Research Report

Erasing the face after-effect

Ghazaleh Kiani, Jodie Davies-Thompson, Jason J.S. Barton*

Human Vision and Eye Movement Laboratory, Departments of Medicine (Neurology) and Ophthalmology and Visual Sciences, University of British Columbia, Vancouver, Canada

ABSTRACT

Perceptual after-effects decay over time at a rate that depends on several factors, such as the duration of adaptation and the duration of the test stimuli. Whether this decay is accelerated by exposure to other faces after adaptation is not known. Our goal was to determine if the appearance of other faces during a delay period after adaptation affected the face identity after-effect. In the first experiment we investigated whether, in the perception of ambiguous stimuli created by morphing between two faces, the repulsive after-effects from adaptation to one face were reduced by brief presentation of the second face in a delay period. We found no effect; however, this may have been confounded by a small attractive after-effect from the interference face. In the second experiment, the interference stimuli were faces unrelated to those used as adaptation stimuli, and we examined after-effects at three different delay periods. This showed a decline in after-effects as the time since adaptation increased, and an enhancement of this decline by the presentation of intervening faces. An exponential model estimated that the intervening faces caused an 85% reduction in the time constant of the after-effect decay. In conclusion, we confirm that face after-effects decline rapidly after adaptation and that exposure to other faces hastens the re-setting of the system.

Crown Copyright © 2014 Published by Elsevier B.V. All rights reserved.

1. Introduction

Exposure to a stimulus can alter perception of a following one. For example, seeing a line with a clockwise tilt causes a subsequent vertical line to appear tilted counter-clockwise (Gibson and Radner, 1937; Harris and Calvert, 1989). Such after-effects have been observed after adaptation for many types of visual properties, such as curvature (Bales and Follansbee, 1935; Gheorghiu and Kingdom, 2007; Gibson, 1933), motion (Hershenson, 1989) and contour shape (Prins, 2009).

After-effects also occur for more complex stimuli such as faces (Webster and MacLeod, 2011). For example, adaptation to a distorted face results in a subsequently viewed ‘normal’ face being perceived as distorted in the opposite direction (MacLin and Webster, 2001). Face after-effects have been shown not just for shape but also for a number of complex facial properties, such as identity (Fox et al., 2008; Leopold et al., 2001), expression (Fox and Barton, 2007), gender (Oruc et al., 2011), and age (Lai et al., 2012, 2013). Although face after-effects are reduced by off-setting the location of...
the test stimuli by 5° relative to the adaptor stimuli (Afriz and Cavanagh, 2008), substantial after-effects remain even if the retinotopic contribution of low-level image properties are reduced by varying the size (Rhodes et al., 2007) or retinal location (Leopold et al., 2001; Roach and Webb, 2013) of the adaptor in relation to the test stimulus. This is consistent with other findings that indicate that face after-effects are not derived from low-level image properties, but from high-level representations (Butler et al., 2008).

After-effects are evidence of a short-term experience-dependent form of plasticity in the visual system. The benefits of these effects to perception are not entirely clear. In motion perception it has been suggested that after-effects may be evidence of a re-calibration or gain control, to make operation under varying conditions of motion more effective (Verstraten et al., 1994). For face after-effects, there is evidence that facilitation from brief exposure is accompanied by a lateral inhibition of perception of other faces (Oruç and Barton, 2010), and that this inhibition has a center-surround organisation (Rostamirad et al., 2009), which could enhance perception of the adapted face over similar faces. With longer adaptation, there is sharpened tuning of shape discrimination specific for the adapted face (Oruc and Barton, 2011), which could again benefit the distinction of the adapted face from other competing faces. Thus, face after-effects could also be manifestations of a type of gain control to enhance processing of the face being viewed.

To be effective in daily experience such benefits should be transient, as recently viewed faces continue to be replaced by new faces in new encounters. For visual adaptation in general, there has long been evidence that after-effects decay over time. This has been shown for displacement after-effects (Hammer, 1949), for example, and has been particularly well studied for the motion after-effect, whose decay has been modelled with an exponential function (Hershenson, 1989; Keck and Pentz, 1977; Taylor, 1963). Recent studies also show a rapid decline in face identity after-effects in the first few seconds after adaptation (Leopold et al., 2001; Leopold et al., 2005; Rhodes et al., 2007). On the other hand, there are also reports that face distortion after-effects may persist at a modest level for 1 to 7 days (Carbon and Ditye, 2011; Carbon et al., 2007). One of the curious aspects of these latter studies of long-term after-effects is that these were found despite the fact that subjects continued to be exposed to other faces in the course of their daily routines. This contrasts with the study of effects over several seconds in the laboratory, in which the time between adaptation and the subject’s response is filled by either a blank interval of varying duration (Leopold et al., 2003) or merely by prolonging the duration of the test stimulus (Rhodes et al., 2007). Although there are ‘de-adaptation’ studies that employ a strategy of using an opposing stimulus to generate after-effects to counter-act those from the first stimulus (Mesik et al., 2013), it is not known whether even brief introduction of other face stimuli in the period between the adaptor and test stimulus affects the dynamics of the face after-effect. However, notwithstanding the findings from studies of long-term after-effects (Carbon and Ditye, 2011; Carbon et al., 2007), it is plausible that the effects of adaptation to one face would be altered and possibly reduced by viewing of another face. The goal of this study was to test the hypothesis that face identity after-effects would be reduced by exposure to other face stimuli.

2. Results

2.1. Experiment 1

In our first experiment, we used the ‘perceptual bias’ method, in which ambiguous test stimuli are created by morphing between a pair of faces. After adapting to one of these two faces, subjects usually show a repulsive after-effect, in that they are more likely to respond that an ambiguous test stimulus looks more like the other face of the pair. We asked whether adaptation to the first face would be reduced if the subject was briefly exposed to the second face of the pair, just before the appearance of the ambiguous test stimuli. While the strategy of following the first face by the second ‘opposing’ face creates similarities with de-adaptation studies, the latter aim to create an after-effect that counteracts and thus nullifies the initial after-effect (Mesik et al., 2013). In our case we wished to determine if a view too brief to create an opposing repulsive after-effect would nevertheless alter the after-effect generated by the first face.

We had three conditions; an Adaptor-only condition in which subjects saw an adapting face for 5 s followed by a brief blank interval and then the test face, an Interference-only condition in which they did not see an adapting face but the brief interval contained a face, and an Adaptor-Interference condition in which the 5 s of the adapting face was followed by the opposite face in the brief interval before the test face appeared.

The 5 s of adaptation in the Adaptor-only condition replicated the previously shown repulsive after-effect, here averaging 29% (t(11)=6.12, p<0.0001, Fig. 1). Introducing an interfering face-opposite identity in the Adaptor-Interference condition resulted in a similar repulsive after-effect at 28% (t(11)=2.57, p=0.026). There is a suggestion that the brief (150 ms) presentation of a face in the Interference-only condition may have led to a slight attractive after-effect of 9%, but this was not significant (t(11)=1.61, p=0.14). The ANOVA confirmed a significant effect of condition (F(2,22)=9.98, p<0.0008). Linear contrasts showed this was due smaller repulsive after-effects in the Interference-only condition compared to either the Adaptor-only (F(1,22)=14.86, p<0.0009) or the Adaptor-Interference (F(1,22)=15.08, p<0.0008) condition. However, there was no difference between the Adaptor-only and Adaptor-Interference condition (F(1,22)=0.0009, p=0.98). While these results suggest that a brief view of a face does not alter the after-effect generated by a face at the opposite end of a morph spectrum, this interpretation is complicated by the possibility that the Interference-only condition generated a small attractive after-effect. Although that failed to reach statistical significance, caution dictates that we should not discount this, especially as other experiments have suggested that brief exposures of around 100 ms can generate facilitatory after-effects on the perception of face identity (Oruç and Barton, 2010). Since the Adaptor-Interference condition would present Face 1 as an adaptor and Face 2 as the interference stimulus (or vice versa), both the repulsive after-
effect of the adaptor (Face 1) and a possible attractive after-effect of the interference stimulus (Face 2) would lead to the subject responding that morphed test images looked more like Face 2. Hence, if (1) the repulsive after-effect from the adapting image was truly unaffected by the interference stimuli, and if (2) the interference and adapting stimuli generated independent and additive effects, then one would have expected after-effects in the Adaptor-Interference condition to be up to 50% larger than those in the Adaptor-only condition, rather than merely equivalent. Put another way, any decline in repulsive after-effects due to an interference stimulus may have been masked by a possible small attractive after-effect generated by that stimulus. Because of this concern, we performed a second experiment with different interference stimuli.

2.2. Experiment 2

In this experiment, instead of using the opposite face on the morph continuum as the interference stimulus, we used several different faces that had no relation to the adapting or test stimuli. Furthermore, we presented exactly the same faces after adaptation to Face 1 and adaptation to Face 2, so that any inadvertent effects of the interference faces on perception of the test stimuli would cancel out in the subtractive calculation of after-effect magnitude. Also, to better characterise any potential effect of interference stimuli on the decay of adaptation, we examined effects for three different delay periods between adaptation and test stimuli (300, 1650, and 3000 ms). Again, we had the three conditions of Adaptor-only, Interference-only, and Adaptor-Interference trials. In addition some subjects did a Test-alone condition, in which the test stimuli were preceded by neither adapting nor interfering faces. This provided a baseline that allowed us to determine if the interference images affected perception of the test faces.

First, to verify that the new interference stimuli did not bias perception of the ambiguous morphed test stimuli, one-sampled t-tests of the Interference-only condition (Fig. 2) showed that subjects were no more likely to respond Face 1 or Face 2 after interference stimuli of 300 ms ($t(15) = -0.59$, $p=0.57$), 1650 ms ($t(15) = -0.63$, $p=0.54$), or 3000 ms ($t(15) = -0.55$, $p=0.59$). Comparing the Interference-only and Test-alone conditions in the seven...
Fig. 2 – Results, Experiment 2, Interference-only condition. Top row, left: Response functions collapsed across all subjects for all pairs of faces, plotting the frequency of Face 2 responses (y-axis) as a function of the percentage of Face 2 in the morphed test image test (x-axis). Bottom row, left: Mean frequency of Face 2 responses. In the absence of adapting stimuli, subjects were as equally likely to respond Face 1 as Face 2, for each of the three delay periods (300 ms, 1650 ms, 3000 ms). Dashed lines indicate frequency = 0.50, which is the point of equivalence. Right graph: Comparison of mean frequency of Face 2 responses for the interference-only condition with the test-alone condition in seven subjects. Interference stimuli do not bias perception of the test stimuli. Error bars represent one standard error.

Fig. 3 – Results, Experiment 2, Adaptor-only and Adaptor-Interference conditions. Top rows: Response functions for Face 1 and Face 2 collapsed across all subjects for all pairs of faces, plotting the frequency of Face 2 responses (y-axis) as a function of the percentage of Face 2 in the morphed test image test (x-axis). Bottom rows: After-effect magnitudes. The after-effects at 300 ms were larger than at 1650 ms or 3000 ms, and those in the Adaptor-Interference conditions were less than those in the Adaptor-only condition. Error bars represent one standard error.

Please cite this article as: Kiani, G., et al., Erasing the face after-effect. Brain Research (2014), http://dx.doi.org/10.1016/j.brainres.2014.08.052
subjects who performed both, ANOVA showed that there was no effect of Condition (F(1,30) = 0.86, p = 0.36) or of the Delay period (F(1,30) = 0.46, p = 0.64), and no interaction between the two (F(1,30) = 1.02, p = 0.37).

In the Adaptor-only condition (Fig. 3), increasing the time between the adaptor and the test stimuli decreased the mean after-effect from 33% in the 300 ms condition (t(15) = 12.95, p < 0.0001), to 15% in the 1650 ms condition (t(15) = 3.06, p = 0.008) and 14% in the 3000 ms condition (t(15) = 2.51, p = 0.024). In the Adaptor-Interference condition, an interference stimulus lasting 300 ms resulted in a mean after-effect of 15% (t(15) = 3.09, p = 0.007). When the duration of this stimulus increased to 1650 ms, the mean after-effect was 8% and failed to reach significance (t(15) = 1.59, p = 0.13), while a further increase to 3000 ms resulted in a similar mean after-effect of 9% (t(15) = 2.31, p = 0.035).

The ANOVA revealed an effect of Condition (F(1,80) = 6.84, p < 0.011), due to larger after-effects for the Adaptation-only condition, and an effect of Delay period (F(2,80) = 4.41, p = 0.016), but no interaction between these two factors (F(2,80) = 1.58, p = 0.22). Linear contrasts revealed that the effect of delay period was due to larger after-effects for 300 ms compared to both 1650 ms (F(1,80) = 6.37, p < 0.0136) and 3000 ms (F(1,80) = 6.86, p < 0.011), but no difference between 1650 ms and 3000 ms (F(1,80) = 0.009, p = 0.93).

2.3. Model

Previous studies of adaptation for other phenomena such as motion (Hershenson, 1989; Keck and Pentz, 1977; Taylor, 1963) have modelled the decay of after-effects with an exponential function, \( A_E = A_{E_{\text{max}}} \, \exp(-t/\tau) \), where \( A_E \) is the after-effect magnitude measured at time \( t \), \( A_{E_{\text{max}}} \) is the maximum after-effect, which occurs when \( t = 0 \), and \( \tau \) is a time constant. This function asymptotes at a value of 0, but given the evidence that there may be modest persistent after-effects up to 7 days after adaptation (Carbon and Ditye, 2011), we modify this equation to include a small floor effect \( A_{E_{\text{f}}} \): hence, \( A_E = A_{E_{\text{max}}} \, \exp(-t/\tau) + A_{E_{\text{f}}} \). Our prior studies of face identity adaptation with similar methods (Fox et al., 2008) yielded aftereffect magnitudes ranging from 0.30 to 0.50, which can serve as an estimate range for \( A_{E_{\text{max}}} \). It is more difficult to derive an estimate range for \( A_{E_{\text{f}}} \) as the method of quantifying aftereffects in prior studies (Carbon and Ditye 2011; Carbon et al., 2007) is difficult to relate to our study. Given our results, we systematically explored the best-fit time constants with \( A_{E_{\text{max}}} \) ranging from 0.30 to 0.50, and \( A_{E_{\text{f}}} \) ranging from 0.03 to 0.09. Although the exact values of these time constants vary with different estimates for \( A_{E_{\text{max}}} \) and \( A_{E_{\text{f}}} \), all combinations of \( A_{E_{\text{max}}} \) and \( A_{E_{\text{f}}} \) yielded a similar proportionate reduction of \( \tau \) of 84–86% by interference stimuli. For illustration, we used values of 0.40 for \( A_{E_{\text{max}}} \) and 0.05 for \( A_{E_{\text{f}}} \) to generate the curves in Fig. 6. In this depiction, the best-fit for the time constant \( \tau \) is 2240 ms for the adaptor-only condition, which is reduced to 310 ms by the presence of the interference stimulus in the adaptor-interference condition, a reduction of 86.2% (Fig. 4).

3. Discussion

In Experiment 1, brief exposure of the second face of a pair in a perceptual bias paradigm did not decrease the after-effect generated by the first face. However, an attractive after-effect generated by the interfering face may have masked a decline in the repulsive after-effect from the adapting face. In Experiment 2, we eliminated this confound and explored the effect of variable delay periods. We found, first, that after-effects decline rapidly by about 50% between 300 ms and 1650 ms and that this decay was reasonably fit by an exponential function. Second, our chief result was that this exponential decline was accelerated by exposure to another face during this period: modelling suggested that an interference face reduced the time constant of after-effect decay by 85%. Hence this confirms the hypothesis that exposure to other faces reduces face identity after-effects.

The dynamics of face after-effects can be complex. After-effect magnitude generally increases with the duration of adaptation (Rhodes et al., 2007), but this simple monotonic effect in a ‘perceptual bias’ design such as ours may contain more complex dynamics contributed from a number of adaptation processes. Experiments using contrast thresholds for face recognition can isolate these component processes (Oruç and Barton, 2010), and show that adaptation generates facilitation at short adapting durations of 100 ms or less, but suppression at adapting durations of more than 800 ms, as well as lateral inhibition for other faces that starts at durations of 100 ms and then increases. Adaptation also sharpens the tuning of discrimination around the adapted face (Oruc and Barton, 2011), but the effect of adaptation duration on this component is not known. At this point, nothing is known about the decay of the different face after-effect components following the adaptation period.

Studies of other types of after-effects show that their decay is related to a number of factors. The time constant of the exponential rate of decay of motion after-effects is not
actually constant, but increases as a function of both the duration of adaptation (Hershenson, 1989; Taylor, 1963) and the contrast of the adapting stimulus (Keck and Pentz, 1977). There is similar effect of adaptation duration on the tilt after-effect but a more complex non-linear relationship with contrast (Harris and Calvert, 1989). For faces there is some weak evidence that the after-effect decay rate is affected by the duration of adaptation (Rhodes et al., 2007). Another factor is the duration of the test stimulus: longer exposures result in an exponential decay in tilt after-effects (Wolfe, 1984), motion (Keck and Pentz, 1977; Taylor, 1963), displacement or ‘figural’ after-effects (Ganz, 1966; Krauskopf, 1954) and face after-effects (Leopold et al., 2005; Rhodes et al., 2007).

While the early reports of ‘storage’ examined the persistence of motion after-effects over periods of darkness (Spigel, 1960; Wohlgemuth, 1911), subsequent studies show that storage can also occur even if the delay period contains stationary or alternating patterns (Thompson and Wright, 1994), or movement in directions orthogonal to the adapting direction (Verstraten et al., 1994). Most relevant to our work, one study showed that storage for grating motion was not affected by whether the delay period consisted of viewing of darkness, lightness, or a variety of gratings, as long as it was not of a stationary grating with the same spatial structure as the moving adaptation grating (Thompson and Wright, 1994). The results from the Adaptor-Interference condition of our second experiment suggest a different effect for face adaptation. Here, face stimuli unrelated to the adapting and test images (‘unrelated’ also insofar as they did not bias perception in the Interference-only condition, as shown in Fig. 2) reduced the time constant of the decay of face after-effects by 85%. Hence, it is not just that “the potency of adaptation survives a period of non-stimulation, but is quickly spent when a test stimulus appears” (Leopold et al., 2001), but that, for faces, this potency is reduced by the appearance of another face even if it has no relation to the test.

A remaining question from our study is whether other interference stimuli besides faces might similarly truncate the time constant of face after-effects. Given the results for motion after-effects (Thompson and Wright, 1994), one would

---

Fig. 5 – Stimuli. (A) The two sets of pairs of face identities used in both Experiments 1 and 2 as adapting stimuli. These were also used as interference stimuli in Experiment 1. (B) The unrelated faces used as interference stimuli in Experiment 2.
surmise that they would not, or at least, that at some point interference stimuli sufficiently different from faces would fail to produce this effect. If face after-effects index processes that confer dynamic perceptual benefits on face processing, it would seem beneficial if these were modified by the appearance of new faces, but not necessarily by unrelated visual objects. Our current results provide evidence that it is indeed possible to ‘erase’ face after-effects by presenting new faces: the specificity of this interference effect for faces awaits further study.

4. Experimental procedure

4.1. Experiment 1

4.1.1. Subjects
Twelve participants (9 female) took part in Experiment 1, with a mean age of 23.6 years (SD = 4.1; range 18 to 32). All subjects had normal or corrected-to-normal vision, no history of psychiatric or neurological disease, and were naive to the purpose of the experiment. The protocols were approved by the institutional review boards of Vancouver General Hospital and the University of British Columbia, and written informed consent was obtained for all subjects in accordance with The Code of Ethics of the World Medical Association, Declaration of Helsinki.

4.1.2. Apparatus and stimuli
All stimuli were displayed at a 60 Hz refresh rate on a 22” Samsung SyncMaster B2240 LCD screen connected to a 15.6” ThinkPad T 520 Lenovo Notebook. The screen was viewed from approximately 57 cm away under consistent lighting condition. The protocol was designed and conducted with SuperLab 4.5.3. (http://www.cedrus.com).

Two sets of four faces were used, with half of the subjects randomly assigned to Set A and the other half to Set B. Frontal images of faces of anonymous people were obtained from the HVEM-FIVE face database and a variety of internet sources (Fig. 5). Hair that fell below the jawline and any distinguishing marks were removed using Adobe Photoshop CS2 (http://www.adobe.com). The facial images were first...
converted to grey scale and superimposed on a black background. The two members of a pair were then matched in size to optimise the morphing process. This was done by making each image the same height, then aligning the pupils of the two images on top of each other, and finally equating the inter-pupillary distance of the two images. This last adjustment resulted in slight variation in image height between the members of a pair.

4.1.2.1. Adapting and interference stimuli. For each subject, one pair of male and one pair of female Caucasian faces served as both adapting and interference images (Fig. 6A). Both adapting and interference images had a height of 15.5° of visual angle. To ensure that subjects did not confuse interference and test stimuli, the former were presented with a pale yellow tint (Fig. 6B).

4.1.2.2. Test stimuli. We used Fantamorph 5 (http://www.fantamorph.com) to generate a series of morphs between a pair of two adaptor faces, in steps of 2.5%, (Fig. 6C). The 13 morph images from ‘35% Face 1/65% Face 2’ to ‘65% Face 1/35% Face 2’ were used. To reduce the contribution from low-level retinotopic after-effects, test images varied in size from the adaptors, with a height of 14.5° of visual angle.

4.1.2.3. Choice screen. These screens were created for each pair showing the two whole, un-morphed choice faces of height of 12° of visual angle. For each face pair there were two versions of the choice screens, one with ‘Face 1’ on the left and ‘Face 2’ on the right, and one with ‘Face 2’ on the left and ‘Face 1’ on the right.

4.1.3. Protocol
A single trial had the following sequence. Each began with an adaptation interval of 5 s (or 1 s if no adapting face was shown), which was followed by a 150 ms Gaussian white noise mask, a delay period for 150 ms, and another 150 ms Gaussian white noise mask. A test stimulus was then presented for 300 ms before the choice screen appeared. Subjects were asked to indicate with a keyboard response which of the two faces on the choice screen the test stimulus most resembled. Within each block, each of the 13 morph test images was presented once with each of the 2 adaptors used to create the morphed images, thus generating 26 trials per condition.

There were three conditions, in the Adaptor-only condition, the adaptation interval contained faces, but the delay period had a blank screen. In the Interference-only condition, the adaptation interval contained a blank screen, but a face was presented in the delay period. In the Adaptor-Interference condition, one of the faces of the pair was shown in the adaptation interval, and the other face of the pair was shown in the delay period. The same three conditions were repeated for one male face pair and one female face pair, resulting in a total of 6 blocks, each with 26 trials, presented in a counterbalanced block design. Each block was preceded by 8 practice trials to familiarise participants with the task. Participants took a rest break after each block.

4.1.4. Analysis
Within a face pair, each face was arbitrarily labelled as either Face 1 or Face 2, and the proportion of responses where the subject responded “Face 2” for all the 13 test images were calculated. For example, in the male pairing, we counted the number of responses that ambiguous test images resembled Face 2 for the entire block. The frequency of Face 2 responses was compared between trials in which the adapting image was of Face 1 and those in which the adapting image was of Face 2. If the frequency of Face 2 responses was greater after adapting to Face 1 than to Face 2, this would indicate a repulsive after-effect. Hence the frequency of Face 2 responses after adapting to Face 1 minus the frequency of Face 2 responses after adapting to Face 2 is the after-effect magnitude (Fox and Barton, 2007). These after-effect magnitudes were our dependent variables.

The data were then first entered into one-sample t-tests to determine if significant after-effects were present for each condition. Second, to determine if our conditions altered after-effects, we used a repeated-measures ANOVA with main factors of Condition (Adaptor-only, Adaptor-Interference, Interference-only), and subjects as a random effect, and used linear contrasts to explore significant effects.

4.2. Experiment 2

4.2.1. Subjects
This experiment involved 24 new participants. All had normal or corrected-to-normal vision, no history of psychiatric or neurological disease, and were naive to the purpose of the experiment. In this and other adaptation studies in our lab, we have noted that a minority of subjects show only weak face after-effects. It is not clear whether this is related to variability in neural mechanisms related to proficiency and expertise, or merely reflects more prosaic issues such as differences in attention. Nevertheless, because the current study was interested in the decline of the after-effect, we excluded subjects in whom the after-effect at the shortest delay period was weak or non-existent, as logically we would not be able to detect a reduction in their after-effect with time. By doing so, we hoped to avoid making a type II error regarding the existence of a decline in performance. Thus eight subjects were excluded from the analysis because their after-effect magnitude with a delay period of 300 ms was less than 10%, leaving a total of 16 participants (10 female, mean age 24 years, S.D. = 4.8; range 18–34).

4.2.2. Apparatus and stimuli
Experimental condition, apparati and stimulus preparation were similar to Experiment 1. The key difference was that seven images of unfamiliar Caucasian males and females were used as interference stimuli. These images were frontal images of faces and chosen to vary in lighting, luminance, and contrast, and not tinted yellow. Also, due to the large number of trials, fewer images from the morph series were used as test stimuli, using 5% rather than 2.5% increments, from 35% to 65%, resulting in seven different ambiguous face images for test stimuli.

4.2.3. Protocol
Participants were presented with the same three conditions as in Experiment 1: (i) faces in the adaptation interval and a blank
screen in the delay period (Adaptor-only condition), (2) a blank screen in the adaptation interval and a face in the delay period (Interference-only condition), and (3) a face in the adaptation interval and an interfering face stimulus in the delay period (Adaptor-Interference condition). The events of a trial were similar to Experiment 1, except that the duration of the delay period had three possible values: 300 ms, 1650 ms, and 3000 ms. For interference stimuli we showed faces of the opposite gender to the adaptors and test stimuli, with each of the 7 ambiguous test stimuli being paired with a different interference stimulus (i.e. male ‘35% Face 1/65% Face 2’ test image was paired with unrelated female Face X, male ‘40% Face 1/65% Face 2’ was paired with unrelated female Face Y, etc.). Also, because the same pairings of interference stimuli and test stimuli were used after adapting to Face 1 and after adapting to Face 2, any inadvertent biasing of perception of test stimuli by the interference stimuli would be neutralised in the subtraction used to calculate the after-effect magnitude.

Condition, adapting face gender, and duration of the delay period were all done in separate blocks with intervening rest periods. Each of the three conditions had a male and female version, and each of these six had three different delay period durations, giving a total of 18 blocks. With 7 test stimuli and 2 adapting or interference stimuli, each block had 14 trials, resulting in a total of 252 trials.

In addition to this main experiment, a subset of seven subjects were presented afterwards with 6 blocks of a Test-alone condition. This presented a dark blank screen for either 300 ms, 1650 ms, or 3000 ms, followed by the test morph stimuli for 300 ms, and then the choice screen. This added 210 trials (3 delay periods, 1 male and 1 female morph series, 7 morph levels, 5 repetitions). The purpose of the Test-alone condition was to allow us to evaluate whether the interference stimuli affected the perception of the morph test stimuli.

4.2.4. Analysis

For the Interference-only condition, there was no opposition of images to generate after-effects relevant to the results in our experimental design. Hence for this condition we merely examined if there was any tendency of our interference stimulus to bias perception in the morphed test stimuli, by determining if the frequency of Face 2 responses differed from 0.50.

For the Adaptation-only and Adaptation-Interference conditions, we calculated after-effect magnitudes as in Experiment 1. These were again first entered into one-sample t-tests to determine if significant after-effects were present for each condition. To determine if our post-adaptation conditions altered after-effects, we used a repeated-measures ANOVA with main factors of Condition (Adaptor-only, Adaptor-Interference), and Delay period (300 ms, 1650 ms, 3000 ms) with subjects as a random effect, and used linear contrasts used to explore significant effects.

Acknowledgements

This work was supported by NSERC Discovery Grant RGPIN 355879-08 and presented at the annual meeting of the Vision Sciences Society in Naples, FL, May 2013. JB was supported by a Canada Research Chair and the Marianne Koerner Chair in Brain Diseases.

References

Bales, J., Folland, G., 1935. The after-effect of the perception of curved lines. J. Exp. Psychol. 18, 499.
Gibson, J.J., 1933. Adaptation, after-effect and contrast in the perception of curved lines. J. Exp. Psychol. 16, 1.

Please cite this article as: Kiani, G., et al., Erasing the face after-effect. Brain Research (2014), http://dx.doi.org/10.1016/j.brainres.2014.08.052