Objective Versus Subjective Measures of Face-Drawing Accuracy and Their Relations With Perceptual Constancies

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We investigated spatial errors nonartists make when drawing a face and the relationships between such errors with measures of perceptual constancies. Participants completed an observation-based free-hand drawing of a face, plus shape and size constancy tasks. Drawings were objectively measured with respect to errors in reproducing spatial relations among facial features as well as subjectively assessed using independent judges' Likert scale-based holistic accuracy ratings. Results revealed systematic (rather than random) errors in the spatial relations between facial features. Further, although holistic accuracy ratings were negatively correlated with shape and size constancy errors, only some objectively measured spatial drawing errors were reliably correlated with the constancy measures. This suggests that holistic accuracy measurements may be too simplified for understanding the relationship between drawing accuracy and performance in nondrawing perceptual tasks, and that objective accuracy measures represent a useful complementary index of performance.

Keywords: face drawing, perceptual constancies, objective measurements

Empirical investigations into observational drawing behaviors have become a burgeoning area of study in cognitive psychology. Typically the aim of such investigations is to determine what psychological processes contribute to the widespread prevalence of errors in realistically reproducing an external model stimulus.

ever, a few studies using objective measures of face drawings by adult artists or children provide some clues. For instance, two although such anecdotal speculations have thus far not been subjected to strong empirical evaluation.

The second question this study aims to answer is whether subjective and objective measures of drawing accuracy are related to one another. Despite the common use of subjective ratings for assessing drawing accuracy, we lack a strong understanding of what types of drawing errors influence accuracy judgments. Although this study by no means intends to be an exhaustive investigation of the types of face drawing errors that influence subjective accuracy ratings, we do anticipate that many objectively measured errors in the drawing of spatial relationships between facial features will be negatively correlated with subjective accuracy ratings. As mentioned above, a subjective accuracy rating is a judgment of how well a drawing represents a recognizable depiction of a model stimulus. Individuals appear highly sensitive to changes in the vertical positioning of the eyes and mouth and the horizontal distance between the eyes for both novel and familiar faces (Haig, 1984; Hosie, Ellis, & Haig, 1988). Therefore, we expect that subjective accuracy ratings of drawings should also be sensitive to the accuracy in which the spatial relations between facial features are reproduced. What is more open to question is the strength of the relationship between subjective accuracy ratings and the objectively measured errors in drawing various spatial relationships between facial features.

The final question this study aims to evaluate is whether objectively measured spatial errors in face drawings are predicted by individuals' experience of perceptual constancy errors. Despite findings that subjectively rated drawing accuracy is negatively correlated with shape (Cohen & Jones, 2008) and size constancy
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numerical rating with respect only to the realistic accuracy of the drawing and to not rate the drawings based on any other criteria, like aesthetic or creative factors. To control for any idiosyncratic biases in the judges' use of the 20 point scale, we transformed each judges' set of ratings into *z* scores. Interjudge agreement was high (Cronbach's $\alpha = .972$), so *z* scores were averaged across judges to create a single subjective accuracy rating score for each drawing.

Objective measures of drawing accuracy in the free-hand drawing task. Next, we made 12 spatial measurements (in centimeters) of the model face photograph and each drawing (see Figure 2 for a representation of the 12 different spatial measurements, A through L). We measured: (a) the length of the head from the top of the head (including hair) to the bottom of the chin, (b) the width of the face (with landmark points being at the point of the image where it appeared that the upper part of the ear connected to the side of the face), (c) the vertical distance from the top of the head to the middle of the eye-line (if the eye-line was not perfectly horizontal, the vertical distance between the top of the face and the midpoint between the two eyes was measured), (d) the distance between the two outer corner of the eyes, (e) the diagonal distance between the outer corner of the left eye (from the observer's perspective) and the center of the bottom of the lower lip, (f) the diagonal distance between the outer corner of the right eye (from the observer's perspective) and the center of the bottom of the lower lip, (g) the width of the eyes (the width of both eyes were measured and averaged to create one width measurement), (h) the interocular distance between the two inner corners of the eyes, (i) the width of the nose, (j) the horizontal distance between the outer corner of the left eye and the left side of the face (from the observer's perspective), (k) the horizontal distance between the outer corner of the right eye and the right side of the face (from the observer's perspective), and (l) the vertical distance between the center of the bottom of the lower lip and the bottom of the chin. We then calculated 13 ratios that quantified most of the spatial relations that Hamm (1963) proposed were the most important to attend to while drawing (defined and described in Figure 2, along with values of these ratios with respect to the model face photograph). Spatial drawing errors with respect to each ratio were defined as:

$$\text{Spatial Drawing Error Ratio} = \text{Drawing Ratio} / \text{Model Ratio}$$

Interpretations of the direction of error are specific to each ratio and are explained in Table 1.

Results

Patterns of Spatial Errors in Face Drawings

Average values for each spatial measurement ratio and the average spatial drawing errors are displayed in Table 2. The first question we addressed was whether the spatial errors participants made in their drawings were random or systematic. To determine this, 13 single-sample *t* tests were conducted, comparing each average spatial drawing error against a value of 1.[6]

These analyses provide evidence for multiple systematic spatial biases in the face drawings. First, we found that participants systematically drew the head as more circular than the model, B/A ratio: $t(45) = 5.33$, $p < .001$, Cohen's $d = .79$. There was also a bias to draw the eye line farther up the head than in the model, C/A ratio: $t(45) = -9.47$, $p < .001$, Cohen's $d = 1.40$. We also observed a bias for participants to draw the interocular distance as larger than in the model, H/B ratio: $t(45) = 6.11$, $p < .001$, Cohen's $d = .90$. Participants also drew both eyes closer to the sides of the face than in the model, J/B ratio: $t(45) = -3.80$, $p < .001$, Cohen's $d = .56$; K/B ratio: $t(45) = -3.57$, $p < .01$, Cohen's $d = .53$. The diagonal distance between the outer corner of the eye and the bottom of the lower lip was shorter than in the model for both the left eye, E/D ratio, $t(45) = 2.14$, $p < .05$, Cohen's $d = .32$, and the right eye, F/D ratio, $t(45) = 2.07$, $p < .05$, Cohen's $d = .30$. There was also a bias to draw the nose as more narrow than in the model, I/B ratio: $t(45) = -4.39$, $p < .001$, Cohen's $d = .65$. Finally, participants drew the bottom of the lower lip farther up the head than in the model, L/A ratio: $t(45) = 5.42$, $p < .001$, Cohen's $d = .80$. The remaining average spatial drawing error ratios were not reliably different from 1 (all $p > .05$).

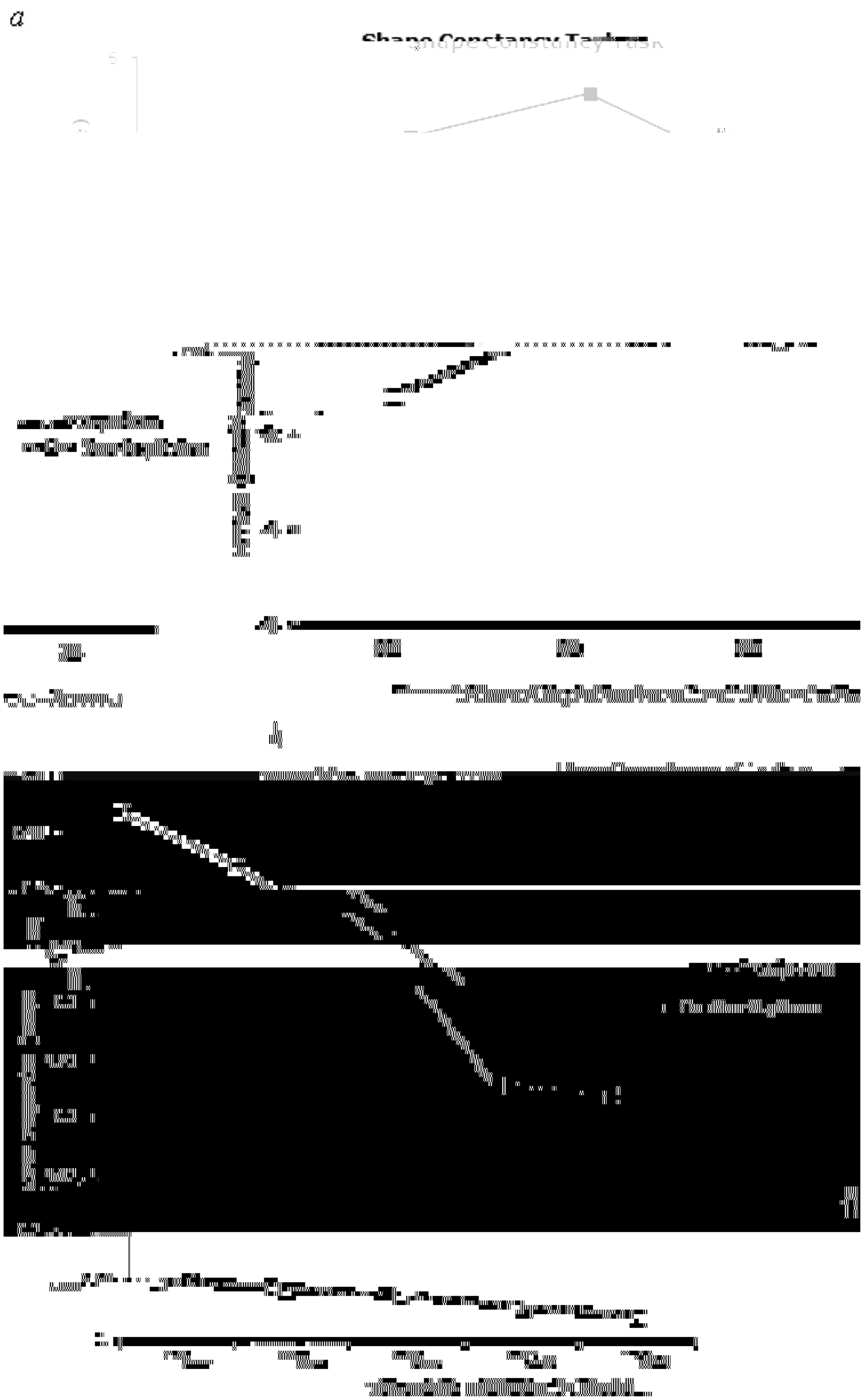
Relationship Between Objective and Subjective Measures of Drawing Accuracy

Next, we wished to determine whether the objective measures of spatial drawing accuracy were related to the independent judges' subjective ratings of drawing accuracy. We recalculated the objective spatial drawing errors as the absolute difference between the spatial relation ratio value of the drawing and the model for each of the 13 spatial relation ratios. Then, we conducted a

cue conditions at each target shape.[7] Results indicated that errors in the depth cue condition were reliably larger than errors in the nondepth cue condition for each target shape (all $p <$ .001). However, between-condition effects reliably differed across target shapes, being greatest for the 65 degree target shape and smallest for the 26 degree target shape.

not with errors made in the nondepth cue version, $r(44) = -.117$, $p = .44$. Similarly, with respect to the size matching task, drawing accuracy was reliably correlated with errors made in the depth cue version, $r(41) = -.488$, $p < .001$, but not with errors made in the nondepth cue version, $r(41) = -.089$, $p = .57$.

Finally, as a preliminary exploratory analysis, we assessed whether perceptual constancy effects were related to objectively measured spatial drawing errors. Correlations between the objective spatial drawing errors and the four perceptual task errors are displayed in Table 4. With respect to the objectively measured spatial drawing errors, errors made in the depth-cue version of the shape matching task were reliably correlated with the C/A ratio errors (vertical position of the eye line), $r(44) = .340$, $p < .05$, the E/F ratio errors (representing the difference in outer corner of eye-bottom of the lower lip distances between the left and right eyes), $r(44) = .309$, $p < .05$, the L/A ratio errors (the vertical position of the bottom lip), $r(44) = .306$, $p < .05$, and the I/B ratio errors (the width of the nose), $r(44) = .423$, $p < .01$. Errors made in the nondepth cue version of the shape matching task were reliably correlated with H/B ratio errors (inTfrs(itances



ular properties of a model have a beneficial effect on observational drawing accuracy (

ence of perceptual constancy effects relating to shape and size. As mentioned in the Introduction, the misperception theory of drawing accuracy posits that errors in drawing are caused by perceptual transformations that operate on the retinal image. One prediction derived from this proposition is that individuals capable of producing accurate drawings should be able to more accurately perceive the veridical properties of a visual stimulus relative to individuals who are not as capable of drawing accurately. This prediction has been supported in the past by studies that have reported negative correlations between subjectively judged drawing accuracy and the degree to which people experience shape constancy errors (Cohen & Jones, 2008, but see our Footnote 1) and size constancy errors (Ostrofsky, Kozbelt, & Seidel, 2012). Our findings replicated these observations, as subjective ratings of drawing accuracy were negatively correlated with errors made in the depth-cue versions, but not in nondepth-cue versions, of the shape and size matching tasks. Such findings suggest that subjectively judged drawing accuracy appears to be related to perceptual constancy errors that are generated by concurrently processing depth cue information along with the shape and size information of the target stimuli.

Moving beyond subjective accuracy ratings, we also investigated how objectively measured spatial drawing errors might be related to errors made in the depth and nondepth cue conditions of the size and shape perceptual matching tasks. Because of the exploratory nature of this analysis, some caution is in order in interpreting the precise values of the observed correlation coefficients. However, some observations suggest something about the

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