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Sequential effects in facial attractiveness judgments: Separating perceptual and response biases

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ABSTRACT

When items are presented sequentially, the evaluation of the current item is biased by both the previous item's value (perceptual bias) and the previous response given (response bias). While these biases have been identified in judgements of facial attractiveness, it is unclear as to whether they produce assimilation and/or contrast effects. Here, two tasks were employed to measure each bias in isolation. By presenting a preceding face without collecting a response, perceptual biases could be investigated, while response biases were considered by requesting a preceding response without presenting a face. Our results demonstrated a perceptual bias in which attractiveness ratings given to the current face shifted away from the baseline attractiveness value of the previous face, while we found no evidence of a response bias due to the previously selected value. These findings highlight the utility in considering sequential biases separately when trying to determine the nature of these effects.

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Introduction

Sequential effects are biases that occur when items are judged in a sequence, and have been found to influence judgements in a variety of areas including economics (Neilson, 1998), marketing (Novemsky & Dhar, 2005), singing (Page & Page, 2010) and sports competitions (Damisch et al., 2006; Kramer, 2017), as well as online reviews (Sikora & Chauhan, 2012). In recent years, research has also focussed on judgements of facial attractiveness since faces are often considered in context rather than in isolation. For example, Kernis and Wheeler (1981) found that people were rated as more attractive when in the presence of an unattractive person or when associated with an attractive other through friendship. In general, faces are seen as more attractive when presented in a group (Walker & Vul, 2014).

When viewed alone, judgements of faces are influenced by previously seen faces (Cogan et al., 2013; Kondo et al., 2012; Wedell et al., 1987), resulting in two effects: assimilation and contrast. The former causes the current judgement to be shifted towards the previous judgement (Kok et al., 2017; Kondo et al., 2012, 2013; Kramer et al., 2013; Taubert & Alais, 2016), whereas the latter sees the current judgement shifted away from the previous judgement (Cogan et al., 2013; Kenrick & Gutierres, 1980; Wedell et al., 1987). Both effects have been found in sequential judgements of facial attractiveness (Huang et al., 2018; Kramer & Jones, 2020; Pegors et al., 2015).

Two mechanisms have been proposed to underlie these effects. A perceptual bias involves a direct comparison between the perceived attractiveness of the previous face and the current face, and as a result, the attractiveness of the previous face influences the rating given to the current face. In contrast, a response bias occurs when the response given to the previous face influences the response given to the current face. This may be due, for example, to a difficult evaluation, and so participants default to repeating their previous response. Distinguishing between these two types of bias is often difficult because the perceived attractiveness of the previous face and the rating it received are likely to be highly correlated. As a result, statistical artefacts due to multicollinearity may produce uninterpretable analytical models (Kramer & Jones, 2020). However, several attempts have been made to tackle this issue in

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recent years. For example, by alternating the type of judgement given on each trial (attractiveness versus hair darkness), Pegors et al. (2015) found that the attractiveness rating given to the current face assimilated towards the hair darkness rating given to the previous face (response bias) while contrasting away from the attractiveness value of the previous face (perceptual bias). This pattern of results was initially replicated by Huang et al. (2018), who then investigated the alternation of a face and a ringtone. Here, no cross-modal contrast effect of the previous stimulus was found – the current face's attractiveness rating was not influenced by the agreeableness of the sound preceding it. However, an assimilative effect due to the previous response remained – responding to the preceding ringtone biased the response given to the current face. Interestingly, the authors also demonstrated an assimilation effect, although weaker, when the previous and current responses were given orally, suggesting that response biases are unlikely to be caused by action repetition alone.

Another way to separate perceptual and response biases is to remove the possibility of one of these being present. Chang and colleagues (2017) examined the effect of perceptual biases on judgements of artistic photographs (predominantly of scenery) by asking participants to first view an image without making a judgement, and then rate how much they liked the image which followed. Through not responding to the first image, the possibility of a response bias was eliminated. The results showed an assimilation effect whereby the second image was liked more when preceded by a more preferable image (determined through ratings given by others) than when preceded by a less preferable one. Considering facial attractiveness, Xia and colleagues (2016) also removed the possibility of a response bias by asking each participant to rate their sequence of images twice, each time presented in a different random order. This way, the participant's attractiveness responses to the previous and current image could be taken from their "independent run" (i.e., the other set of ratings) and used in predicting their current response. In line with the results of Chang and colleagues (2017), an assimilative perceptual bias was identified. Importantly, these findings contradict previous research, discussed above, in which the effect of a perceptual bias was shown to be contrastive (Huang et al., 2018; Pegors et al., 2015).

Pape and colleagues (2017), in contrast, chose to remove the possibility of a perceptual bias. In their task, participants were required to provide an "instructed response" (where they were told which of two responses to give, although no stimulus was present) prior to their binary response in relation to the dynamic random dot pattern that was presented. The results demonstrated a contrast effect in that participants tended not to repeat the instructed motor response – that is, they preferred to alternate between motor responses. Similarly, Zhang and Alais (2020) were able to separate out the response bias by utilizing a random stimulus-response mapping when presenting gratings at two orientations. By decoupling perceptual choice and motor response, these authors also found that the latter involved a contrast effect – responses were repelled away from the preceding response. As such, these findings appear to disagree with the typically assimilative response bias shown in previous work with facial attractiveness judgements (e.g., Huang et al., 2018; Pegors et al., 2015).

Thus, the aim of the current study was to begin to address these inconsistent findings. Given the difficulties noted earlier regarding the examination of both perceptual and response biases in a single design, we followed the approach of previous work (Chang et al., 2017) by investigating each bias separately. By adapting the design of Chang et al. (2017), we were able to create two similar tasks that each removed a single type of bias. In one, no response was given to the preceding face, allowing measurement of a perceptual bias alone (Chang et al., 2017). In the other, following Pape et al. (2017), a rating was given prior to the facial attractiveness judgment of the current face but not in response to an image, allowing measurement of a response bias alone. Our goal was to produce a clearer understanding of how each bias in isolation influenced facial attractiveness judgements. However, even these attempts to isolate each bias may have included some caveats, as discussed later.

Method

Participants

Sixty-two volunteers (age $M = 27.7$ years, $SD = 14.1$ years; 53 women; 87% self-reported as White) gave informed onscreen consent before participating in the experiment and were provided with an onscreen debriefing upon completion. Participants were recruited through "word of mouth" and social media advertisements.

The sample size for this experiment was based on the number of participants used in earlier studies showing both assimilation and contrast effects in sequential attractiveness ratings (25–32 participants – Huang et al., 2018; 35–41 participants – Kramer & Jones, 2020; 30 participants – Pegors et al., 2015).

In addition, through simulations based on our data (SIMR package; Green & MacLeod, 2016), we calculated the power to detect fixed effects of the sizes reported by Kramer and Jones (2020, Experiment 1). First, we fitted a linear mixed-effects model to the data collected in this experiment for each task separately (described below). Second, we replaced the estimated coefficients under investigation with those taken from Kramer and Jones (perceptual bias task: previous image baseline = −0.14; response bias task: previous image rating = 0.23). Finally, we used the "powerSim" function to carry out power analyses, simulating new values for the response variables using the altered model coefficients (although maintaining the same fixed and random effects structure) and then statistically testing the simulated fit. For our perceptual bias task, the power to detect an effect of the size reported by Kramer and Jones (based on 100 Monte Carlo simulations) was high: 94.0%, 95% CI [87.4%, 97.8%]. Our response bias task demonstrated similarly high power: 100.0%, 95% CI [96.4%, 100.0%].

The experiment presented here was approved by the University of Lincoln's School of Psychology ethics committee (PSY20211035) and was carried out in accordance with the provisions of the World Medical Association Declaration of Helsinki.

Stimuli

An initial set of 100 female faces (all self-reported as White ethnicity) taken from previous research (Kramer & Jones, 2020) was used here. These faces were chosen to span a wide range of attractiveness levels. All images were constrained to reflect neutral expression, eyes on the camera; consistent posture, lighting, and distance to the camera; no glasses or make-up; and hair tied back.

Using the baseline attractiveness ratings collected previously for these images (0–9 Likert scale; for more details, see Kramer & Jones, 2020), the set was divided into three subsets of 30 images each (with the remaining ten images discarded). These subsets were matched with respect to the mean and range of attractiveness levels of the faces they comprised: Set A – $M = 3.34$, $SD = 0.85$, range = 1.68–5.15; Set B – $M = 3.34$, $SD = 0.81$, range = 1.93–5.07; Set C – $M = 3.33$, $SD = 0.76$, range = 2.02–5.00.

Procedure

The experiment was completed online using the Qualtrics survey platform (www.qualtrics.com). After consent was obtained, participants provided demographic information (age, sex, and ethnicity). Next, all participants completed both the perceptual bias and response bias tasks, with the order of these tasks randomized across participants.

During the perceptual bias task, participants completed 30 trials, presented in a random order. On each trial, a face was presented onscreen for 3 s and then was replaced by a second face (see Figure 1a). With regard to this second face, participants were asked "How attractive is this face?" and provided their response using a 0 (very unattractive) to 9 (very attractive) Likert scale. This response was self-paced, with the second image remaining onscreen until a response was given (following Chang et al., 2017; Kondo et al., 2012, 2013; Kramer & Jones, 2020; Kramer et al., 2013). Participants selected a value along the scale at the bottom of the screen and then selected the "arrow" button in the corner of the screen to confirm. Finally, an empty screen, other than the instructions "Please click for the next trial", served to characterize these two faces/presentations as a distinct trial.

For the response bias task, participants again completed 30 trials, presented in a random order. On each trial, participants were first asked to "Please select the number X", where X was a randomly generated integer between 0 and 9, with responses being self-paced. The "arrow" button was then selected in order to advance to the next screen, on which a face was presented, and participants were asked "How attractive is this face?" (see Figure 1b). Self-paced responses were provided using a 0 (very unattractive) to 9 (very attractive) Likert scale, with the face again

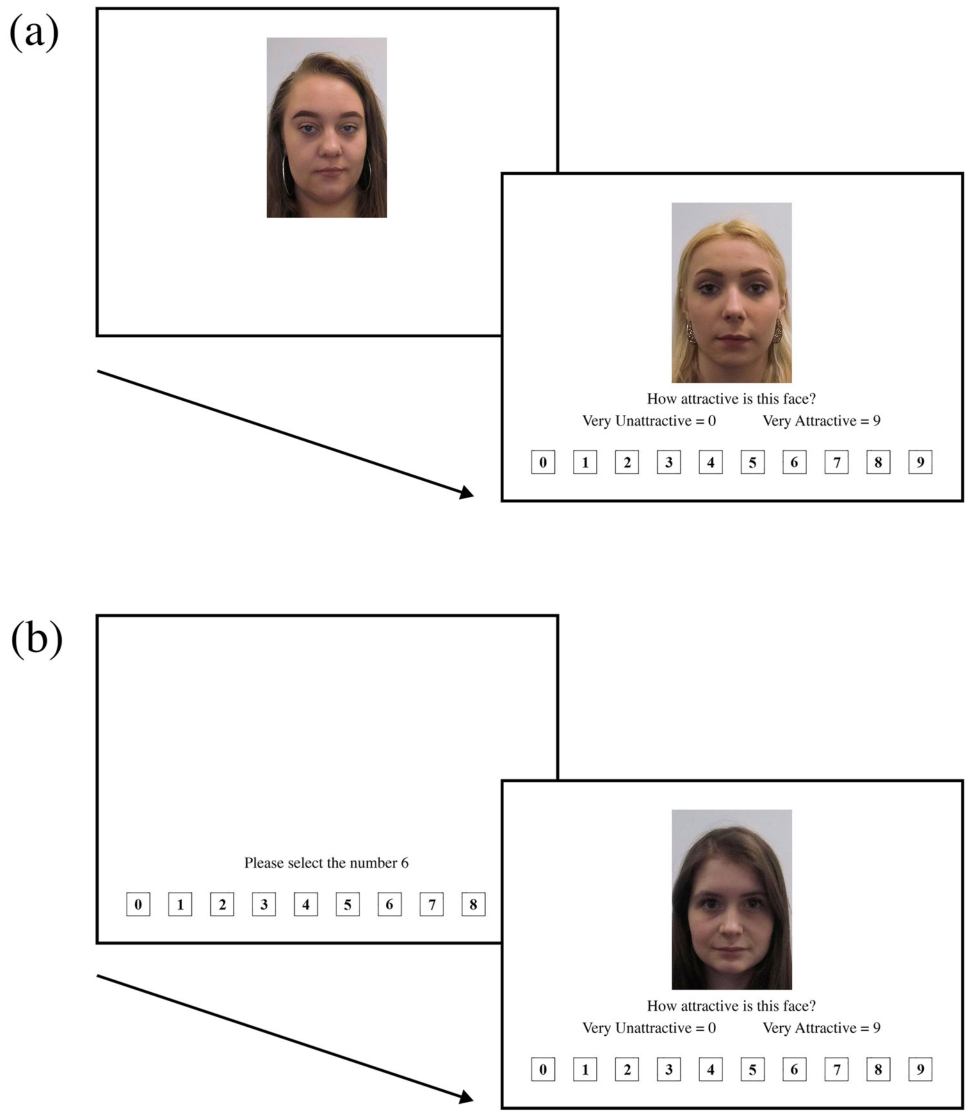

Figure 1. An illustration of (a) the perceptual bias task and (b) the response bias task.

remaining onscreen until a response was given. Participants selected a value along the scale at the bottom of the screen and then clicked the “arrow” button in the corner of the screen to confirm. Finally, instructions asking participants to “Please click for the next trial” then appeared as described above.

Participants completed one of three versions of the experiment. In each version, two subsets of images (described earlier) were presented during the perceptual bias task (one represented viewed-only images while the other represented images to be rated) and the third was presented during the response bias task (as the images to be rated). All three combinations of subsets were utilized via a Latin square design, with participants randomly assigned to experiment version. As such, all faces appeared in all contexts across participants.

Results

Across the two tasks, ratings given to the current image were comparable with previously collected baseline ratings (see the “stimuli” section above, although note that all three sets were rated across participants, which resulted in larger standard deviations) and each other: perceptual bias task – $M =$ 4.22, $SD = 1.99$; response bias task – $M = 4.21$, $SD =$ 2.01.

The data were analysed using linear mixed-effects models with crossed random effects (participants and images) because each participant rated the same set of stimuli (see Kramer & Jones, 2020). Therefore, participants and stimuli variance were considered at Level 2 and residual variance at Level

1. In terms of the dataset, each participant by image observation was the unit of analysis, with each row of data indicating the attractiveness rating given by that participant to that trial's image and the image's baseline attractiveness (calculated from the prior ratings collected by Kramer & Jones, 2020). For the perceptual bias task, we also included the trial's previous image's baseline attractiveness (again, calculated from prior ratings). For the response bias task, we also included the trial's response value given by that participant during the previous screen.

In our analyses, the presence of a bias was determined by the ability to predict the rating given to the current image by either the trial's previous image's baseline attractiveness (perceptual bias task) or the trial's response value given by that participant during the previous screen (response bias task). The strength of any biases were reflected in the fixed effects' coefficient estimates, with the sign of these estimates representing the type of bias – a positive value for assimilation and a negative value for contrast.

Statistical analyses were carried out in R using a linear mixed effects model (lme4 package – Bates et al., 2015). For significance reports, degrees of freedom were estimated using Satterthwaite's method (lmerTest package – Kuznetsova et al., 2017), and restricted maximum likelihood was used to fit the models.

Perceptual bias task

The fixed effects were the intercept, the effect of the current image's baseline attractiveness, and the effect of the previous image's baseline attractiveness. Only the intercept in these models varied randomly across images, whereas the intercept and the slope of the current image's baseline attractiveness varied randomly across participants. Models using more complex random effects structures were identified as singular (Barr et al., 2013).

As Table 1 illustrates (Model 2), we found that ratings of the current face were, unsurprisingly, positively influenced by the current face's baseline attractiveness. That is, the more attractive the face was considered to be by a separate sample of raters, the higher the rating given to that face by the participant. In addition, the previous image's baseline attractiveness was a negative predictor of the rating given to the current image, representing a contrast effect. This is reflected in the model's estimate: for a one-unit increase in the previous image's baseline value, ratings of the current image decreased by a mean of 0.14 units along this same scale. Indeed, the inclusion of the previous image's baseline value as a predictor (Model 2) represented a significant improvement over a model in which only the current face's baseline attractiveness was featured (Model 1), $\chi^2(1) = 11.27$, $p < .001$.

Table 1. Parameter estimates for linear mixed-effects models predicting ratings of attractiveness given to the current image in the perceptual bias task.

	Fixed effect	Estimate	*SE*	*t*	*p*
Model 1					
	Intercept	0.85	0.32	2.62	.011
	Current image baseline	1.01	0.07	14.99	< .001
Model 2					
	Intercept	1.29	0.35	3.73	< .001
	Current image baseline	1.01	0.07	15.39	< .001
	Previous image baseline	−0.14	0.04	−3.43	< .001

Response bias task

The fixed effects were the intercept, the effect of the current image's baseline attractiveness and the effect of the response value given during the previous screen. Only the intercept in these models varied randomly across images and participants. Models using more complex random effects structures were identified as singular (Barr et al., 2013).

As Table 2 illustrates (Model 2), we found that ratings of the current face were again positively influenced by the current face's baseline attractiveness. In addition, the response value given during the previous screen failed to predict the rating given to the current image. This is reflected in the model's estimate: for a one-unit increase in the response value previously given, ratings of the current image increased by a mean of 0.02 units

Table 2. Parameter estimates for linear mixed-effects models predicting ratings of attractiveness given to the current image in the response bias task.

	Fixed effect	Estimate	*SE*	*t*	*p*
Model 1					
	Intercept	0.46	0.22	2.09	.039
	Current image baseline	1.12	0.04	27.05	< .001
Model 2					
	Intercept	0.38	0.23	1.67	.097
	Current image baseline	1.12	0.04	27.01	< .001
	Previous response value	0.02	0.01	1.95	.051

along this same scale. Indeed, the inclusion of the response value as a predictor (Model 2) failed to provide a significant improvement over a model in which only the current face's baseline attractiveness was featured (Model 1), $\chi^2(1) = 3.81$, $p = .051$. Finally, a Bayesian comparison of these two models resulted in a Bayes factor (BF01) of 3.96, representing moderate evidence supporting Model 1 over Model 2.

Discussion

The aim of the current study was to provide further evidence on the nature of perceptual and response biases in light of the contradictory findings produced by previous research (Chang et al., 2017; Huang et al., 2018; Pegors et al., 2015; Xia et al., 2016). To this end, we investigated each bias in isolation by attempting to remove the possibility that the other could be present due to the experimental tasks used.

Our perceptual bias task found that evaluations of the current face contrasted with the baseline attractiveness of the previous face. That is, participants' ratings were shifted away from the attractiveness (as rated by others) of the previous face. This contrast effect aligns with the results of some previous researchers (Huang et al., 2018; Pegors et al., 2015) but not others (Chang et al., 2017; Xia et al., 2016). Surprisingly, our results differed from these latter studies where the perceptual bias was also specifically investigated in isolation.

This inconsistency in findings across studies may be explained by the length of time for which the previous stimulus was presented (Taubert & Alais, 2016; Van der Burg et al., 2019; Xia et al., 2016). Generally, assimilation is found for very short stimulus presentations, thought to be the result of serial dependence, whereas a contrast effect is evident for longer presentations, due to negative aftereffects from prolonged stimulus adaptation (Kanai & Verstraten, 2005; Suárez-Pinilla et al., 2018). Indeed, in studies of facial attractiveness, assimilative effects have been found for stimulus presentation times of up to 1 s (Taubert et al., 2016; Van der Burg et al., 2019; Xia et al., 2016) while contrast effects have been found for presentation times of 3 s and above (Huang et al., 2018; Pegors et al., 2015). In the present study, the previous image was presented for 3 s, perhaps explaining why our findings differed from those with short stimulus presentations (e.g., Xia et al., 2016). Problematically for this account, Chang et al. (2017; Experiment 4) also presented images (although not faces) for this length of time and found a perceptual bias that was assimilative. This may be explained, for example, by 1) their manipulation of the previous image's valence but limiting the current image to be neutral; 2) incorporating a dot detection task when viewing the previous image; or 3) a failure to consider statistical power during recruitment. Considering the diverse findings identified here, there is a clear need to investigate this issue further.

In addition to the presentation time of the previous stimulus, there remain two other sources of timing where studies in this literature can vary. First, the interstimulus interval (ISI; the interval between the previous and current image) may influence the nature of the sequential bias that participants demonstrate. For instance, longer ISIs may decrease the magnitude of the bias (Attali, 2011; Xia et al., 2016). Indeed, it may be that timing affects perceptual and response biases differently, with the suggestion that perceptual biases may be assimilative for short ISIs, while decreasing and/or becoming contrastive at longer ISIs (Xia et al., 2016). However, response biases may simply decrease with an increased ISI if these rely, for example, on motor repetition. Second, the presentation time of the current image (i.e., how long participants are shown the image to be rated) may or may not be unlimited. Of course, in the majority of studies (e.g., Huang et al., 2018; Kondo et al., 2012, 2013; Kramer & Jones, 2020; Kramer et al., 2013; Pegors et al., 2015; Xia et al., 2016), a sequence (rather than a pair) of images is shown, meaning that there is no distinction between the presentation time for the previous and current image. As such, it remains unclear as to how this factor may (independently) influence the nature of any resulting biases. Therefore, research in which timings are systematically varied may provide some much needed information in this field.

It is important to consider through which mechanisms the previous face may have influenced the perceived attractiveness of the current face in our perceptual bias task. Participants could simply have perceived the face, and it was this perception alone (e.g., low-level, sensory adaptation) that subsequently biased the perception of the face that followed and was rated. However, it is also possible that some implicit judgement or response about the attractiveness of the previous face was made (although no explicit response was given; Pascucci et al., 2019; Turbett et al., 2021). Indeed, previous research has demonstrated that facial attractiveness is likely to be perceived automatically (e.g., Chaterjee et al., 2009; Ritchie et al., 2017). As a result, it may be that a bias in judgements, rather than simple perceptions, could be present in the current task. Deriving a method of teasing apart these two explanations, if possible, will inform as to the level of processing and decision-making at which this bias takes place.

The response to the current face has previously been shown to assimilate towards the response given to the previous face (e.g., Huang et al., 2018; Pegors et al., 2015). In our response bias task, we found no such assimilation when the previous response was given to a simple value (a randomly generated integer between 0 and 9) presented on screen. Perhaps one important distinction between the present study and past research is that our participants were not free to choose their previous response. Instead, participants were asked to select a specified value. This "instructed response" mirrored the design of Pape et al. (2017), who found a contrast effect in their data (although using dot patterns and binary responses). In addition, after selecting this value, our participants were required to select an "arrow" button in the corner of the screen to confirm their response. These particular details lend themselves to the three hypotheses that follow.

First, a response bias is driven by a motor response and, more specifically, action repetition, which was disturbed here via the need to select a second (arrow) button to progress to the next trial. However, previous research has shown that relocating the mouse cursor to a location equidistant to all response options between trials failed to prevent an assimilative response bias (Kramer & Jones, 2020), as did asking participants to respond orally (Huang et al., 2018). Second, a response bias is somewhat dependent on perceptual elements, and without the perceptual processing of a preceding face, the effect is extinguished. Support for this idea comes from previous studies showing a weaker (Huang et al., 2018) or absent (Pegors et al., 2015) response bias when the preceding stimulus was not a face image. It may also be that attractiveness responses specifically (the dimension of relevance here) are required for a response bias to occur. Of course, collecting responses to faces risks conflating perceptual and responses biases (Kramer & Jones, 2020). Third, the decision-making of the participant (i.e., actively choosing the response themselves) is imperative for the production of a response bias. Indeed, the preceding decision may be what causes a bias in the current decision (Fritsche et al., 2017). Here, we chose not to give participants a free choice regarding the value to be selected for fear that they would simply choose the same integer on every trial in order to minimize effort. However, future work might focus on this issue of "free will" through utilizing a design targeted at this question in particular.

In both tasks, the current image's baseline attractiveness was a strong predictor of the response given to the current image. Indeed, there was an approximately one-to-one relationship between the two variables: for a one-unit increase in baseline attractiveness, responses increased by around one unit. This result mirrors previous findings (e.g., Kramer & Jones, 2020) and highlights the substantial amount of "shared taste" that raters demonstrate when judging facial attractiveness (Hönekopp, 2006; Kramer et al., 2018). Simply, if other people consider a face to be attractive then it is very likely that I will also provide a high rating for that face. Inter-rater agreement is known to be large across groups, even those differing in age and race (Albright et al., 1997; Cogsdill & Banaji, 2015). As a result, we rightly expect that the baseline attractiveness of the previous face and the previous response should be highly correlated, which can lead to statistical issues regarding multicollinearity (e.g., Kramer & Jones, 2020). For this reason, we have chosen here to investigate perceptual and response biases using separate tasks specifically designed to do so, and strongly encourage other researchers to follow suit.

Above, we considered the nature of biases being either assimilative or contrastive as a possible result of the presentation times utilized within a given task. In addition, researchers have proposed similarity as an important factor. For instance, the Selective Accessibility Model (Mussweiler, 2003) argues that an initial dichotomous decision as to whether the target and standard are similar or dissimilar will result in information supporting that decision becoming more accessible. Subsequently, targets deemed similar to the standard will produce assimilation while dissimilar targets will see a contrast with the standard. In recent work (Barker & Imhoff, 2021), this model has been evidenced in a more continuous manner – that is, as similarity changes to dissimilarity, biases shift from assimilation to contrast. In the tasks presented here, all face images were relatively homogeneous (i.e., young, White women). As such, it seems unlikely that perceived dissimilarity between pairs of faces resulted in the contrastive perceptual bias that was found. However, it is certainly possible that implicit judgements of similarity may play a role in the biases shown when judging attractiveness, and future research should aim to address this idea.

As noted, the current set of stimuli comprised White, female facial photographs displaying neutral expressions. Even within the literature investigating sequential effects when judging facial attractiveness, a variety of stimulus sets have been utilized (White, male, neutral photographs – Huang et al., 2018; Japanese faces of both genders – Kondo et al., 2012, 2013; White, female, neutral photographs – Kramer & Jones, 2020; Pegors et al., 2015; White and Chinese, neutral photographs of both genders – Kramer et al., 2013; celebrities of both genders, with each participant seeing images of only one identity – Xia et al., 2016). It remains unclear as to whether these differences may affect the types of biases found, although evidence has already shown that interspersing different categories of faces (e.g., varying in gender or ethnicity) resulted in within- versus between-category differences in the strength of these biases (e.g., Kondo et al., 2013; Kramer et al., 2013). Other salient category memberships, such as age group, might also play a role, as could the category memberships of the perceivers themselves. These considerations remain unexplored at present.

In sum, we examined the effects of perceptual and response biases individually, finding a contrast effect for the former and no evidence of the latter. These results showed both agreement and contradiction when considered alongside previous evidence, which may be due to presentation times or other elements that require further investigation. The particular design used in the current study to investigate response biases identified interesting further avenues for exploring why such biases are not always present. Here, for example, we focussed on a motor response bias given in isolation, paving the way for future research to incorporate additional factors that may influence its presence or absence. Taken together, our results demonstrate the utility in examining biases separately to better understand the nature of these effects.

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