In our daily lives, we use faces as a major source of information about other people. Recent work has begun to highlight how one's facial width-to-height ratio (fWHR) is linked to a number of behaviours, including deceptive behaviours, aggression and financial performance in firms. fWHR has also been linked to several factors that may be beneficial for sport, such as achievement drive, winning mentality and aggression. Despite this, few studies have examined the relationship between fWHR and sports performance, and these have focused on Caucasian sportsmen. Here, we investigated the relationship between fWHR and baseball performance in professional Japanese baseball players. We show that fWHR is positively related with home run performance across two consecutive seasons. These findings provide the first evidence linking fWHR to baseball performance and linking fWHR to behavioural outcomes in Asian participants.
Table 1. Correlations between fWHR and batting statistics in the 2011 season. When controlling for age and at-bats (normalized using Log_{10} transformation), HR, RBI and SLG were shown to have a positive correlation with fWHR (bold). Results without the control measures are also shown.

<table>
<thead>
<tr>
<th>batting statistic</th>
<th>no. control (d.f. = 102)</th>
<th>partial correlation, controlling for age and at-bats (d.f. = 100)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVG</td>
<td>r = 0.171, p = 0.083</td>
<td>r = 0.178, p = 0.074</td>
</tr>
<tr>
<td>H</td>
<td>r = 0.112, p = 0.256</td>
<td>r = 0.134, p = 0.178</td>
</tr>
<tr>
<td>HR</td>
<td>r = 0.250, p = 0.010</td>
<td>r = 0.266, p = 0.007</td>
</tr>
<tr>
<td>RBI</td>
<td>r = 0.176, p = 0.074</td>
<td>r = 0.211, p = 0.034</td>
</tr>
<tr>
<td>SLG</td>
<td>r = 0.206, p = 0.036</td>
<td>r = 0.201, p = 0.043</td>
</tr>
<tr>
<td>OBP</td>
<td>r = 0.137, p = 0.166</td>
<td>r = 0.165, p = 0.097</td>
</tr>
</tbody>
</table>

2. Experiment 1: 2011 season

(a) Material and methods

(i) Stimuli

Photographs of faces of Japanese professional baseball infield and outfield players in the Central League Pennant (one of two Japanese Professional Baseball Leagues) were collected. There were originally 120 players of Japanese nationality and origin playing in the 2011 season (duration: from 12 April 2011 to 25 October 2011). To account for the impact of games played, players who played fewer than 10 games in this season were excluded. This resulted in a final sample of 104 participants. All retrieved facial images were posed straight ahead, had neutral expressions and looked directly at the camera. Facial features of interest (i.e. left and right zygion (the most lateral point of cheekbone), upper lip and eyebrows in a face) were not obstructed by any object, shadow or hair.

(ii) Width-to-height ratio

We replicated the method of previous studies of fWHR to standardize images and measure facial ratios [3], such that collected faces were converted to 8-bit greyscale with a facial height of 400 pixels measured by IMAGEJ (National Institutes of Health open-source software). Facial height (from eyebrows to upper lip) and width (from left to right zygion) were then measured. fWHR was calculated by dividing the width by the height (data available via http://dx.doi.org/10.5061/dryad.rv857).

(iii) Baseball performance statistics

Baseball performance statistics were collected from a Japanese baseball database website retrieved from http://baseball-data.com/ (in Japanese). As we were only interested in basic batting performance, we focused on a relationship between fWHR and annual performance of batting average (AVG), number of home runs (HR), slugging percentage (SLG), hits (H), runs-batted-in (RBI) and on base percentage (OBP) in the season 2011 (see the electronic supplementary material, table S1 for a further explanation of these batting terms).

(b) Results and discussion

Preliminary analyses revealed a correlation between fWHR and age. A two-tailed Pearson correlation test revealed that fWHR was negatively correlated with age (r(102) = −0.243, p = 0.013). Further, there was a positive correlation between at-bats (broadly corresponding to the number of times the batter faces a pitcher—see the electronic supplementary material, table S1) and all batting statistics (p < 0.001 in all cases; electronic supplementary material, table S2). In view of this, we analysed the relationship between fWHR and each batting statistic controlling for age and at-bats using partial correlations. This revealed that fWHR was significantly positively correlated with HR, SLG and RBI (table 1). Thus, a greater fWHR of baseball players was associated with superior performance on specific batting outcomes. To further examine the test–retest validity of this effect, we conducted a second experiment examining the relationship between batting performance and fWHR in the 2012 season using data from players who played in both 2011 and 2012 seasons.

3. Experiment 2: 2012 season

(a) Material and methods

Using the same criteria as experiment 1, in experiment 2 we collected photographs of Japanese professional baseball players (Central League Pennant) who played at least 10 games in the 2012 season (duration: from 30 March 2012 to 9 October 2012). There were originally 116 Japanese players but this reduced to 102 players who met our criteria for games played. Of these 102 players, 81 players played both in 2011 and 2012 seasons, and their faces were selected for analysis (i.e. n = 81 for this study). Note that the results are consistent even if we include players who did not overlap with our 2011 sample (see the electronic supplementary material, table S3).

(b) Results and discussion

In the same way as experiment 1, we first identified a negative correlation between fWHR and age (r(79) = −0.252, p = 0.023), and a positive correlation between at-bats and other batting statistics (p < 0.001 in all cases; electronic supplementary material, table S2).

As per the 2011 season, we therefore analysed the relationship between fWHR and each batting statistic controlling for age and at-bats. A partial correlation analysis using a two-tailed Pearson correlation test was used. This revealed that fWHR was only positively correlated with HR (table 2). Thus, fWHR was shown to correlate with HR performance consistently across two seasons.
Table 2. Correlations between fWHR and batting statistics in the 2012 season for players who also played in the 2011 season. When controlling for age and at-bats (normalized using Log 10 transformation), HR was found to have a positive correlation with fWHR (bold). Results without the control measures are also shown.

<table>
<thead>
<tr>
<th>batting statistic</th>
<th>no. control (d.f. = 79)</th>
<th>partial correlation, controlling for age and at-bats (d.f. = 77)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVG</td>
<td>$r = 0.052, p = 0.645$</td>
<td>$r = 0.030, p = 0.793$</td>
</tr>
<tr>
<td>H</td>
<td>$r = 0.054, p = 0.632$</td>
<td>$r = -0.006, p = 0.956$</td>
</tr>
<tr>
<td>HR</td>
<td>$r = 0.219, p = 0.050$</td>
<td>$r = 0.230, p = 0.042$</td>
</tr>
<tr>
<td>RBI</td>
<td>$r = 0.137, p = 0.223$</td>
<td>$r = 0.177, p = 0.120$</td>
</tr>
<tr>
<td>SLG</td>
<td>$r = 0.201, p = 0.072$</td>
<td>$r = 0.176, p = 0.121$</td>
</tr>
<tr>
<td>OBP</td>
<td>$r = 0.071, p = 0.528$</td>
<td>$r = 0.081, p = 0.478$</td>
</tr>
</tbody>
</table>

4. General discussion

Collectively, these findings revealed a consistent association between home run performance (HR) and fWHR of professional Japanese baseball players across two consecutive baseball seasons; baseball players who recorded superior HR had a larger fWHR (i.e. a wider face relative to height) each year. There was no such relationship between other batting performance measures (e.g., H, AVG and OBP) over each season, although some other statistics (RBI and SLG) showed some correlations in the 2011 season. The current study, therefore, highlights that fWHR is one perceptual measurement that relates to HR performance of professional Japanese baseball players.

These findings contribute to our understanding of the relationship between fWHR and human behaviour in a number of ways. First, the findings show a relationship between fWHR and professional success of in/outfield baseball players. In this context, the present findings extend prior work reporting links between fWHR and achievement in other professional domains (e.g., finance [5]; political races [10]), by showing that fWHR may also serve as a predictor for successful performance in some sporting professions. The mechanisms underlying the relationship between fWHR and batting performance remain to be determined. The fWHR–batting performance link might be explained by the factors that have previously been linked to fWHR, including predictability of certain physical attributes (e.g., grip strength [8]) or certain social traits [10]. Each of these factors may be mediated by the putative relationship between fWHR and levels of testosterone [6]. For example, some suggest that behavioural effects of testosterone may manifest as the motivation to achieve status [12] or coarse physical strength [13], and it is feasible that these factors may mediate the relationship between batting performance and fWHR observed here.

Second, the findings link fWHR to behavioural outcomes in an Asian sample. To our knowledge, this is the first study to do so and this extends prior work on fWHR performance correlates that have typically been conducted on mainly Caucasian samples. In doing so, the findings imply that fWHR correlates of performance may be generalizable across cultures and that there might be a universal developmental pattern of human face structure that is related to specific behavioural outcomes. It will be interesting for future studies to examine other behavioural outcomes that have been linked to fWHR across different ethnic groups and to determine the trajectory of these correlates throughout development.

In this context, it also is interesting to note that we observed a negative relationship between age and fWHR. To our knowledge, this has not been previously reported explicitly in studies of fWHR, but one implication of this is that age-related controls would be useful to correct fWHR–behaviour relationship in future studies. It remains to be determined, however, whether the negative relationship between age and fWHR observed is specific to our sample of Japanese professional baseball players or extends across different samples. This is an interesting future direction for studies on fWHR.

In sum, here, we show that HR performance of professional Japanese baseball players is consistently associated with fWHR over two baseball seasons. In doing so, we highlight the potential contribution of fWHR to baseball performance and a link between fWHR and behavioural outcomes in an Asian sample.

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7. Kramer RS, Jones AL, Ward R. 2012 A lack of sexual dimorphism in width-to-height ratio in white European faces using 2D photographs, 3D scans,


