Face Imagery Is Based on Featural Representations

Janek S. Lobmaier[1] and Fred W. Mast[2]

[1]Cognitive Neuroscience, Department of Psychology, University of Zurich
[2]Department of Psychology, University of Lausanne, both Switzerland

Abstract. The effect of imagery on featural and configural face processing was investigated using blurred and scrambled faces. By means of blurring, featural information is reduced; by scrambling a face into its constituent parts configural information is lost. Twenty-four participants learned ten faces together with the sound of a name. In following matching-to-sample tasks participants had to decide whether an auditory presented name belonged to a visually presented scrambled or blurred face in two experimental conditions. In the imagery condition, the name was presented prior to the visual stimulus and participants were required to imagine the corresponding face as clearly and vividly as possible. In the perception condition name and test face were presented simultaneously, thus no facilitation via mental imagery was possible. Analyses of the hit values showed that in the imagery condition scrambled faces were recognized significantly better than blurred faces whereas there was no such effect for the perception condition. The results suggest that mental imagery activates featural representations more than configural representations.

Keywords: face imagery, configural information, featural information, top-down, bottom-up

Introduction

Imagine your history teacher back in your old schooldays. It may be a long time, but still the teacher's face can be imagined quite vividly. The pointed nose, the bushy eyebrows behind those shell-rimmed glasses, the thin hair are unforgettable. Needless to say that it feels different when we actually look at a photograph of this teacher as it may be shown around during the next class reunion. But what exactly is the difference? A striking distinction concerns the source that triggers a percept or a mental image. A percept has its origin in the stimulus whereas a mental image is evoked internally, based on previously memorized information. Therefore, it has often been suggested that images never give an impression of novelty, because we already know what we imagine. In his work on the imaginary, Jean-Paul Sartre puts it this way: "if I give myself in image the page of a book, I am in the attitude of the reader, I *look at* the printed lines. But I do not *read*. And, at the bottom, I am not even looking, because I already *know* what is written" (Sartre, 1940, trans. 2004, p. 10). Even though behavioral experiments on imagery found evidence that people can detect new interpretations in their mental images (e.g., Mast & Kosslyn, 2002), the identity of an imagined face is normally known prior to the generation of the image. In contrast, when I see a friend on the street I will have to decide whether it is really her or not.

Despite these apparent differences various neuroimaging studies on mental imagery of faces suggest that visual imagery evokes – at least partly – similar activation as when the faces are in fact perceived (Farah, Peronnet, Gonon, & Giard, 1988; Ishai, Haxby, & Ungerleider, 2002; Ishai, Ungerleider, & Haxby, 2000). In a study using functional magnetic resonance imaging (fMRI), Ishai and colleagues (Ishai et al., 2000) found content-related activation in extrastriate cortex and ventral temporal cortex when the participants visually imagined faces, houses, and chairs. It is noteworthy, however, that Ishai et al. (2000) also found some activity restricted to visual imagery in parietal and frontal cortex (see also Mechelli, Price, Friston, & Ishai, 2004).

Further evidence that imagery and perception of faces underlie similar neural mechanisms comes from case studies with prosopagnosic patients, which revealed that an impairment of face recognition is often accompanied with the disability to mentally visualize faces (Charcot & Bernard, 1883; Young, Humphreys, Riddoch, Hellawell, & de Haan, 1994; Young & Van De Wal, 1996). Some reports, however, have described prosopagnosic patients with intact face imagery (e.g., Bodamer, 1947; Pallis, 1955).

To further understand the relation between imagery and perception of faces, Cabeza and colleagues (Cabeza, Burton, Kelly, & Akamatsu, 1997) conducted a priming study with healthy participants. They found that imagined faces prime imagined faces and seen faces prime seen faces, but they found no priming between seen and imagined faces. This led the authors to favor a view that imagery and perception rely on partly distinct processes. However, it has to be noted that their perception and imagery conditions were not directly comparable. While they used a familiarity judgment as perception task, a speeded imagery test was used for the imagery task in which participants had to make judgments about the appearance of celebrities. The missing priming effect between seen and imagined faces may there-

DOI 10.1027/1618-3169.55.1.47

fore be a result of task inadequacy. Moreover, Cabeza et al. (1997) only analyzed response latencies because their design did not allow for any statement concerning accuracy. We will come back to this issue in the discussion section.

Taken together, a wealth of knowledge suggests that face imagery and face perception involve partly the same neural mechanisms (e.g., Farah et al., 1988; Ishai et al., 2002; Ishai et al., 2000; O'Craven & Kanwisher, 2000). However, it has to be pointed out that the number of studies on face perception and face imagery is not balanced; far more studies have investigated face perception. Many of these studies differentiate between processing of configural and featural face information (e.g., Bartlett, Searcy, & Abdi, 2003; Cabeza & Kato, 2000; Farah, Tanaka, & Drain, 1995; Farah, Wilson, Drain, & Tanaka, 1998; Schwaninger, Lobmaier, & Collishaw, 2002; Tanaka & Farah, 1993). Featural information is referred to the constituent elements of a face (i.e., eyes, nose, mouth) whereas configural information is understood as the spatial relationship between these parts. Many authors have provided evidence that featural and configural information can be activated independently to recognize faces (e.g., Bartlett et al., 2003; Schwaninger et al., 2002) and it has been suggested that configural information plays a dominant role in face perception, as faces were consistently better recognized on the basis of configural information (e.g., Cabeza & Kato, 2000; Diamond & Carey, 1986; Farah et al., 1995; Farah et al., 1998; Goffaux, Hault, Michel, Vuong, & Rossion, 2005; Leder & Carbon, 2006; Schwaninger et al., 2002; Tanaka & Farah, 1993).

Assuming that perception and mental imagery indeed share some common mechanisms, we pursued the aim to investigate whether in mental imagery of faces featural and configural information can be similarly dissociated. Indeed, Ishai and colleagues (Ishai et al., 2002) found differential activation when participants attended to the features or the whole of imagined faces. Specifically, they found increased activation in the right intraparietal sulcus (IPS) and inferior frontal gyrus (IFG) when participants focused on the features of the imagined face. This finding suggests that a separate neural mechanism processes featural information. While in perception configural information seems to play a predominant role, at least for familiar face recognition, this need not necessarily be the case in mental imagery. People asked to imagine a familiar face most likely describe the face by the features and not by configural characteristics. Much more likely they would mention the bushy eyebrows and the thin hair of the history teacher rather than the configural characteristics, such as his inter-eye distance is ≤ the distance between his mouth and eyes. However, when asked to verbally describe a mental image, people tend to characterize a visual mental image of a face as fuzzy or blurred, suggesting that people may not be able to activate in imagery precise representations of facial parts after all. Inspired by these anecdotic observations we designed this study to explore the representations people activate when they imagine a familiar face.

Specifically, we investigate featural and configural representations in mental imagery and compare them to the role they play in perception. We ascertain the importance of configural and featural representations in mental imagery and perception by testing face recognition by means of scrambled and blurred stimuli. By scrambling the constituent parts of a face, global configural information contained in the face is destroyed. By blurring a face the detail featural information contained in the parts is substantially reduced. These manipulations enable independent investigation of featural and configural information. We ascertained whether a mental image of a face facilitates featural or configural information, or both.

Method

Participants

Twenty-four healthy participants (12 male/12 female) ranging in age between 19 and 33 years (mean 25 years) took part in this experiment. Four participants reported to be left handed and all had normal or corrected to normal vision. All participants gave informed consent and were either paid for their participation or received course credits. The participants were treated according to the Declaration of Helsinki (1991).

Apparatus

The study was run on a 15.1-inch Pentium 4 portable Computer using Superlab Pro 2.0.2 running on Windows NT. The experiment took place in a quiet, dimly lit room. The participants were seated in a height-adjustable chair at a distance of 500 mm which was maintained by a headrest. They responded by using a Cedrus© Response Pad (RB-520). Each stimulus face appeared 95 mm wide and 125 mm high and thus subtended a visual angle of approximately 9.5° horizontally.

Stimuli

The stimuli were created from 50 photographs of faces taken at the University of Zurich. The photographs were taken frontally and the faces were of a neutral expression. All faces were scaled to a standard size of 300 pixels across the width of the face at pupil level. The stimuli were created from the same photographs which were manipulated as described in the following: The intact stimuli were cut out with an elliptic tool provided by Adobe Photoshop 7.0 using soft contours (5 pixel feather). Thus the outer features of the faces such as head shape and hair line were discarded and all the faces appeared at the same size and shape (296 × 385 pixels). The target stimuli were given five letter names (e.g., Peter), which were presented acoustically and

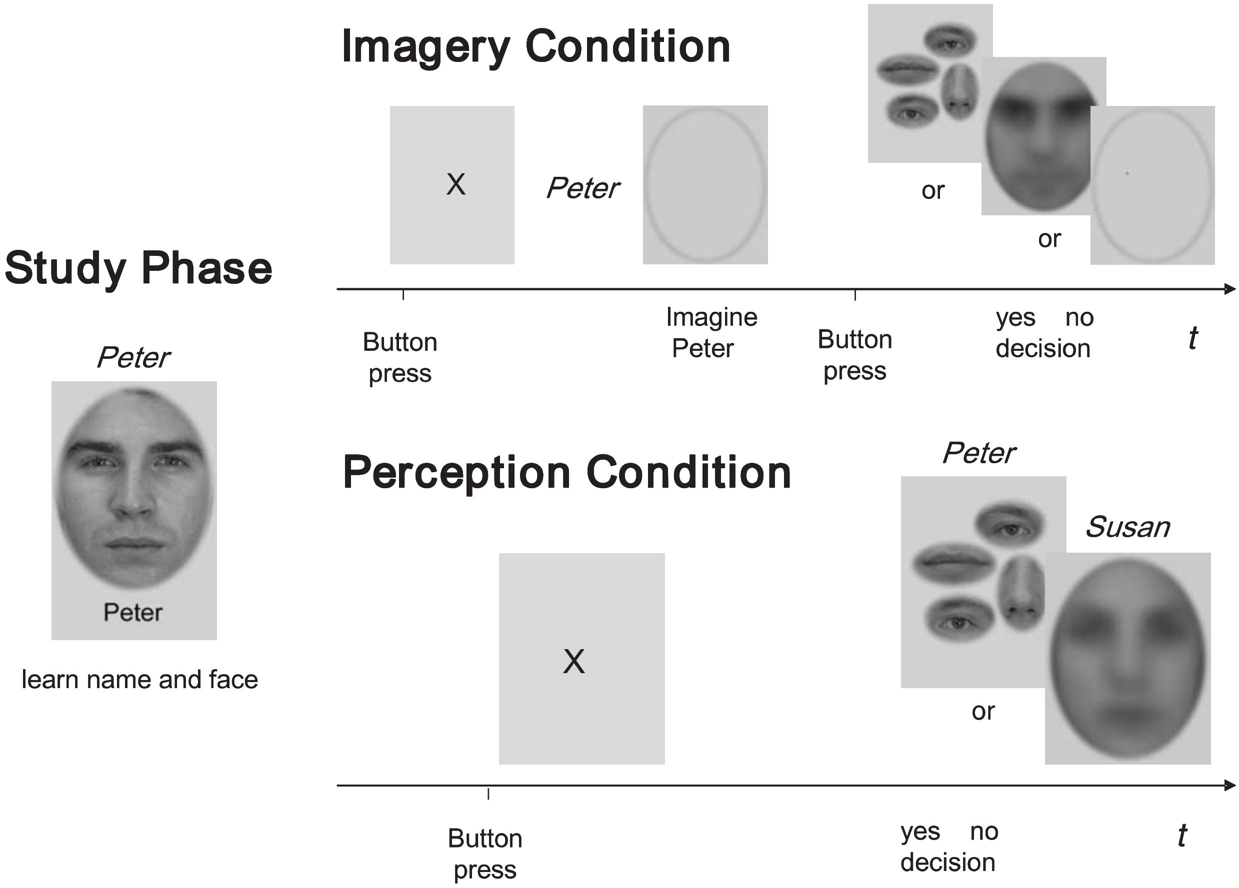

Figure 1. Examples of trials in the study phase, imagery and perception conditions. Italic words were presented acoustically. Intact and scrambled faces were presented in color.

visually during the study phase. The names were typed in bold letters below the face. The same ten faces were used as target faces throughout the experiment. Figure 1 shows an example of an intact stimulus.

The blurred stimuli were created in two steps. First, color information was discarded in the photographs. In a second step the faces were blurred using a Gaussian filter with a sigma of 0.025 of image width in frequency space, using the following equation $exp(-f^2/(2*sigma^2))$. This blurring manipulation is comparable to the manipulation used by Schwaninger et al. (2002) where the blur level which ideally reduces featural information was experimentally ascertained. Using the same elliptic tool as for the intact stimuli the outer features were discarded. Thus the blurred stimuli were the same size and shape as the intact stimuli. An example of a blurred stimulus is shown in Figure 1.

Scrambled stimuli were created from the intact faces in following steps. Eyes, mouth and nose were cut out with the elliptic tool described above (eyes: 131 × 95 pixels, mouth 160 × 82 pixels, nose 98 × 145 pixels). These features were placed on a grey background and scrambled in four different versions. Each version was arranged so that no part was situated in its natural relation to its neighboring part. The scrambled features were placed within the same area as the intact and blurred stimuli, so they subtended to the same visual angle. An example of a scrambled stimulus can be seen in Figure 1.

Task and Procedure

The participants were given written and oral instructions. Prior to the experiment they underwent a demonstration version of the experiment, which consisted of shortened versions of the blocks described below. None of the stimuli used in the demonstration trials appeared in the experiment proper. The experiment started with a learning block. Participants learned the names of ten target faces. Each face was successively presented together with a name (e.g., "Peter"). The name was presented acoustically via headphones and visually in bold letters below the face. Participants were told to precisely memorize the face with its name so that they can later form a mental image that matches the original as precisely as possible. Half of the target faces were female, the other half male. The face was visible until a button was pressed. Then the screen went blank during which the participants were told to hold on to the image. As soon as the mental image started to fade, participants pressed the button again and the face reappeared and participants could correct and consolidate their mental image. On another button press the face disappeared anew and a fixation cross appearing for 2 s signalized the appearance of the next target face. A minimum of two study phases were carried out.

To make sure that the participants learned the faces sufficiently, a naming task was carried out after the study phase. All target faces were presented subsequently and the participants had to name each face. If participants did not name all faces correctly a further study session was accomplished, until all ten faces were named correctly.

To further practice mental imagery of faces another training block was included (imagery practice block). In this block each trial started with a fixation cross appearing for 1 s. Then a name was presented via headphones together with an oval shape indicating the array in which the face was to be imagined. Participants were requested to visualize the appropriate face as vividly as possible and fit the mental image onto the oval array. By presenting the name acoustically we minimized the visual input which could have interfered with the imagery processes. When the mental image was generated participants pressed a button, which made a small dot appear within the oval shape. This dot was either at the exact location where eye, nose or mouth would appear or 1 cm lower or higher than the feature. The participants then had to decide whether or not this dot would appear on a facial feature (eyes, nose, mouth) of the imagined face. The participant could not foresee on or near which feature the dot will appear, thus they were prompted to activate an image of the whole face. As the locations of the dot were determined individually for each face, the task required a highly accurate and vivid visual mental image of each face. After each answer the appropriate face appeared together with the dot, thus the participants were given direct feedback on their answers. This feedback enabled the participants to correct their mental image if necessary.

The experiment proper consisted of an imagery block (imagery condition) and a perception block (perception condition), each comprising 40 trials (each 10 matching and mismatching blurred and scrambled trials). The order of these blocks was counterbalanced across participants. In the imagery condition a name was presented via earphones together with an oval shape indicating the array in which the face was to be imagined. Participants were requested to visualize the appropriate face as vividly as possible and fit the mental image onto the oval array. When the mental image was generated participants pressed a button upon which either a blurred or a scrambled face appeared for 1 s. In a yes/no decision task participants had to decide as quickly and as accurately as possible whether the scrambled or blurred face corresponded to the face they imagined (target face) or not (new distractor face). By pressing the center button of the response box participants could go on to the next trial. To control whether participants really mentally visualized the faces, ten tasks were included at random intervals where a dot appeared instead of a scrambled or blurred face, and participants had to decide whether or not the dot would appear on the location of the left or right eye, nose, or mouth, comparable to the imagery practice tasks.

In the perception condition a trial started with a fixation cross followed by a blurred or scrambled face. At the same time, a name was presented via headphones. The task was to decide as quickly and as accurately as possible whether the presented name belonged to the blurred or scrambled face. As in the imagery condition half of the trials were same and half were different. The experimental design is shown in Figure 1. In order to assess the general visual mental imagery abilities of participants, they completed the Vividness of Visual Imagery Questionnaire (VVIQ, Marks, 1973) after the experiment. The VVIQ consists of 16 situations and scenes for which the vividness of the mental image has to be rated on a scale from 1 to 5. Rating 1 indicated a mental image that is "perfectly clear and as vivid as normal vision," and rating 5 indicated "no image at all, you only 'know' that you are thinking of an objec.t" While Marks (1973) differentiated between imagery with "eyes closed" and with "eyes open," our participants accomplished the questionnaire in the "eyes open" condition only.

Results

Accuracy

The percentage of correctly matched faces was analyzed. In the imagery condition the mean hit rate was 88.3% for scrambled faces and 67.9% for blurred faces. In the perception condition the mean hit rate was 75.0% for scrambled faces and 69.6% for blurred faces. The mean hit rates are depicted in Figure 2. A 2 Task (imagery, perception) × 2 Information (scrambled, blurred) analysis of variance (ANOVA) of the hit rates revealed a significant effect of Information (scrambled, blurred), $F(1, 23) = 19.005$, $MSE = 0.021$, $p < .001$, $\eta^2 = .452$. There was no main effect of Task, $F(1, 23) = 1.766$, $MSE = 0.046$, $p = .197$, $\eta^2 = .071$, but Task and Information interacted, $F(1, 23) = 8.171$, $MSE = 0.017$, $p < .01$, $\eta^2 = .262$. Posthoc t tests (two-tailed) revealed that scrambled trials did not differ from blurred trials in the perception condition, $t = 1.389$, $p = .178$, but differed significantly in the imagery condition, $t = 5.086$, $p < .001$, $d = 1.04$. Furthermore, scrambled trials showed significantly higher hit rates in the imagery condition than in the perception condition, $t = 2.693$, $p < .05$, $d = .55$. The hit rates of blurred trials did not differ in the two conditions, $t = .316$, $p = .755$.

Reaction Times

Reaction times (RTs) that were 3000 ms or longer were treated as outliers and were not included in the analyses. Thus, less than 1.8% of the trials (a total of 17) in the im-

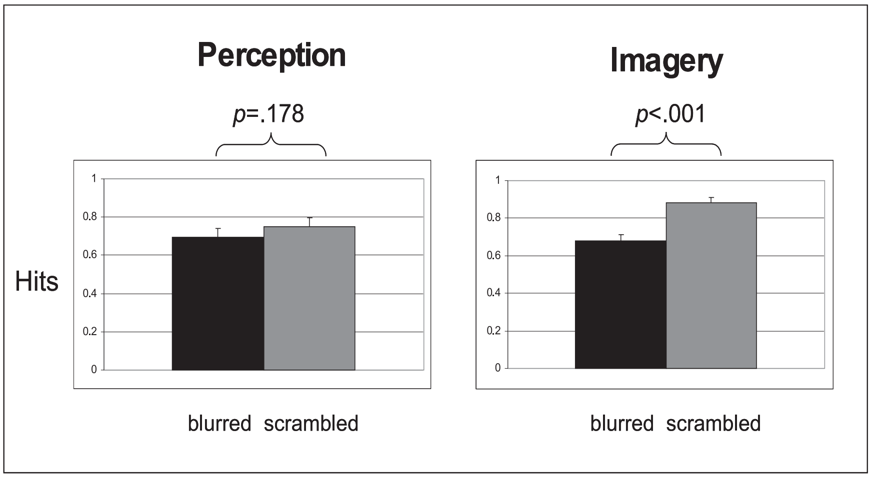

Figure 2. Mean d′ values for scrambled and blurred trials. Left panel = perception condition, right panel = imagery condition. Error bars depict standard errors of the mean (SEM).

agery condition were excluded and less than 1.9% of the trials (a total of 18) were excluded in the perception condition. Also, only RTs of correct answers were considered. In the imagery condition the mean RT was 1762 ms for blurred faces and 1721 ms for scrambled faces. In the perception condition the mean RT was 1739 ms for blurred faces and 1766 ms for scrambled faces. A 2 × 2 ANOVA of the RTs revealed no significant effects, neither for Task (imagery, perception), $F(1, 23) < 1$, $MSE = 120362$, $p = .878$, $\eta^2 = .001$, nor for Information (scrambled, blurred), $F(1, 23) < 1$, $MSE = 37546$, $p = .865$, $\eta^2 = .001$. There was no interaction of Task × Information. This finding suggests that there was no speed accuracy trade-off.

Control Condition

To ascertain whether participants were able to form a mental image of the test faces we calculated the d′ values of the control condition by subtracting the z-transformed false alarm rates from the z-transformed hit rates. The mean d′ value in the control condition of the experiment was 0.84 ($SEM = .35$). A one-sample t-test revealed that the d′ values differed significantly from 0, $T(23) = 2.413$, $p < .05$, indicating that participants performed above chance level. The control condition was designed specifically to assess participants' performance in accurately visualizing the faces.

Questionnaires

The mean VVIQ scores ranged from 1.56 (clear and reasonably vivid image) to 3.31 (moderately clear and vivid image). The VVIQ scores neither correlated with the d′ values of the control condition, $r(24) = .293$, $p = .165$, nor with the hit rates of the blurred imagery condition, $r(24) = .034$, $p = .875$. But the VVIQ scores correlated negatively with the hit rates of the scrambled imagery condition, $r(24) = -.449$, $p < .05$.

Discussion

The most important finding of this study was that face imagery led to higher recognition rates for scrambled than for blurred faces. The advantage we found for scrambled faces in the imagery condition suggests that top-down activation of faces predominantly facilitates featural processing. Mental imagery seems to activate featural more than configural representations. In the perception condition we found no difference between scrambled and blurred trials, which contrasts findings of most other authors who report an advantage for configural face processing. A difference between the present study and other studies using a similar paradigm (e.g., Collishaw & Hole, 2000; Schwaninger et al., 2002) lies in the slightly different stimulus material. Those studies used blurred faces where the outer features (i.e., hairline, face shape) was left intact, thus providing meaningful information which however is not clearly and exclusively configural. In the present study we discarded the external features, which may have made the blurred trials substantially more difficult. The fact that there was no difference between scrambled and blurred trials in the perception condition suggests that blurred and scrambled trials were equally difficult. However, when a face could be imagined beforehand, this had a facilitating effect on the processing of facial features.

Using introspection we may intuitively describe a mental image as blurred or fuzzy, as has accurately been described by Sartre in his important work *The Imaginary* (1940, trans. 2004). While trying to remember the face of his friend Pierre, Sartre finds that the face "is very imperfectly attained: some details are lacking (. . .) the whole is rather blurred" (p. 17). Only a photograph of Pierre can bring back to Sartre's memory the featural details of the face. In contrast to this phenomenological description our findings suggest that introspection may misguide us in the search of the true nature that underlies visual mental images. Scrambled faces were recognized more accurately than blurred faces, indicating that rather than a blurred image we in fact activate relatively detailed featural representations when we imagine a face.

In this study we were interested whether a mental image of a face differentially activated featural and configural information and compared the results from the imagery condition with those from the perception condition. Insofar, in both the imagery condition and the perception condition participants had to match a name of a learned face with a presented face, albeit in the imagery condition they generated a mental image of the face before answering. Interestingly, there was no main effect of task, neither for the hit rates nor for the RTs, suggesting no overall facilitation through imagery. However, the significant interaction of task and information indicates that mental images of faces do not activate configural representations as much as featural representations.

In contrast to Cabeza and colleagues (1997) we draw the conclusion that imagery can indeed enhance recognition of faces. But imagery essentially facilitates the processing of featural information: We found higher accuracy for scrambled faces in the imagery than in the perception condition. Blurred faces, however, were recognized equally well, whether or not a visual mental image of the face could be formed beforehand. Contrary to our study, Cabeza and colleagues did not differentiate between featural and configural representations. Had they included a task involving featural information, they might have found a priming effect of face imagery on face perception. Furthermore, their data analysis was restricted to response latencies. While the response times revealed no significant effects in the present study, response accuracy did. Finally, the tasks in the imagery and perception condition in Cabeza et al.'s study were inconsistent. In our study the tasks were the same with the only difference being the mental image of the face, which was generated before the face stimuli were visually presented.

It has to be noted, however, that almost 70% of the blurred trials in the imagery condition were correctly recognized. We therefore do not claim that imagery fails to activate configural representations, but argue that when asked to spontaneously form a mental visual image of a newly learned face people tend to activate featural more than configural information. Had participants been asked to specifically activate configural representations of a face (e.g., whose eyes are closer together, Peter's or David's) it is possible that configural representations could play a more important role.

Because the target stimuli were based on the same 10 photographs, it is conceivable that the advantage found for the scrambled trials in the imagery condition is attributable to picture processing rather than face processing. If so, the stimuli in the perception condition would be expected to show the same effect. This however, was not the case. It could clearly be demonstrated with the present study that imagery has a differential effect on featural and configural information.

The present results can be interpreted in favor of a dual-mode view, where featural and configural processing can be differentiated in mental imagery. This goes along with findings revealed by means of neuroimaging (Ishai et al., 2002). Moreover, the difference between featural and configural processing in face imagery may help to better understand inconsistent reports of prosopagnosic patients. Some people with prosopagnosia report no difficulties in forming mental images of faces they know (e.g., Bodamer, 1947; Pallis, 1955), while others report a disability to mentally visualize faces (e.g., Charcot & Bernard, 1883; Young et al., 1994). It may be possible that in the former group of patients the lesion affects only perception-driven activation of face representations while a top-down activation of featural representations is still possible. In the latter group, however, it is possible that top-down and perception-driven activation of face representations are equally affected by the lesion. It will have to be the issue of future brain-imaging studies with patients suffering from prosopagnosia with or without impaired imagery abilities to substantiate this proposition.

Another interesting issue is to discuss our findings against the background of studies on the verbal overshadowing effect. The term verbal overshadowing effect describes the phenomenon that people recognized faces less accurately when they previously described the face verbally (Dodson, Johnson, & Schooler, 1997; Schooler & Engstler-Schooler, 1990). Macrae and Lewis (2002) found that when participants adopt a local processing strategy (i.e., pay more attention to featural information), recognition of newly learned faces is impaired. Their finding suggests that not the verbal description per se hampers later recognition of faces, but the processing strategy adopted when describing a face. Describing a face verbally activates a local processing strategy, as faces are most often described by the features. Our findings suggest that, similar to verbal description, a mental image of a face will also activate featural representations. These findings could therefore have practical implications for criminal investigations when trying to find an offender based on the descriptions of eye witnesses. Because mental imagery of a face seems to mainly activate featural information, it will be the features that come to mind when witnesses are asked to remember the face of the person they saw committing a crime. Photofit pictures used by the police meet these concerns, as the faces are built up from different face parts. However, the verbal overshadowing effect suggests that an activation of the features later leads to impaired recognition of the whole face. Taking the findings of Macrae and Lewis together with our findings suggests that forensic psychologists have to be careful about the accuracy of the descriptions of witnesses and their ability to recognize the offender in a later line-up.

In conclusion, we found that although featural and configural processes can be separately activated in both mental imagery and perception, mental imagery seems to particularly activate featural representations. While performance in configural and featural trials was comparable in the perception condition, the importance of featural information was higher in face imagery. This suggests that featural and configural representations are separately formed by extracting featural and configural information from the primary visual input. When a perceived face has to be recognized, these representations are activated bottom-up, but they can also be activated top-down via visual mental imagery. The present data suggest that mental imagery seems to activate featural representations more accurately than configural representations. This assumption is further underlined by the correlation of the VVIQ scores and the hit rates of the scrambled imagery condition. The better the imagery abilities, as assessed with the VVIQ, the higher hit rates were for scrambled faces in the imagery condition. In perception featural and configural representations played an equal role.

Acknowledgments

This research was supported by a grant from the Swiss National Science Foundation (project No. 611–066052) awarded to FM.

References

Bartlett, J.C., Searcy, J., & Abdi, H. (2003). What are the routes to face recognition? In M.A. Petersen & G. Rhodes (Eds.), *Perception of faces, objects, and scenes* (pp. 21–52). New York: Oxford University Press.

Bodamer, J. (1947). Die Prosop-Agnosie [Prosop-agnosia]. *Archiv für Psychiatrie und Nervenkrankheit, 179*, 6–53.

Cabeza, R., Burton, A.M., Kelly, S.W., & Akamatsu, S. (1997). Investigating the relation between imagery and perception: Evidence from face priming. *Quarterly Journal of Experimental Psychology A, 50*, 274–289.

Cabeza, R., & Kato, T. (2000). Features are also important: Contributions of featural and configural processing to face recognition. *Psychological Science, 11*, 429–433.

Charcot, J.-M., & Bernard, D. (1883). Un cas de suppression brusque et isolée de la vision mentale des signes et des objets (formes et couleurs) [A case of sudden and isolated suppression of conscious visual perception of signs and objects (shape and color)]. *Le Progrès Médical, 11*, 568–571.

Collishaw, S.M., & Hole, G.J. (2000). Featural and configurational processes in the recognition of faces of different familiarity. *Perception, 29*, 893–909.

Diamond, R., & Carey, S. (1986). Why faces are and are not special: An effect of expertise. *Journal of Experimental Psychology: General, 115*, 107–117.

Dodson, C.S., Johnson, M.K., & Schooler, J.W. (1997). The verbal overshadowing effect: Why descriptions impair face recognition. *Memory and Cognition, 25*, 129–139.

Farah, M.J., Peronnet, F., Gonon, M.A., & Giard, M.H. (1988). Electrophysiological evidence for a shared representational medium for visual images and visual percepts. *Journal of Experimental Psychology: General, 117*, 248–257.

Farah, M.J., Tanaka, J.W., & Drain, H.M. (1995). What causes the face inversion effect? *Journal of Experimental Psychology: Human Perception and Performance, 21*, 628–634.

Farah, M.J., Wilson, K.D., Drain, M., & Tanaka, J.N. (1998). What is "special" about face perception? *Psychological Review, 105*, 482–498.

Goffaux, V., Hault, B., Michel, C., Vuong, Q.C., & Rossion, B. (2005). The respective role of low and high spatial frequencies in supporting configural and featural processing of faces. *Perception, 34*, 77–86.

Ishai, A., Haxby, J.V., & Ungerleider, L.G. (2002). Visual imagery of famous faces: Effects of memory and attention revealed by fMRI. *Neuroimage, 17*, 1729–1741.

Ishai, A., Ungerleider, L.G., & Haxby, J.V. (2000). Distributed neural systems for the generation of visual images. *Neuron, 28*, 979–990.

Leder, H., & Carbon, C.-C. (2006). Face-specific configural processing of relational information. *British Journal of Psychology, 97*, 19–29.

Macrae, C.N., & Lewis, H.L. (2002). Do I know you? Processing orientation and face recognition. *Psychological Science, 13*, 194–196.

Marks, D.F. (1973). Visual imagery differences in the recall of pictures. *British Journal of Psychology, 64*, 17–24.

Mast, F.W., & Kosslyn, S.M. (2002). Visual mental images can be ambiguous: Insights from individual differences in spatial transformation abilities. *Cognition, 86*, 57–70.

Mechelli, A., Price, C.J., Friston, K.J., & Ishai, A. (2004). Where bottom-up meets top-down: Neuronal interactions during perception and imagery. *Cerebral Cortex, 14*, 1256–1265.

O'Craven, K.M., & Kanwisher, N. (2000). Mental imagery of faces and places activates corresponding stimulus-specific brain regions. *Journal of Cognitive Neuroscience, 12*, 1013–1023.

Pallis, C.A. (1955). Impaired identification of faces and places with agnosia for colors: Report of a case due to cerebral embolism. *Journal of Neurology, Neurosurgery, and Psychiatry, 18*, 218–224.

Sartre, J.-P., (2004). *The imaginary*. (J. Webber, Trans.). London: Routledge. (Original work published 1940).

Schooler, J.W., & Engstler-Schooler, T.Y. (1990). Verbal overshadowing of visual memories: Some things are better left unsaid. *Cognitive Psychology, 22*, 36–71.

Schwaninger, A., Lobmaier, J.S., & Collishaw, S.M. (2002). Role of featural and configural information in familiar and unfamiliar face recognition. *Lecture Notes in Computer Sciences, 2525*, 634–650.

Tanaka, J.W., & Farah, M.J. (1993). Parts and wholes in face recognition. *Quarterly Journal of Experimental Psychology A, 46*, 225–245.

Young, A.W., Humphreys, G.W., Riddoch, M.J., Hellawell, D.J., & de Haan, E.H. (1994). Recognition impairments and face imagery. *Neuropsychologia, 32*, 693–702.

Young, A.W., & Van De Wal, C. (1996). Charcot's case of impaired imagery. In C. Code, C.-W. Wallesch, A.R. Lecours, & Y. Jeanette (Eds.), *Classic cases in neuropsychology* (pp. 31–44). Hove, UK: Erlbaum.

Received June 26, 2006
Revision received November 2, 2006
Accepted November 3, 2006

Fred Mast

Université de Lausanne
Institut de Psychologie, Bâtiment Anthropole
CH-1015 Lausanne
Switzerland
Tel. +41 21 692 32 51
Fax +41 21 692 32 65
E-mail fred.mast@unil.ch