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Preference for normal, reversed or chimeric self-faces with neutral emotional expression in patients with schizophrenia and control subjects

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Abstract

OBJECTIVES: Self-face recognition is one of the most distinctive features in human beings. Disturbances of self-face recognition in people with schizophrenia may reflect the underlying neurobiological and psychological factors of the disorder. Our aim was to establish whether differences in preference for the similarity to the true self-face appearance could be found between patients with schizophrenia and a matched control group.

SUBJECTS AND METHODS: 14 right-handed patients with schizophrenia and 14 control subjects were enrolled. Subjects were photographed, the pictures were converted to black and white, halved vertically, and four faces were used: normal face (NF), mirrored face (MF), face composed from two left halves of the face (LLF) and from two right halves of face (RRF). Four pairs of faces were exposed to subjects and they chose which they felt was closest to their true appearance.

RESULTS: No significant differences for preference were found between the patients and control subjects. Post-hoc analysis of the pooled groups showed a significant difference for preference of NF vs. RRF (20 vs. 8 probands; χ^2=5.14, df=1, p<0.05). 18 subjects from the two groups did not change the right-left visual field focus through all four exposures.

CONCLUSIONS: The absence of significant differences for preference for true self-image between schizophrenia patients and control subjects might show that self-face recognition is of little importance from the evolutionary perspective. Additional measurements such as eye-tracking control and random multiple projections of the same pairs of faces would contribute to a more thorough interpretation of the findings in future studies of similar design.

ORIGINAL ARTICLE

INTRODUCTION

Face recognition is considered to be a higher neurocognitive function with immense impact on social communication and relationships. The face is the most distinctive feature of the body, and self-face recognition is thought to be an index of self-awareness (Uddin *et al.* 2005). Mirror self-recognition is not specific to humans: it is also present in apes, dolphins and Asian elephants (Gallup 1970; Plotnik *et al.* 2006).

Several symptoms and syndromes primarily characterized by disturbances in face recognition have been described. Prosopagnosia is a disorder where sufferers are unable to visually recognize familiarity of the face of persons known from previous contact or experience, although they are able to distinguish them by other characteristics, such as voice (Galdo Alvarez *et al.* 2009). The mirror sign (*le signe de miroir*) is the symptom characterized by perception of the change in face when looking in a mirror. A significantly higher tendency to see distortion of one's own face after gazing at a mirror in a low-illumination environment has been reported in patients with schizophrenia (Caputo *et al.* 2012). In Capgras syndrome (delusional misidentification), patients see identical-looking impostors in persons they know, and often know well. In Fregoli syndrome, the familiar persons are seen as strangers (Feinberg & Keenan 2005; Corlett *et al.* 2010).

Asymmetry in a face configuration and asymmetry in the neuronal processing of the face perception process are both important features and are topics of research. Left-biased asymmetry in the perception of faces has been attributed to the asymmetrical expression of individuality of the person by left and right halves of the face (Kowner 1995), and later by the concept of dominance of the right hemisphere in the processing of faces in right-handed persons (Brady *et al.* 2004; Gilbert & Bakan 1973; Phillips & David 1997). Several brain structures and circuits involved in normal and disturbed recognition of faces have been identified, with particular importance of the fusiform face area (Kanwisher *et al.* 1997; Rapcsak & Kaszniak 2000; Yovel *et al.* 2008). Right hemisphere dominance is not fully accepted. Studies in patients with commissurotomy (split brain) strongly suggested that human subjectivity and ability to recognize faces and facial emotional expression involve both hemispheres (Sperry *et al.* 1979; Stone *et al.* 1996). After an extensive analysis of published data, Gainotti & Marra (2011) proposed different centers in the left and right hemisphere that corresponded with specific disturbances in face recognition and naming.

The existence of neuronal circuits specifically processing self-face recognition has been discussed (Keenan *et al.* 2003). The tripartite model was proposed for identification of areas involved in self-face recognition. At the low level, the left fusiform gyrus is predominantly involved as the detector of stimulus. On a second level, the information on the self is passed through the right precuneus, and on the third level, identity discrimination analysis and analysis of mental attribution of the face stimuli are processed in higher cortical substrates (Platek *et al.* 2008). The mirror neurons system in the right hemisphere might also contribute to the ability to differentiate between self-face pictures and face pictures of others (Uddin *et al.* 2005). Remembering the self-appearance seems to be a dynamic process. Different neural circuits and different cognitive processes are involved in recognition of the current appearance and past self-face appearance remembered from a younger age (Apps *et al.* 2012).

The chimeric face technique has been used in research for analysis of different aspects of face perception since the beginning of twentieth century. It was introduced by Hallenvorden in 1902 and later became known as "Wolff's split-face technique" after a study published in 1933. Wolff described the right hemi-face as showing vitality and individual aspects of personality, whereas the left side of face is more passive and represents unconscious and collective characteristics (cited from Kowner 1995). Different types of chimera have been used in research. An artificial portrait can consists of two left-sides or two right-sides of an original self-portrait (Mita *et al.* 1977) or a different familiar, publicly known, or unfamiliar face, or with different emotional expressions (Gooding *et al.* 2001; Lahera *et al.* 2014) or may be male or female (Butler & Harvey 2005). Newer morphing technology consists of merging different faces with smooth transitions from one to the other (Uddin *et al.* 2005; Heinisch *et al.* 2013;).

Schizophrenia has recently been conceptualized as a neurodevelopmental disorder (Rapoport *et al.* 2012) with several symptom domains including cognitive deficits as essential factors correlated with functional outcome (Keefe 2008). Social cognition deficits present in schizophrenia are related to non-social cognition, but have a different neurobiological basis (Mancuso *et al.* 2011). Disorders of self-recognition and recognition of others may be a result of combination of different neuropathological and psychological factors with subsequent disruption of integration of the intero-self system with the external environment (Feinberg 2013). The impairment in facial processing found in people with schizophrenia may also be part of the underlying neurobiological and psychological factors involved in this disorder (Phillips & David 1995; Feinberg 2013; Heinisch *et al.* 2013).

Aim of the study

The aim of this study was to compare preference of similarity to real appearance using exposure to pairs of self-face pictures consisting of unchanged, reversed and half-side chimeric compositions in patients with schizophrenia and a control group. Differences between the groups were expected, with a more consistent preference in the control group.

METHODS

Subjects

Patients with a diagnosis of schizophrenia hospitalized in the department of psychiatry or attending the day-care center affiliated with the department were enrolled. In hospitalized patients, study procedures were arranged in stabilized status in the week of planned discharge from hospital. All patients signed an informed consent form after being informed of the aims of the study, and being assured that personal data would be kept confidential and that the pictures for the study would not be used publicly. The study was approved by institutional ethics committee. Control subjects were chosen with the aim of matching the subjects with the schizophrenia patients by age and gender as closely as possible. The absence of mental disorders in the control subjects was derived from an informal interview to collect information on their medical history.

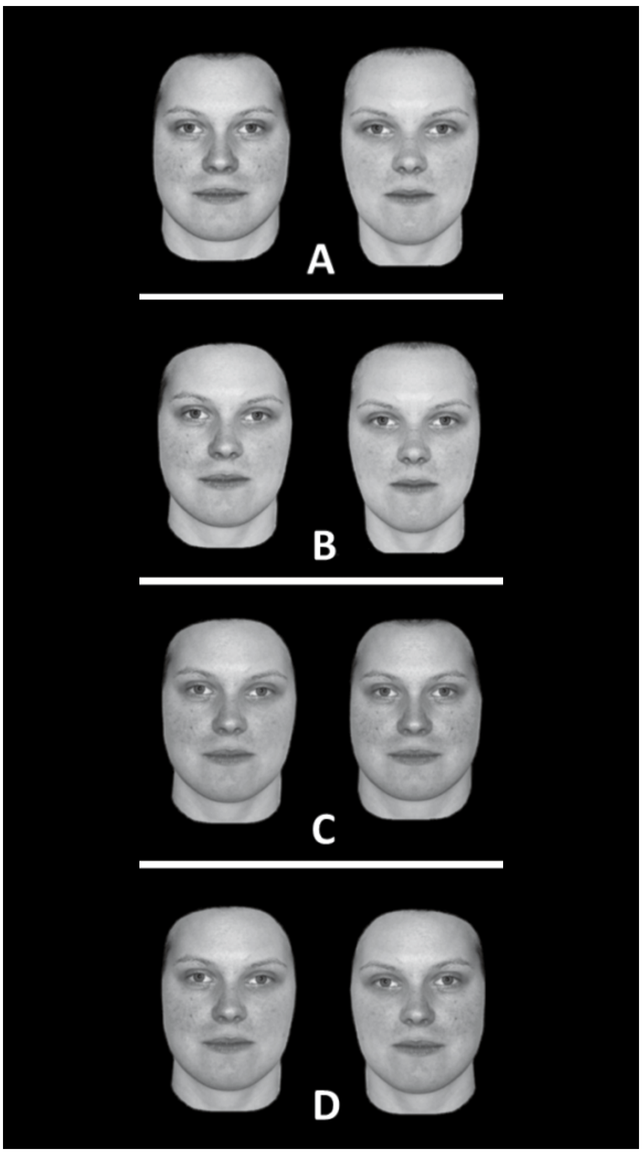

Fig. 1. Pairs of projected faces*. **A** = chimeric right/right halves face (RRF, left) vs. chimeric left/left halves face (LLF, right); **B** = normal face (NF, left) vs. chimeric left/left halves face (LLF, right); **C** = normal face (NF, left) vs. chimeric right/right halves face (RRF, right); **D** = normal face (NF, left) vs. mirrored face (MF, right); *RR, a subject from the control group, gave permission to use these pictures.

Procedures

Subjects were asked to maintain a neutral facial expression and were photographed in a standardized sitting position (camera: SMC Pentax DAL). The quality of the pictures was immediately checked on screen. The best picture was chosen for further processing. Using Microsoft Office software, the pictures were transformed to the black-and-white scale and halved down a line passing through the tip of the nose and glabella. Four face types were created: normal face (NF), mirrored face (MF), face combined from two left halves of face (LLF) and face combined from two right halves of face (RRF). To minimize orientation in chimeric pictures by external clues such as hairstyle or shadows, a black mask was applied around the face (Figure 1). On the second day after taking the pictures, four pairs of faces were presented to the subjects on a 15.6 inch laptop screen: RRF/LLF; NF/LLF; NF/RRF and NF/MF. The sequence of exposure to pairs of pictures was chosen by the level of distraction from normal self-image, starting with two chimeric faces and ending with two faces without chimeric falsification. Exposure started with a black screen and subjects were instructed that they would see two pictures for 5 seconds and then decide which was closest to their real appearance. The decision could be made during the 5 seconds of exposure or afterwards when the screen was black again. Before subsequent exposure, subjects were asked if they were ready to make the next decision.

SPSS 15 software was employed for statistical analyses. Data were analyzed using the nonparametric chi-square test for categorical data and the null hypotheses of sameness of preference for exposures of four pairs of faces were tested. Fisher's exact test with Yates' continuity correction was applied when the expected counts were less than 5. Differences were considered to be significant when p-values were less than 0.05.

RESULTS

14 right-handed patients with a diagnosis of schizophrenia (10 men, 4 women; mean age 35.8 years) and 14 right-handed control subjects (9 men, 5 women; mean age 33.4 years) were enrolled. In the schizophrenia group, the median duration of disorder was 8 years with a range of 1 to 36 years. Six patients had graduate university education or they attended university for some period of time, nine patients received disability support pension and seven patients were either full or part-time employed. All patients were treated with antipsychotics in monotherapy or combination with preponderance of atypical antipsychotics. Valproate,

benzodiazepines, non-benzodiazepine hypnotics or dibenzepin were used as co-medication. All patients and controls subjects cooperated fully and had no problems with understanding instructions.

Tab. 1. Frequency of preference of normal, chimeric or mirrored face from the pairs of faces exposed.

Pair of faces/ preference	RRF vs. LLF		NF vs. LLF		NF vs. RRF		NF vs. MF	
	RRF	LLF	NF	LLF	NF	RRF	NF	MF
Patients (n=14)	6	8	8	6	10	4	5	9
Controls (n=14)	7	7	9	5	10	4	5	9
Total (n=28)	13	15	17	11	20	8	10	18
p-value	0.705		0.699		1.000 *		1.000 *	

* Fisher's exact test; Abbreviations: NF – normal face; LLF – chimeric face composed from two left halves; MF – mirrored (horizontally reversed) face; RRF – chimeric face composed from two right halves

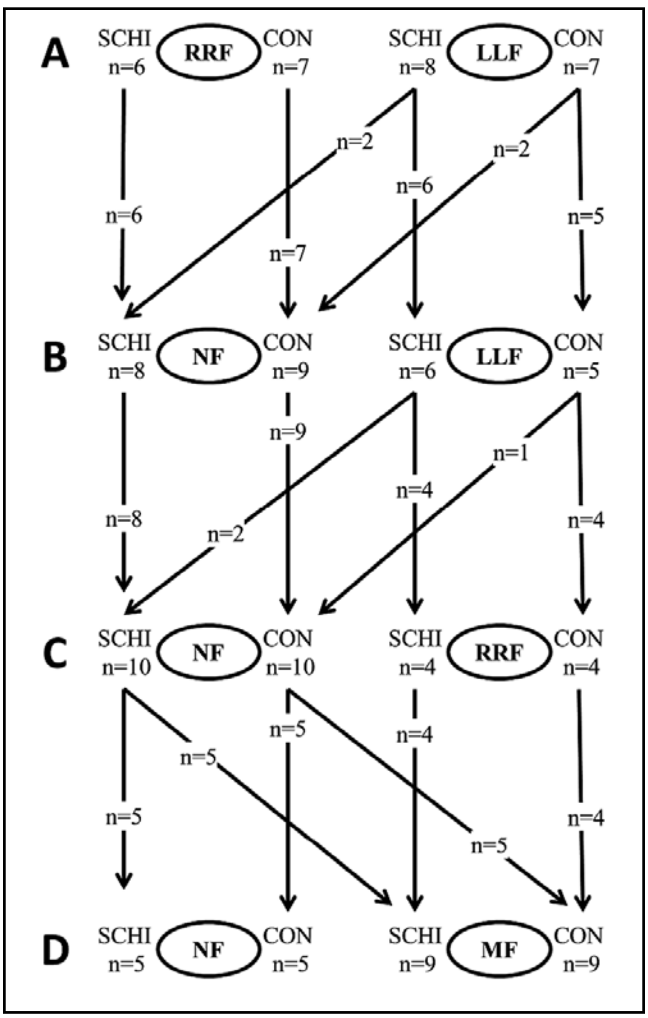

Fig. 2. Flow of choices from first to fourth exposure of pairs of faces. Abbreviations: SCHI – schizophrenia patients; CON – control subjects; NF – normal face; LLF – chimeric face from two left halves; MF – mirrored (horizontally reversed) face; RRF – chimeric face from two right halves. **A** – 1st choice of RRF vs. LLF pair of faces; **B** – 2nd choice of NF vs. LLF pair of faces; **C** – 3rd choice of NF vs. RRF pair of faces; **D** – 4th choice of NF vs. MF pair of faces.

The preferences for the pairs of faces exposed to patients with schizophrenia and control subjects are shown in Table 1.

No significant differences for the preference for any face from four pairs of faces were found between patients with schizophrenia and control subjects. In a post-hoc analysis with both groups pooled, the only significant difference found was for preference of normal face vs. chimeric face composed from right halves (NF vs. RRF;20 vs. 8 probands; χ^2=5.14; df=1; p=0.023). A numerically apparent but not statistically significant difference was found for the preference of mirrored face vs. normal face (NF vs. MF) with the same direction of preference for mirrored faces in both groups.

The flow of choices from the first to the fourth exposure to pairs of faces is shown in Figure 2. After the choice for the first exposure, there was a shift of 4 subjects (2 subjects from each group) to the left visual field for the normal face (NF); the same direction of shift was observed between the second and third exposures (2 patients and 1 control subject). Between the third and the fourth exposures, 10 subjects (5 from each group) changed preference to the right visual field where the mirrored face (MF) was projected. Analysis for change of visual field for all 4 exposures showed that 18 subjects did not change the visual field. 10 subjects (5 from each group) always chose the face in the left visual field, and 8 (4 from each group) always chose the face in the right visual field as the preferred face.

DISCUSSION AND LIMITATIONS

Using the pictures with neutral emotional expressions, we found no significant differences in preference for self-image from exposure of normal, reversed or chimeric faces between subjects with schizophrenia and control subjects. We expected a higher preference – at least in the control group – for the composite pictures made from the left side of the faces. This assumption was not confirmed for the first (RRF vs. LLF) or second (NF vs. LLF) exposures, but there was a clear preference for the NF vs. RRF for the third exposure, and a numerical tendency was found for preference of the reversed face vs. normal face in the fourth exposure, with a substantial shift of visual field in both groups of participants between the third and fourth exposures. The preference for a mirrored picture of the self-face has been tested and verified, as the self-image is remembered from the mirror reflection where the left side of the face is in the left visual field (Mita *et al.* 1977; Brady *et al.* 2004). Knowing one's own face from the mirror is not based merely on visual information, but also on multisensory tactile, motor and visual sensoric cues (Tsakiris 2008). Non-congruity between the preference in the first exposure (no expected preference of LLF vs. RRF) and the fourth exposure (marked shift to the MF vs. NF) may be due to a change in the way the self-image is remembered. Availability of digital technology has considerably changed the traditional visual principles of portraying the face, as is shown by the explosion of "selfies" (Bruno *et al.* 2014). Widespread availability of self-pictures from new imaging technology might confuse the previously remembered picture of the self-face from the mirror reflection. An example of possible confusion is using a front camera when taking a "selfie" as some devices show the final picture as the mirror reflection, while other devices have programs with pre-set automatic reversal of the picture to "normal" orientation.

Chimeric pictures may be associated with problems due to the technique used to create them. In our study, the pictures were made from real photographs of subjects with minimization of confounding technical cues such as hairstyle and shadows, and no visible mid-line. This ensured greater ecological validity of the study (Butler & Harvey 2005; Kowner 1995).

Our exposure period of 5 seconds was the same as in other studies (Phillips & David 1997). A 5-second period should allow participants to apply the visual focus to both pictures presented. But 18 subjects in this study did not change visual field for their choice of preferred face through all four exposures. This casts doubt upon the plausibility of our results, with the possibility that the left-right visual field focus was a more important factor than the appearance of the faces. Taking only visual field preference into account, 51.8% (patients) and 55.4% (control subjects) of choices were for faces placed in the left visual field. The preference of the left visual field was expected, as all subjects were left to right script readers, which may increase left visual field selection (Butler & Harvey 2006). The problem of confusion of results because of an interaction between gaze inclination (Kircher *et al.* 2007; Samson *et al.* 2014) and preference for a particular face may be solved by assessing eye-tracking or analyzing multiple random projections of the same pairs of faces with alternate left-right assignment. Vertical arrangement of the pairs of pictures could also be used, although top-down versus bottom-up dichotomy visual selection bias has also been suggested (Awh *et al.* 2012).

The main limitation of the study is the small number of participants. However, our results showed that almost half of the subjects had split preferences for both chimeric faces in both groups in the first exposure (RRF vs. LLF) when preference for LLF was supposed. Moreover, in the subsequent three exposures, the numerical direction of preference and shifts from previous exposures were the same in both groups.

It is unlikely that performing our investigations in patients in a stabilized phase of the disorder influenced our results because deficits in face recognition in schizophrenia are considered to be a trait-marker (Streit *et al.* 1997).

Pictures of the self-face with neutral emotional expressions may not be a robust enough basis to discover differences in face recognition between patients with schizophrenia and control subjects. A study comparing reaction time for recognition of self-face, faces of publicly know persons, and unknown persons revealed that self-face recognition in patients with schizophrenia is preserved (Lee *et al.* 2007). Using a design with different stimuli consisting of emotional expressions on faces, however, showed that patients with schizophrenia had significantly more difficulty in recognizing emotional expression in unfamiliar and familiar faces (Kucharska-Pietura *et al.* 2002; Lahera *et al.* 2014; Mandal *et al.* 1998). Gooding *et al.* (2001) found differences between patients with schizophrenia and control subjects in left perceptual bias only in recognizing chimeras with emotional expressions, but not for gender or non-face chimeras.

Our results might underline the questions about the plausibility of the general concept of self-face recognition as an independent function from media (mirror, photography, digital media) and context-independency (Suddendorf & Butler 2013). Psychosis and schizophrenia are a disadvantageous by-product of evolution with involvement of genes with a critical effect on social brain evolution and language (Crow 2000; Burns 2006) and self-face recognition may not be a distinctive part of this process from the evolutionary perspective. Although self-face recognition in a smooth water surface is probably as old as the human race, the historical use of non-glass mirrors was closely connected with magic, and the glass mirror industry did not start until the end of 17th Century (Pendergrast 2003). Before the widespread availability of glass mirrors and later photography, the awareness of the self-face image was far less trivial than it now seems to be. This is obvious from the legend of Narcissus and the threat and fascination of tribal people when seeing their own faces for the first time in a mirror (Carpenter 1976, cited by Rochat & Zahavi 2011).

CONCLUSIONS

No significant differences in preference for self-face images with a neutral emotional expression were found between patients with schizophrenia and a control group exposed to pairs of normal, mirrored and chimeric pictures with left and right halves. There was a tendency to preference of the left side of the face. When the two groups were merged, the only significant difference found was for preference of normal face vs. chimeric face composed from right halves.

Because schizophrenia is a complex disorder with demonstrated deficits in self-awareness and social cognition, the negative results of our study may be a sign of the low significance of self-face recognition with neutral emotional expression within the spectrum of cognitive deficits associated with schizophrenia.

Additional measurements such as eye-tracking control and random multiple projections of the same pairs of faces in different left-right visual field configurations would contribute to a more thorough interpretation of the findings in future studies of similar design.

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JP was the initiator of the study. BK performed technical groundwork and experiments. MT participated in the statistical analysis and interpretation of the data. All co-authors participated in the preparation and revision of the manuscript. Authors have no conflict of interest to declare. Language revision of the text was done by A Reeves of ASCRIBE, Wiesbaden, Germany.

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