



OPEN The effect of social factors on eye movements made when judging the aesthetic merit of figurative paintings

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In the present study we explore how social factors (group contact, individuating experience, implicit racial bias) influence the eye movements made during the visual exploration when judging their aesthetic merit of figurative paintings depicting White and Black sitters. An opportunity sample of participants visiting a gallery in Liverpool viewed ten artworks while their eye movements were recorded and completed a set of individual difference measures. The individual difference measures indicated self-report of art interest, social contact and individuating experience with both Black and White communities, and implicitly held racial bias. The results showed that, despite viewing the paintings for less time, the majority of participants reported paintings showing Black sitters as more interesting, emotionally moving, and pleasurable than those depicting White sitters. However, if a participant reported limited social contact with Black community, and a negative implicit racial bias against them, their rating of aesthetic merit of paintings showing Black sitters was reduced, viewing time increased, and fixations became more focused on faces. The influence of social factors on the viewing of paintings showing White sitters was limited to aesthetic rating. The results are discussed in terms of how social factors influence eye movements when viewing paintings in a real-world setting.

The majority of paintings are created to provoke an aesthetic experience in the viewer. The aesthetic experience felt in response to viewing a painting results, in part, from perceptual processes initiated from both an early impression of its overall gist^{1–4} followed by eye movements made to specific visual features^{5–8}. Recent studies have shown reliable and systematic individual differences in eye movements to specific elements of scenes with semantic and emotional value^{9–15}. Given this, an important question to ask is if such influences also impact the viewing of paintings? In the present study, we address this question with respect to figurative paintings showing Black or White sitters. We explore the role of self-reported social contact (defined as quantity of the contact with members of the Black or White community), individuating experience (defined as close, personal contact with members of the Black or White community) and implicitly held racial biases (defined using a measure of unconscious attitudes) on the eye movements made by participants when considering the aesthetic merit of a painting.

The aesthetic appeal of an artwork is influenced by its capacity to resonate with a person's lived experience^{16–18}. The influence of social factors on aesthetic appeal is likely to reflect the impact of lived experience on perceptual processing^{19–22}. Evidence that lived experience impacts perceptual processing is particularly striking in the case of face processing. Many studies have reported that social contact with other racial groups, especially during childhood, is important to developing good face discrimination^{23–25} and recognition^{26–32} of faces from those groups. However, recent research has also emphasized the specific importance of the quality of the individuating experience, rather than of mere social contact^{24,25,33–35}. The quality of individuating experience refers to the type of contact with other groups such as close personal experience, long-term cross-group friendship or cooperation over an extended time.

The level of implicitly held racial bias is also known to affect face processing and memory. Holding a positive implicit bias towards Black people improved sensitivity in a White/Black face categorization task where pairs of faces were combined into weighted morphs (e.g., combined in a 80/20 Black/White faces)²⁵. Implicit racial bias is also known to affect attractiveness or trustworthiness judgment of faces such that a negative bias is associated with lower levels of trust and attractiveness being reported by participants^{36,37}. In addition, the effect of negative bias on face recall is known to be reduced by training to enhance individuating experience with other race

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faces^{34,38}. Overall, it seems that there is widespread evidence that while social contact, individuating experience and implicit racial bias may be related, all have some influence on face processing, memory or both.

Different eye movement strategies have been reported when viewing same versus other-race faces^{39–41}, though see^{42,43}. Recent studies have sought to explore the influence of social contact, individuating experience and implicit racial bias on eye movements to other race faces^{44,45}. Trawiński, Aslanian, et al. showed that having little experience with individuals of another race (as measured by a combined measure of social contact and individuating experience) led to a failure to adopt optimal viewing position when first fixating other race faces. Moreover, and surprisingly, a negative implicit racial bias led to a faster correction towards the optimal viewing position relative to those holding a more positive implicit racial bias. In addition, Anzures et al. showed that a positive implicit racial bias towards your own-race group was associated with longer viewing time of internal facial features of own race faces in a face memory task. It seems, therefore, that the effects of social contact, individuating experience, and implicit racial bias on behavioral measures of face processing and memory may be associated with, and perhaps underpinned by, differences in eye movements.

Behavioural and eye movement studies showing effects of social contact, individuating experience and implicit racial bias on face processing and memory invariably show individual faces to participants. Figurative paintings do not show faces in isolation but in a broader context. Faces that are present in figurative paintings are known to attract attention^{6,8,46,47} and to play a key role in determining the pattern of eye movements that underpin an aesthetic response⁵. As such, the face processing and memory studies reported above probably have implications for determining how the aesthetic merit of a figurative painting showing faces might be reached. This is very likely to be the case if factors influencing the efficiency, quality and accuracy of face processing and memory directly affect the eye movements made when determining of aesthetic merit^{10,48}.

In the present study we explored the influence of self-reported social contact, individuating experience, and implicitly held racial bias on eye movements made during evaluation of the aesthetic merit of figurative paintings. The study was composed of two parts. In the first part, the visitors to an art gallery were asked to view, reflect on, and report the aesthetic merit of ten paintings (5 showing White sitters and 5 showing Black sitters) while their eye movements were recorded using a mobile eye-tracker see also^{9,47,49–52}. The visitors considered the aesthetic merit of each painting in terms of how much pleasure, interest, emotional movement, and familiarity each painting solicited⁹. In the second part, the visitors to the gallery completed a set of individual difference measures that allowed assessment of their interest in art (using the Part A of Vienna Art Interest & Art Knowledge Questionnaire [VAIAK]⁵³), self-report of their social contact and individuating experience with both White and Black communities (using the Social contact and Individuating experience questionnaire²⁴), and implicitly held racial attitudes to both Black and White people (using the Implicit Association Test [IAT]⁵⁴). The data from the individual difference measures were used to predict aesthetic response and eye movements made to paintings (see Fig. 1 for examples of paintings).

The results are structured in three steps. First, we present descriptive analysis of the measures of individual differences. Second, we test for differences in aesthetic experience to paintings depicting White and Black sitters and whether these differences are predicted by individual differences measures. Third, we test for differences in the eye movements made to paintings showing White and Black sitters and explore the extent to which these differences we find are predicted by set of individual differences measures. All data were processed in R version 3.6.0⁵⁵.

Questionnaire and IAT scores

The VAIK scale had a high level of internal consistency (McDonald's $\omega = 0.777$). The range of level of art interest in the participant group was broad (range = 0.88–5.88 out of 7). The social contact scale and individuating experience both had a high level of internal consistency (McDonald's $\omega_{sc} = 0.921$; $\omega_{ie} = 0.949$; $\omega_{sc} = 0.841$; $\omega_{ie} = 0.838$; with Black and White people respectively). Participants reported higher social contact and individuating experience with White than Black people ($t_{72} = 5.64$, $p < 0.001$, $d = 0.66$; $t_{72} = 3.74$, $p < 0.001$, $d = 0.44$; respectively).

The IAT generated a range of positive and negative implicit bias scores. The two-tailed one-sample t-test against 0 (no bias) revealed no significant positive or negative bias towards Black people ($t_{72} = 1.90$, $p = 0.062$,



Fig. 1. Example of paintings used in the present study: (a) Two Jamaican Girls (A. A. John, 1937) and (b) Interior at Paddington (C. L. Freud, 1950-1).

	Mean	Median	SD	Min	Max
VAIAK	2.81	2.75	1	0.88	5.88
IAT	0.12	0.15	0.52	-1.13	1.27
Social contact: Black people	2.81	2.80	1.22	1	5
Social contact: White people	3.91	4.20	0.98	1.20	5
Individuating experience: Black people	3.25	3.20	1.13	1	5
Individuating experience: White people	3.72	3.60	0.74	2.20	5

Table 1. The descriptive statistics for the measures of art interest, implicit racial bias (IAT), social contact, and individuating experience with Black and White people.

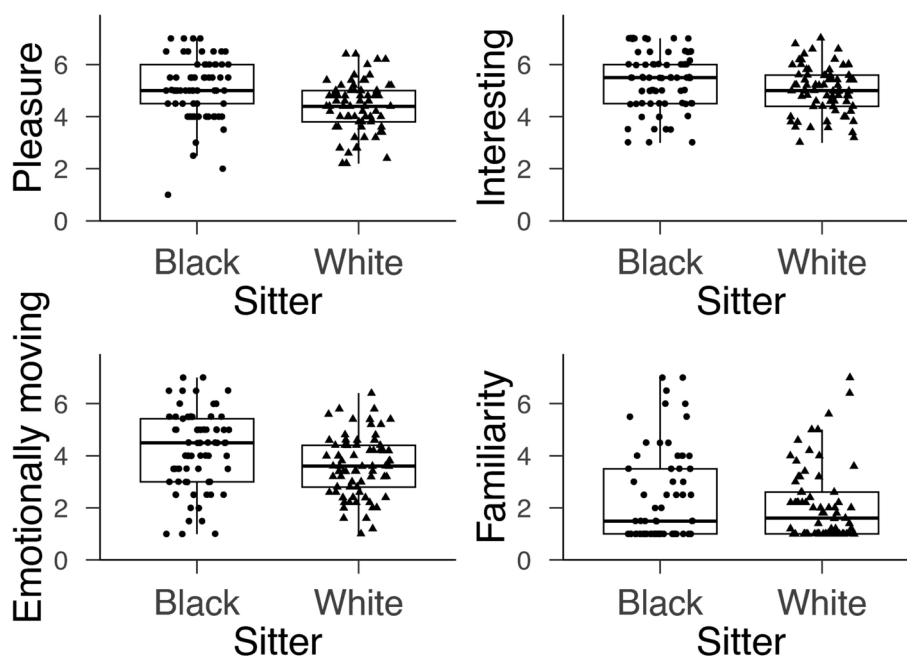


Fig. 2. Boxplot for mean aesthetic responses for paintings depicting Black (indexed by circle) and White (indexed by triangles) sitters.

$d=0.22$). This result suggests a wide distribution of the implicit racial bias was present in our sample. The reliability of the IAT was high: Cronbach's α was 0.758 and the correlation between practice and test trials were $r_{71}=0.793$, $p<0.001$ in the Black-positive/White-negative block and $r_{71}=0.836$, $p<0.001$ in the Black-negative/White-positive block. Descriptive statistics for all questionnaires and the IAT are presented in Table 1.

The effect of social contact, individuating experience, and implicit racial bias on ratings of aesthetic appeal

A set of two-tailed paired t-tests compared the participants ratings of pleasure, interest, emotion and familiarity in response to paintings depicting either Black or White sitters. Paintings showing Black sitters were rated as more pleasurable, interesting, and emotionally moving than those depicting White sitters but not more familiar ($t_{72}=5.13$, $p<0.001$, $d=0.60$; $t_{72}=2.59$, $p=0.011$, $d=0.30$; $t_{72}=4.56$, $p<0.001$, $d=0.53$; $t_{72}=1.48$, $p=0.143$, $d=0.17$, respectively; see Fig. 2).

We next computed two sets of fixed-effects multilevel regression models with random intercept (one set each for paintings showing Black sitters and White sitters). All the models included the main effects of implicit racial bias and self-reported social contact, individuating experience, and art interest. The models also included two sets of interactions. The first interaction tests the extent to which the influence of implicit racial bias may be modulated by self-reported social contact. The second interaction tests the extent to which any influence of implicit racial bias is modulated by self-reported individuating experience. All predictors were mean-centered. A Holm-Bonferroni correction was applied to adjust the reported p-values for significance when conducting a series of subgroup analyses for significant interactions.

The models predicting the aesthetic appeal of the paintings showing Black sitters were significant with respect to pleasure and familiarity ($F_{6,66}=2.62$, $p=0.024$, *adjusted* $R^2=0.12$; $F_{6,66}=9.70$, $p<0.001$, *adjusted* $R^2=0.42$; respectively). The models predicting interest and emotional movement did not reach significance ($F_{6,66}=0.66$, $p=0.679$, *adjusted* $R^2=-0.03$; $F_{6,66}=1.71$, $p=0.133$, *adjusted* $R^2=0.06$; respectively).

We conducted further analyses of the two significant models. The model predicting pleasure showed significant (or very close to significant) main effects of implicit racial bias and self-reported individuating experience ($b=0.71$, $SE=0.26$, $\beta=0.33$, $t=2.77$, $p=0.007$; $b=0.36$, $SE=0.18$, $\beta=0.33$, $t=1.96$, $p=0.054$; respectively). These significant main effects indicated that the more positive the implicit racial bias towards Black people, and the more the individuating experience with Black people, then the more pleasure was reported. However, the interactions between implicit racial bias and self-reported social contact, and implicit racial bias and self-reported individuating experience, were also significant ($b=-0.65$, $SE=0.27$, $\beta=-0.36$, $t=-2.41$, $p=0.019$; $b=0.62$, $SE=0.30$, $\beta=0.32$, $t=2.05$, $p=0.043$; respectively; see Fig. 3).

With respect to the interaction between implicit racial bias and self-reported social contact, implicit racial bias influenced participants reporting a low level of social contact with Black people differently than those participants reporting a high level of social contact ($t=2.41$, $SE=64$, $p=0.016$). Specifically, the effect of implicit racial bias on reported pleasure was only significant for those reporting a low but not a high level of social contact with Black people ($b=1.49$, $SE=0.45$, $\beta=0.46$, $t=3.34$, $p_{adj}=0.002$; $b=-0.06$, $SE=0.38$, $\beta=-0.15$, $t=-0.17$, $p_{adj}=0.864$; respectively).

With respect to the interaction between implicit racial bias and self-reported individuating experience, implicit racial bias affected participants reporting a low level of individuating experience with Black people differently than those participants reporting a high level ($t=-2.05$, $SE=67$, $p=0.04$). The effect of implicit racial bias on pleasure was significant for those reporting a high but not a low level of individuating experience with Black people ($b=1.40$, $SE=0.45$, $\beta=0.28$, $t=3.14$, $p_{adj}=0.003$; $b=0.02$, $SE=0.40$, $\beta=0.23$, $t=0.06$, $p_{adj}=0.956$).

Second, with respect to the model predicting familiarity, participants reporting a higher interest in art rated paintings as more familiar ($b=1.12$, $SE=0.16$, $\beta=0.66$, $t=6.84$, $p<0.001$). No other significant results were found ($ps>0.075$).

With respect to the models predicting the aesthetic appeal of the paintings showing White sitters, only the model for familiarity reached significance ($F_{6,66}=5.71$, $p<0.001$, $adjusted\ R^2=0.28$). The regression models predicting pleasure, interest, and emotional movement were not significant ($F_{6,66}=0.55$, $p=0.765$, $adjusted\ R^2=-0.05$; $F_{6,66}=0.37$, $p=0.893$, $adjusted\ R^2=-0.06$; $F_{6,66}=0.44$, $p=0.847$, $adjusted\ R^2=-0.04$; respectively).

With respect to the model predicting familiarity of paintings depicting White sitters, the main effects of self-reported individuating experience with White people and art interest were significant ($b=-0.49$, $SE=0.21$, $\beta=-0.26$, $t=-2.35$, $p=0.022$; $b=0.77$, $SE=0.15$, $\beta=0.55$, $t=5.25$, $p<0.001$; respectively). Increased familiarity of the paintings showing White sitters was negatively associated with individuating experience with White people and positively associated with art interest.

In sum, the results show three findings. First, paintings showing Black sitters were judged as having more aesthetic merit than those showing White sitters in terms of pleasure, interest and emotional movement. Second, with respect to paintings showing Black sitters, the pleasure experienced when viewing paintings was affected by implicit racial bias when self-reported social contact was low and when self-reported individuating experience was high. Third, and unsurprisingly, interest in art was associated with the report of the familiarity of the paintings being viewed.

The effect of self-reported social contact, individuating experience, and implicit racial bias on eye movements made while rating paintings for their aesthetic appeal

Eye-movement data from fifty-eight (out of the seventy-three) participants was analysed. Data from 15 participants were lost due to data collection issues. A classification algorithm was run to quantify the fixations made in paintings using the Tobii Analyser Pro software⁵⁶. The fixations were classified by using the following framework: Noise reduction—> Moving median, window size (samples)=3; Velocity calculator—> Window length=20 ms; I-VT classifier—> Threshold ($^{\circ}/s$)=100; Merge adjacent fixations—> Max time between fixations=75 ms, Max angle between fixations=0.5; Discard short fixations—> Minimum fixations duration=60

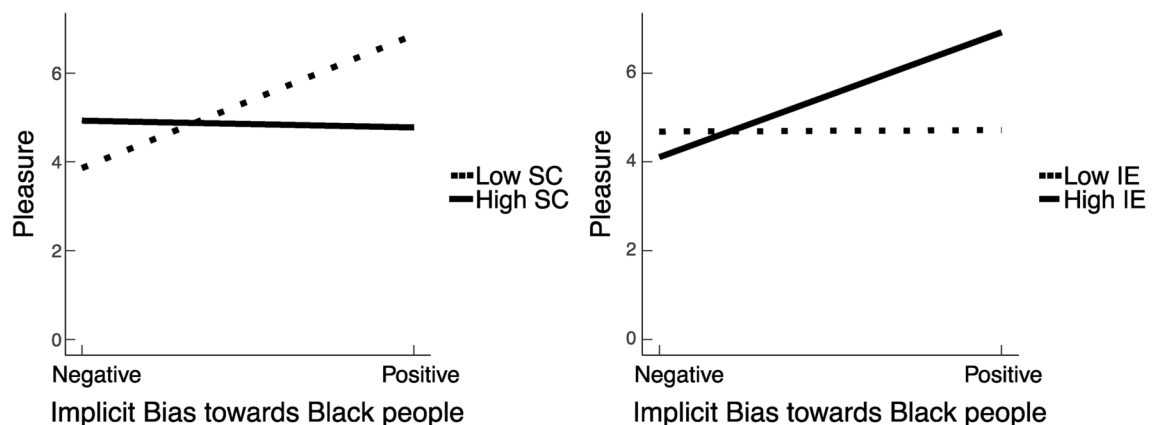


Fig. 3. Mean pleasure response when viewing paintings with Black sitter as a function of 1 SD above and below the means of the measures of implicit racial bias (IAT) and low [indexed by dashed line] and high [indexed by solid line] social contact (SC) and individuating experience (IE) with Black people.

ms⁵⁷. The Tobii Analyzer Pro Real-World Mapping function was then used to map fixations onto the artworks. In addition, fixations were input manually if the algorithm failed to map them automatically.

We first compared the number of fixations and the total fixation duration to paintings showing Black sitters and those showing White sitters. Difference scores were calculated for fixations to whole paintings, and also separately for fixations to a Region of Interest for faces (henceforth faces) and the area beyond faces. Analysing difference scores across paintings showing Black and White sitters allows each participant to act as their own control with respect to participants' overall duration of their viewing of paintings. The difference scores were compared against 0 using three two-tailed, one-sample *t*-tests. Positive difference scores indicate more fixations (or a longer total fixation duration) to paintings depicting Black than White sitters. Second, where the *t*-tests revealed a significant difference in fixations, a set of regression models was run to explore the underpinning causes of this difference. As the analysis of the factors underpinning decisions about aesthetic merit showed that it was only participants' implicit racial bias towards, and self-reported social contact and self-reported individuating experience with, Black people that mattered, it was these data that were included in the regression models. The regression models also included interest in art and two sets of interaction to test if the influence of implicit racial bias is modulated by self-reported social contact or individuating experience with Black people. As in the analyses of aesthetic appeal, all predictors were mean-centered and the Holm-Bonferroni correction was applied when conducting a series of subgroup analyses for significant interactions.

The *t*-tests showed participants made more fixations, and had a longer total fixation duration, to paintings showing White than Black sitters. These differences held whether number of fixations and total fixation duration were considered with respect to whole paintings ($t_{57} = -5.21, p < 0.001, d = -0.68; t_{57} = -6.04, p < 0.001, d = -0.79$; respectively see Fig. 4a), faces ($t_{57} = -2.73, p = 0.009, d = -0.36; t_{57} = -3.92, p < 0.001, d = -0.51$; respectively see Fig. 4b), or the area lying beyond faces ($t_{57} = -5.46, p < 0.001, d = -0.72; t_{57} = -5.35, p < 0.001, d = -0.70$; respectively see Fig. 4c).

With respect to the analysis of fixations to whole paintings, the regression models were significant for difference in the number of fixations [nof] and total fixation duration [tfd] ($F_{6,51} = 3.38, p = 0.007, adjusted R^2 = 0.20; F_{6,51} = 3.94, p = 0.003, adjusted R^2 = 0.24$; respectively). The main effects of individuating experience and implicit racial bias were both significant ($b_{nof} = 25.66, SE = 10.94, \beta = 0.48, t = 2.35, p = 0.023; b_{nof} = -39.62, SE = 15.61, \beta = -0.33, t = -2.54, p = 0.014; b_{tfd} = 8885, SE = 3179, \beta = 0.57, t = 2.80, p = 0.007; b_{tfd} = -9037, SE = 4535, \beta = -0.25, t = -1.99, p = 0.051$; respectively). The difference in the number of fixations and the total fixation duration to paintings showing Black sitters and those showing White sitters increased as self-reported individuating experience decreased and reduced as negative implicit racial bias increased.

The main effect of implicit racial bias was qualified by an interaction with self-reported social contact ($b_{nof} = 33.60, SE = 15.92, \beta = 0.36, t = 2.11, p = 0.040$ and $b_{tfd} = 11,032, SE = 4625, \beta = 0.39, t = 2.39, p = 0.021$; see Fig. 5A). The difference in the number of fixations and the total fixation duration for participants was impacted differently by implicit racial bias for those reporting low or high social contact with Black people ($t_{nof} = -2.11, SE = 39.5, p = 0.035; t_{tfd} = -2.39, SE = 11,469, p = 0.017$; respectively). The negative effect of implicit racial bias was true for those reporting low social contact ($b_{nof} = -82.67, SE = 30, \beta = -0.39, t = -2.76, p_{adj} = 0.012$ and $b_{tfd} = -23,324, SE = 8702, \beta = -0.24, t = -2.68, p_{adj} = 0.015$), but not for those reporting a high level of social contact with Black people ($b_{nof} = 0.65, SE = 20, \beta = 0.14, t = 0.03, p_{adj} = 0.974$ and $b_{tfd} = 4034, SE = 5806, \beta = 0.09, t = 0.70, p_{adj} = 0.487$). No other results approached statistical significance ($ps > 0.095$).

With respect to analysis of fixations made only to the faces in the paintings, the regression models were significant for the differences in the number of fixations and the total fixation duration ($F_{6,51} = 2.81, p = 0.019, adjusted R^2 = 0.16; F_{6,51} = 2.28, p = 0.05, adjusted R^2 = 0.12$; respectively). The main effect of implicit racial bias was significant ($b_{nof} = -15.75, SE = 5.61, \beta = -0.37, t = -2.81, p = 0.007$ and $b_{tfd} = -4626.7, SE = 2067, \beta = -0.30, t = -2.24, p = 0.029$). The difference in the number of fixations and total fixation duration to faces of Black sitters versus White sitters was smaller when participants held a negative implicit racial bias.

The effect of implicit racial bias was qualified by an interaction with self-reported social contact ($b_{nof} = 11.94, SE = 5.72, \beta = 0.36, t = 2.09, p = 0.042$ and $b_{tfd} = 4595.1, SE = 2108, \beta = 0.39, t = 2.18, p = 0.034$). The difference in the number of fixations and the total fixation duration for participants was impacted differently by implicit racial bias for those reporting low or high social contact with Black people ($t_{nof} = -2.09, SE = 14.2, p = 0.037; t_{tfd} = -2.18, SE = 5228, p = 0.029$; respectively). The effect of implicit racial bias on the difference in fixations was significant for participants reporting low social contact with Black people ($b_{nof} = -31.07, SE = 10.77, \beta = -0.48, t = -2.89, p_{adj} = 0.007$ and $b_{tfd} = -10,555, SE = 3967, \beta = -0.39, t = -2.66, p_{adj} = 0.016$), but not for those reporting a high level of social contact with Black people ($b_{nof} = -1.47, SE = 7.19, \beta = -0.14, t = -0.20, p_{adj} = 0.838$ and $b_{tfd} = 841, SE = 2647, \beta = 0.08, t = 0.32, p_{adj} = 0.751$). There were no other significant results ($ps > 0.082$).

With respect to analysis of fixations to the area beyond faces, the regression models for the difference in the number of fixations and the total fixation duration were significant ($F_{6,51} = 2.56, p = 0.031, adjusted R^2 = 0.14; F_{6,51} = 2.74, p = 0.022, adjusted R^2 = 0.15$, respectively). Only the main effect of individuating experience was significant, ($b_{nof} = 22.04, SE = 8.84, \beta = 0.53, t = 2.49, p = 0.016$ and $b_{tfd} = 7862, SE = 2732, \beta = 0.61, t = 2.88, p = 0.006$). Increased difference in fixations and total fixation duration was associated with self-report of low individuating experience with Black people. There were no other significant results ($ps > 0.074$).

In sum, paintings showing Black sitters received less fixations and were looked at for a shorter time than paintings depicting White sitters. However, the difference in fixations and total fixation duration between paintings showing Black sitters and those showing White sitters reduced when participants self-reported low social contact with, and held a negative implicit bias against, Black people. Contrasting the analyses of whole paintings, faces, and the remainder of the paintings shows that it is the fixations to faces that drives this effect.

Taken together, the results from the analysis of aesthetic appeal and eye movements show the evaluation of paintings showing Black sitters are both impacted by participants self-report of their social contact with the

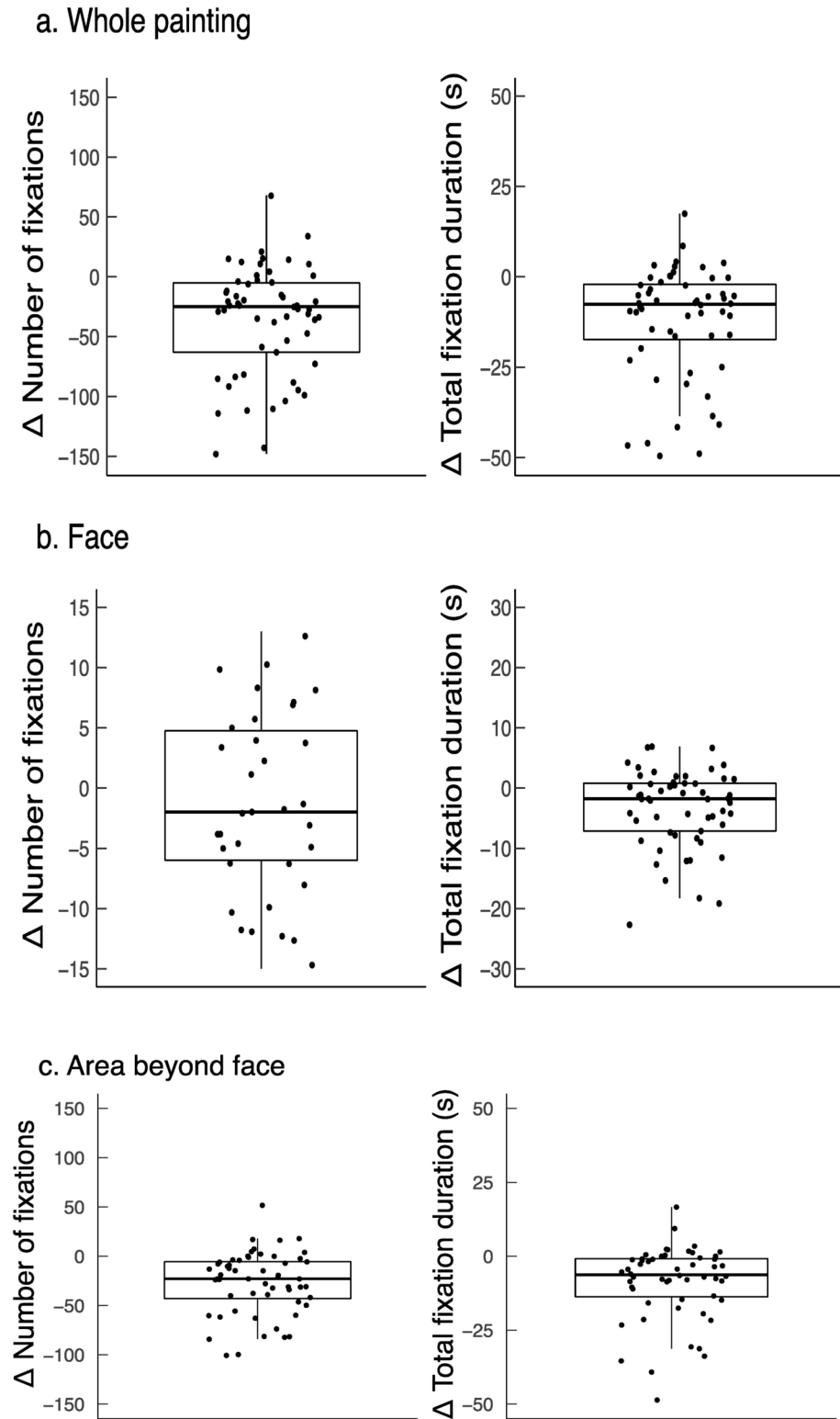
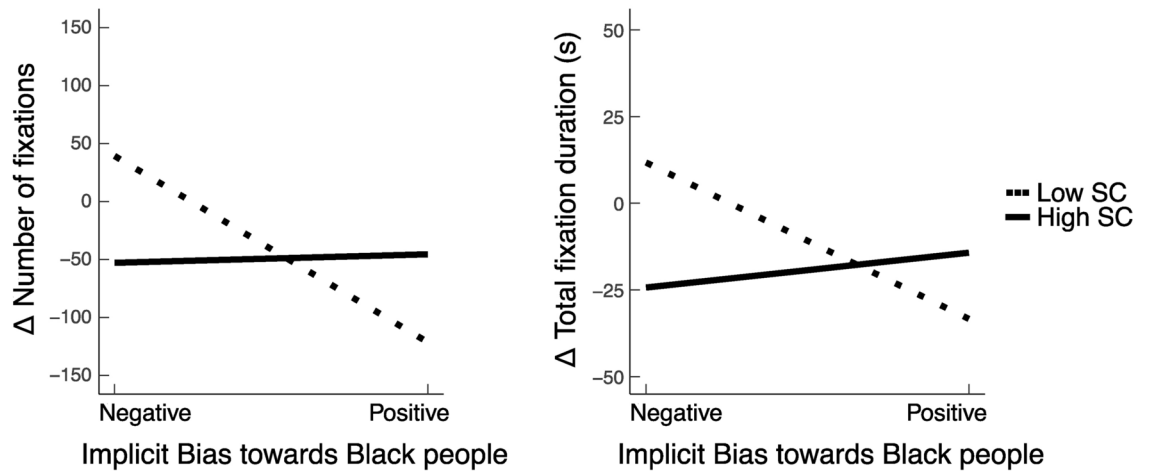


Fig. 4. Boxplot for mean number of fixations and total fixation duration for (a). whole paintings (b). face and (c). area beyond faces. The positive scores indicate higher likelihood of making eye movements to paintings depicting Black sitters. In contrast, the negative scores indicate higher likelihood of making eye movements to paintings depicting White sitters.

a. Whole painting



b. Face

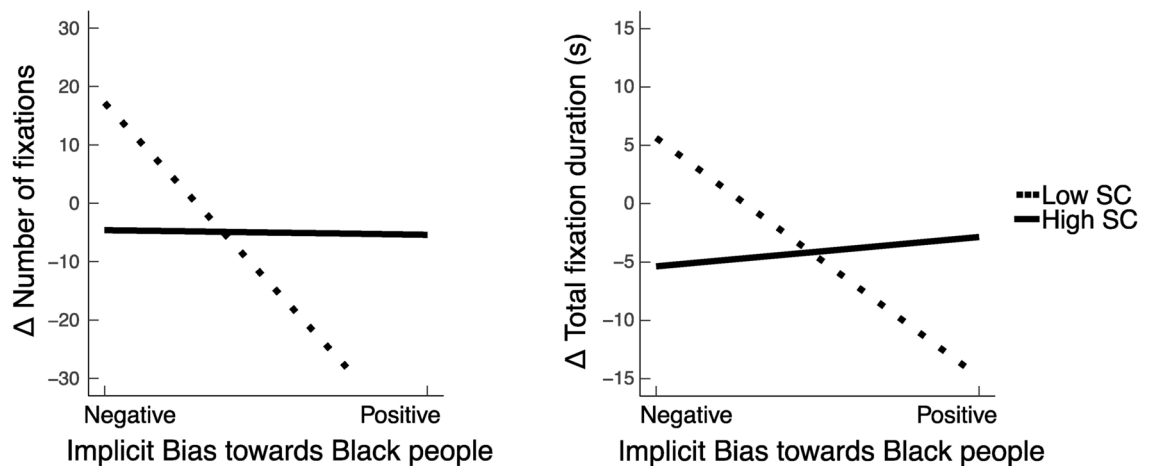


Fig. 5. Mean difference (Δ) in number of fixations and total fixation duration made (a) during viewing whole painting and (b) faces as a function of 1 SD above and below the means of the measures of implicit racial bias (IAT) and low [indexed by dashed line] and high [indexed by solid line] social contact (SC) with Black people. The positive scores indicate a more numerous fixations or longer total fixation duration to paintings depicting Black sitters relative to the paintings showing White sitters.

Black community and implicit bias towards them. Specifically, self-report of low social contact, together with negative implicit bias against Black people, increased the viewing time of paintings showing Black sitters. This increased viewing time was characterised by fixations focused on faces of Black sitters and a negative evaluation of the aesthetic merit of the paintings.

Discussion

The goal of the present study was to investigate if, when determining an aesthetic response, social factors influence fixations to figurative paintings showing either White or Black sitters. The results show that our participants, overall, judged paintings showing Black sitters more positively than those showing White sitters. They reached this view despite using fewer fixations before making an evaluation. However, when social contact with the Black community was low, fixations to Black sitters were influenced by the level of negative implicit racial bias held against the Black community. If participants self-report low social contact with the Black community and hold a negative implicit racial bias against them, then the aesthetic merit of the paintings showing Black sitters is low, and this decision is reached following use of a high number of fixations which are focused on the faces present in the paintings. In contrast, there was no such influence of social factors on fixations to paintings showing White sitters.

Studies on eye movements made during the evaluation of aesthetic merit report that viewers quickly reach a decision when they like a painting, and almost certainly do so on the basis of the gist of the scene^{1–4}. In contrast, those paintings that are liked less are evaluated after more prolonged looking⁵⁸. We think that these findings have relevance to the present study. There are two possible accounts to explain the current data. First, there is a social desirability account: it might be that the responses of those participants self-reporting low social contact with the Black community, and who hold a negative implicit racial bias against them, are unaffected by social desirability. This account explains the present results by suggesting that some participants truncate their visual sampling in a desire to quickly report a positive response but that those participants self-reporting low social contact with the Black community, and who hold a negative implicit racial bias against them, do not do so. In contrast, there is a perceptual account: this account explains the present results by suggesting that whereas most participants respond positively on the basis of gist, participants self-reporting low social contact with the Black community, and who hold a negative implicit racial bias against them, respond after over-sampling in a way that becomes focused on faces.

The eye movement and aesthetic rating data presented so far do not provide sufficient information to allow discrimination between the social desirability and the perceptual accounts. To do so requires an examination of the relative richness of the representation of a painting at the point of making an aesthetic evaluation. The social desirability and perceptual accounts can be distinguished by examining the spatial distribution of fixations of those self-reporting low social contact with the Black community (heat maps that illustrate examples of distribution of fixations are shown in Fig. 6a). Critically, we suggest that if the spatial distribution of fixations is larger for those with a negative implicit racial bias, relative to those with a positive one, then the increased looking would be consistent with the social desirability account. This is because a positive bias would be associated with sampling a smaller area of the painting. However, if the spatial distribution of fixations is smaller for those participants with a negative implicit racial bias, then this would be consistent with their increased looking simply being more focussed, and so would be consistent with the perceptual account. Visual inspection of a set of examples of heatmaps shows that, at least in this case, the prolonged looking of those low social contact in these participants is associated with less distributed fixations. The other cases we have explored show a similar effect and, as such, we conclude that the evidence from the heat maps is consistent with a perceptual rather than social desirability account of the data.

An important question to ask is why the results of the present study only show an effect with paintings of Black sitters? We did not control for participants' demographic background. Our sample was an opportunity sample from visitors to the art gallery. Compared with majority of existing research in empirical aesthetic, which typically includes participants from WEIRD population e.g.,^{1,5,6,8,59}, our sample was relatively diverse. It is the case, however, that the majority of our participants self-classified themselves as White people. As a result, it is inevitable that the study was more likely to detect an effect with respect to the viewing paintings of Black than White sitter. However, although the majority of our participants were White people, the distribution of implicit

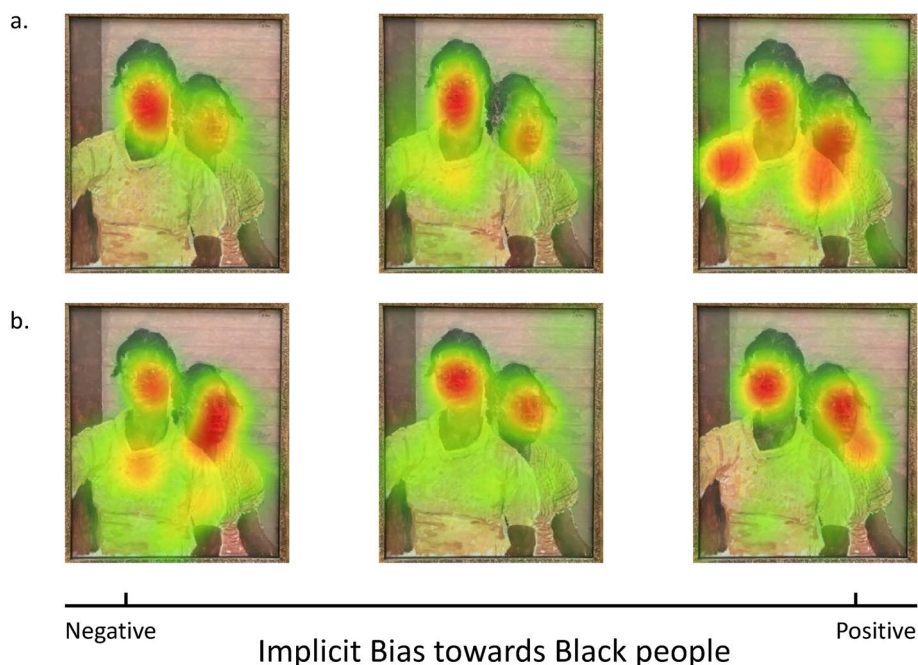


Fig. 6. Example of the heatmaps of participant with (a) low and (b) high social contact with Black people as a function of implicit racial bias. Low social contact and negative implicit racial bias (top left corner) lead to greater focus on the faces of Black sitter than low social contact and positive implicit racial bias (top right corner). In contrast, the distribution of fixations of participants with high social contact was not influence by implicit racial bias.

biases towards/against Black people ranged from positive to negative biases. Our sample was not skewed towards negative implicit racial bias as is often reported in the literature e.g.,²⁵. This variability allowed for the study of individual differences of the effect of implicit racial bias on aesthetic responses and eye movements made to paintings.

Some have suggested that low experience with a specific community is itself reflected in negative implicit racial bias²⁵. In the present study, there is weak positive correlation between implicit biases towards Black people and self-report of lived experience with Black community ($r_{71} = 27, p = 0.021$; $r_{71} = 20, p = 0.088$; for social contact and individuating experience, respectively). We found that, while weakly related, the influence of implicit racial bias on eye movements largely depends on the lack of social contact with another community. Hence the effect of implicit racial bias on judgment of the aesthetic merit and eye movements was not identical to the effect of the social experience. The data support the importance of gathering information about the quality of individuating experience as well as evidence of implicitly held attitude.

In terms of potential limitations, our results might have been driven by some other difference between paintings representing Black and White sitter. The paintings used in the present study were all classified as figurative and most of them were created in the twenty-first century. In other words, they have a high degree of stylistic similarity. Moreover, four of the five paintings showing Black sitters were created by a single artist which may also limit variation in style, especially for paintings showing Black sitters. What we do know is that there was no difference in size between paintings depicting Black and White sitters ($t_8 = 1.18, p = 0.270, d = 0.75$). It could be that paintings showing Black sitters differ in some other way than style and size, however a full examination of potential factors is beyond the scope of the present study. Therefore, while our study used the full set of paintings available to us in the gallery setting, we acknowledge that it remains important to test for the same effects using other stimulus sets if we are to be confident that the effects we report generalise beyond the current set.

Our previous work in a real gallery setting reported evidence that openness-to-experience and need for cognitive closure are important influences on the spatial and temporal extent of fixations during aesthetic evaluation of an artwork⁹. The present study adds to these results by showing that individual differences in self-reported social contact and implicit racial bias also influence looking during evaluation of the aesthetic merit of figurative paintings showing Black sitters. Crucially, self-report of limited social contact with Black community, allied to a negative implicit racial bias against them, was associated with reduced liking and prolonged and focussed looking at faces. Our results show the influence of social and attitudinal factors on participants eye movements while making aesthetic rating of figurative paintings.

The present study demonstrates an influence of social factors on eye movements when judging the aesthetic merit of figurative paintings. The effects we report extend the reports of social factors influencing performance in studies of face processing and memory reported in the Introduction. It is important to note figurative paintings include more than visual information than present in a sitter's face. Therefore, while the aesthetic ratings might reflect views about whole paintings, the eye movements that associated with these ratings were evidently affected by the presence and identity of faces, along with the social factors affecting the viewer. The fact that the eye movements made by participants when making their ratings of aesthetic merit of figurative paintings were influenced by social factors leads us to ask if a similar influence would be found in the eye movements made to other types of social scene across other types of tasks. It is a question that we think is worthy of future study.

Methods

Participants

Seventy-three (23 males and 50 females, $M = 33.44, SD = 16$) visitors to the Walker Art Gallery in Liverpool (UK) participated in the study. The majority of participants declared themselves as White (>79%), <11% identified themselves as Black, Black British, Caribbean, or African, <8% as Asian or Asian British, and <2% as representatives of mixed/multiple ethnic groups. The sample size based on the previous studies that have examined individual differences with respect to implicit racial bias, experience with other communities and eye movements⁴⁴ as well as individual differences among art gallery visitors, eye movements and aesthetic experience⁹. All participants reported normal or corrected-to-normal vision.

The study was approved by the Ethics Committee of the Department of Psychology of Liverpool Hope University and Ethics Committee of the Walker Art Gallery Liverpool. The study was conducted in accordance with the code of practice of the British Psychology Society. The informed consent was obtained from all participants.

Stimuli and materials

Paintings. Participants viewed ten representational paintings and reported on the aesthetic appeal of each artwork. Five paintings depicted Black sitters: *Two Jamaican Girls* (1937) by A. A. John; *Light Inner Dark, In the Garden, I've been thinking*, and *Stop/ Breathe* (2021/2) by B. S. Khader. Five paintings depicted White sitters: *Interior at Paddington* (1950/1) by C. L. Freud; *Lying on Bed in Awkward Position* (2020); *Smoke* (2021) by D. L. J. Prestidge; *Enter Stage Left* (2017) by F. A. Ketskemety; and *Class Queer* (2020) by G. G. Sollars. The paintings were selected before the study from the following displays at the Walker Art Gallery: Liverpool's Refractive Pool Exhibition, the John Moore's Painting Prize, and British Art from 1880–1950. All paintings were located on the same floor. The five paintings of the Black sitters were selected on the basis that they were the only paintings showing Black sitters on display within the gallery. The five paintings of the White sitters were selected because of their physical proximity to the paintings of the Black sitters as well as having roughly comparable, size, dates and styles. The ten paintings selected were displayed amongst other (c. 30) figurative (predominantly depicting White sitters) and non-figurative (e.g., landscapes, still life) paintings in the gallery.

Art interest questionnaire. Art interest was measured using Part A of Vienna Art Interest & Art Knowledge Questionnaire (VAIAK)⁵³. Sample items from the questionnaire include: ‘How interested are you in art’ (1- not at all, 7- very much) and ‘How often do you speak about art with friends or family’ (1- never, 7- very frequently).

Social contact and Individuating experience questionnaire. Participants completed a twenty-item questionnaire about their experience with both Black and White people²⁴. The questionnaire has two sub-scales. One subscale asks about social contact by measuring self-report of the quantity of interactions with Black/White people, while the other asks about individuating experience by measuring self-report of how often participants engaged in activities with Black/White individuals.

Following the report of differences in the effect of social contact and individuating experience on face processing^{33,35} these two scales were separated in our analysis.

Implicit Association Test (IAT). The IAT was run using Black and White faces being paired with positive and negative words to estimate participants’ implicit racial bias. Six Black faces and six White faces (3 males and 3 females for each race in frontal view) with neutral expressions, taken from the Chicago Face Database⁶⁰, were shown in the IAT. The 6 positive words were loyal, kindness, happy, trust, friend, and pleasure, and the 6 negative words were terrible, toxic, hatred, useless, brutal, and traitor⁶¹.

The IAT procedure comprises five blocks of trials⁵⁴. In Block 1, participants categorized by race 40 individually presented faces randomly selected from the face set using a key press response. In Block 2, participants categorised 40 randomly selected words from the word set as positive or negative using a key press response.

Block 3 involved 120 trials where the words and faces were combined such that responses were determined by either positive words/Black faces or negative words/White faces. In Block 4, participants were retrained with 40 trials where they categorized faces such that their response mappings were reversed relative to Block 1. Block 5 involved 120 trials where the words and faces were coalesced such that responses were determined by either positive words/White faces or negative words/Black faces. Half of the participants completed the IAT as described above, and another half completed a version with reverse response mappings.

Implicit bias scores were computed from a comparison of response times (RTs) in Blocks 3 and 5⁶². First, RTs less than 250 ms and greater than 10 s were removed from the analysis and RTs from correct trials only were used to calculate a *D* score for each participant. This led to 3.41% trials being excluded from analyses. Second, the mean RTs were computed for the first 40 trials (i.e., practice trials) and the remaining 80 trials (i.e., test trials) in each of two blocks.

The practice and test trials were analysed separately and the scores were then averaged to form the *D* score⁶². The *D* score indicates the differential performance between the response key mappings between Black-positive/White-negative and Black-negative/White-positive. A positive *D* score indicated positive implicit bias towards Black people, while negative *D* score indicated negative implicit bias towards Black people.

Apparatus

Eye movements to paintings were recorded using Tobii Pro Glasses 2 eye tracker operating at 100 Hz. Viewing was binocular and movements of both eyes were recorded. The eye-tracker used an infrared-light source to estimate the pupil-centre-corneal-reflection-vector to position eye-gaze location⁶³. Computer-based tasks were run on a 16.0-in. laptop display and participants responded by pressing dedicated keys on the standard keyboard.

Procedure

The study was composed of two parts. In the first part, participants completed calibration procedure that consisted of standard task that involved a fixation of a black dot in the centre of the card positioned at the front of participant before the recording of eye-tracking prior to viewing the paintings. After completing the calibration procedure, participants were allowed to move freely in the gallery space. They were free to decide for themselves the order in which they viewed the paintings, as well as whether they wished to see other paintings during the course of the study. Eye movements were recorded during their entire visit in the gallery, although analysis was conducted only on the selected artworks. The duration of the visit to the gallery, and the viewing of each painting, was unrestricted. Aesthetic appeal was measured on four 7-point scales (1 – not at all, 7 – very much) indicating the extent to which a painting was pleasing, interesting, emotionally moving, and familiar⁹. Participants completed the scales immediately after viewing each painting. In the second part, participants completed the VAIAK, the IAT, and the Social contact and Individuating experience questionnaire using a laptop computer positioned on a desk in a quiet space within the gallery.

Data availability

The data presented in this study are available on request from the corresponding author.

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Author contributions

T.T.: Conceptualisation, Methodology, Formal Analysis, Writing—original draft, Writing—review and editing, visualization. L.P.: Conceptualisation, Writing—review and editing. R.B.: Conceptualisation, Investigation. N.D.: Writing—original draft, Writing—review and editing.

Declarations

Competing interests

The authors declare no competing interests.

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