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Using psychophysical tools to quantify body image perception: a tutorial

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Abstract—This article presents a tutorial about two protocols that can be used to measure an individual's perception of body image, *direct* and *indirect*, and which follow S.S. Stevens (1951) methods. Two psychophysical task approaches illustrate the ability of individuals to quantify body image distortions. We selected psychophysical tasks that indirectly assess a participant's *behavioral component of body image* (i.e., satisfaction tendencies about body image); and second, the *cognitive component of body image* (i.e., individuals' perceptual accuracy in magnitude estimation tasks, which depend on a familiarity with interval scales and the use of numbers and ratios to represent physical dimensions of stimuli). We determined individuals' *perceptual sensitivity* (i.e., his or her *perceptual style*) to manipulations of the body's size by using Stevens' *power function* (Stevens, 1951).

Keywords: psychophysics, body image, magnitude estimation, power function

Resumo—"Usando ferramentas psicofísicas para quantificar a percepção da imagem corporal: um tutorial." Este artigo apresenta um tutorial sobre dois protocolos que podem ser usados para medir a percepção de imagem corporal, *direta* e *indiretamente*, com base nos métodos de S.S. Stevens (1951). Duas abordagens psicofísicas ilustram a capacidade dos indivíduos para quantificar as distorções da imagem corporal. Nós selecionamos tarefas psicofísicas que avaliam indiretamente o *componente comportamental da imagem corporal* do participante (ou seja, tendências de satisfação sobre imagem corporal); e segundo, o *componente cognitivo da imagem corporal* (ou seja, precisão perceptual nas tarefas de estimativa de magnitude, que dependem de uma familiaridade com escalas de intervalo, e com o uso de números e proporções para representar dimensões físicas dos estímulos). Determinamos a *sensibilidade perceptual* dos indivíduos (ou seja, seu *estilo perceptual*) em tarefas de manipulação do tamanho do corpo, usando a *função de potência* de S.S. Stevens (Stevens, 1951).

Palavras-chave: psicofísica, imagem corporal, estimativa de magnitude, função de potência

Resumen—"Utilizando herramientas psico-física para cuantificar la percepción de imagen corporal: un tutorial." Este artículo presenta un tutorial en dos protocolos que pueden utilizarse para medir la percepción de imagen corporal, *directa* e *indirectamente*, con base en métodos de S.S. Stevens (1951). Dos enfoques físicos ilustran la capacidad de los individuos para cuantificar las distorsiones de la imagen corporal. Hemos seleccionado las tareas psico-físicas que evalúan indirectamente el *componente conductual de la imagen corporal* del participante (es decir, tendencias de satisfacción sobre imagen corporal); y en segundo lugar, el *componente cognitivo de la imagen corporal* (es decir, precisión perceptiva en las tareas de estimación de magnitud que dependen de una familiaridad con las escalas de intervalo, y con el uso de los números y proporciones para representar dimensiones físicas de los estímulos). Determinar la *sensibilidad perceptual* de los individuos (es decir, su *estilo perceptual*) en tareas de manipulación del tamaño corporal, usando la función de potencia de S.S. Stevens (Stevens, 1951).

Palabras claves: psicofísica, imagen corporal, estimación de magnitud, función de potencia

Introduction

The study of body image is dominated by studies that investigate perceptual distortions and dissatisfaction that reflect neurological (e.g., brain lesion, peripheral lesion, epileptic seizure, etc.) and psychiatric (e.g., eating disorders, dissociative disorders, dysmorphia, etc.) disorders (De Vignemont, 2010; Lovo, 2006; Smolak, 2002). In typical groups, such studies also focus on patterns of responses during body image assessment, with the purpose of identifying the developmental effects of gender, exercise practices, media and peer influences, etc.

Because (visual) perception and satisfaction of body image reflect a complex process of bodily awareness, we can infer that such a process can easily be disrupted by a number of environmental (cultural) and intrinsic factors. For instance, media has played an important role in affecting peoples' standards about size and shape—distinctive in females and males (Knight & Giuliano, 2001). The frequent viewing of fashion models' bodies, considered "beautiful" in terms of media standards, can raise the level of the observer's dissatisfaction with her own body and trigger inappropriate behaviors such as obsessive scrutiny of her own body parts, food restrictions, or compulsive engagement with physical activity (Alves, Vasconcelos, Calvo, & Neves, 2008; Bamber, Cockerill, Rodgers, & Carroll, 2003; Nunes *et al*., 2007). Intrinsic factors such as health condition or even the presence of a disability influence body satisfaction, and can color or diminish one's own perception of skills or movement competencies—the universal measure of a functional body, especially in the presence of a disability.

According to De Vignemont (2010), the ways through which we can relate to our bodies include touch, vision, proprioception, motor behavior, semantic understanding, and emotion. Such relationships, established via bodily awareness, however, reflect a reductionist perception about body image, which is constrained by externally imposed patterns of ideal bodies (e.g., ideal weight). In colloquial terms, body image has little to do with competence and a lot to do with looks. While an individual's body is in motion, he or she must dynamically integrate complex sets of information that come from senses, muscles, organs, and tissues. Yet, the individual's self-perceived visual appearance seems to be the most important factor in triggering positive emotions, even in establishing the individual's criteria of what *is healthy*. That is, with this type of self-talk, if an individual is thin and fits the attractive ideal of the mass media, he or she must *be* healthy (Campbell, & Mauerberg-deCastro, 2011). In fact, such cognitive distortions related to eating disorders include this *thought-shape fusion* phenomenon, in which just imagining the consumption of high-caloric food leads individuals to feel fatter and to perceive weight gain (Coelho, Jansen, & Bouvard, 2011).

Because today obesity is found worldwide in epidemic proportions (WHO, 2014), individuals are commonly aware that the difficulty in maintaining a weight within the "normal" range of *body mass index* (BMI) (between 18.5 and 24.9) stems from widespread environmental factors that promote overeating, physical inactivity, and sedentary leisure activities. Such awareness makes scrutiny and awareness of body size a routine, even for children as young as five years old (Gehrman, Hovell, Sallis, & Keating *et al*., 2006; Li *et al*., 2005).

Individuals who scrutinize body size typically assign a simple value such as BMI to express an acceptable measure. However, in today's world, a majority of men and women perceive that their bodies deviate from their ideal body dimension, even when their body's nutritional status (BMI) is within the normal range (Fiske, Fallon, Blissmer, & Redding, 2014; Murray, Rieger, & Byrne, 2013). Three in four women are dissatisfied with their bodies and wish they were thinner (Campbell & Mauerberg-deCastro, 2011). As related to body image, these projections follow a pervasive and consistent pattern: For women, the pattern is the ideal thin body; for men, the ideal is the strong, large body.

There are two main domains in assessments of body perception: the *cognitive* (or *representational*) and *behavioral* (or *attitudinal*). The cognitive domain relates to an individual's recognition of body dimensions, usually shape and size, and include the estimation of metric parameters, whether direct (e.g., assigning numeric values to an image), or indirect (e.g., adjusting the sizes of an image using the computer tools of a photo editor). The *behavioral* domain refers to the individual's feelings, beliefs, and attitudes about the body's appearance. Body dissatisfaction often is the result of an individual's displeasure with the look of his or her body (negative feelings) (Cash, 2002), and deeply affects a person's body image. Some individuals, especially adolescents and adult women (Siegel, 2002; Richardson, Paxton, & Thompson, 2009), older men and women (Twigg, 2004; Tribess, Virtuoso, & Petroski, 2010), and disabled people (men and women) (Lease, Cohen, & Dahlbeck, 2007) are especially vulnerable to body dissatisfaction.

The issue of body image, along with its association with the risk of developing or worsening eating disorders and body image dysmorphia, is often investigated through the use of image distortion tasks. Experimental settings in this area include tasks with distorted images (typically graphic enlargements or reductions of an actual person's body image) in varying groups and socio-cultural contexts, and clinical conditions (e.g., often with eating disorders). Furthermore, these studies also can include groups of various ages (e.g., teens) (Kakeshita, 2008; Sand, Lask, Hoie, & Stormark, 2011; Ojala, Tynjala, Valimaa, Villberg, & Kannas, 2012), racial and ethnic influences (e.g., African-Americans, Asians, Caucasians) (Li *et al*., 2005; Sampei, Sigulem, Novo, Juliano, & Colugnati, 2009; Smolak, 2002), gender differences (i.e., heterosexual females and males, homosexuals, transsexuals, etc.) (Kakeshita & Almeida, 2006; Mohr, Porter, & Benton, 2007), various health and disability conditions (e.g., amputees, genetic disorders, obesity) (Mussap, McCabe, & Ricciardelli, 2008; Tovée, Benson, Emery, Mason, & Cohen-Tovée, 2003), and effects of participation in sports and physical activities (Slater & Tiggemann, 2006).

Assessing body image perception

In recent years, numerous instruments have been created to assess body image, including questionnaires and scales of silhouettes (Stewart, Benson, Michanikou, Tsiota, & Narli, 2003; Stunkard, Sorenson, & Schlusinger, 1983; Tavares, Campana, Tavares Filho, & Campana, 2010). Qualitative in nature, these instruments mainly attempt to determine the extent of attitudinal dimensions that interfere with accurate body awareness and opinions about appearance.

Despite the increased interest in the phenomenon of body image as a modern-day cultural construct and as a risk factor for the development of eating disorders (Adams, Turner, & Bucks, 2005; Kakeshita & Almeida, 2006), evaluation methods often are questioned with regard to their validity and reliability, particularly with respect to the subjective nature of outcomes derived from qualitative impressions of bodily dimensions. Questionnaires, for example, rely on qualitative variables from verbal input. These inputs later are converted into scores to indirectly represent perceptual dimensions of a body's image (Lu & Hou, 2009; Stewart *et al*., 2003; Toveé *et al*., 2003). An instrument such as the Stunkard silhouettes uses pictorial images of bodies, and requires an observer to estimate his or her body's size by choosing an image that most closely represents it. However, these silhouettes offer no metric units (Stunkard *et al*., 1983). Such tools provide a "glimpse" into the qualitative phenomena (i.e., influences of socio-cultural aspects of behavior) that surround a person's perception of body image.

Some researchers recommend the use of distortion techniques, along with questionnaires, to measure body image (Paula, 2010; Stewart *et al*., 2003; Thompson, 2004; Tovée, Emery, & Cohen-Tovée, 2000). Others (Probst, VanCoppenolle, Vandereycken, & Goris, 1992; Probst, Vandereycken, & VanCoppenolle, 1997) apply video distortion techniques that alter the body in the vertical and horizontal axes, but do not use the actual values of the individuals' body dimensions. Such experimental settings distort the actual body image of the participant in order to assess his or her perception of this distortion, under the assumption that deviations of accuracy can be symptoms of body image disturbances.

Stewart, Allen, Han, and Williamson (2009) developed a computerized measure of body image, the Body Morph Assessment, which utilizes a computer ''morph'' movie of a human body to measure an individual's estimates of his or her actual body size, ideal body size estimates, acceptable body size estimates, and body image/size dissatisfaction. The program uses 100 "avatar" representations for male and female bodies, and individuals are asked to choose, for example, an image that answers the query, "What is an ideal body?" This computerized tool demonstrated that an ideal body size, and to some degree an acceptable body size, remains a fixed ''constant'' of the body's image (no matter what size a person is, they must fit a certain standard size).

Another computerized tool, the Virtual Body (Alcañiz *et al*., 2000; Perpiña *et al*., 1999), was designed to evaluate body image disturbances. It employs a graphic interface of 3-D figures projected onto a computer screen. Participants typically are asked to modify the sizes of different body parts by adjusting components of a distorted body image until they achieve what they believe to be an accurate image of themselves. Differences between their results and an accurate image are indicative of levels of perceptual distortion and body dissatisfaction.

Together with specifically designed questionnaires, image distortion techniques can provide consistent parameters that reflect body image dissatisfaction and dysmorphia (Johnstone, 2008; Paula, 2010; Stewart *et al*., 2003; Thompson, 2004; Toveé *et al*., 2003).

A thorough analysis of the complex issue of body image distortion depends largely on the instrument used to acquire data. We suggest that a broader understanding of this issue can be achieved not only through investigations that employ qualitative data, but through those that use a conceptual base that is centered in the canonical approach by S.S. Stevens (1951): *scalar psychophysical* methods.

This article presents a tutorial about two protocols that can be used to measure an individual's perception of body image, *direct* and *indirect*, and which follow S.S. Stevens (1951) methods. We developed an experimental design that employs these two psychophysical task approaches to assess an observer's ability to quantify body image distortions while viewing two-dimensional photographic images. Such distortions, embedded into the psychophysical tasks, provide a setting to indirectly assess, first, the participant's *behavioral component of body image,* in which his or her satisfaction tendencies are indirectly determined using the individual's own body image as well as that of a stranger's body; and second, the *cognitive component of body image.* The latter provides direct measurements of the individual's perceptual accuracy in magnitude estimation tasks using distorted body images. Furthermore, from magnitude estimation tasks, we are able to determine the individual's *perceptual sensitivity* (i.e., the *perceptual style*) to the manipulation of the body's size in the images by using Stevens' *power function* (Stevens, 1951). Results from the female and male participants reflect the extent of influences of their knowledge, and their attitudes about body image.

Psychophysics as a concept and as an approach to assessing perception

Perception is the result of an adaptive process of spatio-temporal experiences and relationships, both in quantitative as well as qualitative aspects of physical stimuli. Psychophysics, therefore, is concerned with investigating the quantitative relationships between the physical and the psychological magnitudes within and between these experiences and relationships. The most salient question in the history of the study of psychology, "How do the brain and mental processes work?," relates to perception, the mind's "gateway to the world." Yet, in addition to being the mind's gateway to the world, perception provides researchers with a "window to the mind," to help us understand how it works.

The perception of body size is related primarily to the interpretation of information picked up by sensory systems (predominantly the visual system). In practical terms, an individual perceives body size by assessing a graphically

Since the late 18th Century, scientists have used psychophysics to measure perceptual and sensory systems. Simply defined, psychophysics is, "The branch of psychology concerned with the effects of physical stimuli on mental processes" (DaSilva & Ribeiro-Filho, 2006). However, psychophysics is both an area of study and a methodology. The investigation of human perception is centered on human experiences—at different levels of development or adaptation—of space, objects, and events, and of their dimensions.

Wundt, in 1879, founded the first laboratory of experimental psychology in which studies about consciousness and perception included introspective methods (Stevens, 1951; 1975). Introspective methods in the field of perception and psychophysics were abandoned because of the lack of validity, reliability, and new developments in the field, with the advancement of technology and the appearance of animal psychology.

For almost two centuries, scientists of human behavior—mostly psychologists—were intrigued with the possibility of measuring, predicting, and eventually explaining how humans perceive the world. The reliability of early investigations conflicted with the subjectivism of introspective techniques. Given the vast range of possibilities an individual has to express himself, in an experimental situation his impressions of a given stimulus lent little reliability to introspective methods (i.e., analytical insight). These methods left it open to the individual to describe (typically verbal replies) what he perceived about a stimulus.

Studies on sensation and perception since psychometrics' early history have resulted in numerous applications, including:

- Information theory (marketing, advertising, education, internet applications, intelligence)
- Development of communication technology and radar systems (military use)
- Space programs (humans outside of the terrestrial environment and effects of microgravity)
- Artificial intelligence (human-machine analogies, computers, robots)
- Ergonomics (implementation of service equipment in daily life activities, sport, work, leisure)
- Rehabilitation (prostheses, implants, stimulation techniques, adaptations after intervention)
- Public health (consumerism, hygiene habits, disease prevention, lifestyle choices)
- Architecture and urban design (spaces and utilities, comfort and aesthetics, technological growth and demand)
- Social behavior (mass behavior, perception of face and body image, public safety, institutional behavior, traffic, war)

distorted image paired to an actual, undistorted image (also known as the *standard* image) of a body (either of a stranger or his or her own image). The participant is given a value for the physical dimension of the actual (standard) image; then the observer must estimate the new values for several comparative distorted images.

In psychophysics, researchers have demonstrated that the visual perception of a volume of objects can be accurately estimated (Ekman & Junge, 1960). A simple task of magnitude estimation requires an observer to scale the size of several objects based on a standard object—one that is arbitrarily assigned a magnitude size of 10, for example. According to Da Silva and Macedo (1981) and Da Silva and Ribeiro-Filho (2006), the relationship between stimulus and response is constrained by scalar values. For example, during a *magnitude estimation* task, the observer is asked to assign a value (either verbally or written) to each stimulus (e.g., object) of a series of stimuli that vary in their physical dimensions. The observer's numeric response is assigned a position on a scale (i.e., scalar variable) or on a line, which then reflects the *production* of a *dimensional magnitude* that will consistently fit into this psychophysical scale. The psychophysical scale here, therefore, demonstrates how a perceptual process can be "measured" (Stevens, 1951).

In an experimental task, the values assigned (perceived) to a series of objects that are ordered on a (psychological) scale are each matched with the corresponding actual (physical) value. Therefore, equal ratio between the stimuli results in equal ratio between responses. The observers' abilities to scale up and down sizes using values reflect their familiarity with metric or ratio scales. Accuracy depends on how correctly and proportionally individuals adjust the numeric scale (i.e., assigning numbers to an object) as the metrics of a real object changes. In addition to the use of perceptual cues, an individual's estimation of the size of a body image involves the ability to retrieve cognitive representations, which are used to calibrate judgments of form, volume, and size (Braga, 2012; Paula, 2010).

Although, currently, no single assessment tool measures an individual's perceptions of the complexities of a body—simplified here in two-dimensional representations, psychophysical techniques allow us to identify general, yet reliable, behavioral mechanisms underlying sensation and the perception of events or objects. According to Mauerberg-deCastro and Moraes (2002), these techniques allow us to objectively measure changes in a subjective sense modality—magnitude estimation, for example. In this procedure, individuals assign numbers to quantitative variations of a given stimulus. A range of stimuli is assessed, which results in a perceptual scale paired with a physical scale. To illustrate this relationship, we adopted the experimental model of image distortion initially proposed by Paula and Mauerberg-deCastro (Mauerberg-deCastro, 2006; Paula, 2010). Evaluation tools that examine body image perception pose a unique perspective on how complexity can be represented in simple quantitative parameters by using a psychophysical approach.

The "how to," or steps, of our psychophysical approach

The construction of a body image psychophysical task

Step 1. Obtaining the physical body mass index (BMI)

A participant's BMI was calculated by dividing the individual's body mass (in kilograms) by his or her squared height (in meters), as described in Equation 1:

BMI = kg/m² (*Equation 1*)

Step 2. Construction of the stimuli (test image) for the psychophysical tasks

For the purpose of selecting the psychophysical stimuli, each participant's full body was photographed, front view. Participants wore black Lycra shorts and a black cotton sleeveless shirt. This personalized photograph was used as a "standard" image (i.e., the actual, undistorted body image of the individual participant) in two psychophysical experiments: *silhouette task* and *body size magnitude estimation task*.

The standard image capture uses a monochrome background (blue) and is later distorted using Photoshop 7.0 image management software (Adobe®). The distortion (in percentages) of the original image results in a bi-dimensional outcome by using the functions: *filter*, *distort* and *spherize*. The criteria for constructing the scale of body size distortions uses an interval of BMI limits for thinness and heaviness/obesity, 16 kg/m² and 40 kg/m², according to the World Health Organization (WHO, 2014). The two psychophysical tasks arbitrarily included:

- 10 stimuli for the *silhouette task*
- 6 stimuli for the *body size magnitude estimation task*

The scale of these stimuli was built following a geometric progression of the *limited scale method*, which used Equation 2 (Da Silva & Macedo, 1981; Mauerberg-deCastro, 2004).

$$S_t = S_i + (n-1)r \qquad (Equation\ 2)$$

S_t is the value (stimulus) of the terminal stimulus (i.e., 40 kg/m²)
S_i is the value (stimulus) of the initial stimulus (i.e., 16 kg/m²)
n is the number of stimuli (arbitrarily determined)
r ratio (outcome of the equation, i.e., ratio of increment)

Silhouette task

A participant's BMI value was first converted to a percentage to accommodate individual differences in participants. Table 1 illustrates the calculation for a participant whose BMI is 26.6 (stimulus). Then, each corresponding extreme BMI values were entered in Equation 2.

Table 1. Example of the calculation of a geometric progression of a limited scale of image sizes for a participant (BMI = 23.3).

BMI limit for thinness	**BMI limit for heaviness/obesity**
BMI: 16 (S_i, or initial stimulus)	BMI: 40 (S_t, or terminal stimulus)
$S_i = 16 \cdot 100/23.3$	$S_t = 40 \cdot 100/23.3$
S_i= ~68.7 (%)	S_t = ~171.7 (%)
$S_t = S_i + (n-1)r$	
$171.7 = 68.7 + (10-1)r$	
$9r = 103$	
$r = 11.4$	

Each manipulated photo is based on the limited scale method. Therefore, 10 images are distorted, plus the standard image (i.e., 11 images). The task scale is presented in ascending order of increasing magnitudes of BMI (Figure 1).

Body size magnitude estimation task

Similar to the behavioral task above, the manipulation of images can be achieved via the *limited scale* method (Equation 2). However, in order to maintain the standard BMI value (participant's actual, undistorted image) at the middle of the task scale, two separate calculations of the intervals can be used (Table 2). This strategy also can be incorporated into the previous task. This decision, however, can cause images to be distorted, with little variation, when the BMI of the actual, undistorted image is closer to the extremes of the limits of the scale, i.e., 16 and 40 in the illustration above.

When two sub-scales are used, the first portion will include 3 images with BMI dimensions using the BMI 16 (limit for thinness) and the actual, undistorted participant's BMI (4th image) and limiting values. Therefore, the lower limit of the scale refers to stimuli between images 1 and 4, i.e., BMI 16 and the actual, undistorted image) 26.9 BMI, calculated via Equation 2. Secondly, for the upper limit of the scale we calculated the values for S_4, S_5, and S_6, while S_7 is the maximum BMI value, or 40.

Table 2. Example of the calculation of two sub-scales of a geometric progression of a limited scale of image sizes for a participant (BMI = 26.6).

BMI limit for thinness	**BMI limit for heaviness/obesity**
BMI: 16 (S_i, or stimulus)	BMI: 40 (S_f, or stimulus)
$S_i = 16 \cdot 100/26.6$	$S_f = 40 \cdot 100/26.6$
Si= ~60.1 (%)	S_f= ~150.4 (%)
$S_{t\ lower} = S_i + (n\text{-}1)r$	$S_{t\ upper} = S_i + (n-1)r$
$100 = 60.1 + (4\text{-}1)r$	$150.4 = 100 + (4-1)r$
$3r = 39.9$	$3r = 50.4$
$r_{lower} = 13.3$	$r_{upper} = 16.8$

Table 3 shows the sequence of calculations, using the subscales of geometric progression for one participant. Ranges for both BMI and % values appear in a single scale that is used to compose the psychophysical task of magnitude estimation. Notice that the standard value (i.e., the actual, undistorted image of the participant) remains at the middle of the scale. This strategy was used to prevent a 4th image from appearing with a similar size dimension as the actual, undistorted image—which is part of the task scale. Magnitude estimation tasks should not use confusing images such as those with a reduced threshold of differences, which makes them hard to discriminate. Differences between the actual, undistorted image and distorted images should be evident.

The actual, undistorted image is placed into position prior to each photo being manipulated, both sequentially displayed on the computer screen (0.5-second interval). Therefore, in our example, we paired six distorted images with the standard image (i.e., a total of six pairs).

Table 3. Outcome of the calculation of the two sub-scales of a geometric progression of a limited scale of image sizes for a participant with a BMI of 26.6.

Calculating the stimulus increment using *r*	Percentage (%)	BMI value
S_1	60.1	16
$S_1 + r_{lower} = S_2$	73.4	19.5
$S_2 + r_{lower} = S_3$	86.7	23.1
S_4	100	26.6
$S_4 + r_{upper} = S_5$	116.8	31.1
$S_5 + r_{upper} = S_6$	133.6	35.5
S_7	150.4	40

The next process described in this tutorial is the procedure for determining parameters that integrate the concepts and the diagnosis of body image perception accuracy, represented as behavioral and cognitive components. The quantitative variables show the magnitude of perceptual distortions as well as perceptual styles with respect to the visual image of one's own or others' bodies.

Step 3. Evaluating the behavioral component of body image

The *behavioral* component of body image involves aspects such as feelings, beliefs, actions, and attitudes that relate to preoccupation with appearance. In an experimental session, in order to determine the behavioral variable of body image that indicates *levels* of *dissatisfaction*, a female participant, while viewing a set of distorted body images of herself—like the one displayed in Figure 1, responds by choosing an image of herself, according to the following questions:

- "Which image reflects your body now?" (perceived AIP)
- "Which image you would like to look like?" (desired AIP)

The actual image of the participant (AIP—is the BMI of the participant that corresponds to the actual image which is displayed in the scale along with the distorted images), measured for BMI is used to calculate *perceptual inaccuracy* and *levels of dissatisfaction* with one's own body image. The assigned choices for each question are submitted to Equations 3 and 4.

Perceptual inaccuracy = perceived AIP – AIP (*Equation 3*)

Level of dissatisfaction = desired AIP – perceived AIP (*Equation 4*)

- *Perceived AIP* refers to the calculated BMI for the chosen image from the scale of distorted images that indicates the perceived actual body image.
- *Desired AIP* refers to the calculated BMI for the chosen image from the scale of distorted images that indicates the desired body image.

For example, if the participant (in Figure 1) chooses her actual image (i.e., 23.3) as her perceived AIP, then the degree of perceptive accuracy is considered perfect (i.e., 23.3 − 23.3 = 0). On the other hand, if the participant chooses as her *desired* AIP an image with a BMI equivalent to 21.3, and, as her *perceived* AIP an image with a BMI equivalent to 29.3, the result of her level of dissatisfaction is -8 points (BMI). The negative value shows the direction of her dissatisfaction, towards thinness (relative to her real BMI).

Step 4. Evaluating the cognitive component of body image

The *cognitive* component of body image requires an observer to identify physical properties of an image such as size, volume, or any other visual dimension that relate to apparent perception on a metric scale. In an experimental session, in order to determine the cognitive variable of body image that indicates *levels* of accuracy and *perceptual style* (e.g., visual *constancy*, visual *underconstancy*, or visual *overconstancy*), a participant is asked to view images such as those displayed in Figure 2, and to attribute numbers that are proportional to a standard number (e.g., 100), which is assigned to an actual (or unmanipulated) image (also called *standard* stimulus). In our example below, a male participant with a BMI of 26.6 is used. In this psychophysical task, the experimenter provides the following initial instruction prior to the display of the participant's image: "We attributed a value of 100 to your actual, undistorted image (standard)." Then, a second image (distorted) appears, and the experimenter asks, "If the previous image was worth 100, how much is this (distorted)

Figure 1. Scale of distorted images of a female participant's body, including the actual, undistorted image (i.e., 100% or BMI = 23.3).

image worth?" This question is repeated in print for each pair of sequential images (Figure 2).

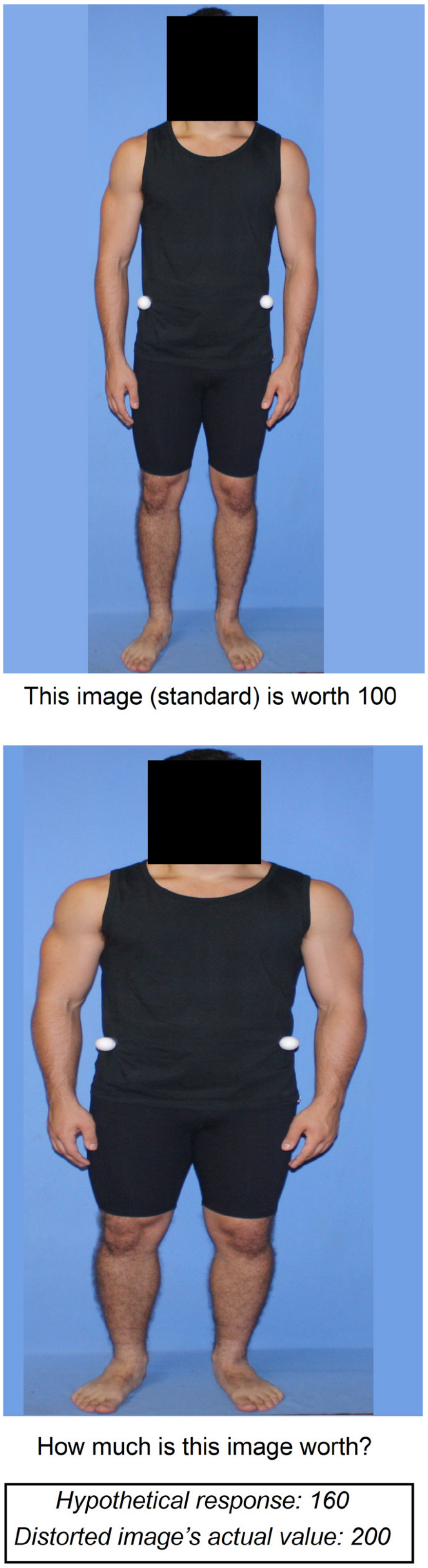

Figure 2. Pair of two images of a participant's body, undistorted (100% or BMI = 26.7, top) and distorted (200% or BMI = 40, bottom).

Step 5. Data analysis using psychophysics

In the *behavioral component,* body image is assessed via two parameters, *perceptual inaccuracy* and *level of dissatisfaction* (see Equations 3 and 4). However, the *cognitive component* via the magnitude estimation task provides a larger set of variables. These variables, representing the verbal (numeric) response to distorted images, are then plotted against the veridical scale that comprises the distorted image.

The first data processing of the magnitude estimation provides us with the magnitude of perceptual accuracy for each image in the scale. Two variables are the *absolute error* (AE) and the *constant error* (CE).

Table 4 depicts an example of a scale (i.e., stimulus) that was constructed using the geometric progression of a limited scale of image sizes for a female participant (BMI = 23.8), in both percentage and BMI units. The participant's respective estimated magnitude of the image (i.e., response) to each distorted image also appears in percentage and BMI units. Results of a participant's responses are initially processed using the absolute error (AE: Equation 5), which is the difference between the actual distorted image value and the estimated magnitude, or the participant's response to this same image (Table 4). In psychophysics, absolute error is the difference between the judged value of a stimulus and its true value, ignoring the direction of the difference. The closer the AE value is to zero the more accurate is the participant's perception of the body size distortion.

$$AE = \Sigma|R_i - S_i|/n \qquad (Equation\ 5)$$

Table 4. Participants' responses (% and BMI) to seven distorted images, and outcomes, respectively, for $\%_{dif}$ and BMI_{dif}.

Stimulus (S) (%)	Stimulus (S) (BMI)	Response (R) (%)	Response (R) (BMI)	%dif	BMIdif
69.3	16.5	55	13.1	-14.3	-3.4
80.3	19.1	65	15.5	-15.3	-3.6
93.1	22.1	80	19.0	-13.1	-3.1
107.9	25.7	120	28.6	12.1	2.9
123.0	29.7	150	35.7	25.0	5.9
144.8	34.5	170	40.5	25.2	6.0
167.8	39.9	250	59.5	82.2	19.5
Absolute error (AE)				26.7	6.3

The constant error (CE) measures any potential bias from direction of the BMIs, to over- or underestimate a BMI extent for any given body image distorted magnitude, by calculating the difference between the judged value of a stimulus and its true value. Negative values indicate that the estimated magnitude value of the body size was smaller than the actual magnitude (i.e., underestimated), and vice-versa. BMI_{dif} represents the difference between the actual BMI of the distorted image and the BMI of perceived distorted image (R-S). In our example, the participant's BMI is 23.8. All distorted images were based on a percentage of the participant's BMI value. When the size of the body was distorted above 167%, the CE was 82.16%, or perceived 19.55 BMI values above the actual body image BMI (i.e., overestimation). The CE seems to increase as the distortion of the image approaches the obesity level (Figure 3).

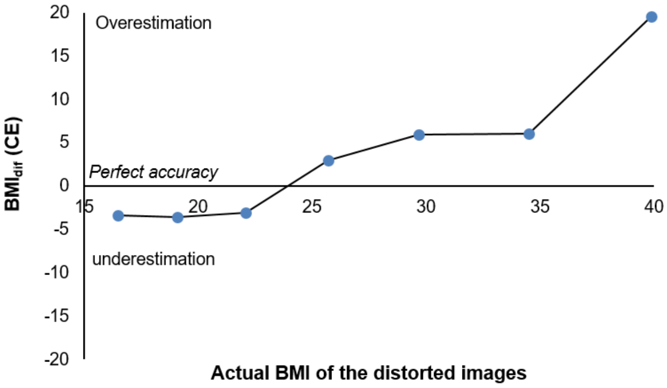

Figure 3. Magnitude estimation of perceived size of distorted body images (psychological scale) and the actual size of distorted body images (physical scale) representing the CE (BMI_{dif}) of a female individual.

Power function in psychophysics

Da Silva and Macedo (1981) proposed that the perceptual and cognitive processes are interrelated and produce a single dimension that specifies such processes (e.g., an individual that uses a numeric representation for multi-dimensional changes of a particular stimulus). To confirm such dimensional specificity, experiments in psychophysics attempt to demonstrate perceptual constancy, accuracy of processes, and to test mathematical model predictions.

Psychophysical experiments measure perception and sensation through a variety of methods. These include fractioning, equisection scaling, magnitude estimation and magnitude production, and cross modal matching, among others. Direct scalar psychophysics methods were popularized by Stevens (1951; 1961; 1975) in order to validate a psychophysical law.

The analysis of the perception of a stimulus' dimension (such as size) typically employs mathematical functions, such as the *psychophysical power function* proposed by Stevens in 1951 (Dang & Macedo, 1983). The power function aligns perceptual judgments with the magnitude of physical stimuli (actual value) in a wide variety of perceptual modalities (e.g., visual, auditory, tactile, etc.). The relationship between the *subjective perceived magnitude* and the *actual magnitude* of a stimulus set obeys what has become known as the *Law of Stevens* (Stevens, 1951), and takes the form:

$$R = K \cdot S^n \qquad (Equation\ 6)$$

R is the magnitude of the perceived stimulus, *K* is an arbitrary scalar constant (which depends on the unit of measurement—height, for example), *S* is the actual value (or intensity) that corresponds to the stimulus, and the exponent *n* is the power law exponent and determines the slope of the function. The *n* parameter varies according to the sensory continuum (for example, auditory threshold for loudness) or perceptual modality (for example, perception of visual distance) that is being measured.

An exponent value of 1 means that the psychophysical function follows a constant symmetrical line between the two continua (i.e., physical and psychological). The subjective response varies in the same proportion as the intensity of the stimulus; that is, there is a perceptual *constancy* (the angle of inclination of the line ascends to 45º). A psychophysical function (e.g., visual perception of line length) that have exponents equal to 1 depict a linear relationship between a stimulus' physical magnitude and its perceptual magnitude (Da Silva, 2004; Da Silva & Macedo, 1981; Da Silva & Ribeiro-Filho, 2006; Mauerberg-deCastro, Paula, Tavares, & Moraes, 2004). On the other hand, if the exponent is greater than 1, the result is a positively accelerated or expansive psychophysical function (*overconstant* perceptual style), and the slope of the function is greater than 45°. If the exponent is less than 1, a negatively accelerated or compressive psychophysical function (*underconstant* perceptual style) appears, with a slope of less than 45º.

The logarithmic metric form of the two continua, $\log(R) = n\log(E) + \log(K)$, are mathematically equivalent and the data fit linearly. Figure 4 illustrates two female participants' perceptions of body sizes. The line in the graph on the left (Participant 1) increased linearly and proportionally, indicating that the magnitude of perceived body size increased as the magnitude of the actual body size increased. The slope indicates an approximation of a *perceptual constancy* (power function exponent is close to

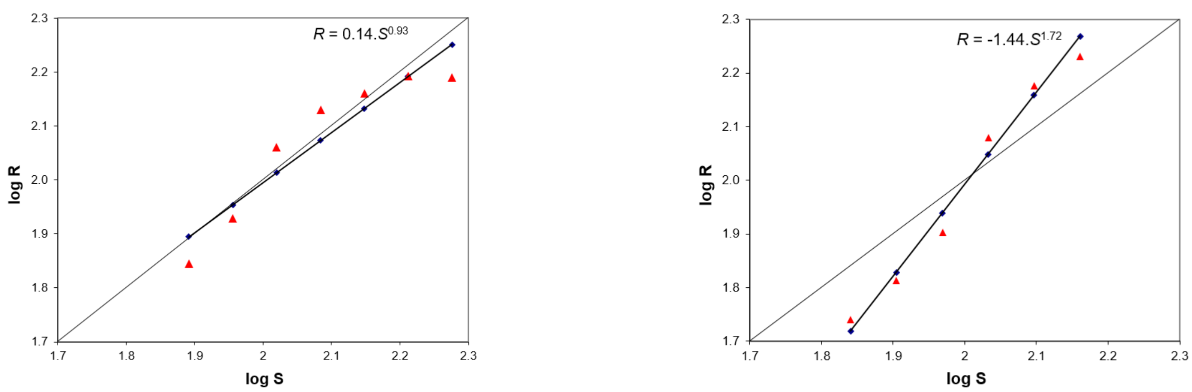

Figure 4. *Di-log* plots of perceived size of body in images (psychological scale) and the actual size of distorted body images (physical scale), using logarithmic values for estimations of magnitude of two different individuals. The first shows a perceptual constancy (*left side*) and the second, a perceptual overconstancy (*right side*).

1, i.e., $n = 0.93$). The graph on the right (Participant 2) indicates that the participant tended to inflate the values in her responses as the magnitude of the body size increased. The slope indicates a *perceptual overconstancy* ($n = 1.72$).

Calculating the power function

To calculate the power function, we employ the *least square method*, an algebraic procedure for fitting linear equations to data. First, individual values for the standard stimulus (the actual photographic image of the participant), and the values of the magnitude estimation (the participant's responses), are transformed into logarithms. Then, by applying the method of least squares to these values, the power function parameters are determined (see Equation 6), where the exponent *n* and the log*K* are calculated as follows:

$$e = \frac{N(\Sigma xy) - (\Sigma x \cdot \Sigma y)}{N(\Sigma x^2) - (\Sigma x)^2} \qquad (\textit{Equation 7})$$

$$\log K = \frac{(\Sigma x^2 \cdot \Sigma y) - (\Sigma x \cdot \Sigma xy)}{N(\Sigma x^2) - (\Sigma x)^2} \qquad (\textit{Equation 8})$$

From the parameters of Equation 6, the stimuli (*S*) are now *x* (log of S_i), and the responses (*R*) are now *y* (log*Ri*). The number of distorted images is *N*. See the example in Table 5.

Table 5. Example of an experimental trial with seven distorted images with respective values, S (%), and a participant's magnitude estimation response, R (%). Each magnitude set (S and R) was converted into log, x_i ($\log S_i$), and y_i ($\log R_i$).

	S	*R*	x	y	xy	x^2
	77.9	70	1.891537	1.845098	3.490072	3.577914
	90.29	85	1.95564	1.929419	3.773248	3.824526
	104.65	115	2.019739	2.060698	4.162072	4.079347
	121.29	135	2.083825	2.130334	4.439243	4.342327
	140.58	145	2.147924	2.161368	4.642453	4.613576
	162.94	156	2.212028	2.193125	4.851252	4.893067
	188.85	155	2.276117	2.190332	4.985451	5.180709
Σ			14.58681	14.51037	30.34379	30.51146
N = 7						

$$n = \frac{7\,(30.34379) - (14.\ 14.58681 \cdot 14.51037)}{7\,(30.51146) - (14.58681)^2}$$

$$n = 0.92705$$

$$\log K = \frac{(30.51146 \cdot 14.51037) - (14.58681 \cdot 30.34379)}{7\,(30.51146) - (14.58681)^2}$$

$$\log K = 0.14109$$

$$\text{Antilog}K = 1.38$$

By adjusting the parameters, $\log R_j = \log K + n \cdot \log R_i$ (or x_i), we have $R_{i\ldots n} = 0.14109 + (0.92705 \cdot S_{i\ldots n})$, where $\log R_j$ is the predicted parameter outcome for the fitting of the psychophysical power function. To construct a *di-log* psychometric graph, we must plot each $\log R_j$ against each corresponding $\log S_i$, as shown in Figure 5.

Variables that affect the power function in body image psychophysical tasks

Perceiving the body image of a stranger vs. perceiving one's own image

The exponents of the psychophysical power function indicate that perceiving the body image of a stranger can be a different experience than perceiving one's own image. In 2010, Paula, using the methodological procedure presented above, investigated levels of perceptual consistency and accuracy of female adolescents in body image psychophysical tasks. She included distorted images of each individual's own body as well as a stranger's body. Forty-three participants at risk for body image disorders completed a psychophysical task in which their levels of satisfaction with body image were assessed using each individual's image, both actual and distorted, as compared to a stranger's image (Figure 5).

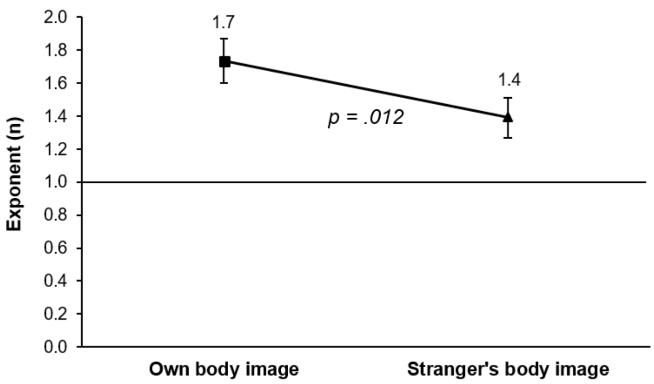

Figure 5. Geometric mean of the power function's exponents in two psychophysical magnitude estimation tasks, with distorted body images of own body and a stranger's body of a group of female adolescents at risk for body image disorders (Paula, 2010). (Standard errors in bars.)

Although each of the female participants in this study had a normal BMI (21.4 ± 2.9), each also perceived herself as being overweight, felt she was obese, or wanted to be thinner. Participants showed a tendency toward perceptual *overconstancy* in both tasks, with a significant difference for tasks using images of the participants' own bodies. Both tasks, when using body images that were compared to a magnitude estimation task that used a neutral image (i.e., a cube, $n = 1.1$), showed a significantly larger exponent (i.e., $n = 1.7$). Magnitude of constant error showed that all participants underestimated distorted images of small-sized bodies (BMI lower than normal), and they overestimated the distorted images of larger-sized bodies.

Similar results were found in a control group of college-aged females in a different study that used the same protocol methodology as presented in the current article. The exponent for perception of one's own body size was 1.6, while the perception of a stranger's body size was 1.3 (p = .05) (Braga, 2012).

In both studies, females perceived themselves differently than when they viewed the body images of a female stranger. When viewing images of themselves during the psychophysical task, these females tended to increase the magnitude ratio between the standard image and the distorted image, as the body size increased toward a BMI that is considered "obese." While the adolescents at risk for developing body image disorders presented a larger exponent, they were not significantly different from the females that were not at risk.

Recently, Tavares (2015) detected no such image effect in males. Using the same protocol, she tested 25 male college-aged students, and a second group of 25 males at risk for body dysmorphia. Both groups showed no significant difference between tasks that used their body images and a stranger's image, although the group at risk showed a slightly (non-significant) larger exponent than that of the control group. In both tasks, the control group showed a geometric mean for the exponent of 1.4 in both tasks (own image and stranger's), and, similarly, 1.5 for the group at risk for body dysmorphia.

Psychophysical exponents found for estimation tasks of own body size in males replicated the results found for females' perceptions of a stranger's body image. This gender bias is well documented in studies of body image (Cash & Pruzinsky, 2002). Females tend to perceive themselves as larger (fatter) than do males, and many would like to be thinner, even though their BMIs fall into what is considered a normal range (Braga 2012; Paula, 2010). Males prefer to be larger, or heavier, than they actually are.

Consistency in the magnitude estimation task can be measured using the *determination coefficient*, denoted as r^2. The outcome indicates how well the psychophysical data fit the function. An r^2 of 1 indicates that the regression line perfectly fits the data, while an r^2 of 0 indicates that the line does not fit the data due to a non-linear trend, or because responses are random. In the first study using manipulated body images and the psychophysical estimation of magnitude task, Paula (2010) found a determination coefficient of .91 for the group of females at risk for body image disorders, and .94 for the control group. Braga (2012), who used this method to study stroke survivors, also found high determination coefficients: .93 for females and .95 for males.

Reliability in the magnitude estimation task for body image perception

In 2012, Braga investigated stroke survivors' perceptions of body size. Two-thirds of the participants had suffered right-side brain damage. She manipulated the hemispheric dimensions of the image by distorting half of the body (Figure 6). She used the same procedure for range of distortion as used by Paula (2010). In the magnitude estimation task, the participant's actual, undistorted, split image, however, was presented simultaneously with a distorted split image (i.e., the other half of the body). Participants estimated magnitudes in tasks that used the entire image, and bisected images (two conditions: 1. actual, undistorted half-body image on the right side, and distorted half-body image on the left side; and 2. actual, undistorted half-body image on the left side, and distorted half-body image on the right side).

Figure 6. Two examples of pairs of images that are distorted on one side only (on right is the actual, undistorted image; on left is the distorted image). Male participant is from the control group (Braga, 2012).

An interesting aspect of this experiment is the control group individuals' reliable responses (i.e., $r^2 > .90$) with regard to the bisected images and the entire images of their own bodies. Table 6 summarizes the results of parameters of the psychophysical power function and the determination coefficient. For the stroke survivors, the main limitation of this experiment was the difficulty in maintaining their attention and dispositions during the task. Many of them became tired, did not consistently respond to the task, and, therefore, were not included in the sample. Their coefficient of determination was smaller than that of the control group ($r^2 > .70$).

Table 6. Exponent of the psychophysical power function and the coefficient of determination of participants in two groups: Young adults and stroke survivors performed an estimation of magnitude task in which their own body images were bisected.

	Young adults (N = 17)		
	Whole body	Right-side distortion	Left-side distortion
n	1.2	1.4	1.4
r^2	.91	.93	.93
	Stroke survivors (N = 15)		
	Whole body (N = 11)	Right-side distortion (N = 9)	Left-side distortion (N = 7)
n	1.2	0.90	0.88
r^2	.83	.78	.77

The stroke survivors had a tendency to show a perceptual *underconstancy* in both of the tasks with bisected images. However, there was no statistical effect, since the large intra-group variability prevented a consistent outcome that could be associated with the disability condition. It appears that, since only a few participants responded with certainty to all of the tasks, this relatively small sample prevented reliable comparisons. On the other hand, the young adults showed a reliable perception of the bisected body images. Although the geometric mean of both exponents indicated perceptual *overconstancy*, they were nearly identical. It is important to note that the group of young adults was composed of males and females equally, and, because they did not show a statistical difference for this task, these results were collapsed into a single group.

Final considerations

The identity and visual perspective effects on perception of body image

One of the main concerns of researchers is to connect an experimental manipulation with a conceptual perspective that explains empirical problems. Disturbances and (mis)perceptions of body image are colloquial (as well as scientific) evidences of humans' dissatisfaction with how we appear. The knowledge of such conflicts is well understood in the field of visual communication—often with the purpose of selling products and methods of body "transformation." How humans perceive ourselves—in ways that justify a seemingly ubiquitous and unending desire for such transformations—is quite a complex topic of research. Yet, some commonalities appear through simple perceptual parameters, even for this complex object (and construct), the body.

When assessing cognitive components of body image perception, psychophysical parameters seem to detect not only accuracy levels, but also can provide a reliable sensitivity index via a psychophysical power function using canonical experimental procedures (Stevens, 1975). The exponent of this function reflects a particular way of assessing body size in groups with body image disturbances. Females, for example, assess their own body image versus a stranger's body image differently than do males (Paula, 2010).

As for assessing the behavioral component, we demonstrated that the extent of levels of satisfaction using a dimensional scale of distorted body images can provide new insights about

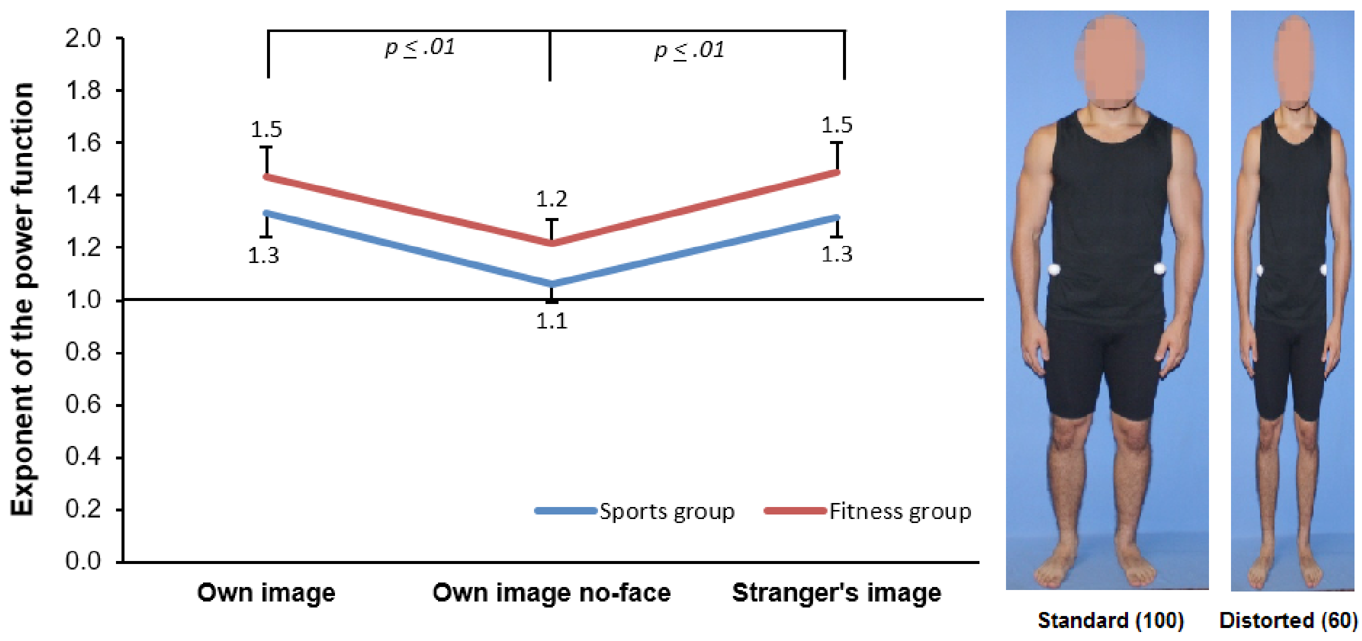

Figure 7. Geometric mean of the power function's exponents of two groups of male participants (sports and fitness) for magnitude estimation of own body image and strangers', and own body image without face (Tavares, 2015).

gender, lifestyle, and presence of body image disturbances. Tavares (2015) found that male individuals, for instance, are as dissatisfied with their body sizes as women, except in the opposite direction. Females in her study desired thinner bodies and erroneously perceived themselves as larger (fatter) than their actual BMIs indicated; males desired larger bodies, and erroneously perceived themselves as smaller (leaner) than their actual BMIs indicated.

Tavares (2015) also found that males with varying lifestyles with respect to exercise are biased when judging their own body sizes. A group of male athletes desired an increase of 3.1 BMI points, towards larger body size; while a group of males who exercised in order to gain muscle mass through fitness protocols desired an increase of 6.6 BMI, towards larger body size. The second group is at risk for body dysmorphia. The literature shows that some individuals with behavioral disturbances can accurately estimate size, but are excessively dissatisfied with shape and or size (Cash & Brown, 1987; Cash & Pruzinsky, 2002; Gardner, 1996; Gardner & Brown, 2014).

Another interesting finding by Tavares (2015) was that if we remove the face details (by blurring the face image), males become more objective in assessing body size dimensions, regardless of lifestyle. In the trials of body images without a face, their exponents reflect a perceptual constancy (exponent close to 1), regardless of their lifestyle of physical activity (Figure 7).

Such results confirm the potential use of psychophysical tools for assessing body image size and constitute a test of conceptual premises, such as the role bi-dimensional visual cues of distorted body images play in the complex phenomena related to perception of the body. Simplicity in scientific experimentation is desirable, but this also should open new perspectives of theoretical accounts and validate criticism of reductionism. Our methodological account corroborates human tendencies towards body image dissatisfaction widely discussed in the literature, and reveals some unique outcomes, resulting from additional experimental manipulations (e.g., perception of bisected body images; perception of faceless body images). It also prompts a discussion of its limitations. One is that manipulated images that are (bi-dimensionally) reduced to photography eliminate the subtleties of motion and the utilitarian function of the body. If attitudes about the body require experience with it, then body competency, mood states, as well as visual appearance are all challenges to assessment techniques. Furthermore, bi-dimensional representations of a body are scaled down to a computer screen, but life-sized images (as studied by Probst, Vandereycken, & VanCoppenolle, 1997) are difficult to display in a laboratory due to high costs and limited convenience. Therefore, questions about the validity of the body image scale at different dimensional levels can prove (or disprove) universal transference or perceptual invariance of body image size.

Reliable and simple tools require scholars to identify coherent research questions that integrate experimental manipulations as part of their predictions. Perception of body image is a complex construct, and the determination of parameters that are relevant to the demonstration of functions and influences is not an easy task, especially when the goal is to quantify these dimensions. The psychophysical approach can be useful for the measurement of perception because it offers both experimental task protocols and mathematical tools, or functions, to reduce and quantitatively represent data patterns that can prove or disprove conjectures. This article provided a glimpse of how such tools can be used, and attempted to guide readers into a practical scenario in which participants perceived the sizes of body images.

Some of the experimental contexts and literature findings related to the perception of body image have shown how the human body can indeed coherently measure objects and events. Da Silva (personal communication, 1992) stated that humans routinely use a "collection of measuring tools that are embedded in their bodies." That is, they accurately weigh food in a market simply by lifting it; they precisely calibrate distances and force when throwing a basketball toward a basket; they measure their bodies to fit into clothes simply by looking at their figures in the mirror, and so on. Metaphorically, humans are measuring tapes, dynamometers, scales, decibel meters, and a seemingly endless array of other devices, which are "built into" our organisms. "The beauty of the thing," Da Silva continued (*ibid*), "is that humans can rely on using their senses and perceptual modalities to accomplish such tasks without external devices." Psychophysical tools help us find the "signatures" of such sensory and perceptual functions.

References

Adams, G., Turner, H., & Bucks, R. (2005). The experience of body dissatisfaction in men. Body Image, 2 (3), 271-283, <doi:10.1016/j.bodyim.2005.05.004>.

Alcañiz, M., Botella, C., Perpiña, C., Baños, R., Lozano, J.A., Montesa, J., … Alozano, J. (2000). A new realistic 3D body representation in virtual environments for the treatment of disturbed body image in eating disorders. CyberPsychology & Behavior, 3 (3), 433-439, <http://online.liebertpub.com/doi/pdf/10.1089/10949310050078896>.

Alves, E., Vasconcelos, F.A.G., Calvo, M.C.M., & Neves, J. (2008). Prevalência de sintomas de anorexia nervosa e insatisfação com a imagem corporal em adolescentes do sexo feminino do Município de Florianópolis, Santa Catarina, Brasil (Prevalence of symptoms of anorexia nervosa and dissatisfaction with body image among female adolescents in Florianópolis, Santa Catarina State, Brazil). Caderno de Saúde Pública, 24 (3), 503-512, <http://dx.doi.org/10.1590/S0102-311X2008000300004>.

Bamber, D.J., Cockerill, I.M., Rodgers, S., & Carroll, D. (2003). Diagnostic criteria for exercise dependence in women. Brazilian Journal of Sports Medicine, 37, 393–400, <doi:10.1136/bjsm.37.5.393>.

Braga, G.F. (2012). Percepção da imagem corporal de adultos após acidente vascular encefálico: uma abordagem psicofísica (Body image perception after stroke adults: a psycho-physical approach). 94 f. Dissertação (Mestrado em Ciências da Motricidade), Departamento de Educação Física, Universidade Estadual Paulista (UNESP), Rio Claro.

Campbell, D.F. & Mauerberg-deCastro. E. (2011). Estereótipos e deficiência: a mídia e a cultura da perfeição (Stereotypes and disability: media and the culture of perfection). In E. Mauerberg-deCastro (Ed.). Atividade Física Adaptada (Adapted Physical Activity) (2nd ed.) (pp 83-112). Ribeirão Preto: Novo Conceito.

Cash, T.F. (2002). Cognitive-behavioral perspective on body image: Cash T.F., Pruzinsky T. (Eds.). Body image: a handbook of theory, research, and clinical practice. New York: Guilford.

Cash, T.F., & Brown, T.A. (1987). Body image in anorexia nervosa and bulimia nervosa: A review of the literature. Behavior Modification, 11, 487-521.

Cash, T.F., & Pruzinsky, T. (2002). Body Image: A Handbook of Theory, Research, and Clinical Practice. NY: Guilford Press.

Coelho, J.S., Jansen, A., & Bouvard, A. (2011). Cognitive distortions in normal-weight and overweight women: susceptibility to thought-shape fusion. Cognitive Therapy and Research, 36 (4), <doi:10.1007/s10608-011-9372-0>.

Da Silva, J.A. (2004). O uso da avaliação e a avaliação de seu uso: acerca da avaliação da qualidade do ensino (The use of assessment and evaluation of its use: on the evaluation of the quality of education). Paidéia, 14 (29), 255-264, <http://dx.doi.org/10.1590/S0103-863X2004000300002>.

Da Silva, J.A., & Macedo, L. (1981) Análise do fenômeno da superconstância e suas implicações para a Psicologia do desenvolvimento e da percepção (Analysis of the super constancy phenomenon and its implications for developmental psychology and perception). Arquivos Brasileiros de Psicologia, 33, 5-31, <http://bibliotecadigital.fgv.br/ojs/index.php/abp/article/view/18440/17190>.

Da Silva, J.A., & Macedo, L. (1983). A função potência na percepção: significado e procedimentos de cálculo do expoente (The power function in perception: meaning and exponent calculation procedures). Arquivos Brasileiros de Psicologia, 34, 27-45, <http://bibliotecadigital.fgv.br/ojs/index.php/abp/article/viewFile/18835/17578>.

Da Silva, J.A., & Ribeiro-Filho, N.P. (2006). Avaliação e mensuração de dor: pesquisa, teoria e prática (Assessment and measurement of pain: research, theory and practice). Ribeirão Preto: Funpec, 467p.

Da Silva, J.A., Santos, R.A., & Silva, C.B. (1983). Análise psicofísica do espaço visual. Teoria e pesquisa: Tributo a S.S. Stevens (Psychophysical analysis of visual space. Theory and research: Tribute to S. S. Stevens). Arquivos Brasileiros de Psicologia, 35, 3-53, <http://bibliotecadigital.fgv.br/ojs/index.php/abp/article/view/18932>.

De Vignemont, F. (2010). Body schema and body image—Pros and cons, Neuropsychologia, 48 (3), 669-680, <http://dx.doi.org/10.1016/j.neuropsychologia.2009.09.022>.

Ekman, G., & Junge, K. (1960). Psychophysical relations in the visual perception of length, area and volume. Sweden: Stockholm univ.

Fiske, L., Fallon, E.A. Blissmer, B., & Redding, C.A. (2014). Prevalence of body dissatisfaction among United States adults: Review and recommendations for future research. Eating Behaviors, 15 (3), 357-365, <http://dx.doi.org/10.1016/j.eatbeh.2014.04.010>.

Gardner, R.M. (1996). Methodological issues in assessment of the perceptual component of body image disturbance. British Psychological Society, 87 (2), 327-337, <doi:10.1111/j.2044-8295.1996.tb02593.x>.

Gardner, R.M., & Brown, D.L. (2014). Body size estimation in anorexia nervosa: A brief review of findings from 2003 through 2013. Psychiatry Research, 219, 407-410. Available: <http://dx.doi.org/10.1016/j.psychres.2014.06.029>. Access: Sept 20, 2014.

Gehrman, C.A., Hovell, M.F., Sallis, J.F., & Keating, K. (2006). The effects of a physical activity and nutrition intervention on body dissatisfaction, drive for thinness, and weight concerns in pre-adolescents. Body Image, 3 (4), 345-351, <doi:10.1016/j.bodyim.2006.07.006>.

Johnstone, A.M., Stewart, A.D., Benson, P.J., Kalafati, M., Rectenwald, L., & Horgan, G. (2008). Assessment of body image in obesity using a digital morphing technique. Journal of Human Nutrition & Dietetics, 21 (3), 256-267, <doi:10.1111/j.1365-277X.2008.00862.x>.

Kakeshita, I.S. (2008). Adaptação e validação de Escalas de Silhuetas para crianças e adultos brasileiros (Adaptation and silhouettes scales validation for Brazilian children and adults). Tese (Doutorado em Psicobiologia), Universidade de São Paulo, Ribeirão Preto.

Kakeshita, I.S., & Almeida, S.S. (2006). Relação entre índice de massa corporal e a percepção da auto-imagem em universitários (Relationship between body mass index and the perception of self-image in undergraduate). Revista de Saúde Pública, 40 (3), 497-504, <http://dx.doi.org/10.1590/S0034-89102006000300019>

Knight, J.L., & Giuliano, T.A. (2001). He's a Laker; She's a "Looker:" The consequences of gender-stereotypical portrayals of male and female athletes by the print media. Sex Roles, 45, 217–229. doi:10.1023/A:1013553811620.

Lease, S.H., Cohen, J.E., & Dahlbeck, D.T. (2007). Body and sexual esteem as mediators of the physical disability-interpersonal competencies relation. Rehabilitation Psychology, 52 (4), 399-408, <doi:10.1037/0090-5550.52.4.399>.

Lovo, T.M.A. (2006). Anosognosia: Imagem corporal na hemiplegia (Anosognosia: Body image in hemiplegia). 137f. Dissertação (Mestrado em Educação Física), Universidade Estadual de Campinas, Campinas.

Mauerberg-deCastro, E. (2004). Percepção e ação: direções teóricas e experimentais atuais (Perception and action: current theoretical and experimental directions). Paidéia, 14 (27), 63-73, <http://dx.doi.org/10.1590/S0103-863X2004000100009>.

Mauerberg-deCastro, E. (2006). Imagem corporal e influências da mídia sobre o corpo (Body image and media influences on body). Projeto de pesquisa UNESP.

Mauerberg-deCastro, E., Paula, A.I., Tavares, C.P., & Moraes, R. (2004). Orientação espacial em adultos com deficiência visual: efeitos de um treinamento de navegação (Spatial orientation in adults with visual impairment: effects of a navigation training). Psicologia: Reflexão e Crítica, 17 (2), 199-210, <http://dx.doi.org/10.1590/S0102-79722004000200008>.

Mauerberg-deCastro, E., & Moraes, R. (2002). Parâmetros psicofísicos e biomecânicos da percepção háptica durante a locomoção em crianças (Psychophysical and biomechanical parameters of haptic perception during locomotion in children). Psicologia: Reflexão e Crítica, 15, 103-112, <http://www.scielo.br/pdf/prc/v15n2/14360.pdf >.

Mohr, C., Porter, G., & Benton, C.P. (2007). Psychophysics reveals a right hemispheric contribution to body image distortions in women but not men. Neuropsychologia, 45 (13), 2942-2950, <doi:10.1016/j.neuropsychologia.2007.06.001>.

Murray, K., Rieger, E., & Byrne, D. A longitudinal investigation of the mediating role of self-esteem and body importance in the relationship between stress and body dissatisfaction in adolescent females and males, Body Image, 10 (4), 544-551, <http://dx.doi.org/10.1016/j.bodyim.2013.07.011>.

Mussap, A.J., McCabe, M.P., & Ricciardelli, L.A. (2008). Implications of accuracy, sensitivity, and variability of body size estimations to disordered eating. Body image, 5 (1), 80-90, <doi:10.1016/j.bodyim.2007.07.003>.

Nunes, R.T., Lopes, E.C.D., Damasceno, V.O., Oliveira, V., Miranda, R., & Bara Filho, M.G. (2007). Dependência do exercício físico e insatisfação com a imagem corporal (Dependence on physical exercise and dissatisfaction with body image). HU Revista, 33 (4), 113-118, <http://hurevista.ufjf.emnuvens.com.br/hurevista/article/view/63>.

Ojala, K., Tynjala, J., Valimaa, R., Villberg, J., & Kannas, L. (2012). Overweight adolescents self-perceived weight and weight control behavior: HBSC study in Finland 1994-2010. Journal of Obesity, 2012, <http://dx.doi.org/10.1155/2012/180176>.

Paula, A.I. (2010). Percepção de dimensões corporais de adolescentes do sexo feminino. Aspectos psicofísicos e comportamentais (Perception of body size of female adolescents. Psychophysical and behavioral aspects). 82 f. Tese (Doutorado em Ciências da Motricidade), Departamento de Educação Física, Universidade Estadual Paulista (UNESP), Rio Claro.

Perpiña, C., Botella, C., Baños, R., Marci, H., Alcañiz, M., & Quero, S. (1999). Body image and virtual reality in eating disorders: Is exposure to virtual reality more effective than the classical body image treatment? CyberPsychology and Behavior, 2 (2), 149-155, <doi:10.1089/cpb.1999.2.149>.

Probst, M., VanCoppenolle, H., Vandereycken, W., & Goris, M. (1992). Body image assessment in anorexia nervosa patients and university students by means of video distortion: A reliability study. Journal of Psychosomatic Research, 36 (1), 89-97, <doi:10.1016/0022-3999(92)90117-K>.

Probst, M., Vandereycken, W., & VanCoppenolle, H. (1997). Body size estimation in eating disorders using video distortion on a life-size screen. Psychotherapy and Psychosomatics, 66 (2), 87-91, <doi:10.1159/000289114>.

Richardson, S.M., Paxton, S.J., & Thompson, J.S. (2009). Is body think an efficacious body image and self-esteem program? A controlled evaluation with adolescents. Body Image, 6 (2), 75-82, <doi:10.1016/j.bodyim.2008.11.001>.

Sampei, M.A., Sigulem, D.M., Novo, N.F., Juliano, Y., & Colugnati, F.A.B. (2009). Atitudes alimentares e imagem corporal em meninas adolescentes de ascendência nipônica e caucasiana em São Paulo (SP) (Eating attitudes and body image in adolescents Nipponese descent and Caucasian girls in São Paulo (SP)). Jornal de Pediatria, 85 (2), 122-128, <http://dx.doi.org/10.1590/S0021-75572009000200007>.

Sand, L., Lask, B., Hoie, K., & Stormark, K.M. (2011). Body size estimation in early adolescence: factors associated with perceptual accuracy in a nonclinical sample. Body Image, 8 (3), 275-81, <doi:10.1016/j.bodyim.2011.03.004>.

Siegel, J.M. (2002). Body image change and adolescent depressive symptoms. Journal of Adolescent Research, 17 (1), 27-41, <doi:10.1177/0743558402171002>.

Slater, A., & Tiggemann, M. (2006). The contribution of physical activity and media use during childhood and adolescence to adult women's body image. Journal of Health Psychology, 11 (4), 553-565, <doi:10.1177/1359105306065016>.

Smolak, L. (2002). Body image development in children. In: Cash T.F., Pruzinsky T. (Eds.). Body Image: a handbook of theory, research, and clinical practice. New York: Guilford.

Stevens, S.S. (Ed.) (1951). Handbook of Experimental Psychology. New York: Wiley.

Stevens, S.S. (1961). To honor Fechner and repeal his law. Science, 133, 80–6.

Stevens, S.S. (1975). Psychophysics: introduction to its perceptual, neural and social prospects. New York: Wiley.

Stewart, A.D., Benson, P.J., Michanikou, E.G., Tsiota, D.G., & Narli, M.K. (2003). Body image perception, satisfaction and somatotype in male and female athletes and non-athletes: results using a novel morphing technique. Journal of Sports Sciences, 21 (10), 815-823, <doi:10.1080/0264041031000140338>.

Stewart, T.M., Allen, H.R., Han, H., & Williamson, D.A. (2009). The development of the body morph assessment version 2.0 (BMA 2.0): tests of reliability and validity. Body Image 6 (2), 67-94, <doi:10.1016/j.bodyim.2009.01.006>.

Stunkard, A.J., Sorenson, T., & Schlusinger, F. (1983). Use of the Danish adoption register for the study of obesity and thinness. In: Kety, S.S., Rowland, L.P., Sidman, R.L., & Matthysse, S.W. (Eds.). The genetics of neurological and psychiatric disorders. New York: Raven, 115-20.

Tavares, C.P. (2015). Aspectos psicofísicos da imagem corporal e a sua relação com a dismorfia muscular e a dependência de exercício (Psychophysical aspects of body image and their relationship with muscle dysmorphia and exercise dependence). 122 f. Tese (Doutorado em Ciências da Motricidade), Departamento de Educação Física, Universidade Estadual Paulista (UNESP), Rio Claro.

Tavares, M.C.C.F., Campana, A.N.N.B., Tavares Filho, R.F., & Campana, M.B. (2010). Avaliação perceptiva da imagem corporal: história, reconceituação e para o Brasil (Perceptual body image: History, reconceptualization and Brazil). Revista Psicologia em Estudo, 15 (3), 509-518, <http://www.scielo.br/pdf/pe/v15n3/v15n3a08.pdf>.

Thompson, J.K. (2004). The (mis)measurement of body image: ten strategies to improve assessment for applied and research purposes. Body Image, 1 (1), 7-14, <doi:10.1016/S1740-1445(03)00004-4>.

Tovée, M.J., Benson, P.J., Emery, J.L., Mason, S.M., & Cohen-Tovée, E.M. (2003). Measurement of body size and shape perception in eating-disordered and control observers using body-shape software. British Journal of Psychology, 94, 501-516, <http://dx.doi.org/10.1348/000712603322503060>.

Tovée, M.J., Emery, J.L., & Cohen-Tovée, E.M. (2000). The estimation of body mass index and physical attractiveness is dependent on the observer's own body mass index. Proc Biol Sci, 267 (1456), 1987-1997, <doi:10.1098/rspb.2000.1240>.

Tribess, S., Virtuoso Junior, J.S., & Petroski, E.L. (2010). Estado nutricional e percepção da imagem corporal de mulheres idosas residentes no nordeste do Brasil (Nutritional status and perception of body image of older women living in northeastern Brazil). Ciência e Saúde Coletiva, 15 (1), 31-38, <http://dx.doi.org/10.1590/S1413-81232010000100008>.

Twigg, J. (2004). The body, gender, and age: Feminist insights in social gerontology. Journal of Aging Studies, 18, 59-73, <https://kar.kent.ac.uk/id/eprint/410>.

World Health Organization (WHO). (2014). Relatórios mundiais de saúde (World Health reports), <http://www.who.int/eportuguese/publications/pt/>.

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The influence of attitudes toward physical activity and sports

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Abstract—Attitude is one of the most important predictor variables in relation to behavioral intentions regarding physical activity. Thus, this study aims to determine the influence of attitudes towards physical activity. The study comprised a sample of 1129 individuals (507 men and 622 women) age between 12 and 58 years ($\bar{x}$ = 18 sd = 4.03). To collect the data, the Scale of Attitudes Towards Physical Activity and Sports (Dosil, 2002) was based on the Portuguese version (Cid, Alves, & Dosil, 2008). The results show that attitudes towards physical activity and sports are more positive in younger male individuals, who do not attend higher education, who regularly engage in physical activity and whose parents engage in physical/sports activity themselves.

Keywords: attitudes, physical activity, sports, practice

Resumo—"A influência de atitudes com relação à atividade física e esportes." A atitude é uma das variáveis preditivas mais importantes em relação as intenções comportamentais face à prática de atividade física. Desta forma, este estudo pretende determinar a influência da atitude para a prática de atividade física. Participou do estudo uma amostra de 1129 sujeitos (507 homens e 622 mulheres) com idades entre os 12 e os 58 anos ($\bar{x}$ = 18 sd = 4,03). Para a recolha dos dados, ministrou-se a Escala de actitudes hacia la actividad física y el deporte (Dosil, 2002) na sua versão portuguesa (EAFDp) (Cid, Alves & Dosil, 2008). Os resultados mostram que a atitude perante a prática de atividade física e desporto é mais positiva nos sujeitos mais jovens, que não frequentam o ensino superior, do gênero masculino, praticantes de atividade física e com pais e mães também praticantes de atividade física/desporto.

Palavras-chave: atitude, atividade física, desporto, prática

Resumen—"La influencia de las actitudes hacia la actividad física y deportes." La actitud es una de las variables predictoras más importantes con respecto a las intenciones de comportamiento hacia la actividad física. Por lo tanto, este estudio tiene como objetivo determinar la influencia de la actitud hacia la actividad física. Participó en el estudio una muestra de 1129 sujetos (507 hombres y 622 mujeres) con edades comprendidas entre los 12 y 58 años ($\bar{x}$ = 18 sd = 4,03). Para la recolección de datos, se ministró la Escala actitudes hacia la actividad física y el deporte (Dosil, 2002), en su versión en portugués (EAFDp) (Cid, Alves y Dosil, 2008). Los resultados muestran que la actitud hacia la actividad física y el deporte es más positiva en sujetos más jóvenes, que no asisten a la educación superior, varón, praticantes de actividad física y con padres y madres también practicantes de actividad física / deportiva.

Palabras claves: actitud, actividad física, deporte, práctica

Introduction

Attitudes reflect a set of beliefs, feelings and behaviors related to one another which are organized around an object or situation that may be favorable or unfavorable. Attitude determines how individuals act towards others and events, therefore, feelings, behaviors and choices become a powerful predictor of behavior that, in turn, can be dynamic, constructed, taught, modified, or even replaced (Cid *et al.*, 2008; Feldman, 2001; Morales 2000; Zabalza, 2000).

For Alcântara (1995) and Munné (1980), motivation, interest, desire and stimulus influence the development of attitudes. On the other hand, these are acquired through information gathered through imitation of family or social models, and are expressed in actions of individuals. However, as attitudes develop, they also change due to various factors such as the existence of variables circumstances, personality changes and coercion effects, i.e., they are modified when the factors that originated them change. This allows us to predict that not only are the attitudes that guide voluntary behavior, but also the volunteer behaviors lead to changes in attitudes.

Hagger, Chatzisanrantis, and Biddle (2001), based on the theory of planned behavior, assume that attitude is the most important prognostic variable regarding behavioral intentions in the field of physical activity. According to Biddle and Mutrie (2001), several studies investigating different populations (youth, adults and seniors) have shown consistently that attitudes have predictive validity in the field of physical activity.

As for physical activity, this has been the subject of numerous scientific investigations due to its influence in the proper