Revista Mexicana de Trastornos Alimentarios (2016) **7**, 85−96

Revista Mexicana de Trastornos Alimentarios

Mexican Journal of Eating Disorders

http://journals.iztacala.unam.mx/index.php/amta/

ARTICLE

Body size estimation: Discrimination of subtle differences in male and female body parts

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Received 8 April 2016; accepted 19 August 2016
Available online 15 September 2016

KEYWORDS
Visual perception;
Body image;
Body-size estimation;
Discrimination ability;
Weber fractions

Abstract The study determined the sensitivity of adults to detect subtle differences in male and female body parts (face, arms, chest, waist, hips, thighs and calves). A total of 202 adults (84 men and 118 women) with a mean age of 34.9 years adjusted the size of each part of a comparison silhouette until it matched that of a sample silhouette. The sensitivity to detect subtle differences was greater for the male than for the female silhouette (mean Weber Fractions, *WF* = .032, .036, respectively). The greatest sensitivity for both silhouettes was in the waist and hips (*WF* = .019 in both cases) and the smallest in the arms and face (*WF* = .048, .049, respectively). Men, young participants and those with high education (*WF* between .017 and .043) detected subtle differences to a greater degree than their counterparts (*WF* between .019 and .053). According to the environmental approach of social psychology, the latter suggests that members of those subgroups have been subjected to more social pressures to sharpen their discrimination of small differences in the body shape of their conspecifics. This study adds evidence to previous knowledge about how cultural variables shape visual perception.

PALABRAS CLAVE
Percepción visual;
Imagen corporal;
Estimación del tamaño corporal;
Habilidad discriminativa;
Fracciones de Weber

Estimación del tamaño corporal: discriminación de diferencias sutiles en partes corporales de hombres y mujeres

Resumen Se determinó la sensibilidad de adultos para detectar diferencias pequeñas en partes del cuerpo masculino y femenino (cara, brazos, pecho, cintura, cadera, muslos y pantorrillas). Participaron 202 adultos (84 hombres, 118 mujeres) con edad promedio de 34.9 años, quienes ajustaron el tamaño de cada parte de una silueta de comparación, hasta igualarlo con el de una silueta muestra. La sensibilidad para detectar diferencias pequeñas fue mayor para la silueta masculina que para la femenina (fracciones medias de Weber, *FW* = 0.032, 0.036,

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Peer Review under the responsibility of Universidad Nacional Autónoma de México.

http://dx.doi.org/10.1016/j.rmta.2016.08.002

respectivamente). La mayor sensibilidad fue para la cintura y la cadera de ambas siluetas (*FW* = 0.019 en ambos casos) y la menor para los brazos y la cara (*FW* = 0.048, 0.049, respectivamente). Los hombres, los jóvenes y aquellos con educación universitaria (*FW* entre 0.017 y 0.043) fueron más sensibles para discriminar diferencias que sus contrapartes (*FW* entre 0.019 y 0.053). De acuerdo con el enfoque ambientalista de la psicología social, esos subgrupos han estado sujetos a mayores presiones sociales para afinar su discriminación de diferencias en la forma del cuerpo de sus conespecíficos. Este estudio añade evidencia al conocimiento existente sobre cómo las variables culturales moldean la percepción corporal.

Introduction

The ability to discriminate subtle differences between stimuli could vary little among the members of the same social group but considerably across different groups. For example, musicians distinguish more tone-frequencies than non-musicians (Kishon-Rabin, Amir, Vexler, & Zaltz, 2001). Russian speakers discriminate between similar tones of blue with greater precision than English speakers, due to the two terms for light and dark blues in the Russian language versus only one term for all kinds of blues in English (Winawer et al., 2007).

Although the precision to discriminate small differences between stimuli is limited by a person's sensory capabilities, the reinforcing value of the stimuli might also affect its discrimination. For example, Lambert, Solomon, and Watson (1949) found that children estimated correctly the size of a token, but after it was established as a conditioned reinforcer they overestimated its size. Unwritten cultural norms might also determine the reinforcement value of a stimulus. Numerous studies have shown that social stimuli shape how people perceive their environment (see Balcetis & Lassiter, 2010). For example, Segall, Campbell, and Herskovits (1966) compared the perception of optical illusions by western and non-western people, finding that the latter were not susceptible to the illusions. They concluded that visual stimuli discrimination is culturally determined. Nisbett and Masuda (2003) asked Japanese and Americans to identify animals that appeared in a specific context. When the context changed, Japanese failed to identify the animals seen before. These results along with those from other studies (Masuda, 2009; Nisbett & Miyamoto, 2005) showed that people from Asian cultures perceive images as a whole, while people from western cultures focus their attention in particular stimuli, while disregarding the context. Thus, the unwritten cultural norms demand different degrees of precision to selectively discriminate between certain properties of the environmental stimuli (cf. Duffy & Kitayama, 2010). One area in which the unwritten cultural norms might determine the discrimination of subtle differences between stimuli by people of different social subgroups is the estimation of body size based on visual cues.

Nowadays, western cultural norms favor thin bodies (Swami et al., 2010). Women, the young, high-income and high-educated people are under more social pressures to adhere to the ideal body size than their counterparts (McCabe & Ricciardelli, 2003; O'Dea, 2008; Pruis & Janowsky, 2010). Thin bodies however are not universally appreciated. Even within the western cultures the social precepts of some subgroups (i.e., African–Americans) favor heavier bodies than other subgroups (i.e., Caucasians; Befort, Thomas, Daley, Rhode, & Ahluwalia, 2008; Miller et al., 2000). Some subgroups from non-western countries (mainly people with low-income) also favor heavier bodies than people from the same cultures that adhere to western standards (Swami et al., 2010). These findings suggest that people of different sex, age and educational level are exposed to specific social demands that might influence their ability to discriminate subtle differences between body sizes.

Although there are numerous studies in psychology on the estimation of people's own body size (see Farrell, Lee, & Shafran, 2005, for a review) there are few reports on the estimation of the body size of other people, especially during the last five to ten years. The main purpose of previous studies that determined how people estimate other people's body size was to find out how people with an eating disorder or with obesity estimated their own body size compared with normal-body-size people (Farrell, Shafran, & Fairburn, 2003; Gardner, Martínez, & Espinoza, 1987; Hundleby, Misumi, Kampen, & Keating, 1993; Sand, Lask, Høie, & Stormark, 2011; Szymanski & Seime, 1997; Whitehouse, Freeman, & Annandale, 1986). The estimation of other people's body size was only included as a control to determine the similarities or differences between both estimations (own and others). Since eating disorders are more frequent amongst women, participants in most of the studies were exclusively undergraduate women with an age range from 21 to 31.5 years (Farrell et al., 2003; Hundleby et al., 1993; Szymanski & Seime, 1997; Whitehouse et al., 1986). The total sample of women included in the studies varied from 40 to 79. Participants in the Gardner et al. (1987) study were 19 men and 19 women, half with obesity and half with normal weight. The authors did not specify the age of the participants. In the Sand et al. (2011) study participants were 406 Norwegian adolescents (59% girls; mean average age 13.7 years) with and without risk of developing an eating disorder.

In all of the studies mentioned above, a variant of the psychophysical method of adjustment was used to determine how people estimate the body size of others. That is, participants were asked to adjust the size of a sample stimulus until it matched that of a comparison stimulus. Although in all the studies the same method was used, the number of trials, the procedure and the types of stimuli varied considerably. In relation with the number of trials, these varied from one to four (Farrell et al., 2003; Hundleby et al., 1993; Whitehouse et al., 1986) and from 20 to 100 (Gardner et al., 1987; Sand et al., 2011). Results based on the judgments performed during a single or during four trials, question the reliability of the results.

Concerning the procedure, in some studies the sample stimulus was presented before the adjustment task (between 20 s to 10 min; Hundleby et al., 1993; Sand et al., 2011; Whitehouse et al., 1986). In other cases, although the sample and the comparison stimuli were presented simultaneously, they were not identical. While the sample stimulus was a full-size mannequin, the comparison stimulus was its image shown on a screen (Gardner et al., 1987; Farrell et al., 2003). In the Szymanski and Seime (1997) study, both stimuli consisted of images, but each one was shown on a different television screen. Presenting the stimulus before the adjustment task implied that the participants had to remember the size of the sample mannequin to match it to the size of the comparison mannequin. Showing each stimulus on a different screen or using a real size mannequin as sample stimulus while using its image as a comparison stimulus surely hindered the adjustment task.

Regarding the type of stimuli, the sample stimulus consisted either of a full-size mannequin, a full-size wooden figure (Gardner et al., 1987; Farrell et al., 2003; Hundleby et al., 1993; Whitehouse et al., 1986) the photograph of a person or its image shown on a television or projection screen (Sand et al., 2011; Szymanski & Seime, 1997). In all the studies the comparison stimulus consisted of a full-body image that was distorted in width to simulate thinner or larger bodies. This strategy was criticized because such distortions do not simulate the real form and width in which each body part augments or reduces as the body size changes (Benson, Emery, Cohen-Tovée, & Tovée, 1999). The different types of stimuli could have influenced the results, which were not consistent between studies. For instance, Whitehouse et al. and Gardner et al. found that participants underestimated the size of the mannequins while Farrell et al. found that they overestimated its size.

None of the researchers reported the just-noticeable difference for detecting subtle differences between the sample and the comparison stimuli; they only reported the point of subjective equality. The latter was shown as the mean percentage of the difference between the width of the sample and the comparison stimuli when participants claimed that both were equal. Such point varied from 92 to 108%, which suggested that people estimated the body size of others quite accurately.

The technique to represent people of different body sizes has been a challenging problem for psychologists. Photographs of real men and women have been favored as the most ecologically valid technique (Swami, Salem, Furnham, & Tovée, 2008). Nevertheless, in those photographs the head has been obscured, giving the impression of apparently beheaded people; this could be considered a limitation on the ecological validity of the images. Obtaining silhouettes from photographs of people with different body sizes, allows preserving the whole body. Although it could be argued that silhouettes are not as ecologically valid as photographs, since they are obtained from photographs of real people, it is possible to depict real morphological body changes. González-García and Acuña (2014) showed that the body size of silhouettes was perceived in correspondence with that of the real men and women represented by them. This result showed that silhouettes could be used to represent people of different body sizes.

Silhouettes obtained from photographs have been used to develop computer programs that allow the distortion of different body parts (e.g., Benson et al., 1999; Smeets, 1999). Smeets' program showed the silhouette of a thin woman whose shoulders, arms, waist, hips and thighs could be modified. All the body parts augmented or reduced simultaneously equally in width. This strategy was criticized because each body part increases or reduces in a different proportion as a person gains or losses weight. Benson et al. developed a computer program that simulates real increases or reductions in the width of the arms, chest, waist, hips, thighs and calves of a woman. They photographed 213 women with different body sizes and measured the width in which each body part augmented or reduced relative to the parts of a woman with normal body size. The computer program displayed a full-body silhouette and each part could be separately modified in a realistic proportion. One disadvantage of the Benson et al.'s program is that it only includes silhouettes of women.

The perceived body size of an individual influences others' behaviors toward him/her. Numerous studies have found that in western cultures obese people are socially rejected, receive poor medical attention, are less likely to get a job, a date or being accepted in college, amongst other things (see Puhl & Heuer, 2009 for a review on the stigma of obesity). In contrast, thin people are socially accepted, are considered healthy and attractive (Graham, Eich, Kephart, & Peterson, 2000). Despite this evidence, there is no information about the body parts of the human body that function as distinctive discriminant stimuli which exert control over a person's labeling behavior of a third party's body as thin, normal or obese. Conventional wisdom suggests that members of different social groups may consider a same body size as normal, slim or even large. The environmental approach to social psychology states that behavior is shaped and controlled by stimulus present in the social environment. The functions (e.g., eliciting, reinforcing, discriminative) of social stimuli do not differ from other stimuli; the only difference is that social stimuli arise from other's people's behavior (Keller & Schoenfeld, 1950). For humans, people are the most important source of reinforcement. According to this approach, the social behaviors of the members of each social group differentially reinforce specific discriminative abilities. Those abilities could include the discrimination of subtle differences in male and female body parts. No previous studies have determined if the ability to discriminate subtle differences in the body size of other people varies according to subgroup membership. Therefore, the purpose of this study was to determine if the sensitivity of adults to detect subtle differences in seven male and female body parts (face, arms, chest, waist, hips, thighs and calves) varied according to their sex, age and educational level.

Method

Participants

Participants were 84 men (41.6%) and 118 women (58.4%), aged 18 to 76 years (*M* = 34.9, *SD* = 16) that lived in Mexico City. Participation was requested through electronic social media and posters. Ads specified that sessions would last 2 h and that only people over 18 years old could volunteer. The researcher agreed an appointment with each volunteer and informed consent was obtained from all participants. No payment or reward was offered. Arbitrarily two age and two educational groups were formed: participants under and over 40 years old (70.3% and 29.7%, respectively); participants under and over 12 years of education (62.4% and 37.6%, respectively).

Instruments

A computer program was developed using Visual Basics®. The experimenter photographed 35 men and 44 women, whose body mass index (BMI) varied between 16.73 (i.e., moderate thinness) to 39.04 (i.e., severely obese; World Health Organization, 2016). All individuals accepted voluntarily to be photographed. The experimenter provided a close-fitting black leotard. They were assured that their pictures will be transformed into silhouettes, ensuring their anonymity and identity. All authorized the use of such silhouettes for research purposes.

The pictures were transformed into black silhouettes using Corel Draw®. According to Lemmens, Brodsky, and Bernstein (2005) the ideal healthy BMI for both men and women is 22.0. A silhouette of a man and of a woman whose BMI was the closest to that ideal (22.95 and 21.5, respectively) were selected as sample stimuli. The silhouettes were segmented into seven parts (face, arms, chest, waist, hips, thighs and calves) using Autocad®. These body parts were similar to those utilized in previous research (e.g., Benson et al., 1999). The width of each part of the silhouettes was measured to determine the range in millimeters in which each augmented or reduced in relation to the parts of the man and woman with normal body size. Comparison stimuli were created by modifying with Corel Draw® the width of each part of the normal body size silhouettes. Of each part, 60 male and 60 female silhouettes were drawn, half with thinner and half with wider parts than those of the normal body size man and woman. The number of comparison stimuli was based on the measurement of the minimum and maximum width in millimeters of each body part of the silhouettes of people of different body sizes.

A pair of silhouettes was displayed in the center of a computer screen. Regardless of the screen's size, the silhouettes were 18 cm high by 12 cm wide. Two keys (+ and −) serve to augment or reduce each part of the comparison stimuli. The program required a computer with a processor of at least 2.20 GHz Dual-Core, 2 GB of RAM memory and a 15 in screen. The program recorded the width of the comparison silhouette at the beginning and at the end of each trial and the sequence of presses to the keys. Each body part augments or reduces in different proportion as a person gains or losses weight, thus in the computer program when the + and − keys are pressed each part of the comparison silhouette is modified in the same amount of millimeters, but different from the other parts. The progressive successive steps in which the width of each body part reduced or augmented with each press of the + and − keys was based on the measurement of the width of each part of the silhouettes of different body sizes.

Table 1 shows the width in millimeters of each part of the male and female sample silhouettes and the amount in which each part was augmented or reduced by pressing the keys. Since the program included 30 thinner and 30 wider comparison silhouettes, the maximum width in which each part could augment or reduce was equal to the width in millimeters of each part of the comparison silhouette shown in Table 1 ±30 times.

Procedure

In each of 12 training and of 280 experimental trials, a sample silhouette of either a man or a woman with normal body size was presented next to a same-sex comparison silhouette deformed in each of seven body parts. Each silhouette appeared randomly within each trial at the right or the left side of the screen. The experimental task consisted in pressing either the + or − keys to adjust the size of the comparison silhouette until it matched that of the sample silhouette. Between trials the screen remained blank for 2 s. For half of the participants 140 pairs of female silhouettes were presented at the beginning and for the other half, 140 pairs of male silhouettes were presented first. Between each 140-block-trial there was a 10 min break. Each deformed body

Table 1 Width in millimeters of each part of the male and female sample silhouettes and width in which each part of the comparison silhouette augmented or reduced in the computer program.

	Body parts						
	Face	Arms	Chest	Waist	Hips	Thighs	Calves
				Male silhouette			
Sample	14.78	9.26	35.38	32.73	38.48	18.21	11.96
Comparison	0.06	0.07	0.16	0.18	0.09	0.10	0.05
				Female silhouette			
Sample	14.28	9.10	35.51	31.76	41.35	16.53	13.47
Comparison	0.08	0.06	0.19	0.15	0.12	0.15	0.08

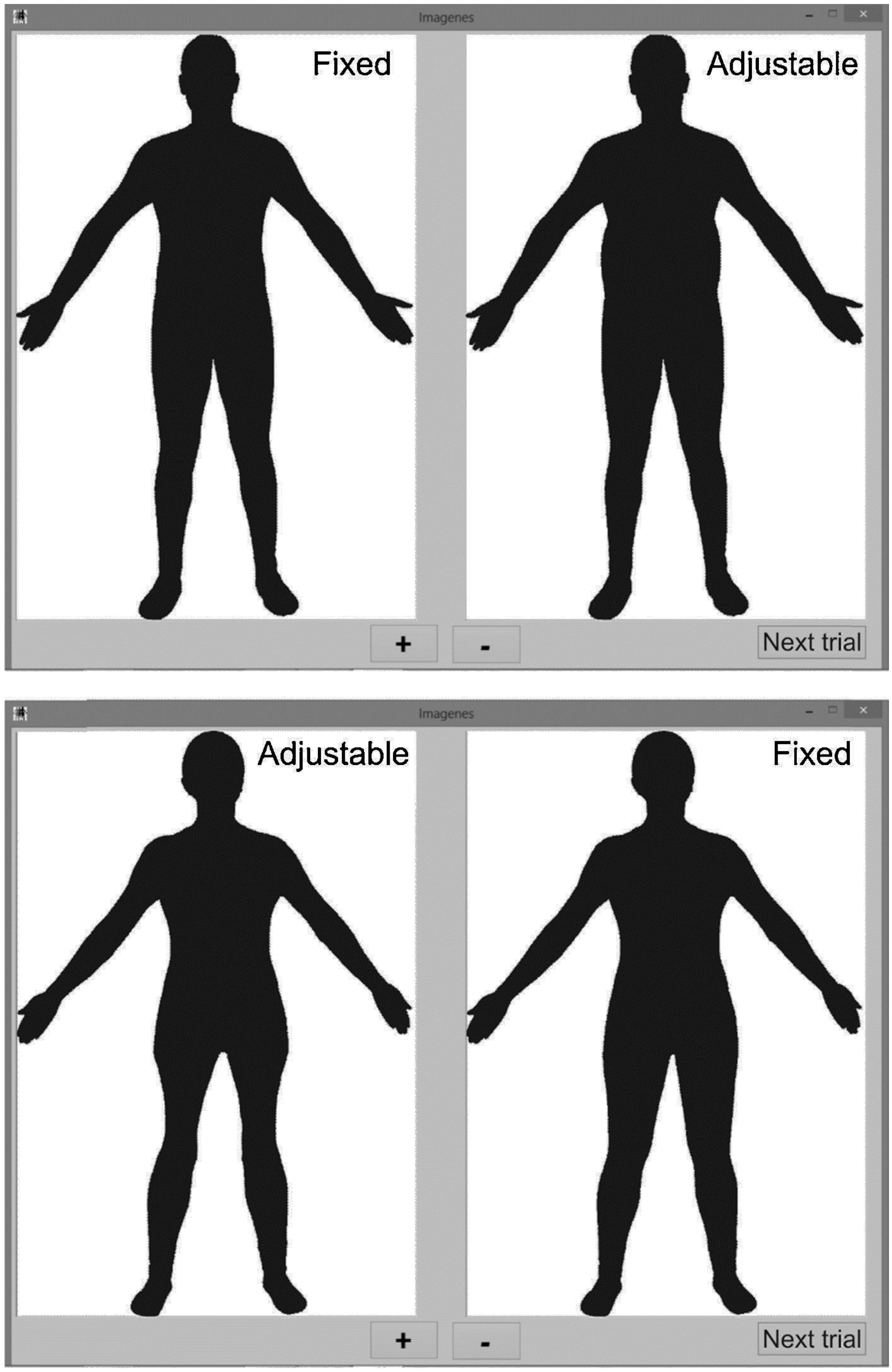

Figure 1 Example of a trial where the waist of a male silhouette has to be reduced and one trial where the thighs of a female silhouette have to be augmented.

part was presented randomly in blocks of six training and of 20 experimental trials with a random mix of augmenting or reducing orders. Appendix A shows the general and specific instructions that appeared in the computer program. The upper part of Fig. 1 exemplifies a trial where the waist of a male silhouette has to be reduced to match it with the normal size silhouette while the bottom part exemplifies a trial where the thighs of a female silhouette have to be augmented.

The task started with six training trials. After completing those trials, participants had the option to either perform six additional training trials or start with the experimental ones. During the training trials the experimenter stood behind each participant and in case of mistakes, she showed how to perform the task. During the experimental trials the experimenter left the participant alone. Participants wore acoustic protectors during the experimental trials to prevent distractions. The researcher assured that all participants knew how to use the computer mouse, which was the only ability needed to participate in the study. The adjustment task took approximately 2 h.

Results

Since silhouettes were miniature versions of the human body and each body part was different in size relative to other parts, differential thresholds were used to calculate Weber fractions, which were the appropriate data to summarize the results of the study. Differential thresholds were obtained by calculating the standard deviation of the mean difference in width between each part of the sample and the comparison silhouettes at the end of each trial (Gescheider, 1997). Appendix B shows the differential thresholds for each body part of the male and female silhouettes. The silhouettes were in a 1:9 scale. In order to present data corresponding to a real size person, data shown below are in a 1:1 scale. Since the experimental task consisted of 280 experimental trials and fatigue could influence the results, participants whose individual differential thresholds were two or more standard deviations from the global mean were excluded. From the 254 adults that originally participated in the study, 52 were excluded. Results shown below correspond to the 202 participants that remained in the study and whose characteristics were described in the method.

Weber fractions for each body part were calculated by dividing the just-noticeable difference by the size in millimeters of the same body part (i.e., $W = \Delta\phi/\phi$; where $\Delta\phi$ = differential threshold and ϕ = width in millimeters of each part of the sample stimulus; cf. Gescheider, 1997). Small fractions represent a high sensitivity to detect differences between stimuli and large fractions represent a low sensitivity. Fig. 2 shows the mean Weber fractions in millimeters with their respective standard deviations for each part of the male and female silhouettes for the whole sample. Fig. 3 shows the mean Weber fractions for each body part and silhouette when the sample was divided according to their sex, age and educational level.

Mean Weber fractions (*WF*) were compared by a five-way mixed analysis of variance (ANOVA) using SPSS®. There were two within subject factors: silhouette (male or female) and body parts (face, arms, chest, waist, hips, thighs and calves). The between-subjects factors were the sex (man or woman), age (40 years old or less and 41 years old or more) and educational level (12 years or less or 13 years or more) of the participants. Results showed that the sphericity assumption was violated for the body parts factor Mauchly $W = .311$, $X^2(20) = 224.06$, $p < .001$ and for the interaction between silhouette and body parts Mauchly $W = .549$, $X^2(20) = 114.97$, $p < .001$. In those cases Huynh–Feldt *F* coefficients are reported. Only significant effects ($p < .05$) are reported below.

The main effects of silhouette and body parts were significant $F(1, 194) = 35.39$, $p < .001$, $\eta_p^2 = .15$, and $F_{\text{Huynh-Feldt}}(4.81, 932.20) = 346.09$, $p < .001$, $\eta_p^2 = .64$, respectively. The interaction between those two factors was also significant $F_{\text{Huynh-Feldt}}(4.49, 1066.90) = 21.59$, $p < .001$, $\eta_p^2 = .10$. Relative to the main effect of body parts, Tukey post hoc tests showed that for both the male and female silhouettes, the greater sensitivity to detect small differences between the sample and the comparison stimuli corresponded to the hips and waist (*WF* = .019 in both cases, 95% CIs [.017–.020] and [.018–.020], respectively). The sensitivity to detect small differences in the chest (*WF* = .024, 95% CI [.022–.026]) was greater than in the thighs (*WF* = .038, 95% CI [.036–.040]), the calves (*WF* = .042, 95% CI [.041–.044]), the arms (*WF* = .048, 95% CI [.046–.050]) and the face (*WF* = .049, 95% CI [.047–.051]). In turn, the sensitivity to detect small differences in the width of the thighs was greater than in the calves, arms and face. The sensitivity to detect small differences in the width of the calves was greater than in the arms and face. Small differences in the width of both the arms and face were the least detected. Relative to the main effect of silhouette, the sensitivity to detect subtle differences was greater for the male (*WF* = .032, 95% CI [.031–.034]) than for the female (*WF* = .036, 95% CI [.034–.038]) silhouette. Both main effects though were qualified by the interaction between both factors. This interaction was analyzed by comparing the mean Weber fractions for each part of the male and female silhouettes by seven simple repeated measures ANOVAS. Results showed that participants detected smaller differences in the male than in the female silhouette in the face $F(1, 201) = 188.99$, $p < .001$, $\eta_p^2 = .64$; chest $F(1, 201) = 14.26$, $p < .001$, $\eta_p^2 = .07$; thighs $F(1, 201) = 10.28$, $p < .01$, $\eta_p^2 = .05$; and calves $F(1, 201) = 10.08$, $p < .01$, $\eta_p^2 = .05$.

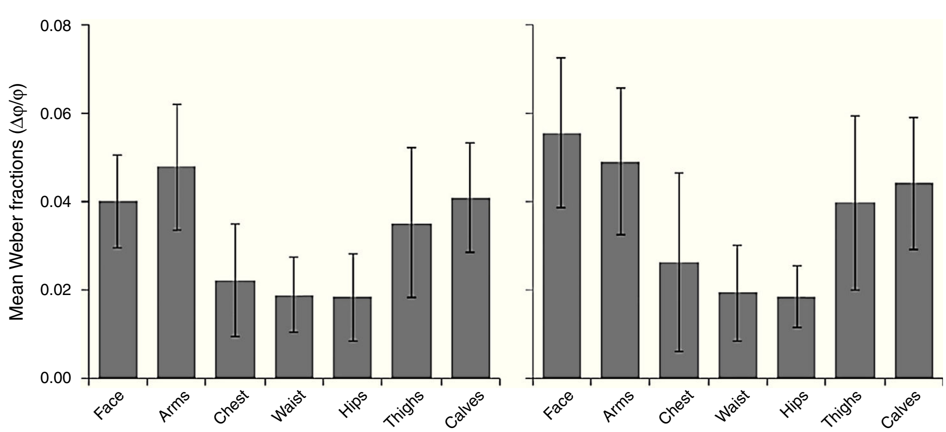

Figure 2 The Weber fractions for different parts of male and female silhouettes.

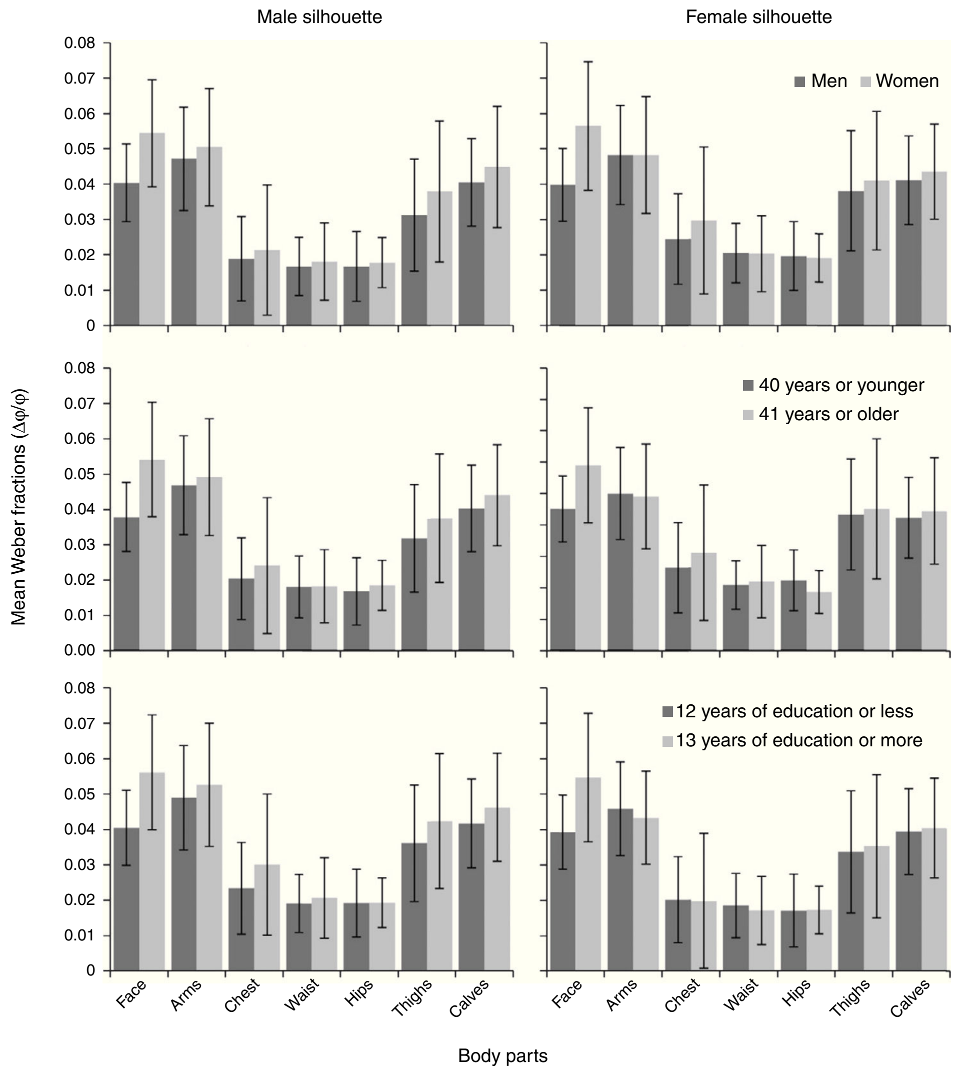

Figure 3 The Weber fractions for different parts of male and female silhouettes according to the sex, age and educational level of the participants.

Relative to the sex of the participants, the triple interaction between body parts, silhouette and sex was significant $F_{\text{Huynh-Feldt}}(4.66, 904.25) = 4.07$, $p < .01$, $\eta_p^2 = .01$. This interaction was analyzed by two 7 (body parts: face, arms, chest, waist, hips, thighs and calves) × 2 (sex: man or woman) mixed ANOVAS; one for the male and one for the female silhouette. In both cases, the interaction between body parts and sex was reliable $F_{\text{Huynh-Feldt}}(4.97, 994.61) = 3.87$, $p < .01$, $\eta_p^2 = .02$ and $F_{\text{Huynh-Feldt}}(4.86, 971.06) = 3.67$, $p < .01$, $\eta_p^2 = .02$, respectively. Simple ANOVAS were used to compare men and women's sensitivity to detect small differences in each part of the male and female silhouettes. Relative to the male silhouette, men detected smaller differences than women in the chest $F(1, 200) = 10.04$, $p < .005$, $\eta_p^2 = .05$; waist, $F(1, 200) = 10.28$, $p < .05$, $\eta_p^2 = .05$; hips, $F(1, 200) = 4.51$, $p < .05$, $\eta_p^2 = .02$; and thighs $F(1, 200) = 8.65$, $p < .05$, $\eta_p^2 = .04$. Relative to the female silhouette, men also detected smaller differences than women, but only in the case of the chest $F(1, 200) = 8.83$, $p < .001$, $\eta_p^2 = .04$.

Concerning the age of the participants, the main effect of this factor was significant $F(1, 194) = 12.90$, $p < .001$, $\eta_p^2 = .06$. The interaction between body parts, silhouette and age was also significant $F_{\text{Huynh-Feldt}}(4.66, 904.25) = 3.59$, $p < .01$, $\eta_p^2 = .01$. This interaction was analyzed by two 7 (body parts: face, arms, chest, waist, hips, thighs and calves) × 2 (age: under 40 years or over 41 years) mixed ANOVAS; one for the male and one for the female silhouette. In both analyzes the interaction between body parts and age was significant $F_{\text{Huynh-Feldt}}(4.97, 992.94) = 4.81$, $p < .01$, $\eta_p^2 = .02$ and $F_{\text{Huynh-Feldt}}(4.81, 961.96) = 2.82$, $p < .05$, $\eta_p^2 = .01$, respectively. The sensitivity of participants of the two age groups to detect small differences in each part of the silhouettes was compared using simple ANOVAS. For both, the male and female silhouettes, participants under 40 years old detected smaller differences than participants older than 40 years in the chest $F(1, 200) = 9.92$, $p < .01$, $\eta_p^2 = .05$, $F(1, 200) = 5.24$, $p < .05$, $\eta_p^2 = .03$, respectively; waist $F(1, 200) = 4.57$, $p < .05$, $\eta_p^2 = .02$, $F(1, 200) = 5.24$, $p < .05$,

$\eta_p^2 = .03$ and thighs $F(1, 200) = 22.06$, $p < .001$, $\eta_p^2 = .10$, $F(1, 200) = 6.53$, $p < .05$, $\eta_p^2 = .03$. Participants under 40 years old also detected smaller differences than older participants in the face $F(1, 200) = 22.02$, $p < .001$, $\eta_p^2 = .10$ and in the hips $F(1, 200) = 14.50$, $p < .01$, $\eta_p^2 = .07$ of the male silhouette.

Regarding the educational level of the participants, the main effect of this factor was reliable $F(1, 194) = 8.23$, $p < .01$, $\eta_p^2 = .04$. The triple interaction between body parts, silhouette and educational level was also significant $F_{\text{Huynh-Feldt}}(5.50, 1066.09) = 2.27$, $p < .05$, $\eta_p^2 = .01$. This interaction was analyzed by two 7 (body parts: face, arms, chest, waist, hips, thighs and calves) $\times$ 2 (educational levels: 12 or less and 13 or more years of education) mixed ANOVAS; one for the male and one for the female silhouette. Results showed that the interaction between body parts and educational level was reliable only for the female silhouette $F_{\text{Huynh-Feldt}}(4.78, 955.66) = 3.57$, $p < .01$, $\eta_p^2 = .10$. To determine in which of the seven body parts the Weber fractions differed as a function of the educational level, one-way ANOVAS were performed. With the exception of the female silhouette's face, in the other six parts those with 13 years or more of education detected smaller differences than those with less years of education. Arms $F(1, 200) = 15.85$, $p < .001$, $\eta_p^2 = .07$; chest $F(1, 200) = 13.07$, $p < .001$, $\eta_p^2 = .06$; waist $F(1, 200) = 5.06$, $p < .05$, $\eta_p^2 = .03$; hips $F(1, 200) = 4.15$, $p < .05$, $\eta_p^2 = .02$; thighs $F(1, 200) = 6.28$, $p < .05$, $\eta_p^2 = .03$; and calves $F(1, 200) = 7.35$, $p < .01$, $\eta_p^2 = .04$.

The point of subjective equality was calculated by determining the mean difference between the width in millimeters of each part of the comparison and the sample stimuli when the participants in each trial deemed both as equal. The percentage of such difference relative to the width of each part of the sample stimulus was then calculated. The percentage points of subjective equality for the different parts varied from 98.48 to 102.08%.

Discussion

A common result to all participants was that the sensitivity to detect small differences between the sample and the comparison stimuli was greater for most parts (face, chest, thighs and calves) of the male than of the female silhouette. This result is similar to those from studies in medicine. For example, Buckley et al. (2012) and Hall, Larkin, Trujillo, Hinds, and Delaney (2004) found that physicians estimated with greater precision the weight of males than of females. This result however differs from the supposedly social pressures for both men and women to scrutinize the female body to a greater degree than the male one (cf. Grogan, 2007).

Another common result to all participants was that the smallest differences were detected in the hips and waist of both silhouettes. Thus, those two parts are mainly responsible for stating that the body size of someone changed. This result is similar to those reported in studies with different purposes. The waist and hips are the two body parts that mainly determine the physical attractiveness of women (Weeden & Sabini, 2005) and the dissatisfaction with their own body image (Hoyt & Kogan, 2001). The result also coincides with studies in medicine and in the forensic sciences. Lorenz et al. (2007) found that physicians and nurses estimated more accurately the body size of patients in a hospital while basing their estimation in the width of the waist and hips than when observing their whole body. Velardo and Dugelay (2010) found that the estimation of the body size of suspected criminals was more precise when based on the measurement of the width of the calves, arms, waist and thighs, than when based on the observation of the whole body. The consistency of results about the salience of the waist and hips in assessing body size in studies with different purposes and in different disciplines suggest that those body parts function as the most distinctive discriminative stimuli of the human body.

In psychology there are numerous studies on the estimation of people's own body size, but few on the estimation of the body size of other people. By contrast, in medicine and in the forensic sciences there are many studies on how people estimate the body size of others (e.g., Buckley et al., 2012; Hall et al., 2004; Lorenz et al., 2007; Velardo & Dugelay, 2010). When an unconscious patient arrives at a hospital's emergency department, the staff needs to estimate their weight to administer the correct amount of medicine. An incorrect estimation might have severe consequences for the patient. During a crime investigation, it is crucial to correctly estimate the weight and height of the supposed criminal by looking at his/her image taken by surveillance cameras. Researchers in those areas found that the measurement of specific body parts yield a more precise body size estimation than when the whole body is observed. Nevertheless, each researcher has measured different body parts, without specific knowledge of which parts are discriminated with greater precision. The results from the present study showed the latter and might be useful to researchers in medicine and in the forensic sciences.

Regarding the sex of the participants, results showed that men detected smaller differences than women in most parts of the male body (chest, waist, hips and thighs) and in the female chest. There are no previous reports about differences between men and women concerning their sensitivity to detect subtle differences in the size of the breasts of other people. Nevertheless, there is evidence that for men a woman's breast size is associated with her attractiveness (e.g., Furnham & Swani, 2007), while for women the attractiveness of other women is not associated with their breast size (e.g., Gitter, Lomranz, Saxe, & Bar-Tal, 1983). The reason why women were less sensitive than men for detecting small differences in various body parts of other people is unknown. Women are trained to inspect their own body frequently (Reas, Whisenhunt, Netemeyer, & Williamson, 2002). This suggests that cultural norms deemphasize the estimation of other's people bodies in the case of women. Another possibility is that men are altogether trained to inspect the body of other people, both men and women, more frequently and more intensely than women. These possibilities would have to be addressed in future research. It is worth mentioning that men and women's ability to discriminate visual stimuli do not differ (cf. Maccoby & Jacklin, 1974). Thus, it is improbable that the variations in their sensitivity to detect small differences in the various body parts were due to dissimilarities in such ability.

Relative to the age of the participants, those under 40 years old were more sensitive to detect differences in the chest, waist, hips and thighs of both silhouettes. This finding is consistent with the social pressures for the young regarding their adherence to the ideal body size (Pruis & Janowsky, 2010). The discrimination of complex visual stimuli decreases with age (cf. Ball, Beard, Roenker, Miller, & Griggs, 1988). For example, adults have difficulties identifying a friend among a multitude or finding a street sign that is located among many others. In the present study the complete body was presented, while the experimental task consisted of augmenting or reducing the size of only one body part at a time. This arrangement could represent a complex visual stimulus situation. Nevertheless, Ball et al. also showed evidence that with enough practice old and young people might perform the task equally well. In the present study participants completed 20 trials of each part and thus had enough practice with the task. Thus, the sensitivity to detect subtle differences of young and old participants was probably due to their adherence to the social norms of each subgroup rather than to a diminished ability of the old for detecting a discrete stimulus in a complex visual situation.

Regarding the educational level, this factor did not affect the ability to detect small differences in the parts of the male body. However, participants with 13 years or more of education were more sensitive to detect small differences in the majority of the parts of the female silhouette (arms, chest, waist, hips, thighs and calves) than those with less education. This finding coincides with the social pressures for those with high education to adhere to the cultural ideal body size (McCabe & Ricciardelli, 2003). The present study contributed by reporting differences in the sensitivity of adults of different sex, age and educational level to detect subtle differences in various body parts of other people.

Concerning the point of subjective equality, results were consistent with those from previous studies (Farrell et al., 2003; Gardner et al., 1987; Sand et al., 2011; Whitehouse et al., 1986). In the latter studies such point varied from 92 to 108%, while in this study varied from 98 to 102%. Although these data suggests that the estimation of other people's body size is quite precise, the present study showed that the sensitivity to detect small differences in body size varies according to each body part and to subgroup membership.

The psychophysical method of adjustment used in previous research varied considerably between studies regarding the type of stimuli, the procedure to present them and the number of trials (Farrell et al., 2003; Gardner et al., 1987; Sand et al., 2011; Szymanski & Seime, 1997; Whitehouse et al., 1986). Unlike previous studies, the procedure used in the present research allowed the presentation of identical stimuli (i.e., silhouettes of the same size), that were both shown simultaneously in a computer screen during block-trials of a same size. While in previous studies the comparison stimulus consisted of a full-body image distorted in width, in the present study the width of each of seven body parts was modified in progressive steps, simulating the real proportion in which each augments or reduces as the body size changes. While participants in the previous studies were mainly undergraduate women, in the present study participants included adult men and women of different age and educational level. Also, different from previous studies (Benson et al., 1999; Smeets, 1999), the computer program developed here included both male and female silhouettes and was designed to simulate the proportional real increases or reductions in the width of each of seven body parts. Therefore, the method used in the present research represents an improvement regarding those of previous studies.

The estimation of the body size of other people should be an important research topic in psychology, since the perceived body size of an individual influences a third party's behaviors toward him/her. While there are many social negative consequences of being considered obese, there are many positive social consequences of being labeled as thin (Graham et al., 2000; Puhl & Heuer, 2009). While conventional wisdom suggests that members of different social groups may consider a certain body size as normal, slim or even large, no evidence was available to support this. The results from the present study suggest that women, people older than 40 years and with basic education, will be less precise than their counterparts in estimating the body size of other people (particularly of women), and thus prone to react either positively or negatively toward those whom they will consider slim or obese.

The interest of the present study was to determine if the sensitivity of adults to detect subtle differences in various female and male body parts varied according to their sex, age and educational level. Such interest was based on the environmental approach to social psychology (cf. Keller & Shoenfeld, 1950). According to this approach, the social behaviors of the members of each social group differentially reinforce specific discriminative abilities. Globally, the results from the present study suggest that different subgroups within the same culture do indeed differ in their ability to discriminate small differences in the body shape of others. If the development of such ability can be attributed to the demands of particular social groups, then it follows that men, people under 40 years old and those with undergraduate or graduate studies may have been subjected to more social pressures to sharpen their discrimination of small differences in the body shape of their conspecifics. Thus, the present study contributed by showing the heuristic value of the environmental approach to social behavior; specifically in the case of the estimation of other's people body size. The results from the present study also add the discrimination of differences in the body shape of other people to the findings of previous studies that have shown that cultural variables shape visual perception (see Balcetis & Lassiter, 2010).

The present paper reports a basic research study with no evident practical applications in the field of eating disorders. Nevertheless, some implications could be derived from these results. Body image distortion and body size dissatisfaction are two of the criteria to consider that someone has an eating disorder (Skrzypek, Wehmeier, & Remschmidt, 2001). A series of drawings, silhouettes or photographs representing people of different body sizes is a common technique used to assess both criteria (Skrzypek et al., 2001; Swami et al., 2008). Participants are asked to select the images that resemble both, their current body size and the one they would like to possess. The difference between the body size of the man or woman represented by the first image and the actual body size of a participant renders an index of body image distortion, while the differences between the ''body size'' of the two images renders and index of body size dissatisfaction. Given the scare research on the estimation of other people's body size, it is surprising that researchers use images of other people to determine how an individual estimates his/her own body size. Without establishing the just-noticeable difference between the size of each drawing, silhouette or photograph, it is impossible to know if the size of each image is really discriminated or if it is excessively large. The results from the present study could help researchers develop new silhouette-scales that are equally spaced in size, making sure that each will be easily discriminated. Furthermore, researchers must take into account the proportion in which each part of a full-body size male and female silhouette needs to be distorted in width to assure that people will notice an increase or decrease in size.

Women are more susceptible to develop an eating disorder than men (Keel & Klump, 2003; Miller & Pumariega, 2001). The results from the present study showed that women estimate less precisely than men the body size of other people, especially of other women. It is possible that when asked to select the images that best represent their actual and ideal weight, women misjudge the ''body size'' of both images. Thus, it could be that rather than having a distorted body image and being dissatisfied with their body size, many of them just fail to estimate correctly the body size of the women represented by the images. If this is the case, many women may be wrongly labeled with an eating disorder or in risk of developing one. The present study showed that the precision which people estimate the body size of others varies according to subgroup membership. It is feasible that the precision to estimate the size of the own body also varies according to subgroup membership. Given that such precision is one of the diagnostic criteria for an eating disorder, it seems necessary to address it in future research.

The study had some limitations. First, the participants were exclusively inhabitants from Mexico City. Also, the subgroups were not of equal size; the percentage of women, people under 40 years old and with less than 12 years of education was higher than their counterparts. These facts limit the generality of the results. Second, participants were arbitrarily divided into two age and educational level groups. This gross division leaves the question of whether the same differences between groups will persist if a more subtle division is made.

Ethical disclosures

Protection of human and animal subjects. The authors declare that the procedures followed were in accordance with the regulations of the relevant clinical research ethics committee and with those of the Code of Ethics of the World Medical Association (Declaration of Helsinki).

Confidentiality of data. The authors declare that no patient data appear in this article.

Right to privacy and informed consent. The authors declare that no patient data appear in this article.

Conflict of interest

The authors declare no conflict of interest.

Sponsors

This study was conducted as part of the first author's doctoral dissertation at the Operant Conditioning Laboratory of the Ph.D. Psychology Program of the Universidad Nacional Autónoma de México under the supervision of the second author. The study was financed by a scholarship (26414) to the first author by Consejo Nacional de Ciencia y Tecnología.

Acknowledgements

The authors would like to thank Teresa Iglesias-Solomon MS and Graciela Acuña for kindly editing the English language of the paper and Carlos A. Bruner PhD for his advice during the whole study.

Appendix A. General and specific instructions that appeared in the computer program

General instructions

''In the next screen you will see two silhouettes of men (women). The size of one of the silhouettes is Fixed; that is, it cannot be modified. The other silhouette is Adjustable; that is, its size can be modified. In each trial a specific part of the Adjustable silhouette will be augmented or reduced in size. Your task is to modify the Adjustable silhouette until it is equal in size to the Fixed silhouette. Press the '+' key to augment and the '−' key to reduce the Adjustable silhouette. Each silhouette is indicated with the words Fixed and Adjustable. When you consider that both silhouettes are of the same size, press the 'Next Trial' key. In blocks of consecutive trials you will have to modify each of seven different body parts of the Adjustable silhouette. Before each block begins, the body part that you will have to modify will be indicated. You can now practice the task doing six training trails. Please press the 'Start with the Training Trials' key when you are ready to begin.''

Specific instructions for each body part

''In each of the following trials the waist (name of each part) of the Adjustable silhouette is augmented or reduced relative to the waist of the Fixed silhouette. Your task is to modify the waist of the Adjustable silhouette until it matches the size of the waist of the Fixed silhouette. Remember, use the '+' key to augment and the '−' key to reduce the Adjustable silhouette. When you consider that the waist of both silhouettes are of the same size, press the 'Next trial' key.''

Appendix B. Differential threshols

Just-noticeable differences in millimeters for different parts of a male and of a female silhouette for the whole sample and divided according to their demographic characteristics.

	Face	Arms	Chest	Waist	Hips	Thighs	Calves
			Male silhouette				
Total sample	5.5	4.1	7.3	5.7	6.6	6.0	4.5
Sex							
Men	5.5	4.1	6.2	5.1	6.0	5.3	4.5
Women	5.5	4.1	8.0	6.2	7.0	6.4	4.6
Age							
40 years or less	5.2	4.0	6.7	5.5	6.0	5.4	4.5
41 years or more	6.2	4.3	8.7	6.3	8.0	7.3	4.7
Years of education							
12 year or less	5.6	4.2	7.7	5.8	6.9	6.1	4.6
13 year or more	5.4	3.9	6.6	5.6	6.1	5.7	4.4
			Female silhouette				
Total sample	7.3	4.1	8.5	5.6	7.0	6.0	5.4
Sex							
Men	7.1	4.2	6.9	5.3	6.7	5.8	5.5
Women	7.4	4.0	9.7	5.9	7.2	6.2	5.4
Age							
40 years or less	7.1	4.1	7.8	5.3	7.0	5.7	5.4
41 years or more	7.7	4.1	10.1	6.4	7.1	6.8	5.5
Years of education							
12 years or less	7.3	4.4	9.8	6.0	7.3	6.4	5.7
13 years or more	7.2	3.6	6.4	5.0	6.6	5.4	5.0

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