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Coping with the weight-centric model of health care: the role of interoception.

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KEYWORDS

interoception, sportsmen/women, overweight, obesity.

ABSTRACT

Interoception (IC) is mostly self-awareness. IC is a little sense constantly monitoring how we feel inside. It can go awry, potentially distorting our body image. This paper considers different aspects of this sort of sixth sense and its role in a medical and social milieu dominated by the stigma for oversized bodies. IC appears to be related to "body consciousness". Some preliminary data using the Heartbeat Perception Task (HPT) are added. The test was administered to three subsamples: sports practicing subjects (SP, or 17 sportsmen and 16 sportswomen aged 23,6±8.5 years); 10 overweight (OV, 25,0<BMI>29,9) males and 15 females (aged 44.8±3,3 years); 13 obese (OB, BMI>30,0) males and 12 females, aged 30.4±6,5. For HBT test significant differences emerged among sub-groups. SP and OV did not show gender differences, while high scores (0.85±0.11) and moderate scores (0.67±0.79) were obtained by SP and OV, respectively. In OB, significant gender differences and low scores (0.44±0.10) were found and the latter in 96% of the subjects, mostly males. SP show a better interoceptive capacity. To reprogram IC contemplative practices, yoga, thai chi, mindfulness training, and graded exercise therapy are suggested.

Introduction

The role of evolution in shaping our sense organs to cope with the objective reality has been discussed for decades (Trivers, 2002; Schmidt-Rhaesa, 2007). Our predecessors able to perform the essential tasks needed to survival sustained by the accuracy of their senses, fed on, fought, fled and mated better, therefore transmitting their genes, that in turn coded for more accurate perceptions. Today, after having abandoned speculations regarding the idea that what we perceive differs from objective reality (in contraposition to objective reality), the core of the problem is focused on the differences existing between the so called "truth strategies" versus the "pay-off strategies". For the former we see objective reality as it is, for the latter only the strategies having a surviving value are valid. In other words, according to Mark et al. (2010), only those allowing fitness pay-off, or those permitting to grasp what is needed to survive are passed to the next generations. Evolutionary game theory (Maynard Smith, 1982) provided the mathematical criteria useful to predict the result of different strategies. For the sake of argument, let's say this model is valid, every living being possessing sense organs lives in its own virtual reality, depending on how its sense organs were shaped by its gender and species evolution. Very simple organisms like bacteria are in fact able to detect signals from their environment, react, and create a picture of it. This thanks to different membrane sensors capable to capture information about the status of PH, temperature, light, nutrient substrates and so on, in the immediate neighborhood of their cell (Etzkorn et al., 2008). Very complex organisms

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use specialized neurons to detect a variety of physical events, thanks to the mechanism of sensorial transduction. Usually five senses are mentioned in the textbooks, actually their number is higher and even the experts disagree on the distinctions existing among the different categories (Carlson, 2001). In short, the role of our senses is to arrange a virtual reality and the sense organs are simplifying interfaces. For decades the sense organs students focalized their attention to the brain, putting the body apart, but after Damasio's idea of "embodied consciousness" (1994), it has been postulated that cognition deeply depends on several and different aspects of the agent's body other than the brain (Garfinkel et al., 2015). The role of the sense of interoception (IC) became more and more important, as it could account for the bodily origins of the sense of self, with implication for consciousness in humans and other animals (Spinney, 2020).

IC represents, moment by moment, the somatic sensations coming from the body (Craig, 2002). It is fundamental for body awareness, that is linked to self-identity (Bermùdez, Marcel & Eidan, 1995; Tsakiris, 2010). For some other Authors IC is a multidimensional construct that includes also how an individual reacts to sensations (Cameron, 2001). IC sensitivity is malleable and its awareness appears to modulate body percepts (Tsakiris et al., 2011). Anorexic patients, for example, showed decreased interoceptive awareness (Pollatos et al., 2008). Other health problems are related to an improper IC, ranging from post-traumatic stress disorder (Wood & Taylor, 2008), dissociative (Michal et al., 2014; Sedeno et al., 2014) and somatoform disorders (Schaefer, 2012). Food and water intake assumption (Herbert et al., 2012), eating disorders (Herbert & Pollatos, 2014), and addiction (Naqvi & Bechara, 2010) are also involved. During time, the concept has been broadened as the neural pathways processing interoceptive information can be used by bodily signals that are not necessarily internal, as it happens for tickle or affective touch (Murphy, Catmur & Bird, 2017). The Authors suggest also a more updated terminology. For example, a distinction between *implicit* and *explicit* IC perception: the latter has more to do with the conscious representation of IC signals. On the other hand, the difference between IC *sensitivity* and *sensibility* exists: the former requires an accurate discrimination of IC signals, while the latter is "an individual's self-reported interoceptive ability" (page 46). Recently IC has been supposed to be of fundamental importance for a lot of higher order abilities (Seth, 2013; Quattrocki & Friston, 2014; Füstös et al., 2013). This is connected to the insula and the cingulate cortex, called "the interoceptive cortex" by Craig (2002) even if a clear definition of IC and the neural regions involved in it is still a matter of debate. This because IC includes all the bodily information sent via two main pathways (Craig, 2004, Critchey & Harrison, 2013). Insula and the anterior cingulate cortex are considered fundamental for IC as here interoceptive signals converge, even if doubts emerged recently (Feinstein et al., 2016). Clearly, many studies have shown huge variability in subjective awareness of inner feelings, therefore an "interoceptive ability" can depend on: the differences in transduction and/or in transmission to the central nervous system; how consciously everyone can perceive and consciously discriminate interoceptive signals; how the individual cognition is affected by the unconscious perception of interoceptive states, and, finally, the force of the signal itself. Murphy et al. (2017) recently introduced the concept of "Atypical IC" defined in this way: "Unusually high or low sensitivity, sensibility or awareness. Used to indicate an interoceptive profile that is not typically observed in the general population" (page 46). This "malfunctioning" has been associated with obesity and diabetes (Herbert & Pollatos, 2014) and, because of new researches highlight IC importance in higher-order cognition, involving learning, decision making (Werner et al., 2009) emotional memory (Pollatos & Schandry, 2008), and in the affective domain (Füstös et al., 2013), its understanding, especially during life span and in different conditions, has become fundamental. The simplest and common way to measure IC is to ask someone to count their heartbeats over a fixed period of time and to compare their results with those of an electrocardiogram. More accuracy was reached using the heartbeat-evoked potential (HEP) and, thanks to an electrocardiogram and brain scanning the monitoring techniques became more and more precise (Pollatos & Schandry, 2004). Despite the fact that people's ability to count the heartbeats shows high variability (Viviani, 2017), it has been however found that those showing more accuracy are better in perceiving the emotions of others and perform better in intuitive decisions (Dunn et al., 2010). This started studies on body illusions and how HEP may influence our conscious experience of things, whose aim is to understand how brain activity turns into conscious experience (Park & Tallon-Baudry, 2014). All these attempts show that our bodily self is not passive but plays a role in all our decisions.

At this point, it must be mentioned that some studies are questioning the weight-centric model of health care (Bacon & Aphramor, 2011; Tomiyama et al., 2018; Hunger et al., 2020), that are contrasting with scientific evidence many weight perceptions and weight-focused campaigns all centered on weight loss. They in fact assume that poor health is connected to higher body weight, conducive to weight stigma. The latter could drive to poor health and could result to weight gain because of direct and indirect effects of social stress, especially on black women. According to Strings & Bacon, (2020) in fact, "difficult life circumstances cause disease. In other words, the predominant reason black women get sick is not because they eat the wrong things but because their lives are often stressful and their neighborhoods are often polluted" (page 23). The weight stigma reflects the racist stigmatization of black people's bodies, a prejudice started in the late 19th century (Strings, 2019). Most of the weight-based policies assume that weight reduction could be achieved if an individual is able to recognize her or his overweight status, for example using the BMI "report cards". However, lot of evidence shows that self-perception regarding the overweight status does not favor health outcomes. The same use of the Body Mass Index (BMI, or the body mass divided by the square of height in Kg/m^2) has been questioned: if evidence showed that the mortality risk increases with individuals with the highest and lowest BMIs, those in the middle range, or those showing overweight or low obesity, do not show higher mortality risk when compared to normal-range BMI subjects. In fact, some doctors are at present moving away from a weight-centric model and prescribe healthier behaviors, thanks to a study carried out more than 11.000 adults. It showed that people lived longer when they moderated the alcohol consumption, where no-smokers, had a diet rich in daily vegetables and fruits and exercised more than 12 times a week (Matheson et al., 2012; Bhaskaran et al., 2018). In order to better understand the role of IC sensibility in this variegated panorama, the present paper presents some preliminary data on IC sensibility on three different cohorts of subjects: people practicing sporting activities (SP), overweight (OV) and obese (OB) subjects, to evaluate the levels of their heartbeat perception, in the idea that a reduced IC ability could be connected to high levels of body fat. Herbert & Pollatos (2014) in fact, not only found a negative correlation between BMI and IC in overweight and obese subjects, but also differences between them and normal weighing subjects. To start a longer and more appropriate research program in this slippery topic, I checked three different cohorts of subjects in the naive idea that a poor IC could permit me to define better the directions to be taken. Nothing special, for goodness' sake, just an attempt. With a lot of limits: subjects were not controlled with an electrocardiogram and were chosen on the basis of their willingness to cooperate in this preliminary effort. Then, their number is very small, therefore the statistical evidence is poor.

Materials and methods

The Heartbeat Perception Task (HPT) was ascertained in three sub-samples: sports practicing subjects (SP, or 17 sportsmen and 16 sportswomen aged 23,6±8.5 years); 10 overweight (OV) males and 15 females (aged 44.8±3,3 years); 13 obese (OB) males and 12 females, aged 30.4±6,5. Among the sub-groups the age differed significantly ($F_{(2,83)}$=72.79, p<.01). None of the SP were obese, and among the OV and the OB subjects, none of them practiced regular sporting activities. The administered HPT was the Arnold's version (2012), based on the original of Schandry (1981), whose reliability was questioned (Rouse, Jones & Jones, 1988; Phillips, Jones, Rieger & Snell, 2003). As the issue is complex, the decision to start with this controversial methodology was taken because its easiness, to collect preliminary data on the person's own sense (even with methodological flaws), because "if one wants to measure the person's accurate perception of visceral sense, then that is probably a different situation entirely" (Gary Jones, 2020, personal communication). The test requires that subjects silently count their heartbeats during a specified time interval. It is a "mental tracking" method, according to Knoll & Hodapp (1992). The Authors found that this methodology could be used all the times where it is not important to assess the difference between heartbeat perception ability, and the ability to estimate heart rate. In addition, it appeared to be useful to compare very good and very bad cohorts of perceivers, according to the findings of Whitehead et al. (1977). This permitted the measurement of the explicit IC sensibility in my sub-groups in a very simple way, as what was needed was a stopwatch and a calculator. Subjects were requested to sit in a comfortable place and to take few deep breaths. Then to start the stopwatch and count their heartbeats for 60 seconds just feeling their heart's rhythm, and then to write the number down. They were not admitted touching their neck or wrist. After couple of minutes subjects were requested to put their fingers on their wrist (or their neck) and count heartbeats for another minute. They repeated the measurements after two minutes and averaged the two measurements. They were then asked to calculate the difference existing between the heartbeat estimate and the two pulse or neck averaged counts. The final value was the absolute value of the difference, or the exact amount by which the mark was missed. Then subjects were requested to calculate the following formula:

1 - (Estimated heartbeat – average pulse)/average pulse.

The scores were fixed in this way: 0.80 or higher = the subject possessed a very good interoceptive ability; from 0.60 to 0.79 the subject had a moderately good sense of self. If s/he scored below 0.59 this had to be interpreted as being poor IC. In the SP sample the short from of IPAQ (International Physical Activity Questionnaire), whose validity as surveillance instrument was ascertained by Hagströmer et al. (2006), was administered to all the subjects, aiming to fully ascertain their sports involvement. It is commonly used as a standardised measure to estimate habitual practice of physical activity and has provided reliability and validity data in many countries worldwide, both in its long and short forms. The latter consists of eight items permitting the estimation of the time spent performing moderate to vigorous physical activities, plus the time spent sitting, considered as being indicator of inactivity. The IPAQ furnishes different degrees of activity/inactivity in Total METS (that are multiples of the resting metabolic rate). If an individual does not reach 700 METS s/he is inactive; from 700 to 2519 s/he is sufficiently active; after the 2520 METS is active or very active. To calculate the BMI, subjects reported their height and weight. Even if self-reports can be conducive of errors, Spencer et al. (2002) suggested to use them to identify relationships, especially in epidemiological studies. OV subjects were those whose BMI ranged between 25,0 and 29,9, OB were those exceeding 30.0. Vital statistics was ascertained in all the subsamples and for SP curricular data were asked. Mean and standard deviations for the sub-groups were calculated and the differences tested by ANOVA. Further on, to partial out the age of the subjects, an ANCOVA was administered, with age as the co-variate.

Results

The SP subsample showed no gender differences for HPT scores (males, M=0.86±0.12, females, F=0.85±0.10). Most of them scored at the highest level (M=76.5%, F=68.8%), and few subjects were found at moderate level (M=17.6%, F=31.3%). Some results of the IPAQ test are interesting. First, only one subject was inactive (MET < 700), six subjects resulted to be sufficiently active, and all the others were active or very active. The average score was 5550.17±5662.74 (min=240, max=31680). In general, the male values were higher, apart the MET for vigorous activity (for M=2780.00±1774.85), that was higher in F=4656.00±4950.06 ($p<.05$), who walked, on average, more (M=1601.54±2168.33, F=2108.08±2905.78, $p<.01$). Female SP, however, remained sit longer than males (M=307.50±205.38, F=465.00±178.66, $p<.05$) and practiced lesser moderate activities (M=1337.14±305.38; F= 672.00±499.12, $p<.05$). No correlations were found for total MET and HPT, some others appear not to be remarkable: measured heartbeat and time spent sit ($r= -.51$, $p<.01$), time spent walking and MET for vigorous activity ($r=.58$, $p<.01$).

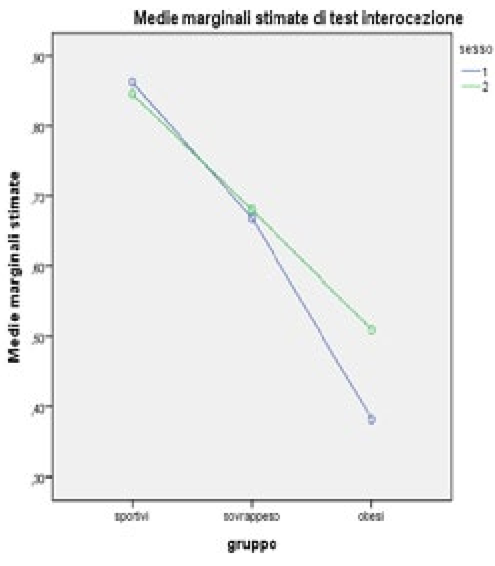
For the HPT test, in the global sample differences emerged among sub-groups (table 1).

Table 1 – Scores obtained in the HBT test in the three different sub-groups.

Sub-samples	**Sportsmen/women**		**Overweight subjects**		**Obese subjects**	
Gender	M	F	M	F	M	F
Average	0,86	0,85	0,67	0,68	0,38	0,51
SD	0,12	0,10	0,08	0,08	0,1	0,06

ANOVA 2 (gender) x 3 (sub-groups), with HBT score as dependent variable, highlighted group differences ($F_{(2,83)}=131.04$, $p<.01$), no gender differences ($F_{(1,83)}=3.71$, $p=.058$), and interaction ($F_{(2,83)}=4.36$, $p<.05$). Inside the sub-groups gender differences emerged for OB only ($F_{(1,83)}=11.25$, $p<.01$). Figure 1 depicts the results.

Figure 1 – HBT rates found in the three cohorts of subjects (sportsmen/women, overweight and obese subjects). Blue line=males, green line=females.



The results of the HBT were subdivided into three classes (poor, moderate, and very good). In the first one 96% of the OB were found (n=24), followed by OV (n=5, 20%) and with one SP only (3%). The OV sub-group placed itself inside the second class (n=19, 76%), followed by SP (n=8, 24%). No OB were found inside the very good class, practically covered by SP (n=24, 76.7%). Significant differences emerged using the chi square test ($p<.01$). To verify if the observed differences in interoceptive sensibility could be ascribed to differences in age, an ANCOVA analysis whereby age was held constant, showed that significant differences existed for groups ($F_{(2,83)}=127.50$, $p<.01$), but not for gender, with interaction ($F_{(2,83)}=4.09$, $p<.05$).

Discussion and conclusions

Despite its methodological faults, two important gradients emerged during this short preliminary study: a gradient for interoceptive sensibility found among sub-groups (SP>OV>OB), followed by another, showing that poor sensibility=OB, moderate=OV, very good=SP. Results are in line with those of Herbert & Pollatos (2014). This confirms the starting hypothesis: high values of BMI correspond to low interoceptive ability, as already signalled by Herbert et al. (2013) who, ascertaining intuitive eating, found that IC is a promising mechanism for most of the eating disorders-related research. In effect, intuitive eating is a philosophy sounding remarkably simple: "Eat when you are hungry, stop when you are full". The Authors found that: "Interoceptive sensitivity predicted relevant facets of intuitive eating and BMI. Interoceptive sensitivity fully mediated the relationship between intuitive eating and BMI" (page 22). Clearly, how this happens in different individuals is completely unclear. The processing of interoceptive signals is believed to underlie self-awareness. Nowadays a growing body of research suggests that the brain masks the sensation of heart beating compensating, because most of the times to be able to feel our pulse racing would be distracting. We must be able to feel it only when it becomes an important signal of fear or excitement (Salomon et al., 2016). So, when flashing objects appear synchronically with the heartbeat, the activity of the insula is suppressed. According to the main Author:" The brain knows that the heartbeat is coming from the self, so it doesn't want to be bothered by the sensory consequences of these signals" (quoted by Kwon, 2016, page 13). At this point, do normal weighing OV and OB subjects behave differently? In which ways IC has systematic effects on our conscious experience of the world? They should be many. In 2002 White et al., studying patients with chronic fatigue syndrome hypothesised that these patients perceive physical activity as more as an effort than healthy controls, as they have shown the tendency to underestimate their cognitive skills. There is more, inactivity appears to increase perception of effort with exercise, therefore IC appears to be enhanced or sensitised (Whiting et al., 2001). This causes an increase of bodily awareness, which could be the cause of sedentary behaviours. The other horn of IC is connected to the fact that cardiac sensations are in relation with threat processing. In effect, if scary images are projected coordinated with heartbeats, they are more easily found to be intense (Kwon, 2016). This could explain why people that are aware of their internal states are more prone to anxiety and panic disorders (Paulus & Stein, 2010). Luckily, in most of the people the heart works unnoticed. Nevertheless, why atypical interoceptive sensitivity is found in some individuals should be ascertained. They could present difficulties in the affective domain that can be ascribed to this "malfunctioning" (Shah et al., 2016). Interesting is to note that in our preliminary survey exercisers show a greater sensibility than other sub-groups, and without gender differences. This could be partially ascribed to the fact that they should be able to make the right decisions on how and when they must invest their energies, a phenomenon called pacing, that is based on circumstantial factors. In practice, they should maintain homeostasis (Smits et al., 2014). Future research on exercisers needs, in my opinion, the introduction of the criterion "level of performance", that could furnish interesting output, despite the difficulties to be precisely ascertained. In the SP sub-group, the IPAQ test furnished congruous correlations, for example the negative one existing between sedentary lifestyle and measured heartbeat, or the positive correlation between walking time and the MET for vigorous activity. In this small sample, gender appears not to influence HTP performance, apart in OB subjects, where females furnished better results. This could be explained in this way: usually women are more circumspect regarding their appearance, and subsequently more attentive to body signals. Rouse, Jones & Jones found, in 1988, that body fatness could play a role in heartbeat perception, given the different distribution of human adipose tissue (android/gynoid) in the male and female bodies. Not only, but

Khalsa et al. (2009) suggested that exteroceptive receptors can signal the vibration of the chest wall due to heartbeat: the differential deposition of fat between sexes could cause the different results. Clearly, the paucity of the sample may have influenced the results. Also the different ages of the sub-samples may have affected the results: parameters varying with age, like the percentage of body fat, the variability of heartbeat, and the systolic blood pressure (Murphy et al., 2017), may have played a role. In effect, in our survey the ANCOVA test did not completely ascertained the effects of age. We must consider that a lot of individual variation in many aspects of IC has been found and this is related to how individuals are able to perceive, use, prioritise and put together all the information belonging to the viscera, with all the affective, motivational and cognitive information. A high number of individual factors play a role in IC perception, ranging from depression, anxiety, eating disorders, culturally-mediated feeding patterns, dietary restraints and so on (Stevenson et al, 2015). Given the importance of IC for typical higher-order cognition, in learning and decision-making and in the affective realm, it is important to examine IC during the lifespan. This because, as magistrally synthesized by Farb et al. (2015) in their introduction: “IC is an iterative process, requiring the interplay between perception of body states and cognitive appraisal of these states to inform response selection”. As some researchers are exploring if “body signals influence emotions and if emotions shape our sense of self through memory and learning” (Spinney, 2020, page 31), it is necessary, at this point, to mention another important aspect concerning the introduction of modalities permitting to “mind” the body, increasing awareness. This could be achieved in different ways, all of them aiming to train subjects to closely heed their ongoing physical sensations: for example through the introduction of contemplative practices, or with yoga (that permits to be focalized in breathing and body sensations) and thai-chi (Carei et al., 2010). Or, as suggested by Tsakiris et al. (2011) with the introduction of mindfulness training (a modality focused on the present moment avoiding any judgement or elaboration). It is also called open-monitoring meditation: expert meditators show diminished activity in anxiety-related areas, for example the insular cortex and the amygdala (Ricard et al., 2014). If incorporated inside the cognitive-behavior therapy it could diminish eating disorders. In practice, all the strategies permitting the development of interoceptive attention, like the above mentioned mindfulness training, are useful (Farb et al., 2013). The results of this group suggest that interoceptive training can modulate task-specific cortical recruitment. This because mindfulness meditation training alters cortical representations of interoceptive attention. There is more: for example distraction awareness, whose network includes the anterior insula and the anterior cingulate cortex, underpins the meditator’s awareness of the distraction (Hasenkamp et al., 2012). Stevenson et al. (2015) reported a wide spectrum of contemplative techniques involved, mainly belonging to the Asian tradition. D’Alessandro et al. (2016) suggested touch-based manual practice and therapies, such as osteopathy, to interactively modify the sensitization states, using interoceptive pathways. Clearly, further studies are necessary, using well-concocted, randomized controlled trials aiming to isolate the meditation-connected effects from other psychological factors that can exert their influences. Also, long-term longitudinal studies for possible comparisons are requested. All these studies on mental trainings potentially beneficial to health and well-being may become an important path to mankind’s welfare. Concluding, given the importance of IC in higher order cognition, and its repercussions on learning, decision-making, in the affective domain and in the emotional experience (Murphy et al., 2017), its study in different ages and populations appears to be fundamental, to found adequate solutions for a vast array of health-related problems. If IC generates or sense of self and if consciousness is not a mere product of our brain acivity, but it is embodied, some philosophical problems will arise, as stated by Spinney (2020, page 32): “Death must be reconsidered because usually it is defined as being the “irreversible loss of brain (but not body) function”. More: research on IC “has implication for the consciousness of other animals and how we treat them. And if consciousness is embodied, it would mean that a machine or a robot with no way to integrating signals from its body will never be conscious”. And, if what we perceive has few to do with objective reality, but it is just an interface with it, only experiments starting with our subjective reality will permit to imagine testable empirical predictions in the *mare magnum* of consciousness that, probably in the future, will become a sort of *ether*. A concept that in the course of the history of science have forged theoretical foundations, creating paradigms that dominated for substantial periods of time.

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