Examining Relationships between Interoceptive Sensibility and Body Image in a non-Western context: A study with Malaysian adults

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Abstract

Previous research has indicated that there are significant associations between interoception and body image, with lower interoceptive sensibility (IS) associated with more negative body image and higher IS associated with more positive body image. However, it is unclear whether these relationships are replicable in populations outside of North America and Western Europe. To address this issue, we asked a sample of 815 Malaysian Malay adults to complete the Multidimensional assessment of Interoceptive Awareness, the Body Appreciation Scale-2, the Functionality Appreciation Scale, the Photographic Figure Rating Scale (women only), and the Drive for Muscularity Scale (men only), using online survey software. There were significant positive correlations between IS and the positive body image indices for both women and men, but the associations between IS and negative body image were generally below thresholds for statistical significance. After controlling for body mass index, age, and gender identity, we identified significant associations between IS and all five indices of body image. Overall, these findings demonstrate that relationships between IS and facets of positive and negative body image are present in a non-Western setting. Furthermore, the direction and strength of relationships identified in the present study were consistent with previous findings from Western samples.

Keywords: Interoception; Interoceptive Sensibility, Positive Body Image, Negative Body Image, Malaysia

Impact Statement

The present work examines whether the perception of internal bodily stimuli (*interoception*) is associated with body image in a sample of Malaysian Malay adults. The key novel finding is that associations between interoceptive sensibility and body image are present in a non-Western sample, suggesting that existing models can be generalised to populations that are more demographically diverse than the Western samples that have been considered previously. Specifically, we identify several significant associations between facets of interoception and positive body image, which could have important therapeutic applications. As such, the work falls within Sustainable Development Goal 3.

1. Introduction

The term *interoception* refers to the processing of stimuli originating inside the body, such as feelings of hunger and heartbeats (Craig, 2003; Khalsa et al., 2018). Conversely, *body image* refers to external appearance-related perceptions, affects, and cognitions (Cash, 2004; Cash & Smolak, 2012). Both constructs are essential components of personal identity and contribute to the regulation of human behaviour (Cash, 2004; Craig, 2009; Damasio, 2010). However, interactions between the two constructs are complex because they are both multidimensional (Khalsa et al., 2018; Tylka, 2018), and because variables such as age, gender, and national and cultural context are known to interact with each construct independently (e.g., interoception: Chentsova-Dutton & Dzokoto, 2014; Freedman et al., 2020; Ma-Kellams, 2014; body image: Swami, 2015, 2018; Swami et al., 2010). To that end, the aim of the present study was to examine whether associations between interoception and body image that have been previously identified in Western samples can be replicated in a non-Western sample of Malaysian Malay adults.

In recent years, interoceptive processing has been parcellated into numerous components that span both conscious and unconscious levels of processing (Garfinkel et al., 2015; Khalsa et al., 2018). Of these components, the present work focuses on *interoceptive sensibility*[1] (IS), which primarily refers to the self-reported salience of interoceptive stimuli (for discussions of interoceptive nomenclature, see Khalsa et al., 2018; Mehling, 2016). IS itself may be considered a broader construct: Mehling (2016) has proposed that it also encompasses cognitive and behavioural aspects, such as appraisals and beliefs surrounding interoceptive stimuli. The components of IS as outlined by Mehling can be measured using the Multidimensional Assessment of Interoceptive Awareness (MAIA; Mehling et al., 2012), which comprises eight subscales in its English format (i.e., noticing, attention regulation, not

worrying, not distracting, emotional awareness, self-regulation, body listening, and body trust; for a review of MAIA translations, see Todd, Barron et al., 2020).

Like interception, body image can be divided into different facets. In particular, the dimensions of negative and positive body image are conceptualised as independent and distinct constructs, rather than opposite ends of the same spectrum (Tylka, 2018; Tylka & Piran, 2019; Tylka & Wood-Barcalow, 2015a). Accordingly, while measures of negative and positive body image are often significantly and negatively correlated, there are also unique relationships between negative and positive body image, respectively, and other outcome variables (Tylka & Wood-Barcalow, 2015a).

1.1. The relationships between IS and body image

Previous research indicates that there are associations between interoception and body image (for a review, see Badoud & Tsakiris, 2017). Overall, the current body of literature suggests that lower IS is associated with body image dissatisfaction (Badoud & Tsakiris, 2017) and body image disturbances (for a review, see Jenkinson et al., 2018). Conversely, greater IS has been associated with more positive body image (e.g., Daubenmier, 2005; Oswald et al., 2017; Todd et al., 2019a, 2019b). Consistent with the multidimensional conceptualisation of body image, the magnitude of the relationships between IS and body image has been found to vary across indices of positive and negative body image. For example, in UK adults and adolescents, associations between IS and positive body image are of greater magnitude than associations between IS and negative body image (Todd et al., 2019a, 2019b). These findings may reflect differences in the focus of attention across the constructs of positive and negative body image: on the one hand, negative body image measures tend to assess negative attention toward aspects of external appearance, while positive body image measures typically examine a more mindful focus upon physiological characteristics of the body, such as body functionality, strengths, and health (Tylka, 2018).

In brief, the relationships between IS and body image vary as a function of the component of body image that is being measured.

Equally, research suggests that there may be differential relationships between body image and lower-order aspects of IS: the trusting, attention regulation, and self-regulation subscales of the MAIA appear to be more closely associated with body image than the noticing subscale (Todd et al., 2019a, 2019b; see also Oswald et al., 2017, who observed a similar pattern of findings with different IS measures). Most notably, the MAIA trusting subscale (which captures the extent to which bodily stimuli are regarded as 'safe' and 'trustworthy' information sources; Mehling et al., 2012) has been consistently associated with indices of positive and negative body image (Brown et al., 2017; Todd et al., 2019a, 2019b). These results suggest that body trust could be a particularly important variable to consider when developing new therapies aimed at the promotion of positive body image. However, an important limitation remains: to our knowledge, the relationships between IS and body image have not been fully examined outside of North American and Western European populations. Therefore, it is unclear whether extant findings will generalise to non-Western contexts.

1.2. The Malaysian context

Malaysia is an interesting cultural context to examine associations between IS and body image for several reasons. First, the conceptualisation of multidimensional IS in Malaysia appears to be unique (i.e., MAIA scores reduce to only three subscales in Malaysian adults, compared to eight subscales in samples from the United States and Western Europe; for an overview see Todd, Barron et al., 2020). This finding suggests that IS may depend upon local contextual factors in Malaysia. For example, there are cultural values specific to Malaysian Malays, such as *maruah* – which refers to a sense of dignity or pride regarding both self-perceptions and what others think about the individual (Goddard, 1997) – and *senang hati*, which refers to an untroubled, relaxed state of mind (Goddard, 1997). It is

possible that the concept of *senang hati* has a localised impact on the extent to which Malaysians pay attention to sensations of physical discomfort. Indeed, the tendency to distract attention from sensations of discomfort appears to be regarded as a positive attribute in Malaysian adults, which contrasts with the negative loading observed in Western samples (for a review, see Todd, Barron et al., 2020).

Malaysia is also a rapidly developing nation, with major socioeconomic development, industrialisation, and urbanisation occurring over the last few decades. These developments have had several important social implications that are relevant to bodily perceptions (for overviews, see Swami, 2006; Swami et al., 2013). Swami (2006) has discussed how rapid economic advances led to the deregulation of mass media, which, in turn, triggered an increase in the prevalence of Westernised body ideals, and greater assimilation of Western cultural values. Alongside these developments, there have been changes to gendered relations, with women experiencing greater employment opportunities, health control, and legal rights. Altogether, these societal changes have resulted in the adoption of the Western thin ideal, which has been conflated with femininity, success, and happiness in urban Malaysian contexts (Swami, 2006, 2015). Similarly, male muscularity is idealised to a similar extent in urban Malaysia as it is in the UK (Swami & Tovée, 2005).

Finally, Malaysia is undergoing a national nutritional and lifestyle transition (e.g., Fournier et al., 2015; Shamsul, 2012), with increasing prevalence of overweight and obesity alongside micronutrient deficiencies (Institute of Public Health, 2015; World Health Organisation, 2018). Swami (2006) has suggested that the increasing rates of overweight and obesity may have further justified the fear of overweight and the glorification of the thin ideal, which, in turn, promotes greater body dissatisfaction. Indeed, several studies have reported that large proportions of the Malaysian population experience body dissatisfaction across childhood, adolescence, and adulthood (for an overview, see Swami et al., 2013).

To our knowledge, only one other study has considered associations between interoception and body image in a non-Western context. Todd, Aspell and colleagues (2020) explored associations between gastric interoception (i.e., the processing of sensory stimuli originating in the gut) and body image across samples of UK and Malaysian Malay adults using a behavioural measure (the 2-stage water load task). In this study, greater levels of gastric interoception were generally associated with more positive body image in both national samples. However, there were subtle differences between the two groups regarding specific components of interoception, with a behavioural index from the water load task significantly associated with facets of positive body image for the Malaysian sample, but not the UK sample, after accounting for gender identity and body mass index.

1.3. The present study

In the present study, we sought to examine previously unexplored relationships between multiple facets of IS and body image in Malaysian adults. In terms of hypotheses, previous research findings from North American and Western European samples have indicated three trends (e.g., Daubenmier, 2005; Oswald et al., 2017; Todd et al., 2019a, 2019b): (1) there tend to be positive associations between facets of IS and positive body image; (2) correlations between IS and positive body image tend to be greater in magnitude than correlations between facets of IS and negative body image; and, (3) the IS facets of body trust and attention regulation tend to be more closely associated with body image than the extent to which interoceptive stimuli are noticed. To test these hypotheses, the present study examined associations between multidimensional IS and indices of positive body image (i.e., body appreciation and functionality appreciation) and negative body image (i.e., weight discrepancy in women and drive for muscularity in men), in Malaysian Malay adults. These constructs were selected based on significant associations in previous research (e.g., Todd et

al., 2019a, 2019b), as well as the availability of validated measures for use with Malay-speaking populations.

We expected that body mass index (BMI), gender (for the positive body image variables) and age would account for some of the variance in the relationships between IS and body image (e.g., Grabauskaitė et al., 2017; Murphy et al., 2018; Ricciardelli et al., 2018; Tiggemann, 2015), because they have been previously associated with facets of interoception and body image, respectively. Accordingly, we planned to use hierarchical regressions to examine whether the MAIA variables significantly explained unique variance in the body image facets once these demographic variables had been taken into consideration.

2. Method

2.1. Participants

A total of 815 adults (403 women, and 412 men) who self-reported as being of Malay ancestry participated in the study. Malays represent the majority ethnic group in Malaysia (Department of Statistics Malaysia, 2017) and must be Muslim, as defined by Article 160 of the Constitution of Malaysia. The participants were aged between 18 and 69 years (M = 33.89, SD = 8.80), and ranged in self-reported body mass index (BMI) from 13.26 to 49.86 kg/m^2 (M = 24.82, SD = 5.48). For men, mean BMI was 25.13, which is comparable to the most recent national estimated mean for men in Malaysia (M = 25.3; World Health Organisation, 2018). For women, mean BMI was 24.45, which is slightly lower than the national estimated mean for women (M = 26.1; World Health Organisation, 2018). In Malaysia, the expected number of years schooling is 13.5 years, and mean years of schooling was recently estimated to be 10.2 years (Conceição, 2019). Of the present sample, 32.1% had completed secondary schooling, 39.4% had an undergraduate degree, 18.7% had a postgraduate degree, and the remainder had some other qualification. Of the total sample,

34.6% were single, 62.7% were married, 2.3% were divorced, and 0.4% had some other marital status.

2.2. Measures

2.2.1. Interoception. The Multidimensional Assessment of Interoceptive Awareness (MAIA; Malay translation: Todd et al., 2020) is a 32-item measure that assesses eight facets of IS. Although scores on the English version of the scale reduce to eight factors (Mehling et al., 2012), Todd and colleagues (2020) found that found that scores on the Malay version reduced to three dimensions, tapping: the ability to sustain and control attention to bodily sensations (Attention Regulation; 9 items), the tendency to notice bodily sensations and how they connect to emotional states (Bodily and Emotional Awareness; 8 items), and the extent to which bodily sensations are regarded as 'safe' and trustworthy (Trusting; 3 items). All items were scored on a 6-point scale, ranging from *never* (0) to *always* (5). Scores for each subscale were computed as the mean of all associated items, and higher scores reflect greater IS. Scores on the Malay version of the MAIA have been shown to have adequate internal consistency (Todd et al., 2020). In the present study, internal consistency coefficients were estimated using McDonald's omega (ω) and associated 95% confidence intervals. ω was used to estimate internal consistency because it is likely to produce a more reliable estimate in comparison to the more commonly employed Cronbach α statistic (for an overview, see Dunn et al., 2014). ω coefficients for scores on each subscale were as follows: Attention Regulation = .89 (95% CI = .86, .91), Bodily and Emotional Awareness = .88 (95% CI = .85, .91), Trusting = .89 (95% CI = .83, .91).

2.2.2. Functionality appreciation. To measure a facet of positive body image, participants were asked to complete the Functionality Appreciation Scale (FAS; Malay translation: Swami, Todd et al., 2019). The FAS is a 7-item scale that assesses the extent to

which individuals respect and appreciate their bodies for the functions they are capable of performing. Items were rated on a 5-point scale (1 = *strongly disagree*, 5 = *strongly agree*). An overall score was computed as the mean of all items, with higher scores reflecting greater functionality appreciation. Scores on the Malay version of the FAS have been shown to have a unidimensional factor structure and adequate construct and incremental validity (Swami, Todd et al., 2019). In the present study, ω for FAS scores was .91 (95% CI = .89, .93).

2.2.3. Body appreciation. To measure a second facet of positive body image, participants were asked to complete the Body Appreciation Scale-2 (BAS-2; Malay translation: Swami, Mohd. Khatib et al., 2019). The BAS-2 was designed to examine the extent to which an individual accepts their body, respects and cares for their body, and protects themselves from unrealistic societal beauty standards. The scale is comprised of ten items, which are rated on a 5-point scale ranging from 1 (*never*) to 5 (*always*). BAS-2 scores were calculated as the mean of all responses, and higher scores indicate greater body appreciation. In previous research the Malay BAS-2 was found to have a unidimensional factor structure, and BAS-2 scores evidenced adequate internal consistency, and good construct and incremental validity (Swami, Mohd. Khatib et al., 2019). In the present study, ω for BAS-2 scores was .92 (95% CI = .91, .93).

2.2.4. Weight discrepancy. To measure a facet of negative body image, women were asked to complete the Photographic Figure Rating Scale (PFRS; Swami et al., 2008; Malay translation: Swami et al., 2013). The PFRS is comprised of 10 photographic images of women with their faces obscured. The images are standardised so that they represent established BMI categories (i.e., emaciated: <15 kg/m^2, underweight: 15–18.5 kg/m^2, healthy range: 18.5–24.9 kg/m^2, overweight: 25.0–29.9 kg/m^2, and obese: >30 kg/m^2; Tovée et al., 1999; see also Bray, 1978). The figures are positioned on a 10-point scale, with 1 representing the image with the lowest BMI, and 10 representing the figure with the highest

BMI. Participants are asked to indicate the numbers that represent the figure that they believe is most closely matched to their own body, and the figure that that they would most like to possess. Scores for actual-ideal weight discrepancy were calculated as the absolute difference between the ratings for current and ideal figures, with higher scores reflecting greater weight discrepancy. In previous research, the PFRS has demonstrated adequate construct validity and test-retest reliability (Swami et al., 2012, 2013). Men did not complete the PFRS because no male version of the PFRS is available.

2.2.5. Drive for muscularity. To measure a facet of negative body image, men were asked to complete the Drive for Muscularity Scale (DMS; Malay translation: Swami et al., 2016). The DMS assesses muscularity-orientated attitudes and behaviours, including the desire to have a more muscular body. The DMS is comprised of 15 items, which are rated on a Likert-scale ranging from 1 (*always*) to 6 (*never*). Overall scores were computed as the mean of all items, and items were reverse-scored so that higher overall scores indicate greater drive for muscularity. In Malaysian men, DMS scores were found to have adequate internal consistency, ad good convergent validity (Swami et al., 2016). In the present study, ω for the overall DMS scores in men was .94 (95% CI = .93, .95). Women did not complete the DMS because its psychometric properties have not yet been examined in Malaysian women.

2.2.6. Demographics. Participants were also asked to report their gender identity, age, height, and weight. These demographic details were used for descriptive purposes only. We computed self-reported BMI (kg/m^2) using the height and weight data.

2.3. Procedures

Ethics approval for the study was obtain from the Anglia Ruskin departmental research ethics committee prior to data collection. The data were collected between March and April (2019) using a Qualtrics research panel. The research survey was advertised as a

study on “attitudes toward the body”, and the advertisement included a brief summary of the subject theme, an estimated duration (15 minutes), and details of remuneration (participants were offered Qualtrics points, which can be exchanged for cash, gift cards, or donations to charity). Our intention was to recruit a homogeneous sample in terms of cultural and national identity, so eligibility was limited to adults (≥ 18 years) with Malaysian citizenship, who were of Malay ancestry and fluent in Malay. In addition, participation was limited to those who had good approval ratings from previous studies. IP addresses were examined to ensure that participants did not complete the survey more than once. All participants were required to provide digital informed consent. Following this, participants were asked to complete the measures described above, presented in a counterbalanced order. Written debriefing information was presented at the end of the survey.

3. Results

3.1. Preliminary Analyses

IP addresses were examined to ensure that participants did not completed the survey more than once. We removed improbable BMI values (< 12 or > 50 kg/m^2) and treated these as missing data. Altogether, missing data accounted for 0.29% of the main data set, but were not missing completely at random (MCAR), as determined by Little’s MCAR analyses, $\chi^2(5159) = 7888.36$, $p < .001$. Given the minimal amount of missing data, missing values were imputed using the multiple imputation technique. Further data screening did not reveal any influential outliers. Means and standard deviations for all variables are reported in Table 1. We controlled for false discovery rate (FDR) using the Benjamini and Hochberg (1995) procedure. As reported in Table 1, we observed gender differences for bodily and emotional awareness with women reporting higher scores. However, these differences were not statistically significant after the FDR correction was applied.

3.2. Bivariate Correlations

Bivariate correlations between all variables were conducted separately for women and men. FDR corrections were also computed separately. As can be seen from Table 1, all the MAIA variables were significantly and positively correlated with the positive body image variables (i.e., body appreciation and functionality appreciation), for both women and men. Correlations between the MAIA variables and the negative body image variables (i.e., weight discrepancy and drive for muscularity) tended to be weaker and generally below the threshold for statistical significance. Fischer's *r*-to-*z* transformation was computed to examine differences in the pattern of the correlation coefficients across gender (see Supplementary Materials). Of note, there was a statistically significant difference in the association between attention regulation and body appreciation, with the correlation being of greater magnitude for men.

3.3. Hierarchical Multiple Regression Analyses

A series of five multiple regression analyses were conducted with the MAIA variables entered simultaneously as the predictor variables and the body image variables entered as the criterion variables. The effects of gender, BMI, and age were controlled for in the first step, to examine whether IS accounts for a significant proportion of the variance in the body image scores, over-and-above the variance associated with gender, BMI, and age. For the two sex-specific body image variables (weight discrepancy and drive for muscularity), only BMI and age were included in the first step. Variance inflation factors were ≤ 1.98, indicating that multicollinearity was not a limiting issue (Hair, Anderson, Tatham, & Black, 1995). Results for body appreciation and functionality appreciation are reported in Table 2, and results for weight discrepancy and drive for muscularity are reported in Table 3.

4. Discussion

In this study, we sought to examine associations between facets of IS and body image in a sample of Malaysian Malay adults. Overall, we identified significant relationships between IS and facets of positive body image (body appreciation, and functionality appreciation) for both women and men. We also identified significant associations between IS and facets of negative body image (actual-ideal weight discrepancy for women, and drive for muscularity for men). In the final models, all three of the MAIA subscales emerged as significant predictors for at least one of the body image facets. These findings represent the first evidence of associations between multiple facets of IS and facets of positive and negative body image in a non-Western cultural context, and build upon existing evidence that the associations between components of interoception and body image may be a transnational phenomenon (Todd, Aspell et al., 2020).

Consistent with our first hypothesis, we observed positive associations between facets of IS and both body appreciation and functionality appreciation, respectively, for both women and men. These findings replicate previous research using Western samples (Daubenmier, 2005; Oswald et al., 2017, Todd et al., 2019a). In terms of theoretical mechanisms, it is possible that people who are more able to regulate attention toward their internal bodily signals are better able to appreciate the positive functions that their bodies perform, which, in turn, might promote a more generalised appreciation of the body (e.g., Alleva et al., 2015; Alleva et al., 2018a, 2018b). In addition, it is also plausible that people who are more able to regulate attention toward interoceptive signals might be more able to attend to the body's needs, which could also promote positive body image (Andrew et al., 2016; Cook-Cottone, 2018; Wood-Barcalow et al., 2010). However, it is important to note that due to the design of the present research, a causal relationship between IS and positive body image can only be inferred hypothetically at present.

We also identified weak, largely negative associations between the MAIA variables and both of the negative body image variables, and these associations were consistent after controlling for the effects of BMI and age in the regression analyses. These findings align with our second hypothesis and extend previous research, which has identified inverse associations between IS and overweight preoccupation (e.g., Brown et al., 2017, Todd et al., 2019a) and muscle dysmorphia (e.g., Babusa & Túry, 2012), respectively, in samples of Western adults. A reduced sensitivity to interoceptive stimuli could constitute a risk factor for the development of more negative body image, due to an over-reliance upon exteroceptive stimuli such as visual appearance-related characteristics (Badoud & Tsakiris, 2017). For example, in manipulations of body ownership such as the rubber hand illusion, participants with body image disturbances and eating disorder symptomology have been found to prioritise exteroceptive cues (i.e., the visual rubber hand) over interoceptive cues (Eshkevari et al., 2012, 2014; Mussap & Salton, 2006).

Consistent with our third hypothesis, we observed a divergence in the findings across the positive and negative body image variables, with the associations between IS and positive body image being generally of greater magnitude than the associations between IS and negative body image. Specifically, after taking into consideration the variance accounted for by gender, BMI, and age, the MAIA variables accounted for 27% of the variance in body appreciation, and 29% in functionality appreciation. However, after taking into consideration the variance accounted for by BMI and age, the MAIA variables accounted for only 4% of the variance in actual-ideal weight discrepancy in women, and just 1% of the variance in drive for muscularity in men. These findings support the conceptual distinction between positive body image and negative body image (see Tylka, 2018). While the inverse correlations between facets of positive and negative body image observed in the present study (r = -.02 to -.42) are typical of the extant literature (Tylka, 2018), the two constructs are also

known to interact with outcome variables in unique ways (e.g., Davis et al., 2019; Gillen, 2015; Thomas & Warren-Findlow, 2019). As was the case in previous research with Western adults (Todd et al., 2019a), demographic variables explained a greater proportion of the variance in scores for the negative body image variables than the MAIA variables. In particular, BMI explained the largest proportion of the variance in actual-ideal weight discrepancy scores (whereby a higher BMI predicts greater actual-ideal weight discrepancy) and age for drive for muscularity (whereby, as men age, they become less preoccupied with muscularity).

Our final hypothesis was that there would be differences in the magnitude of the correlations between the body image variables and the univariate facets of IS, with the IS facet of body trust tending to be more closely associated with body image than the extent to which interoceptive stimuli are noticed (after the findings from Todd et al., 2019a; see also Brown et al., 2017; Daubenmier, 2005; Oswald et al., 2017). Consistent with expectations, body trust was a significant positive univariate predictor of body appreciation and functionality appreciation, and a significant negative univariate predictor of actual-ideal weight discrepancy (women) and drive for muscularity (men). Indeed, of the three MAIA subscales, body trust made the largest contribution to variance in scores for the body image variables. Conversely, while the IS facet of bodily and emotional awareness (which includes the Noticing subscale from the English version of the MAIA) emerged as a significant positive univariate predictor of functionality appreciation, it was also a positive univariate predictor of drive for muscularity, despite the lack of a statistically meaningful correlation (Ferguson, 2009).

This is a puzzling finding, but nevertheless appears consistent with the findings for the MAIA Noticing subscale from previous research (Todd et al., 2019a). The regression models illustrate the relative contribution of bodily and emotional awareness to the prediction

of the body image variables alongside all the other IS and demographic variables. As such, it is possible that once all the other variables have been accounted for, the direction of the beta coefficients for the associations between bodily and emotional awareness and functionality appreciation, and between bodily and emotional awareness and drive for muscularity, respectively, are an accurate depiction of the relationships between these variables. For example, Malaysian Malay men might be less attuned to care for and respect their bodies, because masculinity norms focus men's attention elsewhere (e.g., the attainment of psychological well-being through non-corporeal means, such as occupational success). Indeed, it is possible that the tendency to notice interoceptive stimuli (as measured by these items in the MAIA) may be reflecting a maladaptive tendency towards self-surveillance (Suzuki et al., 2021; Todd et al., 2019a). Nevertheless, (while VIFs were all within acceptable limits), it is also possible that one of the other variables could have biased the regression slope for drive for muscularity (i.e., regression dilution; Fuller, 1987).

Similarly, the IS facet of attention regulation emerged as a significant negative predictor of functionality appreciation within the regression analyses (despite a positive direct correlation) and was not a significant predictor for any of the other body image facets. Thus, a possible interpretation of these findings is that the IS facet of Attention Regulation might be maladaptive in Malaysian adults, when considered in relation to body image. This is somewhat surprising because the findings from UK adults indicated that the ability to sustain attention toward interoceptive stimuli tends to be associated with a more positive body image (Todd et al., 2019a). One possible source of variation relates to differences in the factor structure of the MAIA across English- and Malay-speaking samples. Specifically, an item that is reverse scored in the English MAIA ("I distract myself from sensations of discomfort"), loads positively onto the Attention Regulation subscale of the Malaysian MAIA (Todd, Barron et al., 2020). However, again, it is also possible that the finding reflects

regression dilution (Fuller, 1987), particularly given that the direct correlation between attention regulation and functionality appreciation was positive for men and women.

4.1. Limitations

It is important to note that all the measures used within the present work were developed with Western samples. These measures have all been translated and validated for use with Malaysian-speaking samples previously, and, while some measures (e.g., the BAS-2 and the FAS) have been found to be equivalent across Malay- and English-speaking samples (Todd & Swami, 2020), some of the measurement tools differ in dimensionality (e.g., MAIA subscales). This is problematic because measurement tools that have been originally developed in the West may not capture additional aspects of IS and body image that are specific to other cultural contexts such as Malaysia. Indeed, research on interoception and positive body image with different cultural groups appears to indicate that, while some core components of the constructs are communal, there are aspects that may be unique to specific cultural groups (Freedman et al., 2020; Swami, 2018). Future research could address this issue by qualitatively examining the ways in which the associations between interoception and body image are understood and experienced by Malaysian Malay adults. Such work could also provide an indication of whether associations between interoception and body image are mediated by unique factors.

The present findings should also be considered in the context of other limitations. First, we relied on an online sample of Malaysian citizens, which may limit generalisability, especially as an estimated quarter of Malaysians are not yet online (Malaysian Communications & Multimedia Commission, 2017). A related limitation of the present study is that we recruited a sample of Malaysians of Malay ancestry. While Malays are the majority ethnic group in Malaysia (Department of Statistics Malaysia, 2017), it is important to note that Malaysia is ethnically heterogeneous, and future work should seek to examine whether

the present findings are robust across other ethnic segments. Finally, we did not collect additional demographic data (for example, employment status or income), so it was not possible to further examine the degree to which our online sample is representative of the wider population of Malaysian Malays.

Given the cross-sectional nature of the present work it is unclear whether the relationships identified in the present work are stable longitudinally, or indeed, whether a causal relationship between IS and body image exists in Malaysian adults. Longitudinal research with samples from the United States and Western Europe supports the assertion that early impairments in IS are associated with later vulnerability to the development of eating disorders (for a review, see Lilenfeld et al., 2006), but other cultural groups have yet to be considered. Similarly, longitudinal explorations of the associations between IS and positive body image are also warranted, particularly as the associations appear to be greater in magnitude than the associations between IS and negative body image across diverse samples (i.e., Malaysia and the UK).

4.2. Conclusion

The present work provides evidence of significant associations between facets of multidimensional IS and body image in a non-Western cultural context. While the conceptualisation of multidimensional IS appears to be unique in Malaysian-speaking samples (Todd, Barron, et al., 2020), the findings from the present study indicate that IS is nonetheless an important source of variance for facets of positive body image in Malaysian adults. Given that several of the key trends in the data appear consistent across the present study and previous research with UK samples (Todd et al., 2019a, 2019b), it might also be hypothesised that some relationships between IS and body image are robust across diverse cultural contexts (see Todd, Aspell et al., 2020). In particular, across both UK and Malaysian samples, associations between facets of IS and positive body image have tended to be greater

in magnitude than the associations between facets of IS and negative body image. In addition, across both samples, the IS facet of body trust emerged as a consistent univariate predictor for facets of positive and negative body image.

Footnotes

[1]Please note that our use of the term *interoceptive sensibility* here (i.e., to refer to the self-reported tendency to perceive interoceptive signals) is equivalent to what is sometimes called *interoceptive awareness* (as in the title of the MAIA). We give preference to the term 'sensibility' because it is consistent with two widely cited models of interoception (i.e., Garfinkel et al., 2015; Khalsa et al., 2018). Within the model proposed by Garfinkel and colleagues (2015), the term *interoceptive awareness* is reserved to describe the 'meta-cognitive' correspondence between behavioural interoceptive accuracy and self-reported interoceptive sensibility.

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Tables and Figures

Table 1. *Means, Standard Deviations, and Bivariate Correlations between all Measures for Women (Upper Diagonal) and Men (Lower Diagonal).*

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) Attention regulation			.58**	.50**	.26**	.21**	-.08		.10	.14**
(2) Bodily and emotional awareness		.72**		.56**	.31**	.42**	-.08		.10*	-.04
(3) Trusting		.60**	.53**		.56**	.48**	-.28**		-.08	-.06
(4) Body appreciation		.36**	.35**	.60**		.53**	-.42**		-.17**	.08
(5) Functionality appreciation		.30**	.40**	.51**	.52**		-.23**		-.07	-.05
(6) Actual-ideal weight discrepancy									.55**	.05
(7) Drive for muscularity		-.08	-.02	-.12*	-.02	.03				
(8) Body mass index		.05	.04	-.02	-.01	.05		-.04		.11*
(9) Age		.05	.08	.09	.06	.14**		-.22**	.32**	
Women	*M*	3.25	3.80	3.85	4.17	4.43	2.20		24.49	33.55
	SD	1.03	0.83	1.10	0.67	0.61	1.56		5.39	8.88
Men	*M*	3.24	3.63	3.73	4.08	4.38		4.01	25.13	34.24
	SD	0.84	1.04	1.00	0.76	0.71		1.14	5.56	8.72
	t	-0.10	-2.45	-1.72	-1.67	-1.19			1.68	1.12
	p	.922	.015	.085	.094	.232			.092	.263
	d	0.01	0.18	0.11	0.13	0.08			0.12	0.08

Notes. **p-FDR* < .05, ** *p-FDR* < .01, women *n* = 403, men *n* = 412.

Table 2. *Multiple hierarchical regressions with body appreciation and functionality appreciation as criterion variables.*

		Body appreciation					Functionality appreciation				
Step	Variable	B	SE	β	t	p	B	SE	β	t	p
		$F(3, 811) = 6.71$, $p < .001$, Adj. $R^2 = .02$					$F(3, 811) = 1.18$, $p = .316$, Adj. $R^2 < .01$				
Step 1	BMI	-.02	.01	-.13	-3.59	< .001	.01	.01	.01	0.21	.831
	Gender	.08	.05	.06	1.57	.116	.06	.05	.04	1.26	.208
	Age	.01	.01	.09	2.60	.009	.01	.01	.05	1.39	.164
Step 2		$F(6, 808) = 55.41$, $p < .001$, Adj. $R^2 = .29$, ΔAdj. $R^2 = .27$, ΔF $p < .001$					$F(6, 808) = 55.76$, $p < .001$, Adj. $R^2 = .29$, ΔAdj. $R^2 = .29$, ΔF $p < .001$				
	BMI	-.01	.01	-.09	-3.07	.002	.01	.01	.02	0.79	.429
	Gender	.04	.04	.03	0.82	.411	-.01	.04	-.01	-0.12	.905
	Age	.01	.01	.07	2.23	.026	.01	.01	.03	1.04	.298
	Attention Regulation	-.01	.03	-.02	-0.40	.692	-.09	.03	-.12	-2.70	.007
	Bodily and Emotional Awareness	-.01	.03	-.02	-0.34	.731	.18	.03	.26	5.85	< .001
	Trusting	.37	.03	.54	14.24	< .001	.28	.02	.44	11.67	< .001

Notes. BMI = Body mass index.

Table 3. *Multiple hierarchical regressions with actual-ideal weight discrepancy and drive for muscularity as criterion variables.*

		Actual-ideal weight discrepancy					Drive for muscularity				
Step	Variable	B	SE	β	t	p	B	SE	β	t	p
Step 1		$F(2, 400) = 91.40$, $p < .001$, Adj. $R^2 = .31$					$F(2, 409) = 10.67$, $p < .001$, Adj. $R^2 = .05$				
	BMI	.16	.01	.56	13.43	< .001	.01	.10	.02	0.42	.675
	Age	.01	.01	.02	0.43	.668	-.03	0.01	-.23	-4.58	<.001
Step 2		$F(5, 397) = 44.58$, $p < .001$, Adj. $R^2 = .35$, ΔAdj. $R^2 = .04$, ΔF $p < .001$					$F(5, 406) = 6.35$, $p < .001$, Adj. $R^2 = .06$, ΔAdj. $R^2 = .01$, ΔF $p = .019$				
	BMI	.16	.01	.54	13.00	< .001	.01	.01	.01	0.26	.794
	Age	.01	.01	.02	0.41	.683	-.03	.01	-.22	-4.49	< .001
	Attention Regulation	.01	.11	.01	0.03	.974	-.11	.09	-.10	-1.29	.198
	Bodily and Emotional Awareness	-.02	.10	-.01	-0.22	.827	.19	.08	.17	2.26	.025
	Trusting	-.33	.01	-.21	-4.18	< .001	-.14	.07	-.14	-2.17	.030

Notes. Actual-ideal weight discrepancy was completed by women only ($n = 403$), drive for muscularity was completed by men only ($n = 412$).

BMI = body mass index.