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BRIEF REPORT

Face processing skills predict faithfulness of portraits drawn by novices

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Abstract

Individuals show astonishing variability in their face recognition abilities, and the causes and consequences of this heterogeneity are unclear. Special expertise with faces, for example in portraitists, is associated with advantages on face processing tasks, especially those involving perceptual abilities. Do face processing skills improve through practice, or does drawing skill reflect pre-existing individual differences? If the latter, then the association between face processing skills and production of faithful portraits should also exist in people without practice in drawing. Two exploratory studies and one follow-up confirmatory study provide support for this hypothesis. Drawing ability of novices was predicted by their performance on face recognition tasks involving perceptual discrimination and visual short-term memory, but not by those that rely more heavily on long-term memory or memory for non-face objects. By examining non-experts, we show that expertise with faces might build upon pre-existing individual differences in face processing skills.

Keywords Drawing · Expertise · Individual differences · Face processing · Perceptual discrimination · Plasticity

Recent studies show large heterogeneity in face processing skills (Bobak, Pampoulov, & Bate, 2016; Russell, Duchaine, & Nakayama, 2009). Special expertise with faces, which correlates with face processing abilities (e.g., in artists, Devue & Barsics, 2016; in forensic examiners, White, Phillips, Hahn, Hill, & O'Toole, 2015), is one possible source of heterogeneity. Expertise in portraiture is associated with enhanced face processing skills related to perceptual processes also involved in drawing (i.e., perceptual discrimination and visual short-term memory), but not with long-term memory performance (i.e., recognition of celebrities), suggesting that artists' expertise is specifically related to their practice (Devue & Barsics, 2016). However, these correlations do not indicate whether artistic practice enhances specific face-related skills useful in portraiture, or if pre-existing superior skills encouraged artists to pursue their career. A recent study supports the second hypothesis: art students' face processing skills do not improve after 8 months' training in life drawing (Tree, Horry, Riley, & Wilmer, 2017), presumably due to limited neural plasticity in face-sensitive cortical areas. Artists' advantages may thus reflect stable individual differences in face processing ability, independent of expertise (Wilmer et al., 2010).

To assess the potential for pre-existing skills to support the development of face expertise, we explored associations between portrait drawing and face processing skills in untrained drawers. Portrait drawing provides a unique indicator of face perception abilities; it requires not only extraction of facial features, but also selection and reproduction of those most characteristic of the subject. Untrained drawers generally draw faces and bodies highly inaccurately (Balas & Sinha, 2007; Tchalenko, 2009), while artists are better at selecting key facial features to create a likeness of a model (Kozbelt, Seidel, ElBassiouny, Mark, & Owen, 2010), and produce more faithful portraits (Devue & Barsics, 2016). Yet, if artists' portrait drawing abilities are built on a foundation of stable facial discrimination skills, we should observe associations between these two sets of skills *even within untrained individuals*.

In three studies, we measured correlations between face processing skills of novice drawers (and artists in Study 1) and faithfulness of portraits and houses drawn from photos. Artists' better perceptual skills are not limited to faces (Devue & Barsics, 2016; Kozbelt, 2001), so if the ability to produce faithful portraits relies on non-face-specific perceptual abilities, associations may also exist between face processing skills and faithfulness in drawings of houses.

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Study 1

Methods

We conducted new analyses of data collected in Devue and Barsics (2016)'s study comparing portrait artists to novices. Here we report only the procedures relevant to test hypotheses; an exhaustive description of all tasks can be found in the original publication.

Face processing evaluation and drawing phase Although the focus of this study is on novice drawing, we present analyses on artists for comparison purposes. Portraits and drawings of houses were obtained from 11 artists (4 women, mean age = 26 years, SD = 3.9) and 11 matched novices (4 women, mean age = 26 years, SD = 2.8) instructed to reproduce photographic models as faithfully as possible, on A4 sheets of paper with a black pen, in a 5-min period. Drawings were scanned, cropped to the same ratio so as to frame the sketch, and resized (325 x 450 pixels for faces and 450 x 325 pixels for houses). Darkness of the pen strokes was adjusted so that visibility was similar across the set.

Drawers' face processing skills were measured after the drawing task with a battery of tests, including the Cambridge Face Perception Test (CFPT, Duchaine, Germine, & Nakayama, 2007), the Cambridge Face Memory Test long form (CFMT+, Russell et al., 2009), the Australian version of the CFMT (McKone et al., 2011), and a famous person recognition test (Barsics & Brédart, 2012). The CFPT measures perceptual discrimination of faces; participants arrange a series of faces morphed to different degrees with a target face, from the most similar to the least similar. Lower scores indicate better performance (i.e., smaller deviations from the correct order). The two versions of the CFMT measure ability to learn six faces and recognize (immediately after the learning phase) novel exemplars of these individuals presented alongside two foils. The familiar person recognition test presents short video clips of 32 celebrities and 32 foils, and taps into long-term memory abilities (note that one novice did not complete this task).

Rating phase The 44 drawings were rated by 12 independent judges with no professional expertise in visual arts (six women, mean age = 25.6 years, SD = 3.2) in terms of faithfulness to the photographic model and aesthetic value on 7-point Likert scales (1 = not at all faithful/beautiful; 7 = very faithful/beautiful).[1] The 22 portraits and 22 drawings of houses were presented randomly alongside the relevant photographic model in separate blocks (with order counterbalanced). In order to make comparative ratings, judges passively viewed the full set of drawings in each block for 3 s each before providing ratings for each drawing individually.

Results

We excluded CFPT data of one novice who did not follow instructions. Average ratings are shown in Table 1, and the full set of portraits is visible in Fig. 1. We measured inter-rater reliability separately for portraits and drawings of houses with Intraclass correlations, a measure of consistency based on a two-way random effect model (Landers, 2015; Shrout & Fleiss, 1979). It was high (> .90) for both portraits and houses (see Table 1). Associations between drawing faithfulness and face processing skills were measured with Pearson's correlations (2-tailed) (see Table 2).

Novice drawers There were strong associations between portraits' faithfulness and performance on the two versions of the CFMT, r_{CFMT+} = .787, p = .004, $r_{CFMT\ Australian}$ = .856, p = .001, and a non-significant association in the same direction with the CFPT, r = -.230, p = .523. In contrast, portrait faithfulness was not associated with performance on famous person recognition (hit rates - false alarm rates) that relies more heavily on long-term memory, r = -.014, p = .967.

Faithfulness of drawings of houses was predicted by performance on the CFMT Australian, r = .743, p = .009, and marginally by CFPT scores, r = -.612, p = .060, which suggests that common processes (e.g., selection of distinguishing features) are involved in face recognition, portraiture, and the ability to accurately reproduce other objects. Consistently, novices who produced more faithful portraits also drew more faithful houses, r = .622, p = .041.

Artists Although artists had better face processing skills than novices (Devue & Barsics, 2016), Table 2 shows that portrait faithfulness did not significantly predict their face processing skills, or faithfulness of houses. Presumably, artists form a relatively homogenous subsample of the general population who have better face processing skills, and who also create better portraits, leaving less variance for revealing associations. However, associations in artists were consistent in direction with those in controls, except for the CFPT, suggesting that the small sample has low power.

Study 2

Study 2 replicates and extends Study 1 with a larger set of novices' drawings. We also obtained new ratings of the drawings from Study 1, unaffected by the presence of artists' drawings. We collected drawings and measured face recognition

[1] The aesthetic judgment was meant to discourage judges from confounding faithfulness with other qualities of the drawings, but does not have theoretical relevance here. We present descriptive statistics for the sake of completeness in Table 1.

Table 1 Artists' and novice drawers' mean (standard deviations in italics) performance on drawing and face/car processing tasks, and measures of consistency

	Study 1 (artists)	Study 1 (novices)	Study 2 (novices Study 1)	Study 2 (new novices)	Study 2 (total)	Study 3 (novices)
N drawers	11	11	11	20	31	98
Faithfulness portraits	3.77 ± *1.32*	2.11 ± *.65*	2.63 ± *.93*	2.84 ± *.56*	2.77 ± *.71*	2.59 ± *.62*
Faithfulness houses	5.20 ± *.90*	4.02 ± *.95*	3.67 ± *.77*	3.29 ± *.77*	3.42 ± *.78*	3.48 ± *.69*
Aesthetic value faces	4.20 ± *1.35*	1.86 ± *.90*	2.53 ± *.88*	2.48 ± *.53*	2.50 ± *.66*	2.31 ± *.63*
Aesthetic value houses	4.31 ± *1.32*	2.49 ± *.76*	3.31 ± *.88*	2.94 ± *.72*	3.07 ± *.79*	2.97 ± *.70*
CFPT	28 ± *8.94*	33.60 ± *7.59*	33.60 ± *7.59*	34.10 ± *9.23*	33.93 ± *8.59*	36.17 ± *10.85*
CFMT+	79.15 ± *9.23*	71.30 ± *11.67*	71.30 ± *11.67*	67.94 ± *13.11*	69.13 ± *12.53*	-
CFMT Australian	88.38 ± *7.91*	80.18 ± *12.16*	80.18 ± *12.16*	-	-	77.48 ± *11.08*
Recognition famous faces	.72 ± *.20*	.79 ± *.16*	.79 ± *.16*	-	-	-
CCMT	-	-	-	71.53 ± *14.35*	-	68.45 ± *12.65*
		Study 1	**Study 2**	**Study 3**		
Intraclass correlation portraits		.946	.969	.976		
Intraclass correlation houses		.920	.974	.979		

Notes. Ratings of faithfulness and aesthetic value of portraits and drawings of houses (1 = not at all faithful/beautiful, 7 = very faithful/beautiful) were obtained from independent judges (12 in Study 1, 72 in Study 2, and 102 in Study 3); CFPT: Cambridge Face Perception Test (mean deviation from correct order); CFMT: Cambridge Face Memory Test (accuracy in %); Recognition of famous faces is measured by subtracting false alarm rates from hit rates; CCMT: Cambridge Car Memory Test (accuracy in %). Intraclass correlation measures inter-rater reliability of faithfulness ratings. Eleven drawings of each category were collected in Study 1, and 20 more in Study 2. The total set of 31 pairs of drawings was rated by new judges in Study 2. Study 3 includes 94 portraits and 97 drawings of houses after exclusion of incomplete drawings with inconsistent ratings. Standard deviations are in italics.

ability in 20 new drawers, and a new set of judges rated the drawings from all 31 novices.

Methods

Face processing evaluation and drawing phase We collected new drawings as supplementary data, when time constraints allowed, from a subsample of 20 participants with no artistic education or practice in figurative drawing (11 women, mean age = 23.85 years, SD = 8.09) involved in other experiments examining individual differences in face processing (Devue, Wride, & Grimshaw, in preparation). All drawers first completed a battery of tests including the CFMT+, the CFPT, and the Cambridge Car Memory Test (CCMT, Dennett et al., 2012). This latter is similar to the CFMT but presents cars instead of faces and acts as a control for memory of non-face stimuli. Sample size was limited by numbers participating in the main study and time constraints.

Participants drew a face and a house from photos in conditions similar to those in Study 1. The 40 drawings were added to the novices' drawings from Study 1, producing a set of 31 portraits and 31 drawings of houses. Note that although this new set of drawings contains 11 pairs of drawings from Study 1, all the drawings received completely new ratings, ensuring no full data duplication across the two studies.

Rating phase In order to avoid ratings biased by individual differences in face processing skills in judges themselves, we recruited more judges than in Study 1 (N = 103, 82 women, mean age = 18.53 years, SD = 1.2). All were first year psychology students and provided ratings through an online platform (Testable.org) against course credits. A calibration screen at the start ensured that pictures were fully visible for all participants at similar aspect ratios. As in Study 1, participants first passively viewed the whole set of drawings (portraits and houses in separate blocks), for 3 s each, before rating the faithfulness and aesthetic value of each drawing via two 7-point Likert scales. Because ratings were made in uncontrolled environments, we used the rating given to the least faithful drawing in Study 1 (mean rating = 1.25, SD = 0.6, see Fig. 1) to determine whether participants followed instructions. We excluded 11 judges who gave ratings of 3 or above to this drawing, suggesting that they were not doing the task, or were using the scale in the wrong direction. Further, we excluded 20 judges who reported education or practice in visual arts to avoid including ratings that might be biased by the skilled detection of drawing inaccuracies. The final sample consisted of 72 judges (54 women; mean age = 18.5 years, SD = 1.13).

Results

The inter-rater reliability indexed by Intraclass correlations was high (> .96), see Table 1. Table 2 shows that we largely replicate results from Study 1.[2] Performance on face

[2] Ratings collected via completely different sets of judges in Study 1 and in Study 2 for the 11 novices' portraits from Study 1 were strongly correlated, $r = .842$, $p = .001$.

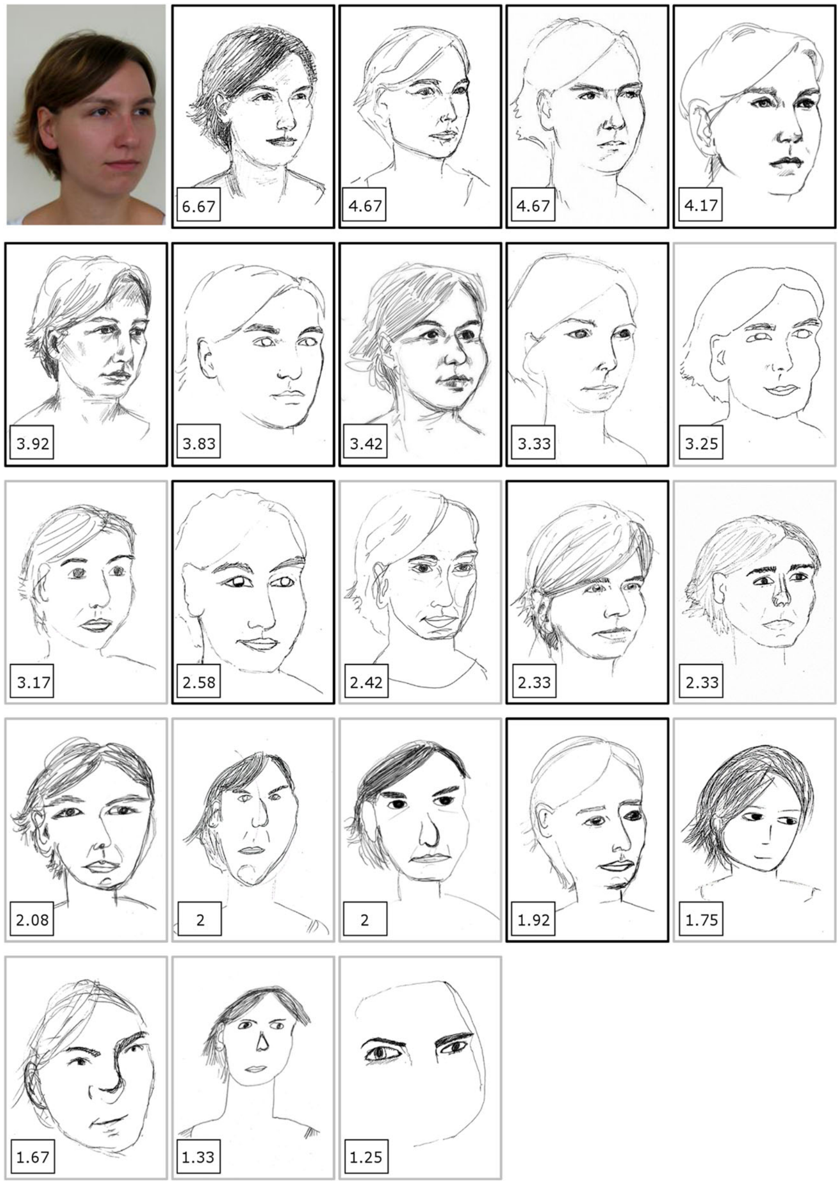

Fig. 1 Photographic model (top left) and portraits drawn by artists (black frames) and novices (grey frames) in Study 1. Portraits are arranged from the most faithful to the least faithful (reading direction) according to ratings from 12 independent judges, blind to the drawers' expertise status. Mean ratings appear in each box

processing tasks that rely on perceptual memory and discrimination predicted faithfulness of novices' portraits; $r_{\text{CFMT+}}$ = .412, p = .021; $r_{\text{CFMT Australian}}$ = .782, p = .004; r_{CFPT} = -.336, p = .070; however, a task relying on long-term memory did not, $r_{\textit{famous face}\ \text{recognition}}$ = .105, p = .773.

Performance on the CFPT also tended to predict faithfulness of drawings of houses, r = -.331, p = .074, again pointing to common processes shared by face discrimination and observational skills involved in drawing faces and other subjects. Novices who drew more faithful portraits also drew more faithful houses, r = .375, p = .038. By contrast, performance on the Cambridge Car Memory Test (CCMT) was unrelated to faithfulness of any of the drawings, both ps > .917, consistent with the observation that the CFMT and the CCMT tap into distinct processes (Dennett et al., 2012).

Study 3

Studies 1 and 2 exploited data collected as part of other projects to explore the association between drawings' faithfulness and face processing skills. Based on these findings, we conducted a third confirmatory study to directly test this association.

Table 2. Associations between drawing faithfulness and performance on face/car processing tests

	N drawers included	1.	2.	3.	4.	5.	6.
Study 1 - Artists							
1. Faithfulness portraits		-					
2. Faithfulness houses	11	.343	-				
3. CFPT	11	**.290**	.294	-			
4. CFMT+	11	**.447**	.072	-.252	-		
5. CFMT Australian	11	**.319**	.019	-.687*	.277	-	
6. Recognition famous faces	11	**-.410**	-.020	-.645*	.164	.478	-
Study 1 - Novices							
1. Faithfulness portraits		-					
2. Faithfulness houses	11	.622*	-				
3. CFPT	10	**-.230**	-.612†	-			
4. CFMT+	11/11/10	**.787****	.244	-.111	-		
5. CFMT Australian	11/11/10/11	**.856*****	.743**	-.445	.756**	-	
6. Recognition famous faces	10	**-.014**	.003	-.038	.183	-.127	-
Study 2 - All novices (Study 1 + Study 2)							
1. Faithfulness portraits		-					
2. Faithfulness houses	31	.375*	-				
3. CFPT	30	**-.336†**	-.331†	-			
4. CFMT+	31/31/30	**.412***	.185	-.364*	-		
5. CFMT Australian	11/11/10/11	**.782****	.469	-.445	.756**	-	
6. Recognition famous faces	10	**.105**	-.044	-.038	.183	-.127	-
Study 2 - New subsample							
1. Faithfulness portraits		-					
2. Faithfulness houses	20	.226	-				
3. CFPT	20	**-.366**	-.313	-			
4. CFMT+	20	**.409†**	.222	-.454*	-		
5. CCMT	20	**.025**	.024	-.108	.464*	-	
Study 3							
1. Faithfulness portraits		-					
2. Faithfulness houses	93	.498***	-				
3. CFPT	90/93	**-.177***	-.071	-			
4. CFMT Australian	94/97/94	**.190***	.208*	-.371**	-		
5. CCMT	94/97/94/98	**.060**	-.079	-.242*	.339**	-	

Notes. The table shows correlation matrix (Pearson's *r*) for faithfulness of portraits, and faithfulness of drawings of houses, both rated by independent judges (12 in Study 1, 72 in Study 2, and 102 in Study 3), and performance on a battery of tests.

CFPT Cambridge Face Perception Test, *CFMT* Cambridge Face Memory Test, *CCMT* Cambridge Car Memory Test.

N for different correlations vary because of missing data (see main text for exclusion criteria). Correlations relevant to hypotheses are bolded; underlined associations were assessed with one-tailed test based on pre-registered analyses.

***$p < .001$, **$p < .01$, *$p < .05$, †$p < .1$.

Methods

This study was pre-registered (http://aspredicted.org/blind.php?x=324xq3).[3]

Face processing evaluation and drawing phase Results of Study 2 indicate that a sample of 87 participants would have power of .95 to test the weakest observed association of interest (i.e., between CFPT and portrait faithfulness; r = -.336, one-tailed). To anticipate for data loss, we tested 104 participants (56 women; 103 first year psychology students at VUW, who received course credits, and one colleague), aged between 18 and 36 years (mean = 19.55 years, SD = 2.4). They were tested in groups of up to four in individual booths. The procedure was similar to that in Study 1, except that after drawing the house and the portrait, participants completed the CFMT Australian (shorter than the CFMT+ and no overlapping faces with the CFPT), the CFPT, and the CCMT. Finally, their experience in arts was verified via two questions. The resulting 208 drawings were processed as described above.

Rating phase We recruited 147 judges via social media (N = 18) and Mechanical Turk (N = 129). They all rated the full set of 208 drawings, plus one control item (i.e., the least resembling face from Study 1), following the same online procedure

[3] Contrary to initial plans laid out in the pre-registration, we decided not to analyse data on aesthetic ratings that would not advance the theoretical understanding of our main question, and only had methodological purposes (see note 1). We also decided that comparing strengths of associations between face processing and faithfulness of portraits and houses would put us at risk of spurious findings at this stage. While Table 2 shows that faithfulness for both portraits and houses correlates with face processing skills, the relative strength of the associations varies from one study to another.

as in Study 2, except that drawings of each category were all shown for only 1 s each before conducting the individual ratings. We excluded 45 participants who reported education or practice in visual arts (N = 21) and/or familiarity with the model (N = 7) on probe questions after the ratings, and/or who gave ratings of 3 or more to the control item (N = 31). The final sample comprised 102 judges (51 women) aged between 19 and 71 (mean = 35.8 years, SD = 10.5).

Results

We excluded data from four drawers who reported drawing regularly (5 or more on a 7-point Likert scale; N = 3) or who had received formal education in visual arts (N = 1). Because a subset of drawings was incomplete, we first examined individual mean inter-item correlations to check whether individual drawings' faithfulness was rated consistently. For portraits, six drawings were rated very inconsistently and had outlier (≤ 2 SD) mean inter-item correlations compared to the mean of all portraits (mean r = .388, SD = .078). These portraits all lacked important facial features and were excluded from further analyses, leaving 94 portraits. Three drawings of houses were rated very inconsistently and had outlier mean inter-item correlations compared to other drawings (mean r = .417, SD = .059) and were excluded, leaving 97 drawings. Again, these three drawings lacked internal features (i.e., windows and door) and two originated from drawers who also produced incomplete portraits. Intraclass correlations were high (> .97) indicating excellent overall consistency. Finally, we excluded CFPT data of 4 participants who had not followed instructions adequately. Results are shown in Table 1 and Table 2.

Replicating findings from Studies 1 and 2, confirmatory analyses show that portrait faithfulness predicted performance on the CFMT Australian, r = .190, p = .033 (one-tailed), and on the CFPT, r = -.177, p = .048 (one-tailed). Scores on the CFMT Australian also predicted faithfulness of houses, r = .208, p = .041, and again, people who drew faithful houses also drew better portraits, r = .498, p < .001. In contrast, there was no significant association between faithfulness of portraits or houses, and performance on the CCMT, r = .060, p = .567, and r = -.079, p = .440, respectively. Associations were all weaker than in Studies 1 and 2. This will be partly accounted for by less controlled environments in which drawings and their ratings were collected. Moreover, small samples in Studies 1 and 2 may have led to overestimates of the actual effect size (Lakens & Albers, 2017).

General discussion

In three studies, we found significant associations between face processing skills and the faithfulness of portraits in people completely untrained in drawing, let alone portraiture. Although people often claim that "they can't even draw a straight line", good face processing skills predict the ability to produce a good facial likeness, and this association might reflect stable individual skills independent of expertise. In other words, advantages observed in portrait artists may be built on pre-existing superior skills.

Similar to group-level differences between artists and novices (Devue & Barsics, 2016), analyses of individual differences within novices show that it is those face processing skills involving perceptual and short-term memory skills, but not long-term face memory, that predict the production of faithful portraits. These associations can be difficult to uncover within experts when they perform close to ceiling on tasks testing their field of expertise. Our approach focusing on novices suggests that good face processing skills might effectively provide the foundation to engage in expert artistic practice, which in turn may improve craftsmanship (e.g., respect for anatomy and perspective laws).

Interestingly, performance on face processing tasks also predicts faithfulness of drawings of houses. Face processing tasks might thus tap into perceptual skills (e.g., selection of key/diagnostic features, Kozbelt et al., 2010) that are supported by cortical areas devoted to fine-tuned discrimination of both faces *and* other objects (e.g., Harel, Kravitz, & Baker, 2013; McGugin, Newton, Gore, & Gauthier, 2014), and are applicable to faithful reproduction of faces and other objects. By contrast, tasks that assess perceptual memory for cars do not predict drawing abilities, indicating that more general perceptual memory skills involved in object recognition are less critical for drawing faithfully.

Our findings suggest several directions for further study. First, we have shown an association at a behavioral level; further investigations will be useful for identifying the specific cognitive and neural mechanisms that support this relationship. Neuroimaging, for example with voxel-based morphometry, could be used to determine whether individual differences observed here are reflected in face-sensitive cortical areas (Bukach et al., 2012), which are also recruited when people draw simple cartoon faces (Miall, Gowen, & Tchalenko, 2009). Our findings also point to a potential use for portrait drawing tasks in applied settings (i.e., forensic or recruitment situations in which good face processing skills are desirable) as an additional marker of skills, since people have poor insight into their face processing abilities (Palermo et al., 2017). To that end, future research might develop more automatic measures of faithfulness, for example algorithms that compute deviations between drawings and the model, instead of subjective ratings that might be more challenging to obtain. Paradoxically, studying novices through an individual difference lens may lay the foundation for a better understanding of expertise.

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