participants

Forty participants (age 21.38 ± 2.38 SD years, 20 females) with no known physical or mental disabilities were recruited online via a University Subject Pool system and took part in a single one-hour experimental session in a laboratory setting. The sample size was determined based on prior calculations for 95% power (effect size f set at 0.28, G*Power 3.1) in accordance with the effect size obtained in the significant interaction in Silani et al. (2013) (η^2 = .074).. Participants were reimbursed for their time with either payment (£7.50) or course credits. Written, informed consent was obtained from all participants prior to their participation. The study was approved by the Ethics Committee of the Research Department of Clinical, Educational and Health Psychology, University College London.

4.3.1.2 Design, Materials, Procedure and Data Analysis

The design, materials, procedure and data analysis were identical to Experiment 1 with three exceptions:

1) Two more fabrics were introduced to this experiment: wool (pleasant) and velcro (unpleasant) also based on an initial pilot study in which a separate set of participants had been asked to evaluate the valence of different fabrics (see Methods Experiment 1). In total, in this second experiment there were 4 fabrics; cotton, wool, scourer, velcro. To obtain ratings for pleasant and unpleasant materials, ratings for cotton and wool were averaged, as well as ratings for scourer and velcro, respectively. As a result, there were 32 trials in this experiment; 16 pleasant (eight congruent/eight incongruent) and 16 unpleasant (eight congruent/eight incongruent); leading to a repetition of 4 times for each condition.

2) All the ratings were made on a visual analogue scale (VAS) anchored from 0 (not at all) to 100 (extremely). The whole experiment was designed and recorded using Psychophysics Toolbox 3, MATLAB R2016a (MathWorks Inc.).

3) The experiment was video-taped using two different cameras that were focusing on each of the participants' faces. A naïve observer watched each video in terms of expression to ensure that none of the participants expressed any obvious emotion during the experiment.

4.3.2 Results

Out of the 40 participants, 19 of them rated the 'self' as more attractive and 21 rated the 'other' as more attractive. In total, there were nine pairs in which there was a mutual agreement on who is more attractive, five pairs in which both participants rated the 'self' as more attractive and six pairs in which both participants rated the 'other' as more attractive.

First, a mixed ANOVA on baseline scores was conducted with target (self vs. other) and valence (pleasant vs. unpleasant) as within-subjects factors and attractiveness as a between-subjects factor.

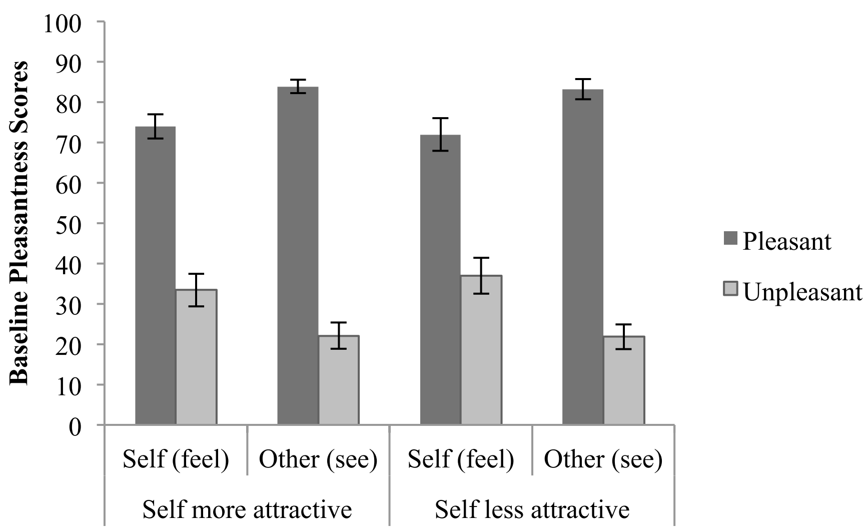

Figure 4. 5 Baseline pleasantness scores for participants who perceived self as more attractive vs. self as less attractive in Exp. 2. Error bars denote standard errors.

The results revealed the expected, main effect of valence [F (1,39) = 421.77, $p < .001$, $\eta^2 = .915$] with pleasant materials (mean = 78.28, SE = 1.83) resulting in higher pleasantness ratings as compared to non-pleasant materials (mean = 28.59, SE = 2.36). A significant interaction *target X valence* was also found [F (1,39) =52.11, $p < .001$, $\eta^2 = .572$]. However, Bonferroni-corrected post hoc analyses (alpha=0.0127) revealed that the difference between pleasant and unpleasant materials was significant both for self judgments [t (39) = 11.88, p < .001] and other judgments [t(39) = 23.07, p < .001]. Moreover, the difference between self and other judgments was significant for unpleasant materials [t(39) = 5.40, p < .001], as well as for pleasant materials [t(379) = -5.07, p < .001]. The main effect of attractiveness, as well as the main effect of target and all other interactions were non-significant (Figure 4.5). Unlike in the previous experiment, no differences in pleasantness ratings between unpleasant fabrics on self (feel) and unpleasant fabrics on other (see) were found. Importantly, there was also no effect of attractiveness on baseline scores.

A mixed ANCOVA on the main task pleasantness rating data revealed a main effect of *valence* [F (1,39) = 86.82, p < .001, η^2 = .707] with pleasant materials (mean = 72.44, SE = 2.22) resulting in higher pleasantness ratings as compared to unpleasant (mean = 35.14, SE = 2.24). An interaction was also found between *congruence X baseline differential for pleasant* [F (1,39) = 4.82, p = .035, η^2 = .118]. All other main effects and interaction were not significant (all p-values < .05).

Figure 4.6 below illustrates the levels of biases for people who found self more attractive vs. people who found the other more attractive.

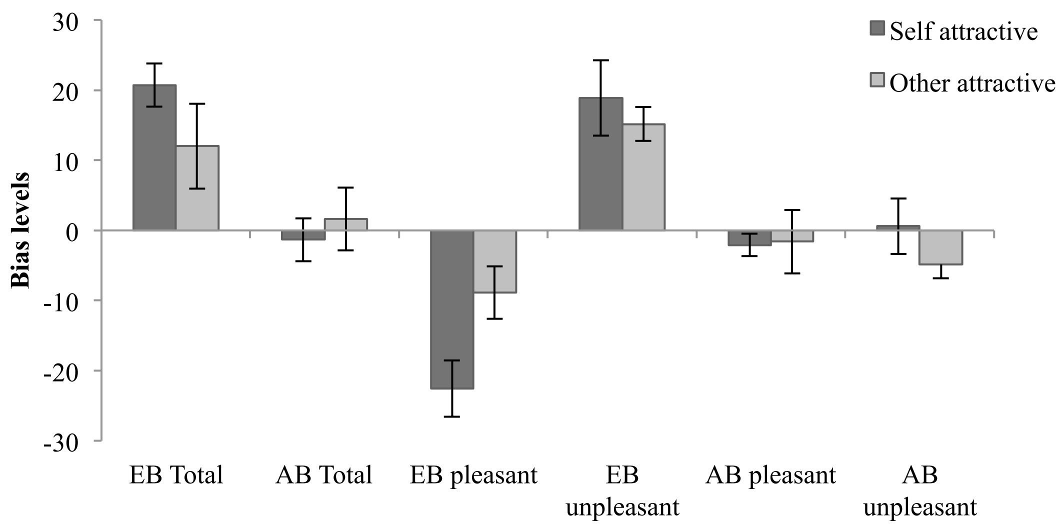

Figure 4. 6 Total levels of egocentricity and altercentricity biases in Exp. 2. In total biases and biases for unpleasant materials, higher scores indicate higher levels. In biases for pleasant materials, lower scores indicate higher levels. Error bars denote standard errors.

Independent samples t-tests revealed that the levels of egocentricity bias (EB) are overall significantly higher than the levels of altercentricity bias (AB) [$t(39) = 4.58$, $p < .001$]. Moreover, as one can see from Figure 4.6, people who rated the self as more attractive appear to be more egocentric overall, whereas people who rated the other as more attractive appear to be slightly more altercentric overall. To explore whether these differences are significant, dyadic multilevel modelling analyses were performed using exactly the same model as in Experiment 1. Contrary to what was found in Experiment 1, attractiveness was found to have a significant effect on egocentricity bias for pleasant materials (b = 13.91, SE = 6.58, p = .041), with people who rate the self as more attractive having a higher egocentricity bias when others are touched by pleasant and self touched by unpleasant materials (M = -22.74, SE = 4.84) as compared to people who rate the other as more attractive (M = -8.83, SE = 4.60) (Figure 4.6). A trend was also found for the effect of total egocentric bias (b = -8.95, SE = 4.59, p = .059), with people who rate the self as more attractive having a higher total egocentricity bias (M = 21.33, SE = 3.37) as compared to people who rate the other as more attractive (M = 12.38, SE = 3.06) (Figure 4.6).

4.4 General Discussion

Over two experiments, this study investigated for the first time the role of perceived attractiveness in self-other distinction of affective states. In a novel visuo-tactile paradigm, participants were paired-up and were touched with pleasant and unpleasant fabrics on the cheek in a congruent (same valence) or incongruent manner (opposite valence). Subsequently, they were asked to rate the pleasantness of the touch that they felt (self) or the touch that they saw (other). Higher levels of ‘egocentricity bias’ were predicted when one perceives the self as more attractive and higher levels of ‘altercentricity bias’ when one perceives the other as more attractive.

To begin with, and in line with previous evidence, in both experiments a significant embodied, emotional egocentricity bias was found. Previous research has shown that cognitive processes are affected by egocentricity biases in healthy adults (Birch & Bloom, 2007; Keysar et al. 2000; Epley et al. 2004). Similarly in the emotional domain, empathic judgments about the emotional experience of others appear to be significantly influenced by one's own emotional state, giving rise to the emotional egocentricity bias (Silani et al. 2013). This study extends previous findings by showing that even in an embodied ecological context whereby participants see each others' faces and make judgments concerning the affective bodily experience of the other person, they tend to use the self as a reference and project their own experience into other minds.

Crucially, this study provides the first direct evidence that perceived attractiveness of self in comparison to others influences self-other distinction of affective states. More specifically, in line with the original hypothesis, the first experiment found that people who rated the other as more attractive had a higher total altercentricity bias, i.e. they introjected the more attractive person's emotional experience into their own. Interestingly, the levels of altercentricity bias were higher for people who rated the self as more attractive, when the self was experiencing unpleasant and the other pleasant stimulation, i.e. they introjected more the pleasant state of the less attractive other. With regards to egocentricity, those who rated the self as more attractive had a higher egocentricity bias, but only when the self was touched by pleasant and the other by unpleasant materials. In other terms, they projected their own pleasant state into other minds. These results combined suggest that people who perceive the self as more attractive are particularly responsive to stimuli of positive valence during incongruent conditions by projecting and introjecting pleasant states. The second experiment confirmed this increased egocentricity bias in people who rated themselves as more attractive but the valence direction was opposite. More specifically, when they were touched by unpleasant and the other by pleasant materials, the level of egocentricity bias was higher as compared to people who rated themselves as less attractive, i.e. more attractive individuals projected their unpleasant state into other minds. It, therefore, appears that people who perceive themselves as more attractive are more egocentric, but the valence direction remains to be confirmed by future studies. In fact, this second experiment found a trend for the total egocentricity bias, suggesting that people who rated themselves as more attractive were overall more egocentric than people who rated the other as more attractive, irrespective of valence.

Despite the fact that one could argue that the egocentricity and altercentricity biases are complementary, measuring similar things, they are not exactly the same given that they have a different focus. While the egocentricity bias focuses on the effect of self on other, the altercentricity bias focuses on the effect of other on self. Surprisingly, the results of the two experiments are not identical, given that in the first experiment an effect of attractiveness was found on both egocentricity and altercentricity biases, while in the second experiment only an effect on egocentricity bias was found. Further research is, therefore, required to explore these mixed results.

Previous research has shown that attractive individuals are more self-centered (Segal-Caspi et al., 2012) and less likely to cooperate with others and share with them (Takahasi et al., 2006; Zaatari & Trivers, 2007; Shinada & Yamagishi, 2014). In addition, women who are perceived by their peers as more attractive are also rated as more egocentric (Galluci & Meyer, 1984). This study shows for the first time that self-perceived attractiveness, i.e. the degree to which one considers oneself attractive in comparison to others, may influence the extent to which people are inclined to identify with the experience of others. According to some evolutionary theories, physical attractiveness is thought to provide signals of biological quality. For example, participants who rate others as more physically attractive also rate them as healthier as compared to those who are rated as less physically attractive (e.g. Cunningham, 1986; Grammer & Thornhill, 1994; Singh, 1995; Nedelec & Beaver, 2014). In addition, attractive people are thought to possess more socially desirable personality traits (Dion et al. 1972), are treated in a more positive way by others (Langlois et al., 2000) and are more likely to get hired (Chiu & Babcock, 2002; Cash & Kilcullen, 1985) and earn more money (Hamermesh & Biddle, 1993). One possible interpretation of why people who perceive themselves as more attractive seem to be more egocentric is that due to such top-down biases associated with attractiveness they may feel more self-sufficient and dominant. This may, in turn, make them more immersed and confident in their own knowledge, cognitions and emotions and, as a consequence, urge them to use the self as a reference to perceive the world around them. On the other hand, people who perceive themselves as less attractive may be more altercentric also due to such top-down biases. Specifically, as mentioned in Chapter 3, a large body of literature has shown that attractiveness leads to imitation (Muller et al., 2013; Babel, 2012) and this may stem from the idea that “what is beautiful is good” and the need to affiliate with and take on characteristics and behaviours of people who are beautiful, hence nice (van Leeuwen et al., 2009; Lakin & Chartand, 2003). Alternatively, bottom-up factors associated with beauty, such as attentional biases (Nakamura & Kawabata, 2014; Sui & Liu, 2009; Liu & Chen, 2012), positive valence (Principe & Langlois, 2011) and processing fluency (see Trujilo et al., 2014) could also provide an explanation for why people who perceive themselves as less attractive tend to focus more on the experience of the more attractive people and, in turn, introject their perspective into their own. Of course, these are only speculative possibilities so more research is required to disentangle whether the effect of attractiveness on self-other distinction is driven by top-down, learned expectations or bottom-up factors.

This study possessed some limitations. To begin with, participants were asked to self-report who is more attractive, hence their answers may have been subject to biases. For example, they may have answered in a way that they thought the experimenter expected (Robie et al. 2001). Moreover, despite the fact that this research was focused on participants’ subjective perception of own vs. other attractiveness, objective measures of attractiveness were not collected, therefore, it is not possible to establish a causal direction. For instance, it might not be the case that people who think that they are more attractive are also more egocentric, but rather that people who are more egocentric are more likely to perceive themselves as more attractive. In addition, although every effort was made to control for micro-expressions as much as possible, future studies could measure facial electromyography to control for emotional expressions, as well as automatic imitation of the other. Last but not least, it is not possible to establish whether the results of this research generalise more broadly to affective states or more specific aspects of it, such as pleasure and displeasure of tactile stimulation with different fabrics.

Overall, the current findings extend previous research indicating that even in an embodied context, and more ecologically valid setting, healthy adults exhibit an emotional egocentricity bias, projecting their own affective states into other minds. Importantly, despite the fact that the second experiment did not replicate the results of the first, the main findings of the two experiments combined suggest that perceived attractiveness may have an impact on how much one identifies with others' experiences by projecting own or introjecting others' perspectives, hence showing less self-other distinction. More specifically, it appears that people who perceive themselves as more attractive tend to project their own affective state, both pleasant (Experiment 1) and unpleasant (Experiment 2), as well as introject the less attractive person's state but only if this is pleasant (Experiment 1), suggesting that people who perceive the self as more attractive are particularly responsive to pleasant sensations. On the other hand, people who perceive themselves as less attractive are more inclined to introject the other's affective experience into their own, irrespective of valence (Experiment 1). Interpersonal understanding and empathy rely on the capacity to distinguish between self and other-related representations (Singer & Lamm, 2009), therefore understanding yet another factor influencing self-other distinction could potentially lead to the development of novel methods to increase the level of empathy in society and, as a consequence, altruistic and prosocial behaviours.

Chapter 5 |

Body Size Risk Taking in Individuals with Sub-clinical Body Image Disturbances

5.1 Introduction

The previous chapters examined how we make sensory and social decisions about the body. This chapter will focus on motivational decisions about the body's appearance with its future and uncertain states in mind. Moreover, while the previous chapters focused on individuals with a healthy body image, in Chapters 5 and 6 the focus will be placed on people with body image disturbances, at sub-clinical and clinical levels, respectively. As mentioned in section 1.2.2, body image disturbance refers to a maladaptive subjective perception and attitude towards one's body weight or shape (Gardner, 2011) and is a rising problem in the modern world, especially in Western societies (Pimenta et al., 2009). Body image disturbances are associated with numerous mental health problems in women and, to a lesser extent, in men (Grossbard, Lee, Neighbors & Larimer, 2008). Such problems include depression, anorexia nervosa, bulimia nervosa and body dysmorphia disorder (e.g. Dunkley & Grilo, 2007; Hrabosky & Grilo, 2007). A large body of research on risk factors promoting body image disturbances nowadays points to an interplay of socio-cultural, cognitive and biological processes, yet more research is required combining concepts and methods across the different fields (see section 1.2.2 for more details).

Crucially, body image disturbances are not merely experienced by people with clinical disorders, but are increasingly prevalent among healthy individuals. According to the British Social Attitudes Survey commissioned by the UK Government Equalities Office, 36% of women and 28% of men report feeling dissatisfied with their physical appearance (UK Government Equalities Office, 2014). In the US and Australia, up to 50% of the general population report body image concerns and regularly practice unhealthy weight control behaviours (Neumark-Sztainer et al., 2011; Wharton et al., 2008). The problem extends to children and adolescents as well, with 4-year-old boys and girls expressing socially prescribed stereotypical body size attitudes and a desire to diet (Damiano et al., 2015). Further support for the notion that body image disturbances are increasingly common among healthy individuals is provided by evidence showing that women whose body fat falls within the Body Mass Index (BMI; an imprecise (Rothman, 2008; Jackson et al., 2009) but universally accepted heuristic index of body fat based on one's height and weight) healthy range – or even slightly below that - perceive themselves as being overweight and are practicing weight control behaviours (Anstine & Grinenko, 2000; Wardle, Haase & Steptoe, 2006; Yaemsiri, Slining & Agarwal, 2011).

As discussed in sections 1.2.2 and 1.2.3, people with self-reported body image dissatisfaction often engage in behaviours conferring risk for the body, in order to change its shape, weight and appearance and conform to a body image ideal (Grogan, 2016). A large body of literature has focused on risky weight-loss behaviours, such as excessive dieting, self-induced vomiting, laxative use and excessive physical activity (e.g. Fairburn & Harrison, 2003; Mintz & Bentz, 1988; Stice, 2002). Engaging in these behaviours over a prolonged period can lead to malnutrition, dehydration, exhaustion, as well as hormonal imbalance and eating disorders. Another risky behaviour that has become increasingly common among women and men is indoor tanning, either with ultraviolet radiation (UVR) or other sunless forms, for which there are also safety concerns (Garone, Howards & Fabrikant, 2015). In fact, people who tan indoors (even a few times) have 34% increased risk for developing melanoma (Colantonio, Bracken & Beecker, 2014). Moreover, women (and increasingly men) often pursue invasive procedures, such as cosmetic surgery, in order to modify their bodies. Rhinoplasty (known familiarly as a nose job), liposuction, and breast augmentation are the most commonly demanded aesthetic surgical procedures (Crerand, Franklin & Sarwer, 2006). Yet, such procedures involve many risks and complications, such as infections, scars and skin graft failures (NHS, 2015). In addition, breast implants make cancer harder to spot, hence the risk of death from breast cancer among women with breast implants is 38% higher than without (NHS, 2013). Despite the fact that all of these behaviours, aimed at "improving" one's body appearance, confer serious risks for people's physical health, they keep increasing.

According to the International Society of Aesthetic Plastic Surgery, there was a 9% overall increase in surgical and non-surgical procedures in 2016, following an 8% increase in 2015 (International Society of Aesthetic Plastic Surgery Report, 2017; 2016). It, therefore, appears that certain individuals with body image concerns and disturbances choose to modify their bodies, either by controlling their weight or by taking advantage of technological advances, and simultaneously put them into risk. Nevertheless, there is a scarcity of research into how such individuals make decisions about their body appearance after weighing potential benefits (e.g. having an ideal body) against potential costs (e.g. health complications).

An emerging interdisciplinary field, combining concepts from psychology, neuroscience and economics, explores motivational decision-making, whereby individuals make value-guided choices on the basis of balancing potential rewards against other factors, such as risk, length of waiting time and effort put to obtain something (Samanez-Larkin & Knutson, 2015). People tend to discount the value of a reward as a function of potential costs (Samanez-Larkin & Knutson, 2015), hence there exist different types of value-guided decision-making (e.g. temporal discounting, effort discounting, risk discounting). Decision-making about risk is defined as the assessment of uncertain future gains vs. uncertain future losses and risk discounting refers to the acceptance of smaller rewards in exchange of smaller risk. In general, people show a tendency to be averse to risks, i.e. averse to losses (Kahneman & Tversky, 1979), although this has been mainly addressed with respect to financial risk.

Research indicates that reward (i.e. gains) and punishment (i.e. losses) influence the degree of risk-taking, with reward increasing the likelihood of a risky behaviour and punishment decreasing it (Gottfredson, 2011; Ronay & Hippel, 2009). Consequently, inter-individual differences in sensitivity to reward and punishment largely affect responses to various cues and risky decisions. For instance, people who are highly sensitive to reward develop high levels of novelty seeking, whereas those who are sensitive to punishment develop high levels of harm avoidance (Cloninger, Svrakic & Przybeck, 1993). Importantly for present purposes, alterations in both reward and punishment sensitivity have been implicated in eating disorders and difficulties (Davis et al., 2004; Bijttebier et al., 2009; see also next chapter) and have been proposed to relate to altered striatal dopamine function (Frank & Kaye, 2005). The role of dopamine in reward processing has been well established (Schultz, 2006) and there is evidence that a network of interconnected brain areas including the dopaminergic midbrain, the striatum, as well as cortical regions, such as frontal lobes and amygdala are involved in reward processing (O' Doherty, 2004). With regards to sensitivity to reward, patients with binge eating disorder (BED) have been found to be more sensitive as compared to healthy controls (Harrison et al. 2010; Eneva et al., 2017). Specifically, there is evidence that binging patients appear to neglect future consequences and instead focus on the immediate appetitive outcome (e.g. Boeka & Lokken, 2006; Cavedini et al. 2004; Brogan et al. 2010; Wu et al., 2013). On the other hand, studies using both self-report, as well as behavioural measures, have shown that patients with restricting types of anorexia nervosa (AN) tend to be less sensitive to reward as compared to healthy controls (Harrison et al., 2010; Cavedini et al., 2006; Tchanturia et al., 2007). In fact, individuals with this type of AN are characterized by anhedonia and they only experience as rewarding the pursuit of weight loss, indicating intrinsic disturbances in reward processing (Wagner et al., 2007). With regards to sensitivity to punishment, individuals across the range of eating disorders appear to be more sensitive towards punishment than healthy controls (Harrison et al. 2010; Harrison, Smilie & Treasure, 2011; Monteleone et al., 2014), suggesting that such individuals are particularly sensitive to failure and criticism. The associations between punishment sensitivity and disordered eating are thought to reflect an increased fear of becoming overweight, which ultimately leads to more weight control behaviours (Mussap, 2007). However this last assumption about the role of body image concerns has never been directly tested. Moreover, if such decision-making tendencies relate to fears about one's body image then they should also be present (to lesser degrees) in subclinical body image disturbances. Nevertheless, despite the plethora of research with individuals who have clinical eating disorders, there has been no research on healthy individuals with body image disturbances at sub-clinical levels.

Taking things a step further, abnormal attitudes towards uncertainty are also strongly related to impairments in risky decision-making. Intolerance to uncertainty (IU) is defined as “a dispositional characteristic that results from a set of negative beliefs about uncertainty and its implications and involves the tendency to react negatively on an emotional, cognitive, and behavioural level to uncertain situations and events” (Buhr & Dugas, 2009). IU represents a core feature of various mental health disorders, such as eating disorders (e.g. Sternheim et al., 2017; Renjan et al., 2016; Sternheim et al., 2011; Konstantellou et al., 2011), as well as obsessive-compulsive disorder (OCD) and hoarding disorder (HD) (Pushkarskaya et al., 2015). Uncertainty has been characterised by two dimensions: risk, referring to situations in which the outcome probabilities are known; and ambiguity, referring to situations in which the necessary information to estimate probabilities is unavailable, hence the outcome probabilities are unknown (Peysakhovich & Karmarkar, 2015). Although people tend to be averse to risk, they are even more averse to ambiguity (Camerer & Weber, 1992; Slovic & Tversky, 1974), indicating that ambiguity is a more profound form of uncertainty as compared to risk (Peysakhovich & Karmarkar, 2015). Moreover, individuals with clinical disorders characterized by IU exhibit even higher levels of aversion to ambiguity. For instance, while subjects with OCD have been found to show significantly lower levels of risk-taking as compared to healthy controls when the outcome probabilities were unknown, their performance did not differ when the outcome probabilities were known (Pushkarskaya et al., 2015; Starcke et al., 2010; Zhang et al., 2015).

With regards to individuals with disordered eating, research has shown that anorexic patients also tend to discount risk more steeply in comparison to healthy subjects when they make decisions under ambiguity, i.e. accept smaller rewards in exchange of smaller risk (e.g. Adoue et al., 2015). The levels of risk aversion increase even more when individuals with eating disorders (both binging and non-binging) are primed with binge food cues as compared to neutral cues (Neveu, 2016). Therefore, it appears that food, which is perceived as a threatening stimulus by these populations, leads to higher levels of risk discounting, in a similar way that control subjects act when primed with non-food stressful cues (Neveu, 2016). This effect may be due to the fact that food increases the probability of an unfavourable outcome or that it increases uncertainty over an unfavourable outcome. Importantly, fear and avoidance of food appear to be core affective and behavioural aspects of body image disturbances and the motivation behind them is that they interact and lead to weight gain and loss (e.g. Steinglass et al., 2010), hence influencing the appearance of the body. However, no study to date has ever investigated risk discounting among individuals with body image disturbances, with specific reference to body appearance. As mentioned before in this thesis (see above and Chapter 1), people with body image disturbances are preoccupied with their body weight and shape and are in a constant pursuit of an ideal body appearance, which, in current, Western cultures, mainly revolves around having a slim figure. Therefore, given that food is perceived as a threatening stimulus leading to higher levels of risk discounting, then a body gaining weight should similarly increase levels of risk discounting, either by increasing aversion to losses and/or by reducing the value of the reward and this should not only hold true for individuals with clinical eating disorders but also people with body image disturbances at sub-threshold levels.

To this end, the current study set out to investigate for the first time how healthy individuals with sub-clinical body image disturbances (and subsequently individuals with restrictive Anorexia Nervosa, see next chapter) weigh rewards (i.e. money) against risk (i.e. losing the won money) under ambiguity (unknown probabilities of loss) and particularly when rewards are not only monetary, but are also accompanied by either desirable or undesirable body image outcomes. To achieve this, a novel behavioural risk-taking task was developed, the so-called Body Risk Task (BRT). The BRT is an adaptation of the Balloon Analogue Risk Task (BART; Lejuez et al., 2002). In this task, participants are asked to maximize the amount of virtual reward they can win by pressing a button that sequentially inflates a virtual balloon that grows larger and affords accumulating rewards until an unknown level at which it explodes and all accumulated reward is lost (more details in Method)**.** Yet, for the purpose of this study, which was to explore the relationship between risk-taking and reward processing with specific reference to body appearance, monetary reward was also coupled with desired or, undesired body outcomes. More specifically, in the original BART, participants press a button to increase the size of a balloon (control condition), but in this new task there were also three other conditions in which participants pressed a button to increase the size of a virtual body (undesired body outcome), decrease the size of a virtual body (desired body outcome), as well as decrease the size of a balloon (control condition). The two balloon conditions were control conditions that allowed not only a well-validated (Lejuez et al., 2002), baseline measurement of risk-taking but also the examination of any confounding effects of the direction of change of stimulus (i.e. increasing balloon size vs. decreasing balloon size). The coupling of monetary reward with desired and undesired body outcomes allowed the task to tap into individuals' prior beliefs regarding body appearance (e.g. fear of gaining weight) and how these impact on risk-taking behaviour. With regards to the target population of this study, as mentioned in 1.2.2, body image disturbance is multi-faceted, encompassing cognitive, evaluative and behavioural components. Given that there are currently numerous different measures tapping into people's perspectives about their bodies, this study focused on cognitive components (i.e. body shape and weight concerns in the context of disordered eating), as well as behavioural components (i.e. eating restraint, as well as openness to pursuing cosmetic surgery).

In a first pilot experiment, participants were divided into two groups and only completed either the body inflating or the body deflating condition. In the second experiment, the neutral stimulus was also added (i.e. the original balloon stimulus of the BART) in two directions in a mixed-design, so that participants were divided into two groups and completed either two inflating conditions or two deflating conditions, one with a balloon and one with a body, respectively. Finally, in a third experiment, participants were asked to complete all four conditions in a within-subjects design. Based on the evidence discussed above, it was hypothesised that for people with subclinical body image disturbances, the extent of risk-taking would be moderated by the value of the body outcome with which both monetary reward and risk were coupled. More specifically, people would be more risk averse when both reward and risk are coupled with a 'feared' body outcome (i.e. body increasing in size), whereas in the reverse direction, where the body becomes progressively thinner (i.e. deflated body), hence the monetary reward is coupled with the intrinsic reward of being thin, risk aversion would be low.

5.2 Experiment 1

5.2.1 Method

5.2.1.1 Participants

For this pilot study, forty-seven participants (age 31.21 ± 10.27 SD years, all females) with no known physical or mental disabilities were tested a) online (via social media; N=33) and b) at a public science event at the Royal Institution in London (N=14). Given the exploratory nature of this study and the opportunistic sampling strategy, a priori power calculations were not performed. The majority of the sample consisted of White participants (57.4%), followed by Hispanic (21.3%) and the rest were of Black (4.3%), Asian (10.6%) or other ethnic origins (6.4%). Written, informed consent was obtained from all participants prior to their participation. The study was approved by the Ethics Committee of the Research Department of Clinical, Educational and Health Psychology, University College London.

Given that part of the data collection took place at a public event and not at the laboratory, participants could not be screened in advance. However, given the interest in individuals who had body image disturbances at sub-clinical levels only, the following inclusion criteria were applied for the analysis: (1) BMI < 30.00, which is considered the cut-off point for obesity (World Health Organization guidelines); (2) BMI > 16.50 which is considered a marker for anorexia nervosa requiring hospitalisation (Schwartz, Mansbach, Marion, Katzman & Forman, 2008); (3) EDE-Q global score ≤ 4**,** which is considered the cut-off point for clinical significance of eating disorder symptoms (Carter, Stewart & Fairburn, 2001). Participants who were slightly below the healthy BMI range (16.5 ≤ BMI ≤ 18.50) were not excluded, taking cultural differences into account, as well as the World Health Organization guidelines according to which a BMI over 16.0 is not severely underweight (WHO, 1997). One participant was found to be an age outlier (70 years) and, hence, was excluded from the analysis. Thus, the final sample comprised of 42 participants.

5.2.1.2 Materials

The 'Body Risk Task'

Description of the task. The Body Risk Task (BRT) is an adaptation of the Balloon Analogue Risk Task (BART; Lejuez et al., 2002), a well-validated behavioural measure of risk-taking behaviour. In the original BART, participants are asked to maximize the amount of virtual reward they can win in a task that allows them to press a button to sequentially inflate a virtual balloon that grows larger and affords accumulating rewards. However, at some sudden, unexpected point the balloon explodes and all the money collected in that trial is lost. Yet, participants have the option to stop inflating the balloon at any point they wish (prior to explosion) and cash out the virtual money earned by transferring it into the 'Permanent bank'. As mentioned earlier, in this novel task, the monetary reward was coupled with a desired or undesired body outcome in order to tap into individual prior beliefs regarding the body's appearance and how these impact on risk discounting. Therefore, apart from the neutral stimulus increasing in size (i.e. balloon inflating), the BRT has 3 extra conditions: balloon decreasing in size (i.e. balloon deflating), as well as female virtual body increasing in size (i.e. body inflating) and decreasing in size (i.e. body deflating). For the purpose of this first, pilot experiment and given the time constraints, only two conditions were kept: "Body Inflating" and "Body Deflating" (Figure 5.1) and no conditions with neutral stimuli (i.e. balloon). The task was run in Inquisit by Millisecond, a general purpose psychological measurement software (https://www.millisecond.com/). For each condition, there were 30 trials.

Preparation of stimuli. The bodies were created in Body Vizualizer (© 2011, Copyright Max Planck Gesellschaf). The average virtual, female body had a BMI of 23.7 (within healthy range recommended by WHO). The body deflated at its maximum had a BMI of 12.6 (underweight) and the body inflated at its maximum had a BMI of 46.4 (obese). Subsequently, a computerized morphing procedure implementing a mesh warping algorithm (ABROSOFT FANTAMORPH™) was used to morph in incremental steps the average body into the deflated body and the average body into the inflated body, generating 116 morphed frames for each of the two directions (deflating and inflating).

Probability of reaching the limit. For the BRT, the bodies did not explode as the explosion may be something intuitive for balloons but not for bodies. Therefore, instead of an explosion a sign of "You reached the limit" appeared. The probability that a body reached its limit was arranged by constructing an array of N numbers. The number 1 was designated as indicating the body reaching the limit. On each pump of the body, a number was selected without replacement from the array. The body reached its limit if the number 1 was selected. The array for the balloons contained the integers 1–116 (given that we had 116 frames in each condition). Thus, the probability that a body reached its limit on the first pump was 1/116. If the body did not reach the limit after the first pump, the probability that it would in the second pump was 1/115, 1/114 on the third pump, and so on up until the 116th pump, at which the probability of an explosion was 1/1 (i.e., 100%).

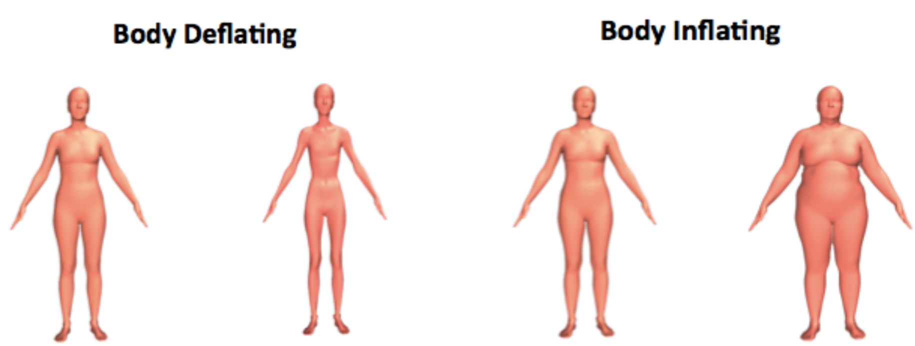

Figure 5. 1 Start and end point in different conditions of BRT in Exp. 1

<ins>Eating Disorders Examination Questionnaire (EDE-Q)</ins>

The EDE-Q (Fairburn & Beglin, 1994) is a self-report questionnaire that assesses the range and severity of eating disorder symptoms. It has fours subscales: Eating Restraint, Weight Concern, Shape concern, Eating Concern. The EDE-Q contains 28 items. Some of the questions are answered on a 7-point Likert scale (items 1-12, 19-28) and those contribute to the attitudinal scores that were used in the analyses. For example, "*Has* *thinking about shape or weight made it very difficult to concentrate on things you are interested in (for example, working, following a conversation, or reading?"* and responses range from 0 (No days), 1 (1-5 days), 2 (6-12 days), 3 (13-15 days), 4(16-22 days), 5 (23-27 days) and 6 (Every day). Other questions are assessing frequency of behaviours and are, therefore, open-ended (items 13-18) and those were not used in the analyses. For instance, "*Over the past 28 days, how many times have you eaten what other people would regard as an unusually large amount of food?"* and participants have to fill in the appropriate number. The psychometric properties of the EDE-Q have been demonstrated to be acceptable with a high internal consistency and test-retest reliability (Mond et al. 2004). In this pilot, Cronbach's alpha was .895, indicating a high level of internal consistency for EDE-Q with this specific sample.

5.2.1.3 Design

This experiment employed a between-subjects design, whereby the manipulated factor was the size of the body: a) inflating (increasing in size) vs. b) deflating (decreasing in size). Participants were randomly assigned into the Inflating condition (N=25) or the Deflating condition (N=17). Some of the participants who were randomly assigned in the Deflating condition did not complete the experiment because they withdrew from the study before they even started, hence the unequal sample sizes in the two conditions. The key dependent variable was based on the primary score to measure BART performance (Bornovalova et al., 2005; Lejuez et al., 2002) and that is the average number of pumps, excluding trials whereby the stimulus had reached its limit, as this would prematurely end the trial, constraining the participant's risk-taking behaviour.

5.2.1.4 Procedure

Online

A link was sent to participants who were recruited through social media and completed the task online (https://www.millisecond.com/). Participants were randomly assigned to the two groups so some of them were given a link for the 'Body Inflating' condition and others for the 'Body Deflating'. Electronic informed consent was obtained from participants prior to the task. The instructions were presented on the screen as part of the BRT. Each click on the pump inflated or deflated the female body by 0.3 cm in all directions. The starting point in both conditions was the average body (BMI within healthy range). With each pump, 5 cents were accrued in a 'Temporary bank'. When the body was pumped past its limit, all money in the 'Temporary bank' was lost. The screen went blank and participants saw 'You reached the limit' and the next average body appeared on the screen for the new trial to begin. Participants were given no detailed information about the probability of reaching the limit. At any point during each trial, the participants had the option to stop pumping the body and click the 'Collect £££' button. Clicking this button transferred all money from the 'Temporary bank' to the 'Permanent bank', during which the new total earned was incrementally updated cent by cent. Therefore, the trial ended either a) when the body reached its limit and all the money was lost, or b) when the participant decided to stop pumping the body and cash out the money. In total, there were 30 trials for each condition, i.e. for each group. After the BRT, participants were automatically taken to UCL Online Surveys (https://www.onlinesurveys.ac.uk/) to complete a socio-demographic questionnaire, including questions about age, ethnicity, weight, height, and the EDE-Q.

Public event at Royal Institution

Female visitors (18 years and above) at a public event on at the Royal Institution in London were informed that we were performing a study on risk-taking in the form of a simple computerised game. Written informed consent was obtained from participants who were interested in taking part. Four laptops were placed on a desk, ensuring that participants who were completing the task simultaneously could not see each others' screens. Participants were randomly assigned into either the 'Body Inflating' or the 'Body Deflating' condition. The procedure was identical to the one described above for online recruitment.

5.2.1.5 Data analysis

Data were analysed using SPSS v. 25 (IBM, Chicago, IL, USA). Normality tests (i.e. Kolmogorov-Smirnov, Shapiro-Wilk) revealed that the assumption of normality was violated for all variables of interest, hence log transformations were performed. Independent samples t-tests were conducted to compare age, BMI, Total EDE-Q and risk-taking (i.e. BRT scores) between the two groups (inflating vs. deflating) in order to ensure that there were no group differences. Then, to investigate the relationship between risk-taking (i.e. BRT score) and disordered eating, Pearson correlations, controlling for age and BMI, were conducted. After establishing a relationship between the variables of interest, and given the unequal sample sizes, hierarchical multiple regressions were performed for each of the two groups to explore whether disordered eating predicts risk-taking, with BRT score as outcome variable, age and BMI as control variables in the first step of the regression and Total EDE-Q as predictor in the second step of the regression.

5.2.2 Results

The table below represents demographic information for participants of both groups.

	Inflating (N=25)		**Deflating (N=17)**	
	Mean (SD)	**Range**	**Mean (SD)**	**Range**
Age	32.32 (9.09)	18 - 52	28.24 (8.21)	17 - 46
BMI	20.61 (1.91)	17.72 – 24.77	21.74 (2.68)	19.03 – 28.65
EDE-Q	1.44 (1.17)	.14 – 3.88	1.41 (.999)	.16 – 3.36

Table 5. 1 Descriptive statistics for age and BMI for inflating vs. deflating condition in Exp. 1

Independent samples t-tests revealed non-significant differences in age [t(40) = -1.57, p = .124, d = .471], BMI, [t(40) = 1.36, p = .186, d = .486], Total EDE-Q [t(40) = .176, p = .861, d = .028] and risk-taking [t(40) = -1.69, p = .099, d = .238] between inflating and deflating group.

Correlations

<u>Inflating group</u>

A Pearson correlation controlling for age and BMI found that in the inflating group, there was a negative correlation between risk-taking (i.e. BRT scores) and total EDE-Q (r = -.523, p = .038), indicating that the higher the total EDE-Q, the higher the aversion to risk when the body increased in size (Figure 5.2). Subsequently, Pearson correlations between BRT scores and the sub-scales of the EDE-Q (i.e. restraint, eating concern, weight concern, shape concern), found a negative correlation between risk-taking and weight concern (r = -.677, p = .045), indicating that the higher the weight concern, the higher the aversion to risk when the body increased in size.

<u>Deflating group</u>

Non-significant correlations were found between risk-taking and total EDE-Q/sub-scales in the deflating condition (p-values > .05; see Appendix 3).

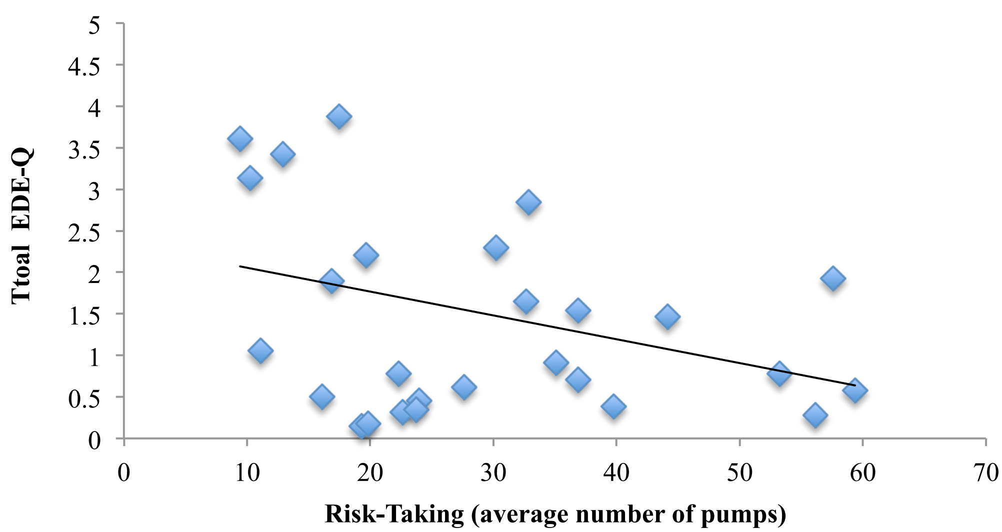

Figure 5. 2 Correlation between total EDE-Q scores and risk-taking in the inflating group

Regressions

Inflating group

A two-stage hierarchical multiple regression was performed with BRT score as outcome variable. Age and BMI were entered as control variables at stage one of the regression. The hierarchical regression revealed that, at Stage one, age and BMI did not contribute significantly to the regression model: F (2,17) = .197, p = .823, accounting for 2.6% of the variance. However, introducing Total EDE-Q to the model explained a total 29.2% of the variance and this change in R^2 was significant, F (1,14) = 5.27, p = .038.

Model		b	SE	
1	(Constant)	2.382	2.014	.255
	Age	-.249	.511	.633
	BMI	-.524	1.471	.727
2	(Constant)	2.160	1.779	.245
	Age	-.606	.477	.224
	BMI	.036	1.321	.978
	Total EDE-Q	**-.267**	**.116**	**.038**

Table 5. 2 Multiple linear regression results for outcome variable 'BRT score' in Exp. 1. Significant results are highlighted in bold.

As one can see from the table above, Total EDE-Q is a significant predictor of risk-taking in the inflating condition. For one unit of change in EDE-Q sore, risk-taking (i.e. BRT scores) decreased by -.267 when the body inflates.

Deflating group

The same two-stage hierarchical regression was performed and all of the results were non-significant (all p-values > .05; see Appendix 4).

5.2.3 Discussion

Overall, the results of this experiment demonstrate that subclinical tendencies for disordered eating relate to risk-taking when the body increases in size, but this is not found when the body decreases in size. More specifically, a higher EDE-Q global score led to increased risk aversion in the condition where reward and risk were coupled with a feared body outcome (i.e. body increasing in size). This was not found in the condition where reward and risk were coupled with an idealised body outcome (i.e. body decreasing in size). Yet, one important limitation of this exploratory, pilot experiment is that there was no control stimulus (i.e. balloon), hence it was not possible to understand whether the risk aversion in the inflating condition was specific to body appearance or not. Moreover, the sample size was relatively small, and the two groups were unequal in size. Nevertheless, the results of the inflating group were encouraging and for these reasons, a second experiment was conducted on a much larger sample introducing two more control conditions: balloon inflating and balloon deflating. It was hypothesised that the extent of risk-taking would be moderated by the direction of the virtual body change and, in particular, risk aversion would be higher when the body inflates (changes towards undesired body outcome) but this risk aversion would be lower when the body deflates (changes towards desired body outcomes). Balloon direction would not have such an effect on risk-taking.

5.3 Experiment 2

5.3.1 Method

5.3.1.1 Participants

Two hundred and six participants (age 30.68 ± 11.04 SD years, all females) with no known physical or mental disabilities were tested at an open-to-public science workshop called "Self-Impressions" at Tate Modern. Given the opportunistic sampling strategy, a priori power calculations were not performed. The mean BMI of the sample was 22.23 (SD=4.53), which is classified as healthy weight, and ranged from 12.46 to 49.54. For some participants, there was no information regarding their BMI (N=21), EDE-Q (N=20) and/or age (N=18) as they omitted these questions. The majority of the sample consisted of White participants (71.7%), followed by Asian (8.2%) and the rest were of Black (1.1%), Hispanic (2.7%) or other ethnic origins (5.4%). Information about ethnicity was missing for 10.9% of the sample. Written, informed consent was obtained from all participants prior to their participation. The study was approved by the Ethics Committee of the Research Department of Clinical, Educational and Health Psychology, University College London. As in the pilot experiment, given the interest in healthy participants with sub-clinical body image disturbances only, the same inclusion/exclusion criteria were used. Therefore, participants who had: (1) BMI > 30.00; (2) BMI < 16.50; (3) EDE-Q global score ≥ 4; (4) age < 16 years; were excluded from the analysis. The final sample comprised of 184 participants.

5.3.1.2 Design

The study employed a 2x2 mixed design, whereby the within-subjects factor was the stimulus (balloon vs. body), whereas the between-subjects factor was the direction in which the size of the stimulus was manipulated (inflating vs. deflating). Participants were randomly assigned into the Inflating condition (N=104) or the Deflating condition (N=102). The key dependent variable was the average number of pumps made for the balloon and body. This excluded trials where the stimulus had reached its limit, as this would prematurely end the trial, constraining the participant's risk-taking behaviour.

5.3.1.3 Materials

For this experiment, we used the bodies from Experiment 1 but we also used balloons like in the original BART (Figure 2). The morphing took place in exactly the same way using ABROSOFT FANTAMORPH™. Instead of being too small or too large, the balloons were matched in size to the bodies. Furthermore, just like the bodies, the balloons did not explode given that the explosion may be something intuitive for balloons but not for bodies, and it was important to ensure that the decisions made were not about the final outcome but rather the direction of change. Therefore, instead of an explosion a sign of "You reached the limit" appeared for both bodies and balloons.

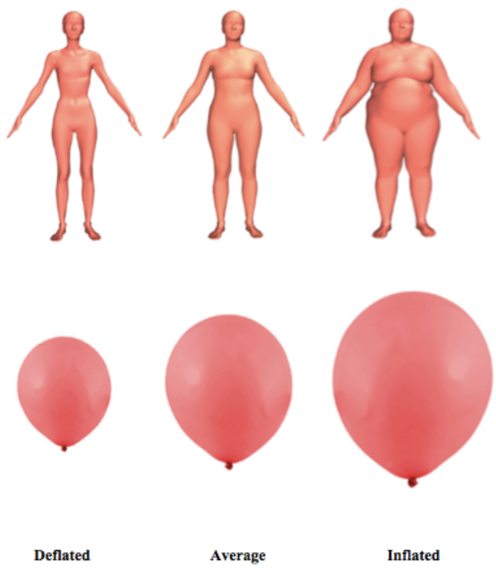

Figure 5. 3 Deflated, average and inflated stimuli in Experiment 2.

5.3.1.4 Procedure

Female visitors (18 years and above) of the open workshop on 'Self-impressions' at Tate Modern were informed that we were performing a study on risk-taking in the form of a simple computerised game and were recruited on a voluntary basis. Written informed consent was obtained from participants who were interested in taking part. Eight laptops were placed on a desk, ensuring that participants who were completing the task simultaneously were unable to see each others' screens. Participants were randomly assigned into either the 'Inflating' or the 'Deflating' condition. For each participant, the task included two blocks, one for the balloon and one for the body. Each block consisted of 20 trials and half of the participants started with the 'balloon' block, while the other half started with the 'body' block. The task was identical to the one described in Experiment 1 but was programmed using C++. Completion of the two blocks of the BRT brought participants to the questionnaire phase. There, they were asked to complete a socio-demographic survey, pertaining to age, ethnicity, weight, height, etc., as well as the EDE-Q.

5.3.1.5 Data analysis

Data were analysed using SPSS v. 25 (IBM, Chicago, IL, USA). Independent samples t-tests were conducted to compare age, BMI and Total EDE-Q between the two groups (inflating vs. deflating). Subsequently, to examine whether there were overall differences in risk-taking between the two directions and the two stimuli, a mixed ANOVA was performed, with 'stimulus' (balloon vs. body) as within-subjects factor and 'direction' (inflating vs. deflating) as between-subjects factor. To check for order effects, given that half of the participants completed the balloon block first and the other half completed the body block first, a mixed ANOVA was performed, with 'stimulus' as the within-subjects factor and 'order' (balloon first vs. body first) as the between-subjects factor. Then, to investigate the relationship between risk-taking (i.e. BRT performance) and disordered eating, Pearson correlations, controlling for age and BMI, were conducted. Subsequently, given that repeated measures (Level 1) were nested within individuals (Level 2), multilevel modelling was implemented. A linear mixed model (LMM) was performed with BRT score as the outcome variable and Restraint, Eating concern, Shape concern and Weight concern as the continuous predictors, mean-centred in order to avoid multicollinearity (Tabachnick & Fidell, 2007). 'Direction' and 'stimulus' conditions were inserted in the models as dummy-coded categorical predictors. In all of the analyses, fixed main effects and interaction for each of the categorical and continuous explanatory variables were specified. Random intercepts for subjects were also specified (i.e. random effects).

5.3.2 Results

The table below represents demographic information for participants of both groups (after exclusions).

	Inflating (N=91)		Deflating (N=93)	
	Mean (SD)	**Range**	**Mean (SD)**	**Range**
Age	29.99 (9.17)	16 – 55	32.95 (12.37)	16 -67
BMI	21.62 (2.79)	16.53 – 28.41	21.81 (2.89)	17.58 – 29.30
EDE-Q	1.37 (.982)	.00 – 3.64	1.39 (.864)	.00 – 3.64

Table 5. 3 Descriptive statistics for age and BMI for inflating vs. deflating condition in Exp. 2

Independent samples t-tests revealed no differences in age [t(161) = 1.73, p = .085, d = .272], BMI [t(158) = .419, p = .676, d = .067], and Total EDE-Q [t(162) = 149, p = .881, d = .022] between participants in the inflating vs. deflating group.

A mixed ANOVA revealed no main effects for 'stimulus' [F(1,160) = 1.21, p = .274, η^2 = .007] or 'direction' [F(1,160) = .075, p = .784, η = .000]. The interaction between 'stimulus' and 'direction' was also non-significant: F(1,160) = .022, p = .882, η^2 = .000. Half of the participants completed the balloon block first, whereas the other half completed the body block first. A mixed ANOVA found no order effects (all p-values > .05).

Correlations

<u>Inflating group</u>

Body risk

The correlation between risk-taking (i.e. BRT scores) and Total EDE-Q was non-significant (r = -.142, p = .218). However, a negative correlation was found between risk-taking and restraint (r = -.277, p = .015), indicating that the higher the restraint, the higher the aversion to risk when the body was increasing in size (Figure 5.4). All other correlations were non-significant (all p-values > .05; see Appendix 5).

Balloon risk

All correlations were non-significant (p-values > .05; see Appendix 6).

Deflating group

All correlations between risk-taking and total EDE-Q or sub-scales were non-significant (p-values > .05; see Appendices 7 and 8).

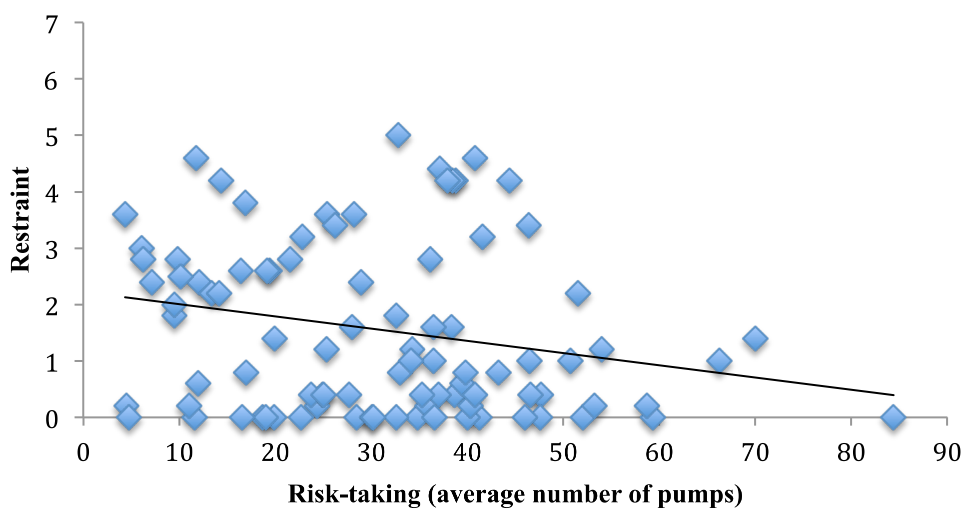

Figure 5. 4 Correlation between restraint scores and risk-taking for the body stimulus in the inflated group

Linear Mixed Model

The linear mixed model (LMM) analysis revealed a significant two-way interaction between direction and restraint: b = 3.99, SE = 1.63, p = .015, 95% CI [.777 to 7.21], a three-way interaction between direction, stimulus and restraint: b = -3.07, SE = 1.51, p = .044, 95% CI: [-6.06 to -.083]. All other main effects and interactions were non-significant (all p-values > .05).

To follow up on the above significant interactions, multiple linear regressions were performed exploring the effect of EDE-Q subscales on risk-taking per condition.

<u>Inflating group</u>

Body risk

A two-stage hierarchical multiple regression was performed with BRT score for the body stimulus as outcome variable. Age and BMI were entered as control variables at Stage one of the regression. Given that a correlation was previously found with restraint rather than Total EDE-Q, the individual subscales were entered as predictors at Stage two instead of the Total EDE-Q in order to identify whether restraint predicts risk-taking. The hierarchical regression revealed that, at Stage one, age and BMI did not contribute significantly to the regression model: F (2,78) = .1.18, p = .314, accounting for 3% of the variance. However, introducing the EDE-Q subscales to the model explained a total 16.1% of the variance and this change in R^2 was significant, F (4,72) = 2.80, p = .032.

Model		b	SE	p-value
1	(Constant)	22.717	13.105	.087
	Age	.283	.187	.135
	BMI	-.067	.610	.913
2	(Constant)	28.093	13.852	.046
	Age	.229	.188	.228
	BMI	-.175	.633	.782

Restraint	**-3.835**	**1.447**	**.010**
Weight concern	-1.419	2.567	.582
Shape concern	3.844	1.968	.055
Eating concern	-1.527	2.747	.580

Table 5. 4 Multiple linear regression results for outcome variable 'BRT score' in Exp. 2. Significant results are highlighted in bold.

As one can see from the table above, Restraint was found to be a significant predictor of body risk in the inflating condition. For one unit of change in restraint, risk-taking (i.e. BRT scores) decreased by 3.835 when the body inflates.

Balloon risk

The same hierarchical multiple regression revealed non-significant results for balloon risk in the inflating group (all p-values > .05; see Appendix 9).

<u>Deflating group</u>

Nothing significant was found for the deflating group neither for balloon nor for body risk (all p-values > .05; see Appendices 10 and 11).

5.3.3 Discussion

Overall, the results of this second experiment, in line with the results of the pilot, show that subclinical tendencies for disordered eating relate to and predict risk-taking behaviour when reward and risk are coupled with a feared body outcome. More specifically, the higher the eating restraint, the higher the aversion to risk when the body was changing towards the undesired direction (i.e. increasing in size). This was not found neither when body and balloon decreased in size, nor when balloon increased size. The findings are, therefore, in line with the original hypothesis according to which the extent of risk-taking appears to be moderated by the value of the body outcome with which reward and risk are coupled.

Yet, one limitation of this experiment is that while there were no significant differences in the variables of interest between the two groups, the results are still subject to the limitations of between-subjects designs, such as the risk of observing differences not due to the independent variable but rather due to differences in the participants of each group. Therefore, it was decided to conduct a third experiment, employing a within-subjects design whereby all participants would undergo all four conditions. Once again, the extent of risk-taking was expected to be moderated by the value of the body outcome with which reward and risk were coupled, hence risk aversion would be higher when the body inflates and this would not be the case when the body deflates, as well as when the balloon inflates and deflates.

5.4 Experiment 3

5.4.1 Method

5.4.1.1 Participants

One hundred ninety-two participants (age 23.36 ± 5.93 SD years, 18 - 67 years, all females) with no known physical or mental disabilities were recruited through a UCL subject pool and took part in a single 1-hour session for course credit or payment (£8 or £10 depending on their virtual earnings in the task). The sample size was determined based on prior calculations for 99% power (effect Cohen's d set at 0.19, G*Power 3.1) in accordance with the effect size of the model in the body inflating condition (Experiment 2). Power calculations indicated that at least eighty-three subjects would be required to achieve a power of .99 and given that the effect size used was based on one of the four conditions and in this new experiment participants completed all conditions in a within-subjects design, an even larger sample was recruited. The inclusion criteria were the same as in the previous two experiments: (1) BMI < 30.00, which is considered the cut-off point for obesity (World Health Organization guidelines); (2) BMI > 16.50 which is considered a marker for anorexia nervosa requiring hospitalisation (Schwartz, Mansbach, Marion, Katzman & Forman, 2008); (3) EDE-Q global score ≤ 4, which is considered the cut-off point for clinical significance of eating disorder symptoms (Carter, Stewart & Fairburn, 2001**).** The mean BMI of the current sample was 21.51 ± 3.13 SD, which is within the healthy range recommended by WHO, and ranged from 16.52 to 29.84. More than half of the sample consisted of Asian participants (54%), followed by White (28.7%), Black (3%), Hispanic (2.5%) and other origins (10.9%). Written, informed consent was obtained from all participants prior to their participation. The study was approved by the Ethics Committee of the Research Department of Clinical, Educational and Health Psychology, University College London.

5.4.1.2 Design

The study employed a 2x2 within-subjects design with two factors: stimulus (balloon vs. body), and direction in which the size of the stimulus was manipulated (inflating vs. deflating). As before, the key dependent variable was the average number of pumps made for the balloon and body. This excluded trials where the stimulus had reached its limit, as this would prematurely end the trial, constraining the participant's risk-taking behaviour.

5.4.1.3 Materials

The materials were identical to the previous two experiments with the only difference being that participants also had to complete the Acceptance of Cosmetic Surgery Scale (ACSS; Henderson-King & Henderson-King, 2005). The ACSS is a self-report questionnaire designed to explore individuals' thoughts, experience and acceptance of cosmetic surgery. It contains 15 items, which are answered on a 7-point Likert scale from 1 (strongly disagree) to 7 (strongly agree). The ACSS has been shown to have high internal consistency, test-retest reliability and convergent validity (Henderson-King & Henderson-King, 2005). Cronbach's alpha was .864, indicating a high level of internal consistency for ACSS with this specific sample.

5.4.1.4 Procedure

The experiment was programmed using C++. Written informed consent was obtained from participants who were interested in taking part. The testing took place at UCL an lasted approximately one hour. Three participants were tested simultaneously and the three laptops were placed on different desks, ensuring that participants were unable to see each others' screens. For each participant, the task included four blocks: balloon inflating, body inflating, balloon deflating, body deflating. Each block consisted of 20 trials. The order of the blocks was counterbalanced and there were 24 possible combinations. Completion of the four blocks of the BRT brought participants to the questionnaire phase, where they were asked to complete a socio-demographic survey, as well as the EDE-Q and the ACSS. To have an accurate BMI measurement, in this experiment, instead of asking participants to self-report their weight and height we took their actual measurements in confidence prior to the end of the experimental session.

5.4.1.5 Data analysis

Data were analysed using SPSS v. 25 (IBM, Chicago, IL, USA). To explore the relationship between risk-taking (i.e. BRT scores) and eating disorders symptoms, as well as acceptance of cosmetic surgery, Pearson correlations were conducted, controlling for age and BMI. Subsequently, given that repeated measures (Level 1) were nested within individuals (Level 2)**,** multilevel modelling was implemented**.** A linear mixed model (LMM) was performed with BRT score as the outcome variable and Total EDE-Q and ACSS score as the continuous predictors, mean-centred in order to avoid multicollinearity (Tabachnick & Fidell, 2007). 'Direction' and 'stimulus' conditions were inserted in the models as dummy-coded categorical predictors. In all of the analyses, fixed main effects and interaction for each of the categorical and continuous explanatory variables were specified. Random intercepts for subjects were also specified (i.e. random effects). Then, to investigate differences in risk-taking between people with high vs. low levels of eating disorder symptoms and acceptance of cosmetic surgery, a mixed ANOVA was conducted with 'stimulus' and 'direction' as within-subject factors and

'ACSS group' or 'EDE-Q group' as between-subjects factor, respectively. To distinguish between participants belonging in the high and low group, participants who scored above the 80th percentile were identified as the high ACSS and EDE-Q group respectively, whereas participants who scored below the 20th percentile were identified as the low group. Finally, to check for order effects, paired samples t-tests were performed to compare BRT scores between first two blocks vs. last two blocks.

5.4.2 Results

The table below represents the demographic characteristics of the current sample:

	Mean	SD	Minimum	Maximum
Restraint	1.14	1.36	.00	6.00
Eating concern	.922	.808	.00	3.60
Shape concern	2.08	1.09	.13	4.88
Weight concern	1.68	1.11	.00	5.00
Total EDEQ	1.46	.849	.06	3.68
ACSS	2.82	1.27	1.33	6.20

Table 5. 5 Demographic characteristics in Exp. 3

Correlations

Pearson correlations, controlling for age and BMI, were conducted to examine the relationship between risk-taking (i.e. BRT score) and a) Total EDE-Q and subscales, and b) ACSS. Positive correlations were found between ACSS and risk-taking in three out of four conditions: body deflating ($r = .147$, $p = .043$), balloon deflating ($r = .195$, $p = .007$) and balloon inflating ($r = .154$, $p = .034$). However, the relationship between ACSS and risk-taking in the inflating body condition was non-significant ($r = .091$, $p = .213$). Moreover, a positive correlation was found between overall risk-taking (i.e. average of four conditions) and ACSS ($r = .178$, $p = .014$), suggesting that the more accepting one is of cosmetic surgery, the higher the levels of overall risk-taking. All other correlations between risk taking and Total EDE-Q/subscales were non-significant (all p-values > .05).

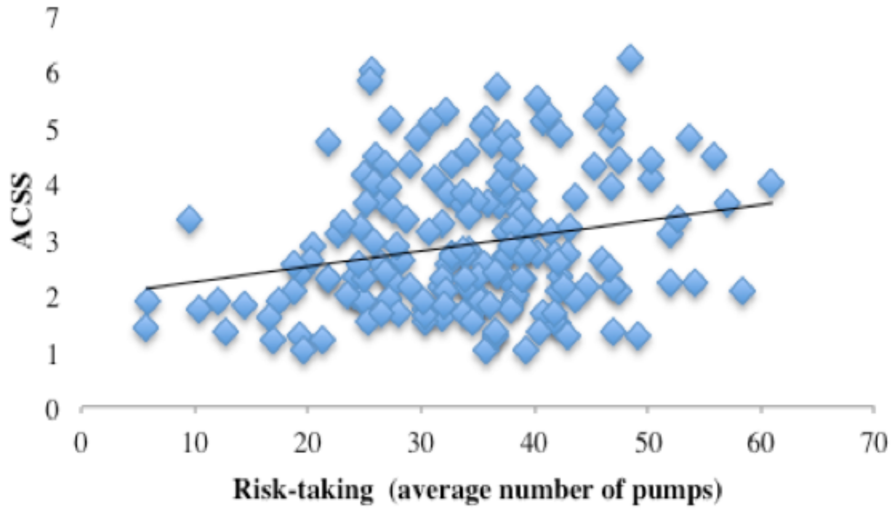

Figure 5. 5 Correlation between ACSS scores and overall risk-taking

Linear Mixed Model

Subsequently, the LMM was conducted and a significant main effect was found for ACSS: b = 1.78, SE = .698, p = .011, 95% CI [.405 to 3.16]. All other main effects and interactions were non-significant (all p-values > .05).

Risk-taking differences between high vs. low groups

ACSS

Participants who scored above the 80th percentile (ACSS score > 3.90) were identified as the high ACSS group (N = 42). Participants who scored below the 20th percentile (ACSS score < 1.74) were classified as the low ACSS group (N = 43).

A mixed ANOVA with 'stimulus' (balloon vs. body) and 'direction' (inflating vs. deflating) as within-subject factors and 'ACSS group' as between-subjects factor (high group > 80th percentile vs. low group < 20th percentile) revealed a main effect of ACSS group: F (1,83) = 5.87, p = .018, η^2 = .066, with the high ACSS group scoring higher in risk-taking overall (M = 37.22, SE = 1.64) as compared to the low ACSS group (M = 31.64, SE = 1.62). All other main effects and interactions were non-significant (all p-values > .05). Independent samples t-tests revealed that the high ACSS group scored higher in risk taking when the balloon deflated [t(83) = -2.09, p = .039], when the balloon inflated [t(83) = -2.00, p = .049] and when the body deflated [t(83) = -2.42, p = .018] but not when the body inflated [t(83) = -1.56, p = 122].

EDE-Q

Participants who were above the 80th percentile (EDE-Q global score > 2.19) were classified as the high EDE-Q group (N = 42). Participants who were below the 20th percentile (EDE-Q global score < 0.74) were classified as the low EDE-Q group (N = 47).

A mixed ANOVA with 'stimulus' (balloon vs. body) and 'direction' (inflating vs. deflating) as within-subject factors and 'EDE-Q group' as between-subjects factor (high group > 80th percentile vs. low group < 20th percentile) revealed no main effects or interactions (all p-values > .05).

Finally, paired samples t-tests revealed that there was a significant difference between the first two blocks vs. the last two blocks [t (191) = -2.75, p = .006], with risk-taking in the first two blocks (M = 33.05, SD = 10.68) being lower than in the last two blocks (M = 34.83, SD = 11.42). Looking separately at the blocks against each other, paired t-tests with Bonferroni adjusted alpha levels of .008 per test (.05/6) revealed that the scores in the first block were significantly lower than those in the third block [t (191) = -2.86 p = .005] and that the scores in the first block were also significantly lower than those in the fourth block [t (191) = -3.54 p = .001]. All other differences were not significant.

5.5 General Discussion

Over three experiments, this study investigated for the first time the relationship between risk-taking and reward processing among individuals with sub-clinical body image disturbances. For this, a novel paradigm was developed measuring behavioural risk-taking with specific reference to body appearance. It was hypothesised that for people with body image concerns, the extent of risk-taking would be moderated by the value of the body outcome with which reward and risk were coupled. More specifically, people would be more risk averse when both reward and risk were coupled with a 'feared' body outcome (i.e. inflated body), whereas in the reverse direction where monetary reward and risk were coupled with the intrinsic reward of being thin, risk aversion would be lower,

The results of the pilot experiment revealed a negative relationship between sub-clinical tendencies for disordered eating and risk-taking when the body increased in size but this was not found when the body decreased in size. Moreover, in line with the original hypothesis, the results showed that disordered eating predicted increased risk aversion in the condition where reward and risk were coupled with a feared body outcome (i.e. body increasing in size), yet this was again not found when they were coupled with a desired body outcome ('body decreasing in size'). In the second experiment, two control conditions were also introduced to the task, whereby a neutral stimulus (i.e. balloon) increased and decreased in size. The results of the second experiment confirmed that subclinical tendencies for disordered eating and, more specifically, eating restraint, was related to and predicted risk-taking when the body increased in size, but this was not found when the body decreased in size. Interestingly, this experiment also demonstrated that the risk aversion found in the inflating condition among healthy individuals with high levels of eating restraint may not only be due to the direction of change but also the stimulus, given that it was not found when the neutral stimulus (i.e. balloon) increased in size. In the third experiment, which employed a within-subjects design, no significant results were found regarding disordered eating and risk-taking. However, the findings of this experiment provided the first direct evidence that people with higher levels of acceptance of cosmetic surgery are more risk-taking overall and also in all individual conditions except for the one in which the body increased in size.

Previous research using the Balloon Analogue Risk Task (BART) has shown that when patients with eating disorders are primed with food cues they adopt more conservative behaviours (i.e. less risk-taking) as compared to neutral or non-food stressful cues (Neveu et al., 2016). Similarly, the present study shows that coupling the risk and the reward with a fearful body outcome (i.e. a body that increases in size) leads to higher levels of risk aversion for people with subclinical tendencies for disordered eating. According to Fairburn, Cooper & Shafran (2003), the overevaluation of shape and weight is at the core of psychopathology of eating disorders. In fact, the fear of gaining weight or becoming fat is a DSV-IV diagnostic criterion for anorexia nervosa (APA, 1994) and it has been found to be associated with higher levels of eating disorder psychopathology (e.g. Carter & Bewell-Weiss, 2011; Santonastaso et al., 2009). On the other hand, recent evidence has shown that anorexia maybe driven by the pleasure of becoming thin rather than the fear of becoming fat. Specifically, in a study by Clarke, Ramoz, Fladung & Gorwood (2016) with 71 anorexic (AN) patients and 20 controls, it was found that AN patients had more positive reactions to images of thin bodies, yet their reactions to normal and overweight bodies did not differ from controls. The current research found that among people with subclinical tendencies for disordered eating, risk-taking was moderated by the value of the body outcome with which reward and risk were coupled, yet this was only found when this body outcome was undesired (i.e. a body increasing in size). The findings, therefore, provide further support for the notion that the emotional risk of becoming fat and the anticipated pleasure of becoming thin may, in fact, rely on different mechanisms.

With regards to the cosmetic surgery findings, despite the scarcity of research into risk-taking behaviours, there is some evidence that people who pursue cosmetic surgery are required to negotiate different types of risks: medical, social and lifestyle (Boulton & Malacrida, 2012). Medical risks involve excessive bleeding, hematoma, infections and complications from anesthesia (ASPS, 2007; Canadian Society of Plastic Surgeons, 2006). Social risks relate to pressures for maximizing one's feminine beauty (Boulton &

Malacrida, 2012), whereas lifestyle risks are associated with consuming commodities for "frivolous" self-enhancement (Lupton, 1999; Boulton & Malacrida, 2012). It is, therefore, unsurprising that people who are open to the idea of cosmetic surgery are more risk-taking than people who are not. Interestingly, their risk-taking does not seem to be moderated by the stimulus or direction with which reward and risk are coupled so it seems that willingness to take risks among individuals who are accepting of cosmetic surgery may be trait related, and not specific to body appearance. Further research is, however, required to explore this possibility further.

Interestingly, the results of the third experiment with regards to subclinical eating disorder symptoms were not significant. One possible explanation is that there were not enough participants with high body image concerns, yet below the cut-off point for clinical significance. Previous literature suggests that a cut-off point for sub-threshold high body image concerns is an EDE-Q global score of around 2.7-2.8 (Mond et al., 2008). In the current sample, a score of 2.72 was on the 92nd percentile. Given that the comparison was drawn between the top 20% and bottom 20% of the sample in terms of EDE-Q scores, the cut-off point for scoring above the 80th percentile was only 2.19, which is below the suggested cut-off point for sub-threshold high body image concerns. Future studies could aim to recruit a larger sample of participants with a global EDE-Q score between 2.7 and 4.0 in order to represent people with sub-clinical body image disturbances and compare them against people with no body image concerns. Another possible explanation was that the majority of the sample comprised of Asian participants. Research comparing the normative data for the EDE-Q among Asian women to norms obtained from previous studies in western cultures suggests that there may be cultural differences in eating disorders psychopathology (Nakai, Nin, Fukushima, Nakamura, Noma, Teramukai, Taniguchi & Wonderlich, 2014; Musa, Bujang, Haniff, Mohamad, Omar & Radeef, 2016). However, running the analyses without including the Asian participants did not yield significant results. Moreover, all participants in the third experiment were UCL students. As a compensation for their participation, the subjects were asked to choose between payment or course credit that went towards completion of their first-year studies. Participants who completed the task in exchange for credit might not have been focused on maximizing their earnings, opting instead to finish the task early. In addition, another important limitation was the absence of practice trials, which may have been responsible for the order effects found in this final experiment, with participants being more risk-taking as the trials progressed and they were becoming more familiar with the task. Last but not least, previous literature suggests that restrictive and binging types of eating disorders may show different sensitivity to reward, with the former showing less sensitivity (Harrison et al., 2010; Cavedini et al., 2006; Tchanturia et al., 2007) and the latter showing more sensitivity than healthy controls (Harrison et al. 2010; Eneva et al., 2017). However, it is important to note that the use of the EDE-Q with healthy participants did not allow the exploration of potential differences between binging and restrictive types of disordered eating with regards to body-related risk-taking, given that these constructs cannot be teased apart with the EDE-Q.

To conclude, this study provides the first direct evidence that for people with subclinical body image disturbances in the context of disordered eating, the level of risk-taking appears to be moderated by the value of the body outcome, with which risk and reward are coupled, with higher levels of risk aversion when the virtual body changes in an undesired direction (i.e. increases in size). Moreover, people who are accepting of cosmetic surgery appear to be more risk-taking overall, regardless of stimulus and direction of change. This research has important implications for understanding the psychological mechanisms of risk discounting as they apply specifically to body image disturbances. Apart from its scientific impact in the fields of neuroscience, psychiatry and humanities, it may also have a clinical impact, given that the understanding of the relationship between risk-taking and reward processing in body image disturbances is of direct relevance to the aetiology of eating disorders and holds potential for leading to novel screening processes and regulations regarding cosmetic surgery. Future research could investigate whether the results extend to males with body image concerns, as well as cosmetic surgery candidates and patients with clinical eating disorders (see Chapter 6), Last but not least, neuroimaging studies would allow the exploration of neural mechanisms underlying risk-discounting biases in clinical and subclinical body image disturbances.

Chapter 6 |

Body-Related Risk Taking in Anorexia Nervosa

6.1 Introduction

The previous chapter examined how individuals with subclinical body image disturbances make motivational decisions about the body's appearance under uncertainty. Specifically, a novel behavioural task assessing risk discounting in relation to desirable and undesirable body image outcomes was developed and validated in several samples of healthy participants with and without subclinical body image disturbances. In this chapter, the same task was used in a clinical study with anorexic patients in order to investigate risk discounting with specific reference to body appearance in this clinical population.

Anorexia Nervosa (AN) is a serious mental health disorder, associated with the highest mortality among all mental disorders (Harris & Barraclough, 1998; Arcelus, Mitchell, Wales & Nielsen, 2011). Anorexia Nervosa has a lifetime prevalence of 1.2-2.2% (Smink, van Hoeken & Hoek, 2012) and 90% of people affected by AN are women (NICE guidelines), representing the third most common chronic illness in young females (Goodheart, Clopton, Robert-McComb, 2012). According to DSM-V, AN is characterised by: (1) persistent restriction of food intake leading to significantly low body weight in the context of what is appropriate for one's sex, age, height and developmental trajectory; (2) intense fear of gaining weight/becoming fat; (3) disturbance in the way one's shape, weight and condition is experienced. There are two sub-types of AN: restricting, which is the most stereotypical view of the disorder, and binge-eating/purging, whereby the individual engages in bing eating and purging behaviours, such as self-induced vomiting and/or misuse of laxatives or diuretics. Despite a plethora of research, the aetiology of AN remains unknown, yet a complex interplay of biological vulnerability, cognitive impairments and socio-cultural factors have been proposed (see section 1.2.2 for more details).

Certain traits have been proposed to be associated with Anorexia Nervosa such as high harm avoidance (i.e. avoidance of perceived punishment/negative consequences) and low novelty seeking and exploration of potential rewards (Kaye, Bulik, Thornton, Barbarich & Masters, 2004; Klump et al., 2000; 2004). In fact, a large body of evidence suggests that individuals with AN have altered sensitivity to reward and punishment. With regards to punishment, individuals across the range of eating disorders, including restricting and bing-eating/purging types of AN, appear to be more sensitive towards punishment as compared to healthy controls (Jappe et al., 2011; Harrison et al. 2010; Harrison, Smilie & Treasure, 2011; Monteleone et al., 2014). Interestingly, this does not seem to depend on anxiety or depression co-morbidity (Jappe et al., 2011). Moreover, patients with AN have been found to have altered sensitivity to reward, yet the evidence is more mixed. While some studies suggest that patients with restricting type of AN tend to be less sensitive to reward (Harrison et al., 2010; Cavedini et al., 2006; Tchanturia et al., 2007) and those with binge eating/purging type tend to have higher levels of sensitivity (Harrison et al. 2010; Eneva et al., 2017), there is also evidence that both sub-types of AN are associated with higher levels of sensitivity to reward (Jappe et al., 2011). Such disturbances in reward and pleasure have been proposed to relate to altered striatal dopamine function (Frank & Kaye, 2005). Evidence for dysregulation of brain reward systems in anorexia nervosa has also been provided by animal models, suggesting that alterations in mesolimbic dopamine and serotonin occur as a result of restricted eating coupled with excessive wheel running (Avena & Bocarsly, 2012). Moreover, patients who have recovered from AN have also been found to show an exaggerated response to both reward and punishment in dorsal executive regions in a simple monetary choice feedback task (Delgado et al., 2000), as well as altered reward modulation within striatal limbic regions associated with the emotional significance of stimuli, exhibited by a failure to differential feedback valence (Wagner et al. 2007). Given that such alterations in adults who have recovered from AN may be confounded by many years of malnutrition or treatment, more recently Bischoff-Grethe et al. (2013) measured brain responses to reward and punishment among adolescents with AN using the same monetary guessing task (Wagner et al. 2007), in order to explore whether altered limbic and executive striatal processes may, in fact, be trait related. While both individuals with AN and healthy controls responded more strongly to wins as compared to losses in limbic and anterior executive striatal regions, AN patients displayed an exaggerated response to losses as compared to wins in posterior executive and sensorimotor striatal regions, areas responsible for processing the affective value of a stimulus and reward-guided action selection. These findings suggest that individuals with AN exaggerate negative consequences, being particularly sensitive to criticism and failure, and these altered brain responses seem to be trait related rather than the result of many years of malnutrition and treatment.

Other core features of Anorexia Nervosa are perfectionism and a heightened need for control (Cassin & von Ranson, 2005; Weiten, 2008). Both of these cognitive tendencies have been found to relate to high levels of intolerance to uncertainty (Buhr & Dugas, 2002, 2006; Stewart, 2009), referring to a negative reaction at a cognitive, emotional and behavioural level in the face of uncertain situations and events. Intolerance to uncertainty (IU) is considered an important component for vulnerability and maintenance of eating disorders and, in particular, anorexia (Brown et al., 2017; Frank et al., 2012; Stewart, 2009), with anorexic individuals displaying higher levels of IU as compared to controls (e.g. Sternheim et al., 2017; Renjan et al., 2016; Sternheim et al., 2011; Konstantellou et al., 2011). The relationship between the need for control and IU has also been demonstrated by a qualitative study employing Interpretative Phenomenological Analysis (IPA) to explore the construct of IU in anorexic patients through focus groups (Sternheim, Konstantellou, Startup & Schmidt, 2011). The findings revealed that uncertain situations make anorexic patients feel 'out-of-control- and the most prominent sources of uncertainty were the feeling of being imperfect and the fear of negative evaluation by others. Research has shown that this intense feeling of lack of control experienced in uncertain situations, is associated with a strong desire for control, manifested through extreme planning and organizing, as well as controlling their weight (Froreich et al., 2016; Sternheim, Konstantellou, Startup, & Schmidt, 2011; Frank et al., 2012), however it is still unclear whether the intolerance of uncertainty drives such control tendencies or vice versa.

This intolerance of uncertainty, however, can be a major problem for individuals with AN given that everyday life frequently requires us to make choices between options that have uncertain outcomes, or as described in Chapter 5, make decisions under uncertainty. Indeed, people typically manage to make such choices by balancing the potential benefits and costs of their value-based decisions. Anorexia Nervosa is associated with impaired decision-making under uncertainty, yet the cognitive processes underlying this impairment remain unknown (e.g. Abbate-Daga et al., 2011; Cavedini et al., 2004; Chan et al., 2014; Fagundo et al., 2012). As mentioned in Chapter 1, one type of value-guided decision-making is delay discounting, defined as the degree to which a reward is devalued as a function of the delay of its receipt (Bickel & Marsch, 2001). In other words, the value of a reward declines with delay and most people appear to prefer immediate delivery of a smaller reward rather than delayed delivery of a bigger reward (e.g. Cardinal, 2006; Hardisty & Weber, 2009; Mazur, 1987). Delay discounting has been linked to a number of clinical disorders, including anorexia nervosa. Research has shown that AN patients reduce the value of a monetary reward over time significantly less than healthy controls (Steinglass et al., 2012). Interestingly, Steinglass et al. (2017) replicated these findings, showing that while individuals with AN have an increased preference for delayed rewards, individuals with OCD did not differ from healthy controls. Moreover, an fMRI study by Decker, Figner & Steinglass (2015) found that before treatment, the AN group showed a preference for delayed over earlier rewards as compared to their healthy peers, yet after weight restoration, there were no significant differences between the two groups. The results suggest that the undernourished state of AN may, in fact, amplify this tendency to forgo immediate rewards in exchange for longer-term goals and this is associated with alterations in cingulo-striatal circuitry. In fact, this tendency to discount the reward of food now in order to achieve an ideal body later, has been attributed to dysregulated ventral striatal pathways and hyperactive dorsal cognitive circuits (Kaye et al., 2013).

Another type of value-guided decision-making, on which this and the previous chapter focus, is risk discounting (see Chapter 5 for more details), which is defined as the tendency to accept smaller rewards in exchange for smaller risk. Adoue et al. (2015) used the Balloon Analogue task (BART; see Chapter 5 for more details of task) and found that anorexic patients exhibit significantly lower levels of risk-taking under uncertainty and this is unrelated to potential co-occurent major depressive disorders. Moreover, research has shown that binge foods cause high levels of anxiety (Neveu et al., 2014) and elicit more conservative choices in women with eating disorders, including restricting AN (Lighthall et al., 2009; Porcelli & Delgado, 2009; van den Bos et al., 2009; Starcke and Brand, 2012). Furthermore, in a cross-sectional study, Neveu et al. (2016) found that after being primed with binge food cues, participants with both binging and non-binging (i.e. restricting) AN made more conservative choices and exhibited higher aversion to losses and, thus, lower sensitivity to reward when completing the BART. Overall, it appears that, just like stressful cues bias healthy women's behaviours towards safer options (Neveu et al., 2016), food cues that are perceived as threatening by individuals with AN also modulate their decisions towards safer options, i.e. higher levels of risk discounting. Crucially, the reason why food is perceived as threatening is that it may lead to weight gain, hence potentially influencing the appearance of the body (e.g. Steinglass et al., 2010). However, risk discounting with specific reference to the body's appearance has been largely neglected until now. While the series of experiments described in Chapter 5 investigated the relationship between body-related, risk-taking and reward processing in individuals with subclinical body image disturbances, no study to date has ever explored this in a clinical population and, more specifically, in anorexic patients.

To this end, the current study set out to investigate for the first time risk discounting with specific reference to body appearance among anorexic patients (restricting type). To achieve this, the Body Risk Task (BRT), the behavioural task developed and used in the experiments of Chapter 5, was employed. Based on the findings of the research described in Chapter 5, it was predicted that patients who are currently diagnosed with AN, as well as recovered patients would show higher levels of risk aversion when risk and reward are coupled with a body that changes in an undesired direction (i.e. increasing in size), given that similar to food, a body that increases in size may be perceived as a threatening stimulus. Moreover, despite this not being found in a subclinical population (Chapter 5), in the reverse direction, where the body becomes progressively thinner (i.e. decreasing size) hence the monetary reward is coupled with the intrinsic reward of being thin, risk aversion was predicted to be lower among AN and recovered patients driven by their anticipated pleasure of being thin, as indicated by previous research (Clarke, Ramoz, Fladung & Gorwood, 2016).

6.2 Method

6.2.1 Participants

Eighty-six females (age 25.76 ± 6.69 SD years, all Italian) were recruited and tested at the Eating Disorders Clinic of the San Paolo University Hospital in Milan, each being assigned to one of the following groups: anorexia nervosa (AN), recovered from anorexia nervosa (RAN) and healthy control (HC). Some control participants (N=15) were recruited and tested in the UK through a UCL subject pool but they were also of Italian nationality. In the AN group, all participants met a DSM-IV diagnosis for the restricting type of anorexia nervosa. In the RAN group, participants had recovered from AN (restricting type) more than one year prior to the study. Finally, the same criteria as in Chapter 5 were applied to the age- and gender-matched HC group: (a) a global EDE-Q score ≤ 4, which is the cut-off point for clinical significance; (b) a BMI > 16.50 as this is a marker for AN requiring hospitalisation; (c) no known history of any axis I clinical disorder. Participants who did not meet the above criteria, age outliers (> 40 years) and those who failed to properly complete all four conditions of the task were excluded from the analysis. In total, three AN, nine RAN and six HC were excluded. All participants were reimbursed for their time with 5€ Amazon voucher. Written, informed consent was obtained from all participants prior to their participation. The study was approved by the Ethics Committee of the Research Department of Clinical, Educational and Health Psychology, University College London.

	Age	*BMI*
Anorexic (N=24)	22.88 (5.84)	16.16 (1.89)
Recovered (N=14)	27.92 (7.44)	19.78 (2.04)
Control (N=30)	26.34 (4.89)	20.60 (2.02)

Table 6. 1 Demographic characteristics of clinical and control group (means, standard deviations)

6.2.2 Design

The study employed a 2x2x3 mixed design with two within-subjects factors: ‘stimulus’ (balloon vs. body), and ‘direction’ in which the size of the stimulus was manipulated (inflating vs. deflating), as well as one between-subjects factor (AN vs. RAN vs. HC). As in the experiments of Chapter 5, the key dependent variable was based on the primary score to measure BART performance (Bornovalova et al., 2005; Lejuez et al., 2002), which is the average number of pumps made for the balloon and body. This excluded trials where the stimulus had reached its limit, as this would prematurely end the trial, constraining the participant’s risk-taking behaviour.

6.2.3 Materials

As before, for the behavioural task, both bodies and balloons that inflated and deflated were used, given that participants completed all four conditions. Moreover, participants were asked to complete the Eating Disorders Examination Questionnaire (EDE-Q; Fairburn & Beglin, 1994), as well as a socio-demographic questionnaire, pertaining to age, nationality, occupation, height, actual/minimum/maximum weight, current BMI, family psychiatric history, psychiatric comorbidity, onset age, duration of disorder, years from recovery, relapse and duration, and pharmacological treatment.

6.2.4 Procedure

The procedure was similar to that of Experiment 3 in Chapter 5 (see section 5.8.4 for more details). The experiment was programmed using C++. Written informed consent was obtained from participants who were interested in taking part. The testing took place at the Eating Disorders Clinic of the San Paolo University Hospital in Milan (Italy) and lasted approximately one hour. Each participant was tested separately by either a Psychiatry Consultant (Dr. Benedetta Demartini) or a Psychiatry Registrar (Dr Diana Goeta). For each participant, the task included four blocks: balloon inflating, body inflating, balloon deflating, body deflating. Each block consisted of 20 trials. The order of the blocks was counterbalanced and there were 24 possible combinations based on ID number. Completion of the four blocks of the BRT brought participants to the questionnaire phase, where they were asked to complete a socio-demographic survey, as well as the EDE-Q.

6.2.5 Data Analysis

Data were analysed using SPSS v. 25 (IBM, Chicago, IL, USA). Normality tests (i.e. Kolmogorov-Smirnov, Shapiro-Wilk) were performed to ensure that the assumptions of normality were not violated. A mixed ANOVA was conducted with direction and stimulus as within-subjects factors and group as the between-subjects factor. Subsequently, given that these repeated measures (Level 1) were nested within individuals (Level 2), multilevel modelling was implemented. A linear mixed model (LMM) was performed with BRT score as the outcome variable. 'Direction' (inflate vs. deflate), 'stimulus' (body vs. balloon) and 'group' (anorexic vs. recovered vs. control) were inserted in the models as dummy-coded categorical predictors. BMI and age were entered as continuous covariates, mean-centred in order to avoid multicollinearity (Tabachnick & Fidell, 2007). In all of the analyses, fixed effects for main effects and interaction terms between categorical variables and BMI were specified. Random intercepts for subjects were also specified (i.e. random effects).

6.3 Results

The mixed ANOVA with ‘direction’ and ‘stimulus’ as within-subjects factors and ‘group’ as between-subjects factor revealed that all main effects and interactions were non-significant (all p-values > .05; see Appendix 12).

The results of the interactions of the linear mixed model analysis are illustrated in the table below:

				95% Confidence Interval	
Effect	**b**	**SE**	**p-value**	**Lower Bound**	**Upper Bound**
Intercept	23.845077	2.388069	.000	19.078472	28.611682
[Stimulus=1] * [Direction=1]	-.177857	2.789312	.949	-5.745348	5.389633
[Stimulus=1] * [Group=1]	7.435083	3.857975	.058	-.265466	15.135633
[Stimulus=1] * [Group=2]	-5.180319	3.431243	.136	-12.029108	1.668471
[Stimulus=1] * BMI	.245357	.415538	.557	-.584061	1.074775
[Direction=1] * [Group=1]	**10.154703**	**4.898903**	**.042**	**.376452**	**19.932954**
[Direction=1] * [Group=2]	-8.232586	4.357034	.063	-16.929262	.464090
[Direction=1] * BMI	.359363	.527656	.498	-.693842	1.412568
[Group=1] * BMI	-2.709626	1.500288	.075	-5.704214	.284962

[Group=2] * BMI	.729421	1.877969	.699	-3.019021	4.477863
[Stimulus=1] * [Direction=1] * [Group=1]	**-15.164459**	**6.002037**	**.014**	**-27.144575**	**-3.184344**
[Stimulus=1] * [Direction=1] * [Group=2]	7.939164	5.338149	.142	-2.715826	18.594155
[Stimulus=1] * [Direction=1] * BMI	-.539363	.646473	.407	-1.829729	.751002
[Stimulus=1] * [Group=1] * BMI	1.848271	1.126382	.106	-.399998	4.096539
[Stimulus=1] * [Group=2] * BMI	2.731452	1.409936	.057	-.082792	5.545697
[Direction=1] * [Group=1] * BMI	1.571871	1.430294	.276	-1.283007	4.426750
[Direction=1] * [Group=2] * BMI	2.723299	1.790354	.133	-.850263	6.296862
[Stimulus=1] * [Direction=1] * [Group=1] * BMI	-3.218898	1.752367	.071	-6.716638	.278841
[Stimulus=1] * [Direction=1] * [Group=2] * BMI	-2.733684	2.193506	.217	-7.111940	1.644572

Table 6. 2 Multilevel modelling results for outcome variable 'BRT scores'. Significant main effects and interactions are highlighted in bold.

Following up the two-way interaction between direction and Group 1 (AN), paired t-tests revealed a trend [t (23) = 1.77, p = .091], with anorexic patients being more risk-taking in the deflating condition (M = 26.36, SD = 11.43) as compared to the inflating (M = 22.86, SD = 9.10), irrespective of stimulus.

Following up the three way interaction between stimulus, direction and AN group, paired t-tests (Bonferroni-corrected p-value is .025) revealed that in the anorexic group, there is a significant difference in risk-taking between body deflate vs. balloon deflate [t(23) = -2.49, p = .021], while the difference in risk-taking for balloon inflate vs. body inflate condition is not significant [t (23) = .509, p = .619],

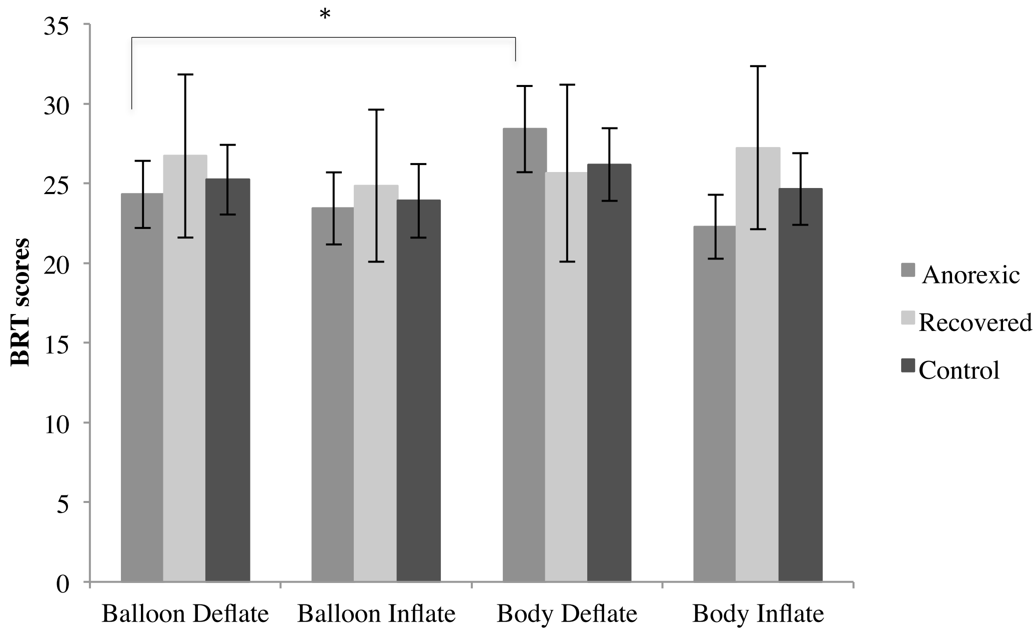

Figure 6. 1 Risk-taking (i.e. BRT scores) per condition in AN vs. RAN vs. HC. AN were significantly more risk-taking when they saw the body deflating as compared to balloon deflating**.**

6.4 Discussion

This clinical study investigated for the first time body-related risk-taking in Anorexia Nervosa (AN). It was predicted that patients who are currently diagnosed with AN, as well as recovered patients (RAN), would show higher levels of risk aversion as compared to healthy controls (HC) when risk and reward were coupled with a body that changes in an undesired direction (i.e. increasing in size). In the reverse direction, where the body becomes progressively thinner (i.e. decreasing size) hence the monetary reward is coupled with the intrinsic reward of being thin, risk-taking was expected to be higher for AN and RAN as compared to HC.

The results revealed a significant three-way interaction between ‘stimulus’ ‘direction’ and ‘AN group’, with anorexic patients being significantly more risk-taking when they saw the body deflating, as compared to when they saw the balloon deflating. The increased riskiness of anorexic patients towards bodies that decrease in size as compared to balloons that decrease in size, suggests that this is specific to body appearance, and is, therefore, in line with evidence that individuals with body image disturbances engage in weight-loss behaviours that confer serious risk for their bodies in pursuit of an idealized physical appearance (Fairburn & Harrison, 2003; Mintz & Bentz, 1988; Stice, 2002). Interestingly, while the results of Chapter 5 showed that people with subclinical body image disturbances are more risk averse when the body increases in size, the current findings showed that people with anorexia nervosa are more risk-taking when the body decreases in size. In fact, despite the fear of gaining weight being a core aspect of eating disorder psychopathology (e.g. Carter & Bewell-Weiss, 2011; Santonastaso et al., 2009), in a recent study by Clarke, Ramoz, Fladung & Gorwood (2016) with 71 anorexic (AN) patients and 20 controls, it was found that AN patients had more positive reactions to images of thin bodies, yet their reactions to normal and overweight bodies did not differ from controls. These results suggest that AN seems to be driven by the pleasure of becoming thin rather than the fear of becoming fat and this might actually be genetically influenced (i.e. Val66Met BDNF polymorphism). One possibility for the discrepancy between the results of Chapter 5 and the current findings is that body-related risk-taking in sub-threshold body image disturbances is mediated by the fear of gaining weight, whereas in clinical eating disorders, and more specifically, anorexia nervosa, it may be mediated by the anticipated pleasure of being thin. Therefore, the emotional risk of becoming fat and the anticipated pleasure of becoming thin may possibly rely on different mechanisms. Of course, these are only speculative hypotheses as there is no way of knowing whether the greater tendency in AN to take risks when reward is coupled with an increasingly thin body outcome is truly a matter of pleasure or may be due to other factors, such as a simple positive association between a body becoming thin and gaining money.

Moreover, while it was predicted that both anorexic and recovered patients would be more risk-taking when the body decreases in size, this was merely confirmed for anorexic but not recovered patients. The current findings, therefore, suggest that the increased risk-taking in the body deflating condition is possibly state-dependent rather than trait-related. Our knowledge about the neurobiology of eating disorders is still limited, so the question remains as to whether brain alterations in eating disorders are premorbid traits or state-related, remnants of the illness (Frank, 2013). Previous research suggests that altered reward modulation within striatal limbic regions associated with the emotional significance of stimuli in anorexia nervosa may be trait-related (Bischoff-Grethe et al., 2013). In addition, some of the characteristics of AN, such as heightened need for control, low impulsivity and high harm avoidance, appear to be premorbid traits that persist after recovery (e.g. Lilenfeld et al., 2006; Wagener et al., 2006). However, the current study suggests that body-related risk-taking and reward processing may be dependent on the acute (undernourished) state of AN patients, rather than more stable traits that persist after recovery.

One limitation of this study is that only females were tested given that this disorder is significantly more prevalent among women, plus the virtual bodies of the task were female. Consequently, the results cannot be generalised to men with anorexia nervosa. Furthermore, all participants were Caucasians and, more specifically, Italian, hence generalisation of findings should be made with caution, given that cultural differences may exist in how eating disorders present (e.g. Makino et al., 2004), as well as in risk-seeking behaviours (e.g. Hsee & Weber, 1999). In addition, all participants were reimbursed for their time with 5€ Amazon voucher, regardless of how they performed in the task, which means that some participants might not have been focused on maximizing their earnings, opting instead to finish the task early. Finally, another limitation of this study is that we do now know whether the subjects merely saw the virtual body presented to them changing in size or if they actually imagined their own body increasing or decreasing in size.

To conclude, this clinical study provides the first direct evidence for differences in how anorexic patients make motivational decisions about the body under uncertainty as compared to recovered patients and healthy controls. More specifically, individuals who are currently diagnosed with AN (restricting type) tend to be more risk-taking when they see the body decreasing in size, i.e. when the monetary reward is coupled with the intrinsic value of being thin. These results suggest that the level of risk-taking may be mediated by the anticipated pleasure of being thin and this is possibly due to their acute state rather than more stable traits. Combined with the results of Chapter 5, these findings suggest that one possibility among others is that the emotional risk of becoming fat and the anticipated pleasure of becoming thin rely on different mechanisms. This research has important implications for understanding the psychological mechanisms of risk discounting as they apply specifically to clinical eating disorders and this is of direct relevance to their aetiology. Future research could investigate body-related risk-taking in the binging sub-type of anorexia nervosa, as well as other clinical eating disorders to explore whether there exist differences between restricting vs. binging types of eating disorder psychopathology. Computational modeling in future research would also allow to explore whether any difference are due to impairments in reward sensitivity, harm avoidance, intolerance to uncertainty or a combination of all these. Last but not least, adjusting the paradigm used in this experiment to a neuroimaging study would allow the investigation of the neural mechanisms underlying risk-discounting biases in anorexia nervosa and, more generally, clinical body image disturbances.

Chapter 7 |

General Discussion

7.1 Introduction

The main aim of this thesis was to examine: 1) how we combine sensory modalities to perceive our bodily self (self-face recognition), 2) how we combine sensory signals from our own versus other bodies to perceive the bodily affective state (self-other distinction) and 3) how we compare ideals about the body against other rewards and risks to make body-related decisions under uncertainty. These questions were addressed in healthy individuals, people with subclinical tendencies for disordered eating, as well as patients with anorexia nervosa. The thesis used methods from experimental psychology and social cognitive neuroscience, and drew on a variety of research traditions to combine some of their insights in a novel way. In particular, the first two studies investigated the role of affective touch (Chapter 2) and facial attractiveness (Chapter 3) in the multisensory modulation of self-face recognition. Relatedly, Chapter 4 investigated the role of perceived attractiveness in self-other distinction of affective states in an embodied context. Finally, the last two studies investigated body-related risk-taking under uncertainty in people with subclinical body image disturbances (Chapter 5) and Anorexia Nervosa (Chapter 6). Overall, the findings revealed that embodied affectivity (i.e. affective touch) as well as affectivity that is merely visually presented (i.e. facial attractiveness) enhance self-face recognition during multisensory integration. Moreover, perceived attractiveness of self in active comparison with other people was found to have an impact on how much one identifies with others' experiences by projecting own or introjecting others' perspectives, hence showing less self-other distinction. Finally, both for people with sub-clinical tendencies for disordered eating and anorexic patients, the level of risk-taking was found to be moderated by the value of the body outcome with which risk and reward were coupled. In this concluding chapter, the findings of all experimental studies will be reviewed collectively, and methodological issues, as well as clinical implications and future suggestions will be discussed.

7.2 Collective review of main findings

Over the last 30 years, a large body of research in the growing field of embodied cognition has shown that cognitive processes are deeply rooted in the body's interactions with the world (see Wilson, 2002) and, therefore, the bodily self is considered to be the starting point for the science of the study of self (Tsakiris, 2016). As a consequence, there has been a large body of research focusing on different dimensions of the bodily self: bodily self-awareness (Babo-Rebelo et al., 2016), body ownership (Tsakiris et al. 2011) and body image (e.g. Badoud & Tsakiris, 2017). Nevertheless, up until now our understanding of the relationship between these dimensions has been poorly understood. This thesis examined multisensory perceptions on the body and combined experimental methods of embodied cognition with cognitive and emotional manipulations to answer the following questions: How does our awareness of the body from inside (i.e. interoception) relate to our perception of the body from the outside (i.e. physical appearance)? How does our subjective experience of the body relate to how we perceive other bodies, and how does the latter perception influence the various facets of the self? Over ten experiments, this thesis investigated the relationship between different dimensions of the bodily self in order to provide answers to the above questions.

7.2.1 How does our awareness of the body from inside (i.e. interoception) relate to our perception of the body from outside (i.e. physical appearance)?

Over two experiments described in Chapter 2, the enfacement illusion paradigm was used to investigate for the first time the role of affective touch in the modulation of self-face recognition. As mentioned in Chapter 1, affective touch is a specialised interoceptive modality coming from outside of the body and is thought to be coded by specialised, slow-conducting, unmyelinated peripheral nerve fibers, known as C tactile afferents (Olausson et al., 2002; McGlone, Vallbo, Olausson, Löken & Weeberg, 2007). The activation of CT-afferent fibers correlates with subjective ratings of pleasantness, indicating that CT-afferents may constitute a peripheral ascending pathway for pleasant tactile stimulation (Löken et al. 2009). The results of Chapter 2 showed that affective touch, delivered interpersonally according to the properties of the specialised C tactile (CT) afferents and giving rise to subjective feelings of sensory pleasure, played a crucial role in the modulation of self-face recognition during multisensory integration. Specifically, in both experiments, when the multisensory stimulation between the two faces was synchronous and spatially congruent, affective touch appeared to lead to higher levels of subjective enfacement of the "other" face as compared to emotionally neutral touch. In Experiment 1, this difference between affective vs. neutral touch was also observed when the stimulation was asynchronous, with affective touch leading to less resistance to subjective enfacement as compared to neutral touch. This could have been due to the fact that the positive valence of affective touch has the potential to reduce the "deafference", e.g. unpleasant, numb feelings about the body (Longo et al., 2008) caused by the temporal mismatch between felt and seen tactile stimulation.

Increased embodied affectivity is thought to be strongly linked to body awareness (Gentsch, Crucianelli, Jenksinson & Fotopoulou, 2016; Ciaunica & Fotopoulou, 2017; Fotopoulou & Tsakiris, 2017), with affective touch enhancing the rubber hand illusion both in subjective reports (Crucianelli et al. 2013; 2018; Lloyd et al. 2013) and in more implicit, behavioural measures (vanStralen et al. 2014). The results of the current study suggest that increased embodied affectivity may actually have a potent role in the formation of the bodily boundaries of the self, by allowing identification of the psychological self with a physical body and, more specifically, a face, which is considered a hallmark of our identity. In other terms, it appears that sensory pleasure on the skin increases awareness of the body from inside, i.e. interoception, and, subsequently, enhances self-face recognition, influencing how we perceive the body from outside, i.e. its physical appearance. In particular, it blurs the categorical boundaries between self and other and leads participants to assimilate the other person's features in their own self-face representation.

Nevertheless, one question raised by this study is whether the modulatory effects of affective touch on self-face recognition are due to bottom-up CT-afferent signalling or top-down learned expectations conveyed by the "seen" slow touch on the other face

(Gentsch, Panagiotopoulou & Fotopoulou, 2015; Morrison et al., 2011). It is, therefore, not possible to answer with certainty whether it is our awareness of the body from inside that affects our perception of the body from outside. Knowing that the CT-afferents are found in hairy skin only (i.e. cheek, forehead) and not on the glabrous skin (Vallbo et al., 1999; Liu et al., 2011), it would be interesting to compare the effects of slow vs. fast tactile stimulation on both hairy (e.g. cheek) and glabrous sites (e.g. lips) in order to gain insight into the separate involvement of bottom-up mechanisms and top-down expectations of sensory pleasure and, as a consequence, the relationship between our awareness of the body from inside and our perception of the body from outside.

7.2.2 How does our subjective experience of the body relate to how we perceive other bodies?

Over two experiments in Chapter 4, the study investigated, for the first time, the role of perceived attractiveness in self-other distinction of bodily affective states. Previous research has shown that cognitive processes are affected by egocentricity biases in healthy adults (Birch & Bloom, 2007; Keysar et al., 2000; Epley et al., 2004), with people being immersed in their own sensations and cognitions when judging others' experience based on what they can perceive externally. Similarly in the emotional domain, empathic judgments about the emotional experience of others appear to be significantly influenced by one's own emotional state, giving rise to the emotional egocentricity bias (Silani et al., 2013). This study extends previous findings by showing that even in an embodied ecological context whereby participants see each others' faces and make judgments concerning the affective bodily experience of the other person, they tend to use the self as a reference and project their own experience into other minds. In other terms, people have a tendency to project their own subjective experience of a bodily state, pleasant or unpleasant, to other people, and, accordingly judge others' bodily experiences. Overall, the findings of this study indicate that our subjective experience of the body influences how we combine sensory signals from our own versus other bodies to perceive own and others' bodily affective states.

7.2.3 How does our perception of other bodies relate to different facets of the self?

In the previous sections, I reviewed the evidence on how our awareness of the body and subjective experience of it influence how we perceive other bodies, as well as our own body from outside. In this section, I will review the evidence on how the perception of other bodies influences different facets of the self.

To begin with, over two experiments in Chapter 3, this study investigated for the first time the role of attractiveness in the multisensory modulation of face ownership using the enfacement illusion paradigm. While previous research has shown that synchronous visuo-tactile stimulation blurs the categorical boundaries between self and other and also increases ratings of attractiveness towards the other face (Tajadura-Jimenez et al., 2012), this study experimentally manipulated facial attractiveness and showed for the first time that the opposite is also true. Increased ratings of attractiveness of a new, unfamiliar face lead to blurring of self-other boundaries, allowing the identification of our psychological self with another's physical self, and more specifically their face, the most representative instance of personal and social identity. Crucially, while the effect of attractiveness on perceived similarity appeared to be dependent on multisensory integration, its effect on identification appeared to be independent of the multisensory integration processes (i.e. orthogonal effects). In fact, people appear to be more inclined to identify with attractive faces even after being visually exposed to them for a brief period of time, in the absence of visuo-tactile processes, suggesting that this effect may be purely based on vision. The results of this study suggest that our perception of other bodies, specifically our perception of their facial attractiveness, influences how we combine sensory modalities to perceive our bodily self (self-face recognition).

Apart from self-face recognition, our perception of other bodies also appears to influence how we make social decisions about the body. As discussed in section 7.2.2, the study described in Chapter 4 explored how the subjective perception of one's own attractiveness in active comparison to others influences the extent to which they introject others' bodily affective states into own and project own bodily affective states into others. The results showed that our perception of the attractiveness of others as compared to the self influences our ability to distinguish own vs. other affective states. More specifically, it appears that people who perceive the other as less attractive tend to project their own affective state, both pleasant (Experiment 1) and unpleasant (Experiment 2), as well as introject the less attractive person's state but only if this is pleasant (Experiment 1), suggesting that people who perceive the self as more attractive are particularly responsive to pleasant sensations. On the other hand, people who perceive the other as more attractive are more inclined to introject the other's affective experience into their own, irrespective of valence (Experiment 1). Overall, the findings of this study suggest that apart from self-face recognition, our subjective perception of other people's attractiveness influences how we combine sensory signals from our own versus other bodies to perceive bodily affective states (self-other distinction).

Finally, motivational aspects of the self and, particularly, body-related decisions made in the face of uncertainty, also appear to relate to our perception of other bodies. The studies described in Chapters 5 and 6 investigated the relationship between risk-taking and reward processing with specific reference to body appearance among individuals with sub-clinical body image disturbances (Chapter 5) and anorexia nervosa (Chapter 6). The results of Chapter 5 showed that, for people with subclinical body image disturbances in the context of disordered eating, the level of risk-taking appears to be moderated by the value of the body outcome, with which risk and reward are coupled, with higher levels of risk aversion when the virtual body changes in an undesired direction (i.e. increases in size). On the other hand, the results of the clinical chapter showed that individuals who are currently diagnosed with AN (restricting type) tend to be more risk-taking when risk and reward are coupled with a body outcome that changes in a desired direction, i.e. when the monetary reward is coupled with the intrinsic value of being thin. The results, therefore, suggest that for people with body image disturbances at clinical and subclinical levels risk-taking is moderated by the value attached to the body outcome with which risk and reward are coupled. A possible interpretation of this is that distortions in the subjective perception of one's body image influence the value one attaches to other people's bodies, that is a body with lower weight is idealised, whereas a body with higher weight is feared. This could be linked to the above section, describing how the subjective experience of our own body relates to how we perceive other bodies. This positive or negative perception and evaluation of other bodies, in turn, appears to influence motivational aspects of the self, and more specifically, how likely one is to take risks or not in the face of uncertainty. However, one important limitation of this study is that we cannot know if these differences are due to merely seeing other bodies changing in size in desired and undesired directions or if this is because they actually imagine their own bodies increasing or decreasing in size.

7.3 Methodological issues

With regards to methodological issues, the current thesis employed an interdisciplinary approach and combined methods from independent domains, such as social psychology, cognitive neuroscience and psychophysics of tactile perception. As such, using an interdisciplinary approach gives rise to numerous methodological challenges, which will be discussed in detail in the sections that follow.

7.3.1 Methodological issues in the study of affective touch

In Chapter 2, affective (CT-optimal) touch was used as an affective manipulation to explore how awareness of the body from inside influences perception of the body from outside. CT-optimal touch can specifically and without prior knowledge elicit positive affective states. Moreover, in comparison to other types of embodied affectivity, for instance hand-holding, affective touch is manipulated with a degree of experimental control and can be tested against control conditions that involve the same support provider. This, in combination with the fact that we have no pre-existing conscious beliefs about the velocity of the touch, allows us to assume that any observed effects of affective touch are the outcome of the feelings elicited by the touch rather than the knowledge of the meaning that is conveyed by it.

However, despite these methodological advantages of affective touch, there are some important limitations intrinsic to this specific type of embodied affectivity. To begin with, as already mentioned above, the current study raised the question of whether the modulatory effects of affective touch on self-face recognition are due to bottom-up CT-afferent signalling or top-down learned expectations conveyed by the "seen" slow touch on the other face (Gentsch, Panagiotopoulou & Fotopoulou, 2015; Morrison et al., 2011). This issue can be addressed by applying touch to other control, non- CT skin conditions, such as the lips. Moreover, distraction effects, such as frequency of strokes and differences in attentional demands, could have also played a role. Firstly, when testing slow, affective touch against a control condition, i.e. fast, neutral touch, there is always a necessity to compromise between the frequency of tactile stimulation and the duration of the stroking. In the current study, the duration of stroking was kept constant, hence there were always more strokes administered in the fast, neutral condition. Secondly, stroking delivered at fast speeds might have greater attentional demands than slow, affective touch (see also Davidovic et al., 2017 for an attenuation of the Default Mode Network in response to non-affective touch). Last but not least, another limitation that should be considered is the ecological validity of this socio-tactile manipulation, and specifically, the use of a brush to administer the touch. The current study employed cosmetic-like soft brushes to deliver the touch, which is undeniably different from giving and receiving skin-to-skin tactile stimulation. Gentle skin-to-skin touch plays a key role in social bonding as well as conveys social support (Field, 2010; Hertenstain et al., 2006), and these mechanisms of embodied affectivity may be missed when using brushes. However, this technique of delivery of touch, as compared to skin-to-skin contact, allows a greater experimental control over various factors that could influence tactile perception, such as sweating rates and variations in skin temperature of the person delivering the touch, as well as potential feelings of awkwardness of the person receiving skin-to-skin touch by a stranger. Most importantly, the touch was always manually delivered (i.e. non-computerised) in order to increase ecological validity as much as possible.

7.3.2 Methodological issues in the study of body image and appearance

Presently, several measures exist tapping into people's perceptions of their bodies and physical appearance. Yet, the complex and varied nature of physical appearance and body image gives rise to a number of methodological issues that will be discussed in detail below.

7.3.2.1 Measuring body image disturbances

Currently, there are at least four major types of measures used to assess body image. These are: (a) global satisfaction measures assessing people’s overall evaluation of their body (e.g. calculating the discrepancy between a person's ideal physical appearance and his or her actual physical appearance); (b) affective measures assessing emotions (e.g. anxiety) experienced as a result of satisfaction/dissatisfaction with the body; (c) cognitive measures assessing thoughts, beliefs, and schemas regarding the body; and (d) behavioural measures assessing behaviours aimed at altering/improving physical appearance (e.g. restrained eating, cosmetic surgery, avoiding mirrors) (Krawczyk, Menzel & Thompson, 2012). Numerous researchers have created their own measures and instruments to assess the different components that body image disturbances encompass, such as body image preoccupations, body image dissatisfaction and body size/shape concerns. Despite the plethora of high quality instruments with sound psychometric properties, there is relative scarcity of standardized measures, which, in turn, makes comparison studies and meta-analyses problematic (Krawczyk, Menzel & Thompson, 2012). In addition, the majority of such measures are self-reported, which makes them susceptible to various biases, such as social desirability and self-deception (Glashouwerm Bennik, de Jong & Spruyt, 2018). Chapter 5, which examined body-related risk-taking in subclinical body image disturbances, focused exclusively on body size/shape concerns in the context of disordered eating, using the Eating Disorders Examination Questionnaire (EDE-Q). Although the EDE-Q has shown a good test-retest reliability (Reas, Grilo & Masheb, 2006) and convergence with the Eating Disorder Examination (EDE) interview in studies with diverse patient and community studies of EDs (Grilo, Masheb & Wilson, 2001; Mond, Hay, Rodger, Owen & Beumont, 2004), it is a self-report measure, thus, it may be unreliable and biased. To address this, in the clinical study described in Chapter 6, the study groups were created based on clinician-derived diagnoses according to the DSM-V criteria. Moreover, it would have been interesting to obtain an implicit measure of actual versus ideal discrepancies in order to understand whether the observed effects were due to body image disturbances or general associations, for example between earning money and being thin. For this, figural rating scales could be used, whereby participants are presented with a series of figure drawings that vary based on one physical attribute (e.g. height, muscularity, shape, etc.) and are asked to choose the one that best represents their current appearance and the figure that best represents their ideal appearance. Such measures are useful because they allow researchers to control for variation among one physical attribute, as well as easily quantify actual vs. ideal discrepancy. More recent figure rating scales, such as the Body Image Assessment Scale (Gardner et al., 2009) and the Photographic Figure Rating Scale (Swami et al., 2008) use anthropomorphic measurements to increase the accuracy in representing body types.

7.3.2.2 Specifying and selecting an appropriate population

Identifying an appropriate population of study is fundamental in numerous different areas of research, but it is particularly important in the field of body image. When studying appearance and body image, there are several demographic variables that are of particular importance.

To begin with, gender differences play an important role in the study of body image and appearance. Not only do men and women differ in physical appearance, but they also tend to value different aspects of it (Krawczyk, Menzel & Thompson, 2012). For instance, muscularity is vital among males, whereas thinness is valued among females

(Cafri et al., 2002; McCabe & Ricciardelli, 2004; Thompson, 2004). In all of the experiments of this thesis, except for the one described in Chapter 4, only females were tested, given that body image disturbances are significantly more prevalent in women, however the results cannot be generalised to the general population.

Another issue is that it cannot be assumed that appearance and body image constructs manifest themselves in the same way for people of different age groups Krawczyk, Menzel & Thompson, 2012). For instance, adolescents and children as young as 8 years of age express dissatisfaction with their appearance (Gardner, 2002; Smolak & Thompson, 2009), yet they do not express it always in the same way as adults do, possibly because they are not able to accurately report feelings related to appearance. In the majority of the studies of this thesis, there is a relatively narrow range of ages given that participants were self-selected volunteers who were recruited through the UCL subject pool, hence they were mostly undergraduate or postgraduate students. This issue was addressed, however, in Chapters 5 and 6, where participants were not only students, but people with a wider range of ages, hence being more representative of the general population.

Taking things a step further, there is evidence that different appearance and body ideals are emphasized in different ethnicities and cultures (Krawczyk, Menzel & Thompson, 2012). For instance, a wider range of body shapes and weights is accepted in the African American culture (Celio et al., 2002) as compared to European or Asian cultures. Body image satisfaction is also different across cultures, with Latin-American women reporting higher levels of weight satisfaction as compared to their European/American peers (Altabe & O'Garo, 2002). Interestingly, this effect disappears when these women become more acculturated in the US (Altabe & O'Garo, 2002). Additionally, recent research has shown that the levels of body dysmorphic disorder (BDD) are significantly lower among African American women as compared to other ethnic groups, whereas this does not hold true for men (Boroughs et al., 2010). In the studies of this thesis, the majority of participants were Caucasians and Asians, and while African Americans and Latin Americans were also tested they were relatively underrepresented in the samples. Therefore, any generalisations should be made with caution.

Last but not least, sexual orientation is another demographic factor that is quite important when studying appearance and body image. For instance, there is evidence that lesbian sexual orientation is predictive of positive body image and fewer negative attitudes toward eating and weight, and while these effects are modest they are significant (Owens, Highes & Owens – Nicholson, 2003). However, sexual orientation was not controlled for in the current studies. Moreover, in Chapters 3 and 4, participants were asked to judge the attractiveness of same-sex individuals, hence sexual orientation is a factor that could have influenced their judgments.

7.3.2.3 Experimentally manipulating appearance-related constructs

Generally, experimental methodologies are very good for investigating directional and causal relationships between variables of interest. In fact, this is the only way through which causal conclusions can be drawn given that other types of methodologies, such as correlational studies or case studies, cannot provide this type of information. However, experimentally manipulating appearance-related constructs can pose various challenges.

In Chapter 3, facial attractiveness was experimentally manipulated. To identify the attractive and non-attractive faces, a survey was completed by a large sample of women of different ethnicities and age groups. However, while there seems to be a general agreement about what makes a face attractive on not (e.g. Langlois et al. 2000; Woo, 2007), there is evidence pointing to inter-individual differences in attractiveness judgments that may arise from differences in learning and prior life experience (Little & Perrett, 2014; Hönekopp, 2007). Although this problem was addressed to an extent by conducting a second experiment with a new set of attractive/non-attractive faces, rated by a new sample of women, all faces were Caucasian so future studies could perhaps try to also include faces from different ethnic groups. Moreover, while the focus of Chapter 4 was placed on perceived attractiveness, rather experimentally manipulated attractiveness, it was still subject to self-report biases, response biases and social desirability effects. A potential solution would be to obtain attractiveness ratings for participants from a third naïve rater to check agreement with self-reported ratings.

Apart from manipulating facial attractiveness, body size was also manipulated in Chapters 5 and 6. The WHO guidelines for healthy, underweight and obese BMIs were used as a reference. Nevertheless, BMI has been criticized for not properly reflecting changes that occur with age (Rothman, 2008) and not taking into account racial/ethinc differences (Jackson et al., 2009). Future studies could address this limitation by using the participant's own body as the starting point from which the size will increase or decrease, instead of a default average.

7.4 Clinical Impact

The studies reported in the current thesis were conducted on both experimental and clinical settings. Healthy subjects, as well as individuals with sub-clinical body image disturbances and patients with clinical eating disorders and, more specifically, anorexia nervosa (restricting type) were tested. Both clinical and experimental studies have clinical applicability as will be discussed below.

To begin with, the studies described in Chapters 2 and 3, exploring factors that enhance self-face recognition during multisensory integration have practical implications for people with facial damage or who have experienced cosmetic surgeries and need to establish new self-face identification. More specifically, the findings of Chapter 2, which demonstrate that affective touch enhances self-face recognition, may point to ways by which affective touch can be used as a therapeutic tool increasing people's (interoceptive) resilience against external, idealized images of the body. Similarly, the findings of Chapter 3, which demonstrate that facial attractiveness enhances self-face recognition, may provide a neuropsychological starting point for studying the impact of others' perceived attractiveness in cases of body dysmorphic disorder and other conditions where self-perception is grossly disturbed and the self is experienced as non-attractive. These findings are, therefore, of central importance for body image concerns in the general population, as well as in patients with eating disorders.

Moving on to the study described in Chapter 4, exploring the role of perceived attractiveness in self/other distinction, the findings open the route for further research into how body image disturbances may relate to specific body mentalizing biases, such as self-other distinction impairments. The potential commonality between body image disturbances and mentalising deficits long reported in other psychopathologies (e.g. Borderline Personality Disorders; Fonagy et al., 2011) could suggest common, transdiagnostic causes in mental health (Krueger & Eaton, 2015). Interestingly, while research to date suggests that people with body image disturbances and eating disorders show impairments in mentalizing, the current research demonstrates for the first time that the opposite is also true. Specifically, while people who perceive themselves as less attractive than others show less self-other distinction by introjecting others' perspectives into their own, people who perceive themselves as more attractive than others also show less self-other distinction by using the self as reference to judge others' experiences. Self-other distinction is an important component of mentalisation and apart from cognitive and emotional mentalisation, the social mentalisation of the body also plays a crucial role for the constitution of the self (Fotopoulou & Tsakiris, 2017). The findings of this chapter, therefore, shed more light into how our subjective perception of the body's appearance influences a fundamental component of mentalisation, which is our ability to distinguish own from others' embodied states and this can be particularly important in mental health disorders, such as major depressive disorder, autism spectrum disorders, psychopathy and alexithymia, which are characterised by self-other distinction deficits.

Last but not least, the studies described in Chapters 5 and 6 explored how individuals who are putting (or are willing to put) their body into risk in order to "improve" its appearance, process rewards against risk when they have to make body-related decisions in the face of uncertainty. The findings of this research open the route for understanding the psychological mechanisms of body-related risk discounting as they apply specifically to disordered eating at clinical and sub-clinical levels, specifically, how people tolerate the effects and risks of malnutrition, and this is of direct relevance to the aetiology of eating disorders, and recent developments in psychiatry regarding transdiagnostic understanding of psychopathology. Moreover, the current research may have an impact in the field of plastic surgery where psychological, societal and ethical questions are abundant and experimental studies are absent. Specifically, understanding how individuals who seek cosmetic surgery balance the reward of improving the appearance of the body against risks, such as health complications, holds potential of leading to novel screening processes and regulations regarding cosmetic surgery that can predict surgery satisfaction and quality of life.

7.5 Directions for future research

Based on the findings from this thesis and methodological considerations discussed in section 7.3, there are several directions for future research that should be taken into consideration. However, given the space constraints, here just a few will be outlined.

Firstly, with regards to studying body image disturbances, this thesis focused exclusively on body shape and weight concerns in the context of disordered eating, as well as eating restraint. Future research could, therefore, employ additional self-report and also implicit measures to assess other components too, such as body image satisfaction and/or body image preoccupations. With regards to plastic surgery, the focus was placed on people who are open to the idea of pursuing cosmetic surgery but have not necessarily pursued so future research could recruit a larger sample of plastic surgery candidates.

Secondly, this research focused (almost) exclusively on females, hence it would be interesting to apply the same paradigms to male healthy subjects, as well as males with subclinical and clinical body image disturbances in order to explore possible gender differences. Similarly, the vast majority of participants were young adults, so, in the future, these experiments could be also conducted with children, adolescents and older adults in order to see how these phenomena manifest in different age groups across the lifespan. Additionally, recruiting participants from different ethnicities would allow to draw comparisons among them and, hence, gaining a greater insight into possible cultural differences.

Thirdly, all of the research conducted in this thesis was behavioural in nature. Applying all of these paradigms to neuroimaging studies too would allow the exploration of the neural mechanisms underlying these phenomena. Moreover, the neurobiological mechanisms that may underpin these effects also remain unknown. Given that there is evidence that oxytocin alters anorexic patients' tendencies to fixate on images of larger body shape (Kim et al., 2014), as well as modulate multisensory integration (Crucianelli et al., 2018), future research could examine whether this neuropeptide hormone mediates the current effects.

Finally, given the current replication crisis in psychology (Maxwell, Lau, & Howard, 2015), the findings reported in this thesis should be replicated using even larger sample sizes and computational modelling in order to validate with a more detailed model the hypothesized processes derived from the current data.

7.6 Concluding remarks

Overall, the current thesis combined experimental methods of embodied cognition with cognitive and emotional manipulations to explore the relationship between different dimensions of the bodily self, such as bodily self-awareness, body ownership and body image. The findings suggest that all of these dimensions are interlinked. Specifically, our physical body, as perceived and represented from the inside, as well as from the outside, appears to influence sensory, social and motivational aspects of the self. With regards to sensory aspects of the self, increased embodied affectivity, as well as increased attractiveness of other people, enhance the multisensory modulation of self-face recognition. With regards to social aspects of the self, perceived attractiveness of the self in active comparison to other people influences self-other distinction of bodily affective states, with people who perceive themselves as less attractive showing a tendency to introject others' perspectives into their own, while those who perceive themselves as more attractive tend to project own perspectives into others. Finally, with regards to motivational aspects of the self, for people with subclinical and clinical body image disturbances in the context of disordered eating, risk-taking in the face of uncertainty appears to be moderated by the value of the body outcome with which reward and risk are coupled.

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Appendices

Appendix 1: Illusion sub-component mean scores (standard deviations) in Experiment 1 (Chapter 2)

	Identification	Similarity	Affect
Slow/synchronous	.542 (1.07)	.617 (1.14)	.983 (.969)
Fast/synchronous	.125 (1.31)	-.050 (1.37)	.500 (.928)
Slow/asynchronous	-.708 (1.20)	-.617 (1.51)	.667 (1.14)
Fast/asynchronous	-1.04 (1.20)	-.967 (1.34)	.267 (.740)

Appendix 2: Illusion sub-component mean scores (standard deviations) in Experiment 2 (Chapter 2)

	Identification	Similarity	Affect
Slow/congruent	.395 (1.27)	.118 (1.70)	1.16 (1.03)
Fast/congruent	-.099 (1.22)	-.303 (1.67)	.868 (1.00)
Slow/incongruent	-.678 (1.40)	-.684 (1.54)	.934 (1.10)
Fast/icongruent	-.691 (1.41)	-.934 (1.61)	.737 (1.10)

Appendix 3: Correlations for the deflating condition (Chapter 5, Experiment 1)

Control Variables			BRT scores
Age & BMI	EDE-Q total	Correlation	-.445
		Significance (2-tailed)	.269
		df	6
	Restraint	Correlation	-.482
		Significance (2-tailed)	.226
		df	6
	Shape concern	Correlation	-.194
		Significance (2-tailed)	.645
		df	6
	Eating concern	Correlation	-.361
		Significance (2-tailed)	.379
		df	6
	Weight concern	Correlation	-.448
		Significance (2-tailed)	.265
		df	6

Appendix 4: Regression for deflating condition (Chapter 5, Experiment 1)

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	-1.642	4.390		-.374	.716
	Age	1.565	1.355	.355	1.155	.275
	BMI	.367	2.595	.043	.142	.890
2	(Constant)	-2.422	4.710		-.514	.620
	Age	1.275	1.477	.289	.863	.411
	BMI	1.270	3.060	.150	.415	.688
	EDE-1	-.216	.353	-.233	-.611	.556

a. Dependent Variable: BRT scores

Appendix 5: Correlations for body inflating condition (Chapter 5, Experiment 2)

Control Variables			BRT scores
BMI & Age	Restraint	Correlation	-.277
		Significance (2-tailed)	.015
		df	75
	Weight concern	Correlation	-.091
		Significance (2-tailed)	.434
		df	75
	Shape concern	Correlation	.030
		Significance (2-tailed)	.798
		df	75
	Eating concern	Correlation	-.143
		Significance (2-tailed)	.214
		df	75

Appendix 6: Correlations for balloon inflating condition (Chapter 5, Experiment 2)

Control Variables			BRT scores
BMI & Age	Restraint	Correlation	-.114
		Significance (2-tailed)	.328
		df	73
	Weight concern	Correlation	.020
		Significance (2-tailed)	.867
		df	73
	Shape concern	Correlation	.105
		Significance (2-tailed)	.372
		df	73
	Eating concern	Correlation	.032
		Significance (2-tailed)	.786
		df	73
	Total EDEQ	Correlation	.008
		Significance (2-tailed)	.943
		df	73

Appendix 7: Correlations for body deflating condition (Chapter 5, Experiment 2)

Control Variables			BRT scores
BMI & Age	Restraint	Correlation	.064
		Significance (2-tailed)	.579
		df	76
	Weight concern	Correlation	-.180
		Significance (2-tailed)	.116
		df	76
	Shape concern	Correlation	-.140
		Significance (2-tailed)	.222
		df	76
	Eating concern	Correlation	.042
		Significance (2-tailed)	.713
		df	76
	Total EDEQ	Correlation	-.080
		Significance (2-tailed)	.489
		df	76

Appendix 8: Correlations for balloon deflating condition (Chapter 5, Experiment 2)

Control Variables			BRT scores
BMI & Age	Restraint	Correlation	-.048
		Significance (2-tailed)	.677
		df	76
	Weight concern	Correlation	-.207
		Significance (2-tailed)	.069
		df	76
	Shape concern	Correlation	-.103
		Significance (2-tailed)	.368
		df	76
	Eating concern	Correlation	-.084
		Significance (2-tailed)	.462
		df	76
	Total EDEQ	Correlation	-.144
		Significance (2-tailed)	.208
		df	76

Appendix 9: Regression for balloon inflating condition (Chapter 5, Experiment 2)

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	23.457	13.160		1.783	.079
	Age	.095	.187	.061	.510	.612
	BMI	.211	.606	.041	.349	.728
2	(Constant)	21.928	14.653		1.496	.139
	Age	.100	.197	.064	.511	.611
	BMI	.233	.660	.046	.353	.725
	Restraint	-2.422	1.509	-.235	-1.605	.113
	Weight concern	-1.473	2.654	-.124	-.555	.581
	Shape concern	3.064	2.035	.295	1.505	.137
	Eating concern	1.307	2.851	.072	.459	.648

a. Dependent Variable: BRT Balloon

Appendix 10: Regression for body deflating condition (Chapter 5, Experiment 2)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	26.456	11.882		2.226	.029
	Age	-.119	.133	-.105	-.889	.377
	BMI	.389	.563	.082	.691	.492
2	(Constant)	21.116	12.096		1.746	.085
	Age	-.140	.136	-.125	-1.030	.307
	BMI	.763	.588	.160	1.297	.199
	Restraint	1.589	1.454	.142	1.093	.278
	Weight concern	-3.481	2.341	-.302	-1.487	.141
	Shape concern	.056	2.230	.005	.025	.980
	Eating concern	2.206	2.573	.112	.857	.394

a. Dependent Variable: BRT Body

Appendix 11: Regression for balloon deflating condition (Chapter 5, Experiment 2)

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	27.297	12.400		2.201	.031
	Age	-.070	.139	-.060	-.504	.616
	BMI	.333	.587	.067	.567	.572
2	(Constant)	24.241	12.698		1.909	.060
	Age	-.092	.143	-.079	-.643	.522
	BMI	.611	.617	.124	.990	.326
	Restraint	.594	1.526	.051	.389	.698
	Weight concern	-4.388	2.458	-.366	-1.785	.078
	Shape concern	2.032	2.341	.167	.868	.388
	Eating concern	-.137	2.701	-.007	-.051	.960

a. Dependent Variable: Balloon BRT

Appendix 12: Results for Mixed ANOVA (Chapter 6)

		F	**Sig.**	**Partial Eta Squared**
Direction	Sphericity Assumed	1.793	.185	.027
Direction * Group	Sphericity Assumed	.686	.507	.021
Stimulus	Sphericity Assumed	1.136	.290	.017
Stimulus * Group	Sphericity Assumed	.086	.918	.003
Direction * Stimulus	Sphericity Assumed	.172	.680	.003
Direction * Stimulus * Group	Sphericity Assumed	1.352	.266	.040